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IMPERFECT MOBILITY OF LABOR ACROSS SECTORS AND FISCAL TRANSMISSION*

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Abstract

This paper develops a two-sector open economy model with imperfect mobility of labor across sectors in order to account for time-series evidence on the aggregate and sectoral effects of a government spending shock. Using a panel of sixteen OECD countries over the period 1970-2007, our VAR evidence shows that a rise in government consumption i) increases hours worked and GDP and produces a simultaneous decline in investment and the current account, ii) increases non traded output relative to GDP and thus its output share (in real terms) and lowers the output share of tradables, and iii) causes both the relative price and the relative wage of non tradables to appreciate. While the second set of findings reveals that the government spending shock is biased toward non tradables and triggers a shift of resources for this sector, the third finding indicates the presence of labor mobility costs, thus preventing wage equalization across sectors. Turning to cross-country differences, empirically we detect a positive relationship between the magnitude of impact responses of sectoral output shares and the degree of labor mobility across sectors. Our quantitative analysis shows that our empirical findings for aggregate and sectoral variables can be rationalized as long as we allow for a difficulty in reallocating labor across sectors along with adjustment costs to capital accumulation. Finally, the model is able to generate a cross-country relationship between the degree of labor mobility and the responses of sectoral output shares which is similar to that in the data.

Keywords: Fiscal policy; Labor mobility; Investment; Relative price of non tradables; Sectoral wages.
JEL Classification: E22; E62; F11; F41; J31.

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1 Introduction

Does a government spending shock affect the production sectors of an open economy uniformly? If not, how can we explain the heterogeneity in the sectoral effects of a rise in government consumption? Does the magnitude of the sectoral effects vary across countries and what factors cause such differences? Our paper provides an attempt to answer these questions by exploring empirically both the aggregate and the sectoral impacts of a government spending shock and calibrating an open economy version of the neoclassical model with tradables and non tradables. We find that the model is successful in replicating the evidence on the sectoral and aggregate effects of fiscal policy once we allow for imperfect mobility of labor across sectors along with capital installation costs. While these two features change the predictions of the model in a way that makes them consistent with our empirical findings on fiscal policy transmission, we find that the degree of labor mobility across sectors varies substantially across countries and is key to generating cross-country differences in the sectoral impact of a government spending shock.

Following the empirical work pioneered by Blanchard and Perotti [2002] on the identification of fiscal shocks in a VAR model, fiscal policy transmission has attracted considerable attention in the literature which has focused mainly on two issues. The first is the positive response of consumption to a rise in government spending, as exemplified in the papers by Gali, Lopez-Salido, and Vallès [2007], and Bilbiie [2011]. The second is related to factors determining the size of the aggregate fiscal multiplier. The theoretical study by Christiano, Eichenbaum, Rebelo [2011] shows that the fiscal multiplier is less than one in the neoclassical model, greater than one in a New-Keynesian model, as much as three times greater when the zero lower bound on the nominal interest binds. Despite the revival of interest in the fiscal policy tool and the vast existing literature on this subject, we believe that there is still a need to improve our understanding of fiscal transmission as the sectoral impact of fiscal shocks has received little attention in the literature.

The motivation for the analysis of the sectoral effects of a rise in government consumption is based on our panel VAR evidence which highlights two major findings. First, a government spending shock has a strong expansionary effect on hours worked and output in the non traded sector while the traded sector experiences a decline in hours worked and output. Moreover, non traded output increases relative to GDP (in real terms), thus raising the output share of non tradables while at the same time the output share of tradables falls. These findings suggest that the rise in government consumption is biased toward non traded goods and triggers a reallocation of resources toward this sector. Second, the extent of the positive impact on the share of non tradables and the size of the contraction in the share of tradables display a wide dispersion across OECD economies. In our paper, we propose an interpretation of cross-country differences in the magnitude of the sectoral impact of a government spending shock based on international differences in the degree of labor mobility across sectors.

In this regard, our study can be viewed as complementary to three papers which contrast the effects of fiscal policy on output across a number of country characteristics. Using a panel of 44 industrialized and developing countries, Ilzetzki, Mendoza, and Vegh [2013] find that fiscal multipliers increase with the level of development, decrease with the level of public debt, and are lower in countries which are more open to international trade, or operating under flexible exchange rate regimes. The last of these findings has been further explored by Born, Juessen and Müller [2013] who shed some light empirically on the fiscal transmission underlying this result and show that a New Keynesian small open economy model can account for the diversity of the size of government spending multipliers across exchange rate regimes. A third noteworthy work is the paper by Brinca, Holter, Krusell, Malafry [2016] who show both empirically and theoretically that there is a strong positive relationship across countries between the magnitude of fiscal multipliers and wealth inequality captured by the Gini index. While these papers focus only the aggregate fiscal multiplier, we analyze the factors determining the size of the sectoral fiscal multiplier along with the movement of sectoral output relative to GDP corresponding to sectoral output shares in real terms. By investigating the change in sectoral output relative to GDP, we filter the change in sectoral output arising from GDP growth and thus isolate the pure reallocation effect. Using a panel of 16 OECD countries over the period 1970-2007, we estimate a VAR model that includes sectoral variables by adopting the fiscal shock identifying assumption proposed by Blanchard and Perotti [2002]. We find empirically that non traded output increases by 0.7% of GDP on impact while the output share of non tradables rises initially by 0.35% of GDP. That is to say, non traded ouput would increase by 0.35% if GDP remained constant. Thus the reallocation of resources toward the non traded sector contributes to 50% of non traded output growth.

While a government spending shock generates a substantial reallocation of resources which significantly affects the relative size of sectors, our evidence also reveals that non traded wages increase sharply relative to traded wages. This empirical finding casts doubt over the assumption of perfect mobility of labor across sectors and rather suggests some difficulty in reallocating labor between sectors. To assess the extent of mobility costs, we estimate the elasticity of labor supply across sectors for each country in our sample which plays a pivotal role in our model. Estimating the panel VAR model for countries with a low and a high elasticity of labor supply across sectors, we find that non traded wages increase more relative to traded wages while hours worked (output) in tradables relative to non tradables fall less in countries where the elasticity is low. This corroborates our conjecture that in countries where mobility costs are higher, non traded firms wishing to produce more must pay much higher wages to attract workers. In order to emphasize the importance of mobility costs for fiscal transmission, we explore the cross-country relationship between the responses of sectoral output shares and the degree of labor mobility captured by the elasticity of labor supply across sectors. While the vast majority of the economies experience a rise (decline) in their output share of non tradables (tradables), we empirically detect a positive relationship between the size of the responses of sectoral output shares and the degree of labor mobility.

In order to account for the aggregate and the sectoral effects of a government spending shock, we put forward a variant of the two-sector open economy model with tradables and non tradables. Our setup has two distinct pivotal features. First, we consider a difficulty in reallocating labor across sectors. To generate imperfect mobility of labor, we assume limited substitutability in hours worked across sectors along the lines of Horvath [2000]. The advantage of such a modelling strategy is that the elasticity of substitution of labor across sectors that captures the degree of labor mobility can be estimated. An additional attractive feature is that it allows us to consider the range of all degrees of labor mobility across sectors, with perfect labor mobility emerging as a special case. Second, we assume that physical capital accumulation is subject to adjustment costs.

Calibrating the model to a representative OECD economy, we explore quantitatively the dynamic effects of a rise in government consumption by 1% of GDP biased toward non traded goods. We find that the time-series evidence on fiscal transmission can be rationalized provided we allow for both capital installation costs and imperfect mobility of labor across sectors. Regarding the aggregate effects, the baseline model is able to account for the rise in hours worked and GDP in the short-run along with the simultaneous decline in investment and the current account. Turning to the sectoral effects, the model is also successful in replicating the expansionary effect of a government spending shock on non traded labor and output, together with the appreciation in the relative price of non tradables and the rise in the non traded wage relative to the traded wage. Importantly, we find quantitatively that the rise in government consumption increases the output share of non tradables and lowers the relative size of the traded sector, and more so in countries with a higher degree of labor mobility across sectors. Our sensitivity analysis reveals that by imposing perfect mobility of labor and/or abstracting from capital installation costs, the model fails to account for both the aggregate and the sectoral effects of a government spending shock.

Given the success of our model in replicating the evidence, the final exercise we perform is to calibrate the model to match data from the 16 OECD countries regarding dimensions such as the non tradable content of labor, consumption, investment, government spending, and the elasticity of labor supply across sectors capturing the degree of labor mobility that we estimate for each economy in our sample. In line with the evidence, the countries experience a decline in the output share of tradables and a rise in the output share of non tradables which are more pronounced in countries with higher degree of labor mobility. We find quantitatively that impact responses of sectoral output shares to a government spending shock are sensitive to the degree of labor mobility, as they vary between 0.26% and 0.49% of GDP for non tradables when we move from the lowest to the highest value of the elasticity of labor supply across sectors. Although the model tends to understate changes in the relative size of sectors, it is able to generate a cross-country relationship between the responses of sectoral output shares and the degree of labor mobility that is similar to that in the data.

We contribute to the vast literature investigating fiscal transmission both empirically and theoretically by focusing on the sectoral impact which has so far received little attention. From an empirical point of view, one major finding is that the impact of government spending shocks is not uniform across sectors and generates a reallocation of labor toward the sector where the rise in public purchases is heavily concentrated. In this regard, like Ramey and Shapiro [1998], we emphasize the importance of the composition of government spending for understanding both the aggregate and the sectoral effects of a fiscal shock. In contrast to the authors who consider a rise in defense spending during a military buildup, which is heavily concentrated in the manufacturing sector, we investigate a rise in government consumption in 'normal times' and find that such a government spending shock leads to a sharp increase in the relative size of the non traded sector. This finding is in line with estimates documented by Monacelli and Perotti [2008] and Benetrix and Lane [2010] which reveal that an increase in government spending disproportionately benefits the non traded sector. In contrast to the authors who restrict their attention to sectoral outputs, we also analyze the effects on sectoral output shares along with the consequences for the labor markets of both sectors. Such an empirical investigation enables us to highlight the pivotal role of labor reallocation across sectors for fiscal transmission in open economies and to uncover a relationship between the magnitude of the sectoral impact of a fiscal shock and the degree of labor mobility across sectors.

From a theoretical point of view, we develop an open economy version of the neoclassical model with tradables and non tradables along the lines of Cordoba (de) and Kehoe [2000]. We extend their setup by considering elastic labor supply and limited substitutability in hours worked across sectors. Abstracting from physical capital accumulation, our model is tractable enough to deliver a number of analytical results that give a better understanding of the role of imperfect mobility of labor for fiscal transmission. In particular, by hampering the shift of labor toward non tradables, labor mobility costs trigger an excess demand in the non traded goods market caused by a rise in government consumption biased toward non tradables. The consecutive appreciation in the relative price of non tradables provides an incentive to produce and thus to hire more, which in turn increases the output share of non tradables. Our quantitative analysis reveals that this mechanism is key to reproducing the rise in the output share of non tradables estimated empirically. Furthermore, limited labor mobility is not sufficient, on its own, to account quantitatively for the evidence as capital installation costs contribute to magnifying the increase in the output share of non tradables. Intuitively, by mitigating the crowding out of investment, adjustment costs to capital accumulation amplifies the excess demand in the non traded goods market and thus the appreciation in the relative price. In this regard, our work can be viewed as close to the paper by Bouakez, Cardia and Ruge-Murcia [2011]. The authors show that imperfect labor mobility makes the predictions of the sticky-price model consistent with empirical evidence on the sectoral and aggregate effects of monetary policy shocks as long as a second feature, namely input-output interactions, is accounted for.

The remainder of the paper is organized as follows. In section 2, we establish panel VAR evidence on aggregate and sectoral effects of a government spending shock and then document an empirical relationship between the responses of sectoral output shares and the degree of labor mobility. In section 3, we develop an open economy version of the neoclassical model with a difficulty in reallocating labor across sectors. In section 4, we abstract from physical capital accumulation in order to derive a number of analytical results and to build up intuition on fiscal transmission with imperfect mobility of labor. In section 5, we report the results of our numerical simulations and assess the ability of the model to account for the evidence. In section 6, we summarize our main results and present our conclusions.

2 Stylized Facts on Fiscal Transmission

Recently, several studies have explored open economy aspects of the fiscal transmission mechanism on the basis of estimated vector autoregression (VAR) models in panel format, see e.g., Beetsma et al.[2008], Benetrix and Lane [2010], Corsetti, Meier and Muller [2012], Ilzetzki, Mendoza, and Vegh [2013]. However, little attention has been paid to the sectoral effects of a government spending shock, except for Benetrix and Lane [2010]. In this section, we thus revisit the time-series evidence on the aggregate and sectoral effects of government spending shocks. Because the sectoral impact of an expansionary fiscal shock varies considerably across the countries in our sample, we also contrast the effects of government spending shocks in economies with low and high workers' mobility costs and document an empirical relationship between the degree of labor mobility across sectors and the magnitude of the sectoral impact of a fiscal shock. We denote below the level of the variable in upper case and the logarithm in lower case.

2.1 VAR Model and Identification

In order to shed some light on fiscal transmission and guide our quantitative analysis, we estimate the VAR model in panel format on annual data. We consider a structural model with $k = 2$ lags in the following form:

$$AZ_{i,t} = \sum_{k=1}^{2} B_k Z_{i,t-k} + \epsilon_{i,t}, \tag{1}$$

where subscripts i and t denote the country and the year, respectively, $Z_{i,t}$ is the vector of endogenous variables, A is a matrix that describes the contemporaneous relation among the variables collected in vector $Z_{i,t}$, B_k is a matrix of lag specific own- and cross-effects of variables on current observations, and the vector $\epsilon_{i,t}$ contains the structural disturbances which are uncorrelated with each other.

Because the VAR model cannot be estimated in its structural form, we pre-multiply (1) by A^{-1} which gives the reduced form of the VAR model:

$$Z_{i,t} = \sum_{k=1}^{2} A^{-1} B_k Z_{i,t-k} + e_{it}, \tag{2}$$

where $A^{-1}B_k$ and $e_{it} = A^{-1}\epsilon_{it}$ are estimated by using a panel OLS regression with country fixed effects and country specific linear trends. To identify the VAR model and recover the government spending shocks, we need assumptions on the matrix A as the reduced form of the VAR model that we estimate contains fewer parameters than the structural VAR model shown in eq. (1).

To identify fiscal shock, we follow Blanchard and Perotti [2002] and assume that government spending is predetermined relative to the other variables in the VAR model. We thus adopt a Choleski decomposition in which government spending is ordered before the other variables so that the fiscal shock is exogenous. Technically, matrix A is thus lower-triangular. The identifying assumption holds as long as public spending does not respond to current output developments. As argued by Blanchard and Perotti [2002] who use quarterly data, typical fiscal policy conduct suggests that public spending cannot react contemporaneously to the state of the economy due to delays between current output observation and the implementation of fiscal measures. However, because our aim is to estimate the effects of public spending on a number of sectoral variables, quarterly data are not available for most of the countries, so we must use annual data. The potential problem is that Blanchard and Perotti's argument is not necessarily true when using annual data as some adjustment could be possible. To support our assumption, we estimated the same panel VAR model that includes aggregate variables which are available on a yearly and a quarterly basis. The responses of variables to an exogenous fiscal shock are similar whether we use annual or quarterly series as our estimates using quarterly data lie within the confidence interval of those obtained from yearly data.[1] Our results accord well with the conclusion reached by

[1] The results are included in a Technical Appendix available on request from the authors.

Born and Müller [2012] whose test reveals that the assumption that government spending is predetermined within the year cannot be rejected. Furthermore, we obtain results for aggregate variables which confirm those obtained by previous empirical studies using quarterly data. Moreover, as government spending does not include transfers (such as unemployment benefits), it is therefore much less likely to respond automatically to the other variables. Finally, the advantage of using annual data instead of quarterly series is that potential anticipation effects of policy changes are less likely to bias the estimates, as the identified shocks are more likely to be truly unanticipated.

2.2 Data Construction

Before presenting the VAR model, we briefly discuss the dataset we use. Our sample consists of a panel of 16 OECD countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Spain (ESP), Sweden (SWE), the United Kingdom (GBR), and the United States (USA). Our sample covers the period 1970-2007 and contains annual observations.

As detailed in the next subsection, we consider a number of VAR specifications as we wish to shed some light on the reallocation of resources triggered by a fiscal shock that affects the relative size of sectors. Because their movements are strongly intertwined, we explore empirically both the aggregate and sectoral effects of government spending shocks. The former variables consist of government consumption (G_{it}), GDP (Y_{it}), private fixed investment (JE_{it}), current account (CA_{it}), labor (L_{it}), real consumption wage ($W_{C,it}$). All data are obtained from the OECD Economic outlook and OECD STAN database together with EU KLEMS database. For government final consumption expenditure, GDP, private investment (excluding residential investment), we use the volumes reported by the OECD. Aggregates G_{it}, Y_{it}, JE_{it} are deflated with their own deflators. We use hours worked to measure labor.[2] All quantities are scaled by the working age population and are measured in logs, except for the current account which is expressed as a fraction of GDP. The real consumption wage is the ratio of the nominal aggregate wage, W_{it}, to the consumption price index, $P_{C,it}$, and is measured in logs. The nominal wage is obtained by calculating the ratio of labor compensation to the number of hours worked. Details of data construction and the source of variables used in our estimate are given in Appendix A.

Because we also empirically explore the sectoral effects of fiscal transmission, we briefly describe how we construct time series at a sectoral level. Our sample covers the period 1970-2007 (except for Japan: 1974-2007), for eleven 1-digit ISIC-rev.3 industries. To split these eleven industries into traded and non traded sectors, we follow the classification

[2] Alternatively we use the number of employees as a measure of labor. All results remain almost unchanged.

suggested by De Gregorio et al. [1994]. Agriculture, hunting, forestry and fishing; Mining and quarrying; Total manufacturing; Transport, storage and communication are classified as traded industries. Following Jensen and Kletzer [2006], we updated the classification by De Gregorio et al. [1994] by treating Financial intermediation as a traded industry. Electricity, gas and water supply; Construction; Wholesale and retail trade; Hotels and restaurants; Real estate, renting and business services; Community, social and personal services are classified as non traded industries. Once industries have been classified as traded or non traded, series for sectoral value added in current (constant) prices are constructed by adding value added in current (constant) prices for all sub-industries in sector $j = T, N$. The same logic applies to constructing series for hours worked and labor compensation in the traded and the non traded sectors.[3]

We use the EU KLEMS [2011] and OECD STAN database which provide domestic currency series of value added in current and constant prices, labor compensation and employment (number of hours worked) at an industry level, from which we construct price indices, P_{it}^j, which correspond to sectoral value added deflators, and sectoral wage rates, W_{it}^j. The relative price of non tradables, P_{it}, is the ratio of the non traded value added deflator to the traded value added deflator (i.e., $P_{it} = P_{it}^N / P_{it}^T$). The relative wage, Ω_{it}, is the ratio of the non traded wage to the traded wage (i.e., $\Omega_{it} = W_{it}^N / W_{it}^T$).

2.3 VAR Specification

Because we wish to provide a better understanding of fiscal policy transmission in open economies we consider four specifications. The choice of variables is motivated in part by the variables discussed in the quantitative analysis. All quantities are measured in log and real terms (except for the current account), while prices and wages are logged:

- To explore the magnitude of the aggregate fiscal multiplier empirically, we consider a VAR model that includes in the baseline specification (log) government consumption, g_{it}, GDP, y_{it}, total hours worked, l_{it}, private fixed investment, je_{it}, the real consumption wage denoted by $w_{C,it}$. Our vector of endogenous variables, is given by: $z_{it} = [g_{it}, y_{it}, l_{it}, je_{it}, w_{C,it}]$. In the second specification we replace private investment with the current account expressed in percentage of GDP, ca_{it}.

- To investigate the magnitude of the sectoral fiscal multiplier, we consider a VAR model that includes value added at constant prices in sector j, y_{it}^j, hours worked in sector j,

[3] In contrast to De Gregorio et al. [1994] who treat "Financial intermediation" as non tradable, we classify this industry as tradable, following Jensen and Kletzer [2006]; our sensitivity analysis reveals that our conclusions hold whether "Financial intermediation" is classified as tradable or non tradable. The classification of items "Wholesale and Retail Trade", "Hotels and Restaurants", "Transport, Storage and Communication", "Real Estate, Renting and Business Services" may also display some ambiguity. In order to address this issue, we re-estimated the various VAR specifications for different classifications in which one of the above industries initially marked as tradable (non tradable resp.) is classified as non tradable (tradable resp.), all others industries staying in their original sector. Because results are very similar, to save space we do not present them and are therefore relegated to the Technical Appendix.

l^j_{it}, and the real consumption wage in sector j, $w^j_{C,it}$, defined as the sectoral nominal wage w^j_{it} divided by the consumption price index, $p_{C,it}$. Our vector of endogenous variables, is given by: $z^j_{it} = \left[g_{it}, y^j_{it}, l^j_{it}, w^j_{C,it}\right]$ with $j = T, N$.

- To estimate the change in sectoral output share which is defined as the excess of sectoral fiscal multiplier over the aggregate fiscal multiplier, we consider a VAR model where we divide sectoral value added at constant prices (labor) by GDP in order to filter the change in sectoral output (labor) arising from GDP (total hours worked) growth which allows us to isolate the 'pure' reallocation effect and thus gauge the importance of the shift of resources across sectors that affects their relative size. Denoting the output and labor share of sector j by $\nu^{Y,j}_{it} = y^j_{it} - y_{it}$ and $\nu^{L,j}_{it} = l^j_{it} - l_{it}$, respectively, our vector of endogenous variables, is given by: $z^{S,j}_{it} = \left[g_{it}, \nu^{Y,j}_{it}, \nu^{L,j}_{it}, w^j_{C,it}\right]$ with $j = T, N$.

- Finally, to investigate the relative price (p) and relative wage (ω) effects of a fiscal shock, we consider a VAR model where we replace sectoral quantities with the ratio of sectoral quantities for both the product and the labor market. Our vector of endogenous variables, is given by: $z^P_{it} = \left[g_{it}, y^T_{it} - y^N_{it}, p_{it}\right]$ and $z^W_{it} = \left[g_{it}, l^T_{it} - l^N_{it}, \omega_{it}\right]$, respectively.

2.4 Effects of Government Spending Shocks: VAR Evidence

We generated impulse response functions which summarize the responses of variables to an increase in government spending by 1 percentage point of GDP. Fig. 1-3 displays the estimated effects of a fiscal shock for our four alternative sets of specifications. The horizontal axis measures time after the shock in years and the vertical axis measures percentage deviations from trend. Government consumption, investment, the current account and GDP are measured in percentage points of total output relative to trend. Total labor, aggregate real consumption wage, sectoral real consumption wages, the relative price of non tradables and the relative wage are measured in percentage deviations from trend. Sectoral labor and sectoral labor share are both measured in percentage deviations of total hours worked from trend, while sectoral output and sectoral output share are both measured in percentage deviations of total output from trend. In each case, the solid line represents the point estimate, while the shaded area indicates 90% confidence bounds obtained by bootstrap sampling. Point estimates are shown in Panel A of Table 1 at a one year-, two-year and four-year horizon.

2.4.1 Aggregate Effects

We start with the aggregate effects of a government spending shock. Fig. 1 shows results for the first VAR model. The top left panel of Fig. 1 shows the endogenous response of government spending to an exogenous fiscal shock. The response of government consumption is hump-shaped, as it peaks after one year and then gradually declines; it shows a high level of persistence over time as it is about 8 years before the shock dies out. The impact on GDP is fairly moderate as the fiscal multiplier is about 0.5 and averages 0.29 during the first four years after the shock.[4] As shown in the last row, the dynamic adjustment of real GDP seems to mimic the dynamic adjustment of hours worked which increases on impact by 0.53% and declines after one year. In addition, we detect a moderate increase in the real consumption wage followed by a rapid decline. Its cumulative response over a two-year horizon is 0.6% approximately, and subsequently becomes negative.

Turning to the response of investment and the current account as shown in the second column of Fig. 1, the top panel indicates that investment is fairly unresponsive on impact which suggests the presence of installation costs, while the middle panel reveals that the current account moves into deficit in the short-run. The government spending shock leads to a protracted decline in investment which remains below trend while the current account recovers after two years and moves into surplus after about 5 years. As shown in Table 1, after four years, the cumulative decline in investment amounts to -1.29 percent of GDP while the current account deficit is substantial at -3.35 GDP percentage points.

< Please insert Figure 1 about here >

< Please insert Table 1 about here >

2.4.2 Sectoral Effects

We now discuss the sectoral effects of a government spending shock. In Fig. 2 we report results for the second VAR model. The first column shows responses for the traded sector while the second column displays results for the non traded sector. As shown in the first row, the response of government consumption to an exogenous fiscal shock is almost identical to that shown in Fig 1. The second row shows the dynamic adjustment of sectoral output. We find that a rise in government consumption has a strong expansionary effect on non traded output which increases significantly on impact by 0.70 percentage point of GDP, as reported in column 3 of Table 1, while its four-year horizon cumulative response is substantial at 1.88 percentage points of GDP. During the first four years after the shock, the non traded output multiplier of government spending averages at about 0.47 percentage point of GDP. In contrast, the traded sector displays a negative fiscal multiplier for the first four years as

[4] Like Ilzetzki, Mendoza, and Vegh [2013], we calculate the (aggregate or sectoral) multiplier at a k-year horizon by computing the ratio of the present value of the cumulative change in output to the present value of the cumulative change in government consumption:

$$\frac{\sum_{t=0}^{k} (1+r^\star)^{-t}\, \hat{y}_t}{\sum_{t=0}^{k} (1+r^\star)^{-t}\, \hat{g}_t},$$

where $r^\star$ is the world interest rate set to 4% to be consistent with the model calibration and $\hat{y}_t$ and $\hat{g}_t$ correspond to the percentage deviation of output and government consumption from trend in output units, respectively.

the government spending shock gives rise to a contraction in traded output which remains below trend. As shown in the third row of Fig. 2, higher non traded output is associated with a sharp increase in hours worked on impact while the traded sector experiences a gradual decline in labor for the first five years. In addition, the fourth row of Fig. 2 suggests that non traded firms pay higher real consumption wages in the short-run. In sum, our evidence shown in Fig. 2 reveals that the **government spending shock is strongly biased toward non tradable goods** as it benefits the non traded sector at the expense of the traded sector.

The first column of Fig. 3 enables us to gauge the contribution of the reallocation of inputs, labor especially, to the expansion of the relative size of the non traded sector. The first two rows show that the labor share of tradables declines by 0.27 percentage point of total labor while the reverse is true for non tradables. Since the response of sectoral labor share filters the change in sectoral labor arising from growth in total hours worked, our estimates thus suggest that over the first year, a government spending shock causes 0.27% of workers to shift from the traded to the non traded sector. Since non traded hours worked increase by 0.55% of total employment, 50% of non traded employment growth is the result of labor reallocation. As shown in the last two rows of the first column, fiscal shock lowers the output share of tradables significantly and substantially increases that of non tradables. Because changes in output shares indicate how much sectoral output would increase if GDP remained constant, they provide us with valuable information on the shift of inputs across sectors and the resulting changes in their relative size. Quantitatively, since non traded output rises by 0.7 percentage point of GDP while the output share of tradables rises by 0.35 percentage point of GDP, the shift of resources toward the non traded sector alone contributes to 50% of non traded output growth. Our second set of findings shown in Fig. 3 thus reveals that a government spending shock **generates a reallocation of labor that significantly affects the relative size of sectors**.

The second column of Fig. 3 enables us to shed some light on fiscal transmission. The last two rows support the conjecture that government spending shock is biased toward non traded goods as it causes the relative price of non tradables to appreciate significantly in the short-run and generates a decline in the ratio of traded output relative to non traded output. The first two rows show that the sharp decline in hours worked in the traded sector relative to the non traded sector is associated with a significant increase in non traded wages relative to traded wages. The positive response of the relative wage to a government spending shock casts doubt over the assumption of perfect mobility of labor that implies that sectoral wages will equalize and rather **reveals the presence of intersectoral labor mobility costs**.

< Please insert Figures 2-3 about here >

2.5 Comparison with Previous Studies

Overall, our panel VAR evidence for aggregate variables is well in line with that reported in earlier studies. In particular, our estimate of an aggregate output multiplier of government spending being lower than one on impact accords well with earlier findings. For example, Corsetti et al. [2012], who use a panel of 17 OECD countries for the period 1975-2008, report an increase in aggregate output by about 0.7 percentage points on impact. As documented by Corsetti et al., an increase in government spending leads to a protracted decline in private investment. The fall in the current account following a rise in public purchases is also in line with earlier findings. Although the empirical literature commonly uses net exports, replacing the current account with the trade balance leads to similar results. Beetsma, Giuliodori and Klaassen [2008] report a fall in the trade balance by 0.5% of GDP for a panel of 11 Euro Area Members while Corsetti et al. [2012] document a decline in net exports on impact which is very similar to ours.

Regarding labor market variables, our evidence reveal that a government spending shock increases hours worked, a finding that again squares well with conventional wisdom and earlier empirical studies, see e.g., Pappa [2009], Ramey [2011]. While there is no debate in the literature about the empirical facts mentioned above, the response of the real wage to a government spending shock is not a clear-cut result. As summarized by Nekarda and Ramey [2011], the literature adopting Blanchard and Perotti's [2002] approach to identifying fiscal shock reports an increase in the real consumption wage while application of the 'narrative' approach reveals that real consumption wages tend to fall in response to military spending shocks, see e.g., Ramey [2011]. While we find a significant rise in the real consumption wage on impact, our panel VAR evidence indicates that it is followed by a rapid decline. In this regard, our result can be viewed as halfway between these two strands of literature applying different identification schemes to U.S. data.

To our knowledge, only Monacelli and Perotti [2008] and Benetrix and Lane [2010] conduct an empirical investigation of the sectoral impact of a government spending shock by differentiating the traded from the non traded sector. Both Monacelli and Perotti [2008] and Benetrix and Lane [2010] find empirically that a government spending shock increases both traded and non traded output, the latter sector increasing by a much larger amount. While our estimates corroborate this finding, we nevertheless find that traded output falls slightly on impact and remains below trend while the fiscal shock is in effect. Beyond the fact that the sample is different, this discrepancy could be attributed to the classification we adopt to split industries into traded and non traded sectors.[5] More specifically, Benetrix and Lane [2010] treat 'Transport, Storage and Communication' and 'Financial Intermediation'

[5] We use a panel of 16 OECD economies over 1970-2007 while Benetrix and Lane [2010] consider a sample of 11 EMU countries over 1970-2005 and Monacelli and Perotti [2008] restrict attention to the US, using quarterly data from 1954 to 2006.

as non traded rather than traded industries while Monacelli and Perotti [2008] refer to industries producing services as non tradables and thus take a different approach from ours.

2.6 Cross-Country Differences in the Sectoral Impact and Imperfect Mobility of Labor

One major empirical fact we established above is that the reallocation of resources toward the non traded sector is associated with a significant rise in non traded wages relative to traded wages.[6] The positive response of the relative wage to a government spending shock can be rationalized through the presence of workers' costs of switching sectors. Intuitively, following a rise in public purchases that are heavily concentrated in non traded industries, establishments in the non traded sector wish to increase their production to meet this additional demand. To attract workers, non traded firms must pay higher wages in order to cover their mobility costs, and all the more so as the difficulty in reallocating hours worked across sectors is more pronounced. In countries where workers' mobility costs are higher, we thus expect the positive response of the relative wage to a fiscal shock to be greater as non traded firms must pay much higher wages to increase hours worked. As the labor demand shifts along a steeper labor supply schedule in countries with greater mobility costs, the decline in relative hours worked in tradables is expected to be less pronounced. Since the traded sector experiences a lower labor outflow, the fall in traded output relative to non traded output should also be less (in absolute terms).

To gauge the importance of workers' mobility costs for fiscal transmission, we thus ask whether the positive response of the relative wage to a fiscal shock is more pronounced while the reallocation of labor is lower in countries where mobility costs are higher. To explore our conjecture empirically, we draw on Horvath [2000] and estimate the elasticity of labor supply across sectors for each country.[7] This parameter measures the extent to which workers are willing to reallocate their hours worked toward the non traded sector following a 1% increase in the relative wage. When the elasticity of labor supply across sectors is greater, workers' mobility costs are thus lower which in turn implies a higher degree of labor mobility. These workers' costs of switching sectors be interpreted as psychological costs when switching from one sector to another (see e.g., Dix-Carneiro [2014]), geographic mobility costs (see e.g., Kennan and Walker [2011]) or can be the result of sector-specific human capital (see e.g., Lee and Wolpin [2006]).

[6]This finding is in line with evidence documented by Artuç et al. [2010], Dix-Carneiro [2014], Lee and Wolpin [2006] who find substantial barriers to mobility and observe that wages are not equalized across sectors in the short run following both trade liberalization episodes and sector-biased technological change.

[7]In section 3, we develop a model with imperfect labor mobility. Along the lines of Horvath [2000], we generate a difficulty in reallocating labor across sectors by assuming limited substitutability in hours worked across sectors. One of the advantage of such a modelling strategy over alternatives is that it allows us to estimate the elasticity of substitution of labor across sectors for each country in our sample. Details about the empirical strategy can be found in Appendix B while details of derivation of the testable equation are provided in a Technical Appendix.

Building on our panel data estimates for the 16 OECD countries over the period 1970-2007, we split our sample into groups of 'high mobility' and 'low mobility' economies and re-estimate the sectoral effects for each of the two groups. The 'low mobility' economies are those for which the switching cost is above average for the sample. In order to provide some support for our measure of workers' mobility cost, we compute an intersectoral labor reallocation index in year t for each country i, denoted by $LR_{i,t}$, by calculating the average change between year t and $t-\tau$ in the amount of labor employed in sector j as a fraction of total employment:[8]

$$LR_{i,t}(\tau) = 0.5 \left[\sum_{j=T}^{N} \left| \frac{L_{i,t}^{j}}{\sum_{j=T}^{N} L_{i,t}^{j}} - \frac{L_{i,t-\tau}^{j}}{\sum_{j=T}^{N} L_{i,t-\tau}^{j}} \right| \right]. \tag{3}$$

We choose $\tau = 2$ to eschew year-to-year changes because of the low frequency changes in labor at that horizon and consider only differences over 2 years. As the values of the labor reallocation index, LR, increase, the fraction of workers who are working in a different sector in year t than in year $t-\tau$ is thus larger.[9]

While the third column of Fig. 3 contrasts the cumulative responses for the labor reallocation index, hours worked in tradables relative to non tradables, and the relative wage, the last two columns of Panel B of Table 1 show the point estimates for both sub-samples for selected horizons. Focusing first on cumulative responses displayed in the last column of Fig. 3 with the solid (dotted) line showing results for our sub-sample of countries which we classify as 'low mobility' ('high-mobility') economies, a government spending shock increases the reallocation of labor across sectors, although this is less pronounced for the 'low mobility' economies. Contrasting point estimates reported in columns 5 and 6 of Table 1, we find that the magnitude of the shift of labor in the 'low mobility' group is about five times less in first year. This finding thus lends credence to our measure of mobility costs. Importantly, in accordance with our conjecture, we find that the magnitude of the responses of the relative wage and relative hours worked of tradables are different across the sub-samples. As can be seen in the last row of Fig. 3, non traded wages increase substantially relative to traded wages for the 'low mobility' economies while the relative wage response for 'high mobility' countries is not statistically different from zero. The third row of Fig. 3 shows that the 'low mobility' economies experience a fall in relative hours worked of tradables which is less pronounced as labor supply is less elastic to the relative wage. Because the shift of labor toward the non traded sector is less, 'low mobility' economies also experience a smaller decline in output of tradables relative to non tradables as shown by point estimates reported in the last two columns of Table 1.

Overall, our results emphasize the importance of labor mobility for fiscal transmission.

[8] See e.g., Kambourov [2009] who computes the same labor reallocation index (3).

[9] When we estimate the response of the intersectoral labor reallocation index to a government spending shock, we replace hours worked in the traded sector in terms of hours worked in the non traded sector, $l_{it}^{T} - l_{it}^{N}$ with $LR(2)_{it}$ and thus consider the 'labor reallocation' specification that is given by: $z_{it}^{W} = [g_{it}, LR_{it}(2), \omega_{it}]$.

We now move a step further and explore the cross-country relationship between changes in the relative size of sectors and the magnitude of workers' costs of switching sectors. We estimate the same model as in eq. (2) but for a single country at a time.[10] Then in Fig. 4, we plot the impact responses of selected sectoral variables on the vertical axis against our measure of the degree of labor mobility, denoted ϵ, on the horizontal axis.[11] This exercise may be viewed as tentative as the sectoral effect of a government spending shock varies considerably across countries and there is substantial uncertainty surrounding point estimates given the relatively small number of observations available per country.

< Please insert Figure 4 about here >

The first column of Fig. 4 plots the point estimates for hours worked and output of tradables in terms of non tradables, respectively, against the respective country's degree of labor mobility. The trend line shows that hours worked and output of tradables tend to fall more relative to non tradables in countries where the elasticity of labor supply across sectors (i.e., ϵ) is higher. The second and third columns of Fig. 4 plot sectoral labor and sectoral output shares against the degree of labor mobility across sectors. The cross-country analysis highlights two major findings. First, as shown in the top panels, whether we use labor or output, almost all countries in our sample experience a fall in the relative size of the traded sector as impact responses from the VAR model are below the X-axis. The bottom panels reveal that the reverse is true for the non traded sector which benefits the reallocation of inputs. This evidence supports our earlier conjecture according to which government spending shock is biased toward non tradables as for the vast majority of OECD countries in our sample, the non traded sector expands while the traded sector shrinks. Second, as can be seen in the last two columns of Fig. 4, the top panels indicate that countries where workers have lower mobility costs experience a larger decline in the share of tradables while the bottom panels show that the relative size of non tradables increases more in these economies. In sum, our findings reveal that **the magnitude of the sectoral impact of a government spending shock increases with the degree of labor mobility across sectors**.

In the following, we develop a dynamic general equilibrium model with imperfect mobility of labor and capital installation costs in order to account for our evidence on fiscal transmission. We show that the model's predictions are consistent with the evidence on

[10]When estimating the responses of sectoral labor and sectoral output shares to a government spending shock for each country, we omit $w^j_{C,it}$ in order to economize some degrees of freedom; the vector of endogenous variables is thus $z^{S,j}_{it} = \left[g_{it}, \nu^{Y,j}_{it}, \nu^{L,j}_{it}\right]$. We also estimated the VAR model by including $\omega^j_{C,it}$ and find that the results are similar. When estimating the effects on the ratio of sectoral hours worked and sectoral outputs, the vectors of endogenous variables are identical to those specified for the whole sample, i.e., $z^{P,j}_{it} = \left[g_{it}, y^T_{it} - y^N_{it}, p_{it}\right]$ and $z^{W,j}_{it} = \left[g_{it}, l^T_{it} - l^N_{it}, \omega_{it}\right]$. We allow for two lags (i.e., $k = 2$ in eq. (1)), as we did for the panel data estimate.

[11]Because our panel data estimates are not statistically significant at 10% for Denmark and Norway, these two countries are removed from the cross-country analysis. If we include them, the conclusions are unaffected both qualitatively and qualitatively.

the aggregate and sectoral effects of fiscal shocks once we allow for these two features.

3 A Two-Sector Open Economy Model with Imperfect Mobility of Labor across Sectors

We consider a small open economy populated by a constant number of identical households and firms that have perfect foresight and live forever. The country is small in terms of both world goods and capital markets, and faces a given world interest rate, $r^{\star}$. One sector produces a traded good denoted by the superscript T which can be exported at no cost, invested and consumed domestically. A second sector produces a non traded good denoted by the superscript N which can be consumed domestically or invested. The traded good is chosen as the numeraire.[12] Time is continuous and indexed by t.

3.1 Households

At each instant the representative household consumes traded and non traded goods denoted by C^T and C^N, respectively, which are aggregated by means of a CES function:

$$C(t) = \left[\varphi^{\frac{1}{\phi}} \left(C^T(t)\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(C^N(t)\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{4}$$

where $0 < \varphi < 1$ is the weight of the traded good in the overall consumption bundle and ϕ corresponds to the elasticity of substitution between traded goods and non traded goods.

The representative household supplies labor L^T and L^N in the traded and non traded sectors, respectively. To rationalize the rise in the non traded wage relative to the traded wage, we assume limited labor mobility across sectors. A shortcut to produce a difficulty in reallocating hours worked is to assume that workers experience a utility loss when shifting hours worked from one sector to another.[13] We follow Horvath [2000] and consider that hours worked in the traded and the non traded sectors are aggregated by means of a CES function:

$$L(t) = \left[\vartheta^{-1/\epsilon} \left(L^T(t)\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-1/\epsilon} \left(L^N(t)\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}, \tag{5}$$

and $0 < \vartheta < 1$ parametrizes the weight attached to the supply of hours worked in the traded sector and ϵ is the degree of substitutability in hours worked across sectors. When we let ϵ tend toward infinity, the special case of perfect labor mobility is obtained; in this configuration, eq. (5) reduces to $L = L^T + L^N$; because agents no longer experience a

[12] The price of the traded good is determined on the world market and exogenously given for the small open economy.

[13] An alternative way to break wage equalization across sectors is to consider a model with search unemployment along the lines of Alvarez and Shimer [2011]. In Bertinelli, Cardi and Restout [2016], we show that workers' costs of switching sectors, as reflected by a utility loss, are key to breaking wage equalization. Formally, such a utility loss shows up as long as we allow for an endogenous sectoral labor force participation decision where the elasticity of labor supply at the extensive margin plays exactly the same role as the elasticity of labor supply across sectors in the present model abstracting from search frictions. The authors show that search frictions on firms' hiring alone cannot generate on their own a change in the relative wage because the vacancy creation schedule shifts along a horizontal search decision schedule.

mobility cost and are thus willing to work in the sector that pays the highest wage, both sectors must pay the same wage. In contrast, hours worked are no longer perfect substitutes if $\epsilon < \infty$. As ϵ takes smaller values, workers experience a larger utility loss when shifting from one sector to another and thus the degree of labor mobility is lower.

The representative agent is endowed with one unit of time, she/he supplies a fraction $L(t)$ as labor, and consumes the remainder $l(t) \equiv 1 - L(t)$ as leisure. At any instant of time, households derive utility from their consumption and experience disutility from working. Assuming that the felicity function is additively separable in consumption and labor, the representative household maximizes the following objective function:[14]

$$U = \int_0^\infty \left\{ \frac{C(t)^{1-\frac{1}{\sigma_C}}}{1-\frac{1}{\sigma_C}} - \frac{L(t)^{1+\frac{1}{\sigma_L}}}{1+\frac{1}{\sigma_L}} \right\} e^{-\beta t} \mathrm{d}t, \tag{6}$$

where β is the discount rate, σ_C the intertemporal elasticity of substitution for consumption, and $\sigma_L > 0$ is the Frisch elasticity of labor supply or intertemporal elasticity of substitution for (aggregate) labor supply.

Factor income is derived by supplying labor $L(t)$ at a wage rate $W(t)$, and capital $K(t)$ at a rental rate $R(t)$. In addition, households accumulate internationally traded bonds, $B(t)$, that yield net interest rate earnings of $r^\star B(t)$. Denoting lump-sum taxes by $T(t)$, households' flow budget constraint states that real disposable income (on the RHS) can be saved by accumulating traded bonds, consumed, $P_C(t)C(t)$, or invested, $P_J(t)J(t)$:

$$\dot{B}(t) + P_C(t)C(t) + P_J(t)J(t) = r^\star B(t) + R(t)K(t) + W(t)L(t) - T(t), \tag{7}$$

where $P_C\,(P(t))$ and $P_J\,(P(t))$ are consumption and the investment price index, respectively, which are a function of the relative price of non traded goods, $P(t)$. The aggregate wage index, $W(t) = W\left(W^T(t), W^N(t)\right)$, associated with the labor index defined above (5) is:

$$W(t) = \left[\vartheta \left(W^T(t)\right)^{\epsilon+1} + (1-\vartheta)\left(W^N(t)\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}, \tag{8}$$

where $W^T(t)$ and $W^N(t)$ are wages paid in the traded and the non traded sectors, respectively.

The investment good is (costlessly) produced using traded good and non traded good inputs according to a constant returns to scale function which is assumed to take a CES form:

$$J(t) = \left[\varphi_J^{\frac{1}{\phi_J}} \left(J^T(t)\right)^{\frac{\phi_J-1}{\phi_J}} + (1-\varphi_J)^{\frac{1}{\phi_J}} \left(J^N(t)\right)^{\frac{\phi_J-1}{\phi_J}}\right]^{\frac{\phi_J}{\phi_J-1}}, \tag{9}$$

where $0 < \varphi_J < 1$ is the weight of the investment traded input and ϕ_J corresponds to the elasticity of substitution between traded good and non traded good inputs. Installation of new investment goods involves increasing and convex costs, assumed quadratic, of net

[14] In the quantitative analysis we conduct in section 5, we show that relaxing the assumption of separability in preferences between consumption and labor merely affects the results.

investment. Thus, total investment $J(t)$ differs from effectively installed new capital, $I(t)$:

$$J(t) = I(t) + \frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)^2 K(t), \tag{10}$$

where the parameter $\kappa > 0$ governs the magnitude of adjustment costs to capital accumulation, and $0 \leq \delta_K < 1$ is a fixed depreciation rate. Net investment gives rise to capital accumulation according to the dynamic equation:

$$\dot{K}(t) = I(t) - \delta_K K(t). \tag{11}$$

Households choose consumption, worked hours and investment in physical capital by maximizing lifetime utility (6) subject to (7) and (11) together with (10). Denoting by λ and Q' the co-state variables associated with (7) and (11), the first-order conditions characterizing the representative household's optimal plans are:[15]

$$C(t) = \left(P_C(t)\lambda\right)^{-\sigma_C}, \tag{12a}$$

$$L(t) = \left(W(t)\lambda\right)^{\sigma_L}, \tag{12b}$$

$$\frac{I(t)}{K(t)} = \frac{1}{\kappa}\left(\frac{Q(t)}{P_J(t)} - 1\right) + \delta_K, \tag{12c}$$

$$\dot{\lambda}(t) = \lambda(t)\left(\beta - r^\star\right), \tag{12d}$$

$$\dot{Q}(t) = \left(r^\star + \delta_K\right) Q(t) - \left\{R(t) + P_J(t)\frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)\left(\frac{I(t)}{K(t)} + \delta_K\right)\right\}, \tag{12e}$$

and the transversality conditions $\lim_{t\to\infty} \lambda B(t)e^{-\beta t} = 0$, $\lim_{t\to\infty} Q(t)K(t)e^{-\beta t} = 0$. In an open economy model with a representative agent who has perfect foresight, a constant rate of time preference and perfect access to world capital markets, we impose $\beta = r^\star$ in order to generate an interior solution. Setting $\beta = r^\star$ into (12) yields $\lambda = \bar{\lambda}$. Eqs. (12a)-(12b) can be solved for consumption $C = C\left(\bar{\lambda}, P\right)$ and labor $L = L\left(\bar{\lambda}, W^T, W^N\right)$. A rise in the shadow value of wealth $\bar{\lambda}$ causes agents to cut their real expenditure and supply more labor. By raising the consumption price index, an appreciation in the relative price of non tradables drives down consumption. A rise in the sectoral wage W^j pushes up the aggregate wage index which provides an incentive to supply more labor.

Eq. (12c) can be solved for investment:

$$\frac{I(t)}{K(t)} = v\left(\frac{Q(t)}{P_J(t)}\right) + \delta_K, \quad v\left(.\right) = \frac{1}{\kappa}\left(\frac{Q(t)}{P_J(t)} - 1\right). \tag{13}$$

Equation (13) states that investment is an increasing function of Tobin's q, which is defined as the shadow value to the firm of installed capital, $Q(t)$, divided by its replacement cost, $P_J(t)$. For the sake of clarity, we drop the time argument below provided this causes no confusion.

[15] To derive (12c), we used the fact that $Q(t) = Q'(t)/\lambda$ which is the shadow value of capital in terms of foreign assets.

Once households have chosen aggregate consumption, they decide on its allocation between traded and the non traded goods according to the following optimal rule:

$$\left(\frac{1-\varphi}{\varphi}\right)\frac{C^T}{C^N} = P^{\phi}. \tag{14}$$

Applying Shephard's lemma (or the envelope theorem) yields consumption in non tradables, i.e., $C^N = \frac{\partial P_C}{\partial P}C = P_C'C$. Denoting the share of non traded goods in consumption expenditure by α_C, expenditure in non tradables and tradables is given by $PC^N = \alpha_C P_C C$ and $C^T = (1-\alpha_C) P_C C$, respectively.[16] The same logic applies to the allocation of aggregate investment expenditure; denoting the investment expenditure share on non tradables by α_J, the amounts spent on acquiring output from non tradables and tradables are $PJ^N = \alpha_J P_J J$ and $J^T = (1-\alpha_J) P_J J$, respectively.

Denoting the relative wage by $\Omega \equiv W^N/W^T$, workers allocate hours worked in the traded and the non traded sectors according to the following optimal rule:

$$\left(\frac{1-\vartheta}{\vartheta}\right)\frac{L^T}{L^N} = \Omega^{-\epsilon}, \tag{15}$$

where ϵ is the elasticity of labor supply across sectors as it measures the extent to which agents are willing to increase their hours worked in the non traded sector relative to the traded sector following a 1% rise in the relative wage. As ϵ takes higher values, workers experience lower mobility costs and thus demand a smaller increase in the relative wage to reallocate their hours worked toward the non traded sector; as a result, the degree of labor mobility across sectors increases. As for consumption, intra-temporal allocation of hours worked across sectors follows from Shephard's Lemma. We therefore obtain labor income from supplying hours worked in the non traded and the traded sectors, i.e., $W^N L^N = \alpha_L WL$ and $W^T L^T = (1-\alpha_L) WL$, with α_L being the share of non tradable labor revenue in the labor income.[17]

3.2 Firms

Each sector consists of a large number of identical firms which use labor, L^j, and physical capital, K^j, according to a constant returns to scale technology:

$$Y^j = Z^j \left(L^j\right)^{\theta^j} \left(K^j\right)^{1-\theta^j}, \tag{16}$$

where Z^j represents the TFP index which is introduced for calibration purposes only and θ^j corresponds to the labor income share in the value added of sector j. Firms lease capital from households and hire workers. They face two cost components: a capital rental cost equal to R, and wage rates in the traded and non traded sectors equal to W^T and W^N,

[16] Specifically, the non tradable content of consumption expenditure is given by $\alpha_C = \frac{(1-\varphi)P^{1-\phi}}{\varphi+(1-\varphi)P^{1-\phi}}$.

[17] Specifically, we have $\alpha_L = \frac{(1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1}+(1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]}$.

respectively. Both sectors are assumed to be perfectly competitive and thus choose capital and labor by taking prices as given:

$$\max_{K^j,L^j} \Pi^j = \max_{K^j,L^j} \left\{ P^j Y^j - W^j L^j - R K^j \right\}. \tag{17}$$

Since capital can move freely between the two sectors, the value of marginal products in the traded and non traded sectors equalizes while costly labor mobility implies a wage differential across sectors:

$$Z^T \left(1-\theta^T\right) \left(k^T\right)^{-\theta^T} = P Z^N \left(1-\theta^N\right) \left(k^N\right)^{-\theta^N} \equiv R, \tag{18a}$$

$$Z^T \theta^T \left(k^T\right)^{1-\theta^T} \equiv W^T, \tag{18b}$$

$$P Z^N \theta^N \left(k^N\right)^{1-\theta^N} \equiv W^N, \tag{18c}$$

where $k^j \equiv K^j/L^j$ denotes the capital-labor ratio for sector $j = T, N$.

Aggregating over the two sectors gives us the resource constraint for capital:

$$K^T + K^N = K. \tag{19}$$

3.3 Government

The final agent in the economy is the government. Total government spending, G, falls on goods, G^N, produced by non traded firms and goods, G^T, produced by traded firms. Both components of government spending are determined exogenously. The government finances public spending by raising lump-sum taxes, T. As a result, Ricardian equivalence obtains and the time path of taxes is irrelevant for the real allocation. We may thus assume without loss of generality that government budget is balanced at each instant:

$$G = G^T + P G^N = T. \tag{20}$$

3.4 Model Closure and Equilibrium

To fully describe equilibrium, we impose goods market clearing conditions. The non traded goods market clearing condition requires that output is equalized with expenditure:[18]

$$Y^N\left(\bar{\lambda}, K, P\right) = C^N\left(\bar{\lambda}, P\right) + G^N + P_J' K \left[v\left(\frac{Q}{P_I}\right) + \delta_K + \frac{\kappa}{2}\left(v\left(\frac{Q}{P_I}\right)\right)^2 \right], \tag{21}$$

[18] Using the fact that $C^N = \frac{\partial P_C(P)}{\partial P} C$ and $C^T = \left(P_C - P P_C'\right) C$ and inserting the short-run solution for consumption yields: $C^N = C^N\left(\bar{\lambda}, P\right)$ and $C^T = C^T\left(\bar{\lambda}, P\right)$. Using the fact that $L^T = \frac{\partial W\left(W^T, W^N\right)}{\partial W^T} L$ and $L^N = \frac{\partial W\left(W^T, W^N\right)}{\partial W^N} L$, respectively, and inserting the short-run solution for labor yields $L^T = L^T\left(\bar{\lambda}, W^T, W^N\right)$ and $L^N = L^N\left(\bar{\lambda}, W^T, W^N\right)$. Plugging first the short-run solutions for L^T and L^N into the resource constraint for capital, (18a)-(18c) and (19) can be solved for sectoral capital-labor ratio $k^j = k^j\left(\bar{\lambda}, K, P\right)$ and sectoral wage $W^j = W^j\left(\bar{\lambda}, K, P\right)$ (with $j = T, N$). Inserting $k^T\left(\bar{\lambda}, K, P\right)$ into $R = Z^T\left(k^T\right)^{-\theta^T}$ allows us to solve for the return on domestic capital, i.e., $R = R\left(\bar{\lambda}, K, P\right)$. Inserting short-run solutions for sectoral capital-labor ratios and sectoral labor into production functions (16) allows us to solve for sectoral output: $Y^j = Y^j\left(\bar{\lambda}, K, P\right)$.

where we have substituted the optimal investment rule $v(.)$ given by (13). Eq. (21) can be solved for the relative price of non tradables:

$$P = P\left(\bar{\lambda}, K, Q, G^N\right). \tag{22}$$

It is worth mentioning that in contrast to the standard Rybczynski effect, as long as there is a difficulty in reallocating labor across sectors, a rise in the shadow value of wealth that increases labor supply or a rise in the stock of physical capital has an expansionary effect on non traded output, irrespective of sectoral capital intensities. As a result, the relative price of non tradables depreciates, i.e., $P_{\bar{\lambda}} < 0$ and $P_K < 0$. Conversely, a rise in the shadow value of installed capital, Q, which stimulates investment or an increase in government expenditure on non tradables, G^N, causes the relative price, P, to appreciate, i.e., $P_Q > 0$ and $P_{G^N} > 0$.

The adjustment of the open economy towards the steady state is described by a dynamic system which comprises two equations that form a separate subsystem in K and Q. The first equation corresponds to the non traded goods market clearing condition. The second equation is described by (12e) which equalizes the rates of return on domestic equities and foreign bonds, $r^\star$. The dynamic system reads as:[19]

$$\begin{aligned}
\dot{K} \equiv \Upsilon\left(K, Q, G^N\right) &= \frac{Y^N\left(K, P(.), \bar{\lambda}\right) - C^N\left(\bar{\lambda}, P(.)\right) - G^N}{P_J'\left(P(.)\right)} - \delta_K K \\
&- \frac{K}{2\kappa}\left[\frac{Q}{P_J'\left(P(.)\right)} - 1\right]^2, \qquad (23a)\\
\dot{Q} \equiv \Sigma\left(K, Q, G^N\right) &= \left(r^\star + \delta_K\right) Q - \left[R\left(K, P(.)\right) + P_J(P(.))\frac{\kappa}{2} v(.)\left(v(.) + 2\delta_K\right)\right], \qquad (23b)
\end{aligned}$$

where $P(.)$ is given by (22) and $R = R(K, P)$ is the return on domestic capital which is a decreasing function of physical capital and an increasing function of P, i.e., $R_K < 0$ and $R_P > 0$.

Regarding the allocation of government consumption in good $j = T, N$, we consider a rise in government consumption which is split between non tradables and tradables in accordance with their respective share in government expenditure which we denote by ω_{G^N} and $\omega_{G^T} \equiv 1 - \omega_{G^N}$, respectively; more specifically, denoting the long-term values with a tilde, we have in linearized form:

$$\tilde{P}\left(G^N(t) - \tilde{G}^N\right) = \omega_{G^N}\left(G(t) - \tilde{G}\right), \quad \left(G^T(t) - \tilde{G}^T\right) = \left(1 - \omega_{G^N}\right)\left(G(t) - \tilde{G}\right). \tag{24}$$

As detailed in section 5.1, since ω_{G^N} is substantial relative to ω_{G^T}, the rise in government consumption is biased toward non tradables.

Linearizing (23a) and (23b) in the neighborhood of the steady-state and using (24), we

[19] Using eq. (12c) and the fact that $J^N = P_J' J$ with $J = \dot{K} + \delta_K + \frac{K}{2\kappa}\left(\frac{Q}{P_I} - 1\right)^2$, leads to the accumulation equation for physical capital; inserting the optimal investment decision $v(.)$ given by eq. (13) into (12e) leads to the dynamic equation for the shadow price of installed capital (23b).

get in a matrix form:

$$\begin{pmatrix} \dot{K}(t) \\ \dot{Q}(t) \end{pmatrix} = \begin{pmatrix} \Upsilon_K & \Upsilon_Q \\ \Sigma_K & \Sigma_Q \end{pmatrix} \begin{pmatrix} K(t) - \tilde{K} \\ Q(t) - \tilde{Q} \end{pmatrix} + \begin{pmatrix} \varepsilon_K \\ \varepsilon_Q \end{pmatrix} \begin{pmatrix} G(t) - \tilde{G} \\ G(t) - \tilde{G} \end{pmatrix} \tag{25}$$

where the coefficients of the Jacobian matrix are partial derivatives of (23a) and (23b) evaluated at the steady-state, e.g., $\Upsilon_K = \frac{\partial \Upsilon}{\partial K}$, and the direct effects of an exogenous change in government spending on K and Q are described by $\varepsilon_K = \frac{\partial \Upsilon}{\partial G}$ and $\varepsilon_Q = \frac{\partial \Sigma}{\partial G}$, also evaluated at the steady-state.

To determine the solutions for physical capital and the shadow value of installed capital, we have to set the endogenous response of government spending to an exogenous fiscal shock. In order to account for the non monotonic pattern of the dynamic adjustment of government consumption in line with our evidence (see Figure 1(a)), we assume that the deviation of government spending relative to its initial value as a percentage of initial GDP is:

$$\frac{G(t) - \tilde{G}}{\tilde{Y}} = e^{-\xi t} - (1 - g)\, e^{-\chi t}, \tag{26}$$

where $g > 0$ parametrizes the magnitude of the exogenous fiscal shock, $\xi > 0$ and $\chi > 0$ parametrize the degree of persistence of the fiscal shock; as ξ and χ take higher values, government spending returns to its initial level more rapidly. More specifically, eq. (26) allows us to generate an inverted U pattern for the endogenous response of $G(t)$: if $\chi > \xi$, we have $\dot{G}(t) > 0$ following the exogenous fiscal shock and then government consumption declines after reaching a peak at some time t. As χ takes values closer to ξ, government spending reaches a peak more rapidly.

Denoting the negative eigenvalue by ν_1 and the positive eigenvalue by ν_2, applying standard method to solve systems of deterministic first order linear differential equations and making use of (26), the general solutions for K and Q can be written in a compact form:[20]

$$K(t) - \tilde{K} = X_1(t) + X_2(t), \quad Q(t) - \tilde{Q} = \omega_2^1 X_1(t) + \omega_2^2 X_2(t), \tag{27}$$

where ω_2^i is the element of the eigenvector associated with the eigenvalue ν_i (with $i = 1, 2$) and $X_1(t)$ and $X_2(t)$ are solutions which characterize the trajectory of physical capital and the shadow value of capital:

$$X_1(t) = e^{\nu_1 t}\left[\left(K_0 - \tilde{K}\right) + \Gamma_2\left(1 - \Theta_2\right) - \Gamma_1\left(1 - \Theta_1\right)\right] + \Gamma_1\left(e^{-\xi t} - \Theta_1 e^{-\chi t}\right), \tag{28a}$$

$$X_2(t) = -\Gamma_2\left(e^{-\xi t} - \Theta_2 e^{-\chi t}\right), \tag{28b}$$

where $\Gamma_i = -\frac{\Phi_i \tilde{Y}}{\nu_1 - \nu_2}\frac{1}{(\nu_i + \xi)}$, $\Phi_1 = (\Upsilon_K - \nu_2) + \Upsilon_Q \varepsilon_Q$, $\Phi_2 = (\Upsilon_K - \nu_1) + \Upsilon_Q \varepsilon_Q$, and $\Theta_i = (1 - g)\frac{\nu_i + \xi}{\nu_i + \chi}$ (with $i = 1, 2$). When the shock is permanent, $X_2(t) = 0$ while $X_1(t)$ reduces

[20] See e.g., Buiter [1984] who presents the continuous time adaptation of the method of Blanchard and Kahn. We find numerically that the determinant of the Jacobian matrix is negative for all parametrization, regardless of sectoral capital intensities. Since the number of predetermined variables (K) equals the number of negative eigenvalues, and the number of jump variables (Q) equals the number of positive eigenvalues, there is a unique one-dimensional convergent path towards the steady state.

to $e^{\nu_1 t}\left(K_0 - \tilde{K}\right)$. Because our objective is to account for VAR evidence, we restrict our attention to a temporary fiscal shock.

Using the fact that $RK + WL = Y^T + PY^N$ and inserting the market clearing condition for non tradables $Y^N = C^N + G^N + J^N$ into (7) gives the current account equation:

$$\dot{B} \equiv \Xi\left(B, K, Q, P(.), G\right) = r^\star B + Y^T\left(K, P(.)\right) - C^T\left(P(.)\right) - G^T - J^T, \tag{29}$$

where we substitute appropriate short-run static solutions along with $P(.)$ given by eq. (22). Using the fact that traded investment J^T can be written as $\left(1-\alpha_J\right)P_J J$ with $J = \frac{Y^N - C^N - G^N}{P_J'}$ and inserting the optimal investment decision (13), linearizing (29) around the steady state, substituting the solutions for $K(t)$ and $Q(t)$ given by (27), solving and invoking the transversality condition, yields the solution for traded bonds:

$$\begin{aligned} B(t) - \tilde{B} &= \frac{\omega_B^1}{\nu_1 - r^\star} e^{\nu_1 t} - \frac{\Xi_G \tilde{Y}}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right) - \frac{N_1 \Gamma_1}{\xi + r^\star}\left(e^{-\xi t} - \Theta_1' e^{-\chi t}\right), \\ &+ \frac{N_2 \Gamma_2}{\xi + r^\star}\left(e^{-\xi t} - \Theta_2' e^{-\chi t}\right), \end{aligned} \tag{30}$$

where $\omega_B^1 = \left[\Xi_K + \Xi_Q \omega_2^1\right]\left[\left(K_0 - \tilde{K}\right) + \Gamma_2\left(1 - \Theta_2\right) - \Gamma_1\left(1 - \Theta_1\right)\right]$, with $\Xi_K = \frac{\partial \Xi}{\partial K}$, $\Xi_Q = \frac{\partial \Xi}{\partial Q}$, and $\Xi_G = \frac{\partial \Xi}{\partial G}$ evaluated at the steady-state, and $\Theta' = (1-g)\frac{r^\star + \xi}{r^\star + \chi}$, and $\Theta_i' = \Theta_i \frac{r^\star + \xi}{r^\star + \chi}$ (with $i = 1, 2$). To ultimately remain solvent, the open economy must satisfy the following condition:

$$\tilde{B} - B_0 = -\frac{\omega_B^1}{\nu_1 - r^\star} + \frac{\omega_B^2}{\xi + r^\star}, \tag{31}$$

where B_0 is the initial stock of traded bonds and $\omega_B^2 = \Xi_G \tilde{Y}\left(1 - \Theta'\right) + \left[\Xi_K + \Xi_Q \omega_2^1\right]\Gamma_1\left(1 - \Theta_1'\right) - \left[\Xi_K + \Xi_Q \omega_2^2\right]\Gamma_2\left(1 - \Theta_2'\right)$. As emphasized by Schubert and Turnovsky [2002], the assumption $\beta = r^\star$ implies that temporary policies have permanent effects. In this regard, eq. (31) determines the steady-state change of the net foreign asset position following a temporary fiscal expansion.

3.5 The Steady State

We now characterize the long-run equilibrium by using a graphical apparatus and discuss the steady-state effects of a temporary fiscal expansion. In order to avoid unnecessary complications, we normalize sectoral TFPs, i.e., Z^T and Z^N, to 1. Setting $\dot{Q} = \dot{K} = 0$ into (11) and (12e), we obtain equality between the marginal product of capital and the capital rental cost:

$$\tilde{R} \equiv \left(1 - \theta^T\right)\left(\tilde{k}^T\right)^{-\theta^T} = P_J\left(\tilde{P}\right)\left(\delta_K + r^\star\right), \tag{32}$$

where we use the fact that $\tilde{Q} = P_J\left(\tilde{P}\right)$. Since capital installation costs are absent in the long-run, the market clearing condition for non tradables (22) reduces to $\tilde{Y}^N = \tilde{C}^N + G^N + \tilde{I}^N$ with $\tilde{I}^N = P_J' \delta_K \tilde{K}$. Setting $\dot{B} = 0$ into (23a) and denoting net exports by $\tilde{NX}$, the market clearing condition for tradables can be written $\tilde{Y}^T = \tilde{C}^T + G^T + \tilde{I}^T + \tilde{NX}$. Combining the market clearing conditions for tradables and non tradables, and denoting by $\upsilon_{I^j} \equiv \tilde{I}^j/\tilde{Y}^j$ the ratio of investment to output in sector $j = T, N$, $\upsilon_{NX} \equiv \tilde{NX}/\tilde{Y}^T$ the ratio of net exports to traded output, yields:

$$\frac{\tilde{Y}^T \left(1 - \upsilon_{NX} - \upsilon_{I^T} - \upsilon_{G^T}\right)}{\tilde{Y}^N \left(1 - \upsilon_{I^N} - \upsilon_{G^N}\right)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{33}$$

where the allocation of aggregate consumption expenditure between traded and non traded goods follows from (14).

To characterize the steady state, we can either focus on the goods market or the labor market. We choose to concentrate on the former. The steady state is summarized graphically by two-schedules in the $(y^T - y^N, p)$-space, as shown in Figure 5. Combining the market clearing condition given by (33) with (14), and taking the logarithm yields the goods market equilibrium (GME henceforth) schedule:

$$\left(\tilde{y}^T - \tilde{y}^N\right)\Big|^{GME} = x + \phi\tilde{p} + \ln \frac{\left(1 - \upsilon_{I^N} - \upsilon_{G^N}\right)}{\left(1 - \upsilon_{NX} - \upsilon_{I^T} + \upsilon_{G^T}\right)}, \tag{34}$$

where $x = \ln\left(\frac{\varphi}{1-\varphi}\right)$. The GME-schedule is upward-sloping in the $(y^T - y^N, p)$-space with a slope equal to $1/\phi$. We assume that $\phi = 1$ so that the GME-schedule coincides with the 45° dotted line. When $\phi < 1$, the GME-equilibrium becomes steeper.

< Please insert Figure 5 about here >

The labor market equilibrium (LME henceforth) schedule is downward-sloping in the $(y^T - y^N, p)$-space since an increase in p allows non traded producers to pay higher wages, which in turn encourages workers to supply more labor in that sector and thus lowers traded output relative to non traded output. Formally, the LME-schedule is given by:[21]

$$\left(\tilde{y}^T - \tilde{y}^N\right)\Big|^{LME} = -\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]\tilde{p} + \ln \Pi. \tag{35}$$

To begin with, a temporary fiscal shock has permanent effects on macroeconomic aggregates since the marginal utility of wealth must increase for the intertemporal solvency condition (31) to hold. The resulting negative wealth effect induces Ricardian agents to respond to higher tax burden by lowering consumption and increasing labor supply. Because the shock is temporary, households reduce savings, as they try to avoid a large reduction in consumption and/or a large increase in labor supply. The decline in private savings leads to a decumulation in both domestic capital and net foreign assets so that the open economy runs a current account deficit along the transitional path. Because interest receipts from traded bond holdings are reduced, the balance of trade must improve in the long-run. Higher demand for tradables increases traded output relative to non traded output and depreciates

[21] Using (18c) to determine the relative wage Ω, inserting the optimal allocation of aggregate labor supply across sectors (15) and production functions (16), using (32) and (18a) to eliminate the sectoral capital-labor ratios, yields the LME-schedule (35), where Π is a term composed of fixed parameters which is given by:

$$\Pi = \frac{\vartheta}{1-\vartheta}\left(r^\star + \delta_K\right)^{\left(\frac{\theta_T - \theta_N}{\theta_T \theta_N}\right)(1+\epsilon)} \frac{\left[\left(\theta_T\right)^{\epsilon\theta_T}\left(1-\theta_T\right)^{(1-\theta_T)(1+\epsilon)}\right]^{1/\theta_T}}{\left[\left(\theta_N\right)^{\epsilon\theta_N}\left(1-\theta_N\right)^{(1-\theta_N)(1+\epsilon)}\right]^{1/\theta_N}} > 0.$$

the relative price of non tradables. Graphically, as shown in Figure 5, the GME-schedule shifts to the right along the LME-schedule. Hence, traded output increases relative to non traded output while the relative price of non tradables falls in the long-run. In the next section, we discuss impact effects resulting from government spending shock.

4 Imperfect Mobility of Labor and the Transmission of Government Spending

In order to emphasize how a difficulty in reallocating labor across sectors modifies the fiscal transmission, we solve the model analytically by abstracting from physical capital.[22] Building on our panel VAR evidence which reveals that a rise in government consumption disproportionately benefits the non traded sector, we consider a rise in government consumption which is fully biased toward non tradables but discuss the consequences of an increase in G^T as well at the end of the section. As the shocks identified in the VAR literature are transitory, we focus the theoretical analysis on temporary increases in government spending. To avoid unnecessary complications, we solve the model by assuming that the endogenous response to an exogenous fiscal shock is governed by the following dynamic equation:

$$dG(t) = \tilde{Y} g e^{-\xi t}. \tag{36}$$

According to (36), government spending rises initially by g percentage points of GDP and declines monotonically at rate ξ.

Both sectors use labor as the sole input in a constant returns to scale technology, i.e., $Y^j = L^j$ with $j = T, N$. Because there is a difficulty in reallocating labor, sectoral wages do not equalize, i.e., $1 = W^T$ and $P = W^N$. The key equations characterizing optimal household behavior are given by first-order conditions described by (12a)-(12b) and (14)-(15). The market clearing conditions for non traded and traded goods read as $Y^N = C^N + G^N$ and $\dot{B} = r^\star B + Y^T - C^T - G^T$, respectively.

4.1 Solving Analytically the Model

Substituting first (12a) into $C^N = \alpha_C \frac{P_C}{P} C$, (12b) and $W^N = P$ into $L^N = \alpha_L \frac{W}{W^N} L$, the market clearing condition for the non traded good can be rewritten as follows:

$$\frac{\alpha_L \bar{\lambda}^{\sigma_L} W^{1+\sigma_L}}{P} = \frac{\alpha_C P_C^{1-\sigma_C} \bar{\lambda}^{-\sigma_C}}{P} + G^N. \tag{37}$$

Totally differentiating (37), using the fact that $\hat{\alpha}_L = (1+\epsilon)(1-\alpha_L)\hat{P}$, $\hat{\alpha_C} = (1-\phi)(1-\alpha_C)\hat{P}$, $\hat{W} = \alpha_L \hat{P}$ and $\hat{P}_C = \alpha_C \hat{P}$, collecting terms, and denoting by a hat the percentage deviation relative to initial steady-state, the change in the relative price of non tradables is described by:

$$\hat{P} = \frac{-\left[\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C\right]}{\Psi} \hat{\bar{\lambda}} + \frac{P dG^N}{Y} \Psi > 0, \tag{38}$$

[22] The implications of physical capital accumulation into the setup are discussed in the next section.

where we set $\Psi = \alpha_L \left[\epsilon\left(1-\alpha_L\right)+\sigma_L\alpha_L\right] + \omega_C\alpha_C\left[\left(1-\alpha_C\right)\phi+\alpha_C\sigma_C\right] > 0$ and we denote by $\omega_C = \frac{P_C C}{Y}$ consumption expenditure as a share of GDP; $\alpha_C = \frac{PC^N}{P_C C}$ and $\alpha_L = \frac{PY^N}{Y} = \frac{W^N L^N}{WL}$ correspond to the non tradable content of consumption expenditure and labor compensation, respectively;[23]

Substituting $L^T = \left(1-\alpha_L\right)(W)^{1+\sigma_L}\left(\bar{\lambda}\right)^{\sigma_L}$ and $C^T = \left(1-\alpha_C\right)P_C^{1-\sigma_C}\bar{\lambda}^{-\sigma_C}$ into the market clearing condition for traded goods leads to:

$$\dot{B}(t) = r^\star B(t) + \left(1-\alpha_L(t)\right)W(t)^{1+\sigma_L}\bar{\lambda}^{\sigma_L} - \left(1-\alpha_C(t)\right)P_C(t)^{1-\sigma_C}\bar{\lambda}^{-\sigma_C} - G^T. \tag{39}$$

Using the fact that both $\bar{\lambda}$ and G^T are constant over time, linearizing (39) in the neighborhood of the steady-state, substituting the law of motion of government spending (36), solving and invoking the transversality condition leads to the solution for $B(t)$:

$$B(t) - \tilde{B} = \frac{\Upsilon_G \tilde{Y}}{\xi + r^\star} g e^{-\xi t}, \tag{40}$$

consistent with the intertemporal solvency condition

$$\left(\tilde{B} - B_0\right) = -\frac{\Upsilon_G \tilde{Y}}{\xi + r^\star} g, \tag{41}$$

where $\Upsilon_G = \frac{\left[(1-\alpha_L)\alpha_L(\epsilon-\sigma_L)+(1-\alpha_C)\omega_C\alpha_C(\phi-\sigma_C)\right]}{\Psi} \gtrless 0$. The sign of the term Υ_G is ambiguous since $\epsilon \gtreqless \sigma_L$ and $\phi \gtreqless \sigma_C$. Intuitively, by pushing up the relative price of non tradables, higher government spending exerts two opposite effects on the current account. On the one hand, the appreciation in the relative price P raises the wage rate and the consumption price index which in turn leads workers to supply more labor in both sectors and to cut consumption expenditure. On the other hand, an increase in the relative price of non tradables encourages agents to substitute traded for non traded goods and to shift hours worked toward the non traded sector as the non traded wage increases. The former channel tends to improve the current account while the latter exerts a negative impact. Assuming $\epsilon > \sigma_L$ along with $\phi \simeq \sigma_C$, then we have $\Upsilon_G > 0$, so that the current account deteriorates following a temporary fiscal expansion, in line with our VAR evidence.

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition (39) for the traded good evaluated at the steady-state (i.e., $\dot{B}(t) = 0$), using the fact that in the long-run government spending is restored to its initial level (i.e., $dG^N = 0$); next, inserting (41) into the resulting expression leads to the change in the equilibrium value of the marginal utility of wealth:

$$\hat{\bar{\lambda}} = \frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi + r^\star} g > 0, \tag{42}$$

where $\Psi > 0$, $\Upsilon_G > 0$, $\xi > 0$, $g > 0$, and we set

$$\Gamma = \Psi\left\{\left[\left(1-\alpha_L\right)\sigma_L + \omega_C\left(1-\alpha_C\right)\sigma_C\right] + \left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\Upsilon_G\right\} > 0. \tag{43}$$

[23]Because we abstract from physical capital and assume constant returns to scale technology, the non tradable content of labor compensation, $\frac{W^N L^N}{WL}$, coincides with the non tradable content of GDP, $\frac{PY^N}{Y}$.

4.2 Implications of Imperfect Mobility of Labor

What are the implications of imperfect mobility for fiscal transmission? As in a model that imposes perfect mobility of labor, a rise in government consumption produces an increase in the shadow value of wealth as taxes must be raised to balance the budget which reduces households' disposable income. It can be shown analytically that the term $\frac{\Psi\Upsilon_G}{\Gamma}$ in eq. (42) increases with the elasticity of labor supply across sectors, ϵ. Hence, as the difficulty in reallocating labor across sectors is reduced, a government spending shock further raises $\bar{\lambda}$, the largest increase being obtained when labor is perfectly mobile across sectors. Formally, if we let ϵ tend toward infinity, we have $\lim_{\epsilon\to\infty}\hat{\bar{\lambda}} = \frac{1}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g > 0$.[24] Intuitively, as discussed below, the relative price of non tradables is fixed when labor can move freely across sectors and thus does not influence private consumption; consequently, for the intertemporal solvency condition to hold, the rise in the shadow value of wealth must be greater.

The negative wealth effect encourages agents to work more and cut real expenditure. Because the decline in real expenditure is spread over the two goods, the rise in G^N more than offsets the fall in C^N. As long as there is a difficulty in reallocating labor, an excess demand arises in the non traded goods market, which in turn causes the relative price of non tradables to appreciate. Evaluating (37) at time $t = 0$, inserting (42), and using the fact that $\frac{\tilde{P}dG^N(0)}{\tilde{Y}} = \frac{dG(0)}{\tilde{Y}} = g > 0$, leads to the initial response of the relative price of non tradables:

$$\hat{P}(0) = \left\{1 - \frac{[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C]\,\Upsilon_G\Psi}{\Gamma}\frac{r^\star}{\xi + r^\star}\right\}\frac{g}{\Psi} > 0, \tag{44}$$

where the sign in braces is unambiguously positive since $0 < [\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C]\,\frac{\Upsilon_G\Psi}{\Gamma} < 1$ and $0 < \frac{r^\star}{\xi+r^\star} < 1$. As the degree of labor mobility across sectors increases, a government spending shock results in a lower appreciation in the relative price of non tradables. The reason is that the shadow value of wealth, $\bar{\lambda}$, further increases. Hence, non traded output increases more while consumption falls by a larger amount. In a model imposing perfect mobility of labor across sectors (i.e., $\epsilon \to \infty$), the relative price of non tradables remains unaffected by a fiscal shock. Intuitively, a larger supply of non tradables triggered by the shift of labor toward the non traded sector allows to meet additional demand for non tradables so that the relative price is unchanged. Conversely, as long as there is a difficulty in reallocating labor across sectors, the rise in non traded output is not sufficent to meet the higher demand for non tradables. The subsequent excess demand for non tradables causes the relative price P to appreciate on impact, which provides an incentive to increase output and thus to hire more workers. This mechanism contributes to magnifying the sectoral impact of fiscal policy in a model with limited labor mobility.

To persuade workers who experience mobility costs to increase their hours worked in the non traded sector, non traded firms must pay higher wages. The subsequent shift of

[24] In a Technical Appendix, we show that $\lim_{\epsilon\to\infty}\frac{\Psi\Upsilon_G}{\Gamma} = \frac{1}{\sigma_L+\omega_C\sigma_C}$.

labor toward the non traded sector unambiguously raises hours worked in the non traded sector:[25]

$$\alpha_L \hat{L}^N(0) = \frac{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]}{\Psi}\left[1-\left(\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C\right)\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}\right]g + \alpha_L\sigma_L\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}g>0, \tag{45}$$

where the response of non traded labor is measured in percentage points of total labor. According to (45), the change in non traded labor is the result of two reinforcing effects. First, as shown by the first term on the RHS of (45), a fiscal shock tends to increase hours worked in the non traded sector by raising the wage in this sector (i.e., W^N), and all the more so the greater the elasticity of substitution between traded and non traded employment, ϵ. Second, as can be seen in the second term on the RHS of (45), which is positive, the negative wealth effect causes agents to supply more labor, which raises L^N in percent of total employment by an amount equal to α_L. If we let ϵ tend toward infinity, eq. (45) reduces to $\lim_{\epsilon\to\infty}\alpha_L\hat{L}^N(0)=\left[1-\frac{\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}\right]g>0$. In order to be able to contrast the case of perfect labor mobility with the situation of limited labor mobility, it is useful to neutralize the effect of higher labor supply by setting $\sigma_L=0$. In this case, we have $\alpha_L\hat{L}^N(0)=\frac{\alpha_L\epsilon(1-\alpha_L)}{\Psi}\left[1-\alpha_C\omega_C\sigma_C\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}\right]g>0$. On the one hand, as ϵ takes higher values, the excess demand in the non traded goods market leads to a larger reallocation of labor toward the non traded sector. On the other hand, as labor mobility increases, the excess demand gets lower which mitigates the shift of hours worked toward the non traded sector. As discussed in the next section, our numerical results reveal that the latter effect predominates for large values of ϵ so that L^N rises more in the baseline scenario with limited labor mobility than if labor were perfectly mobile across sectors.

Traded labor falls or rises depending on whether labor mobility captured by ϵ is high or low:[26]

$$\left(1-\alpha_L\right)\hat{L}^T(0) = -\frac{\left(1-\alpha_L\right)\alpha_L\left(\epsilon-\sigma_L\right)}{\Psi}\left[1-\left(\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C\right)\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}\right]g - \left(1-\alpha_L\right)\sigma_L\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}g \lesseqgtr 0. \tag{46}$$

According to (46), as long as $\epsilon>\sigma_L$, the initial reaction of traded labor to a fiscal shock is the result of two opposite effects. More precisely, the first term on the RHS of (46) captures the impact of increased non traded wages on L^T. On the one hand, a higher W^N causes a shift of labor away from the traded sector proportional to ϵ. On the other hand, the

[25]Substituting $L=\left(\bar{\lambda}W\right)^{\sigma_L}$ and $W^N=\frac{P}{\mu}$ into $L^N=\alpha_L\frac{W}{W^N}L$ leads to $L^N=\alpha_L\frac{\mu}{P}\left(W\right)^{1+\sigma_L}\bar{\lambda}^{\sigma_L}$. Totally differentiating, using the fact that $\hat{\alpha}_L=\left(\epsilon+1\right)\left(1-\alpha_L\right)\hat{P}$ and $\hat{W}=\alpha_L\hat{W}^N$ with $\hat{W}^N=\hat{P}$, one obtains $\hat{L}^N=\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]\hat{P}+\sigma_L\hat{\bar{\lambda}}$. Evaluating at time $t=0$, substituting (42) and (44), and collecting terms leads to eq. (45).

[26]Substituting $L=\left(\bar{\lambda}W\right)^{\sigma_L}$ and $W^T=1$ into $L^T=\left(1-\alpha_L\right)\frac{W}{W^T}L$ leads to $L^T=\left(1-\alpha_L\right)\left(W\right)^{1+\sigma_L}\bar{\lambda}^{\sigma_L}$. Totally differentiating, using the fact that $\widehat{\left(1-\alpha_L\right)}=-\left(\epsilon+1\right)\alpha_L\hat{P}$ and $\hat{W}=\alpha_L\hat{P}$, one obtains $\hat{L}^T=-\alpha_L\left(\epsilon-\sigma_L\right)\hat{P}+\sigma_L\hat{\bar{\lambda}}$. Evaluating at time $t=0$, substituting (42) and (44), and collecting terms leads to eq. (46).

subsequent increase in the aggregate wage provides an incentive to supply more labor, and all the more so the higher the value of σ_L. When $\epsilon > \sigma_L$, the former effect more than offsets the latter. Hence, as non traded wages go up, L^T falls. The second term on the RHS of (46) indicates that the negative wealth effect increases total hours worked, the traded sector receiving a share equal to $(1-\alpha_L)$. While the effect of a government spending shock on L^T is ambiguous, traded labor falls, in line with the evidence, as long as the elasticity of labor supply, σ_L, is not too high. If we let ϵ tend toward infinity, traded labor unambiguously declines; formally, we have $\lim_{\epsilon \to \infty} (1-\alpha_L)\, \hat{L}^T(0) = -\left[1 - \frac{\sigma_L + \alpha_C \omega_C \sigma_C}{\sigma_L + \omega_C \sigma_C} \frac{r^\star}{\xi + r^\star}\right] g < 0$. Thus, when workers' costs of switching sectors are nil, labor must be shifted toward the non traded sector to meet additional demand. In contrast, if labor is weakly mobile across sectors, L^T merely falls or even rises as workers' mobility costs put upward pressure on the aggregate wage which magnifies the positive response of labor supply, thus making the rise in non traded labor large enough to meet increased demand for non tradables.

Because $Y^j = L^j$, eqs. (45) and (46) measure the fiscal multiplier on impact for non tradables and tradables, respectively. The magnitude of sectoral fiscal multipliers depend on four parameters: the degree of labor mobility captured by ϵ, the degree of persistence of the fiscal shock, ξ, the elasticity of labor supply, σ_L, and the non tradable content of consumption expenditure, α_C. Since we discuss the implications of ϵ for sectoral output shares below, we focus first on the other three parameters. As the values of ξ increase, government spending reverts to its initial level more rapidly, which mitigates the present value of the necessary tax increases and thus moderates the rise in $\bar{\lambda}$. Hence, excess demand in the non traded goods market is higher so that the relative price P appreciates by a larger amount, which further increases the non traded output multiplier and drives down the traded output multiplier of government spending. When agents are more willing to supply labor, the positive response of total hours worked to a rise in government spending is amplified. Higher L is split between both sectors and thus raises both sectoral fiscal multipliers. In contrast, raising the non tradable content of consumption expenditure, α_C, increases the fiscal multiplier for tradables (which thus becomes less negative) and lowers the fiscal multiplier for non tradables (which becomes less positive). Intuitively, at the final steady-state, net exports must be greater for the open economy to be solvent. To improve the balance of trade in the long-run, output of tradables must be higher while consumption in tradables must be lower. Because the share of tradables in the economy is lower, the marginal utility of wealth must increase by a larger amount to lower consumption in tradables and thus increase net exports. As the negative wealth effect is stronger, the excess of demand for non tradables and thus the appreciation in the relative price P is smaller, which mitigates the shift of resources toward the non traded sector.

In section 2, we documented a positive relationship between the magnitude of the sectoral impact of a government spending shock and the degree of labor mobility across sectors. In the data, the sectoral impact is measured by the initial response of the sectoral output share. This is calculated as the growth differential in GDP units between sectoral value added at constant prices and real GDP denoted by Y_R. Totally differentiating non traded output and real GDP, the latter being equal to overall labor compensation WL with $L = \left(\bar{\lambda}W\right)^{\sigma_L}$, and evaluating at time $t = 0$ leads to the impact response of the output share of non tradables in real terms:[27]

$$\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) = \alpha_L \left(1 - \alpha_L\right) \epsilon \hat{P}(0) > 0, \tag{47}$$

where $\hat{P}(0)$ is given by eq. (44). According to (47), the appreciation in the relative price of non tradables and the subsequent increase in non traded wages leads to a shift of labor toward the non traded sector. While higher non traded output relative to real GDP increases its relative size, a rise in the parameter ϵ exerts two opposite effects on the magnitude of the positive response of the output share of non tradables. On the one hand, as the parameter ϵ on the RHS of (47) takes higher values, more labor shifts toward the non traded sector, thus amplifying the positive response of the output share of non tradables. On the other hand, as mentioned above, the negative wealth effect turns out to be greater as labor becomes more mobile across sectors; as a result, increased labor mobility mitigates the excess demand in the non traded goods market and thus the appreciation in the relative price of non tradables as reflected in smaller values of $\hat{P}(0) > 0$. While we find analytically that raising ϵ may amplify or mitigate the impact response of the output share of non tradables, it is most likely that the relationship between the two variables displays an inverted U-shaped pattern; more specifically, it is clear that the positive influence of increased labor mobility is large when ϵ is initially small since in this case $\hat{P}(0) > 0$ is high.[28] Conversely, the positive influence on the output share of increased labor mobility gets much lower if ϵ is initially high because $\hat{P}(0) > 0$ is low. As the traded sector experiences a labor outflow, its expression is exactly the opposite of (47), and thus the relative size of the traded sector

[27] Real GDP is the sum of value added at constant prices, i.e., $Y_R = Y^T + \tilde{P}Y^N$ where $\tilde{P}$ corresponds to the initial steady-state value for the relative price of non tradables. Using the fact that $Y_R = WL$, totally differentiating real GDP and inserting $\hat{L} = \sigma_L \hat{\bar{\lambda}} + \sigma_L \hat{W}$ with $\hat{W} = \alpha_L \hat{P}$, leads to $\hat{Y}_R = \sigma_L \hat{\bar{\lambda}} + \alpha_L \sigma_L \hat{P}$. Using the fact that $\hat{Y}^N = \left[\epsilon\left(1 - \alpha_L\right) + \alpha_L \sigma_L\right] \hat{P} + \sigma_L \hat{\bar{\lambda}}$, multiplying the growth differential between non traded output and real GDP (i.e., $\hat{Y}^N - \hat{Y}_R$) by α_L and evaluating at time $t = 0$ leads to eq. (47).

[28] Formally, differentiating (47) w.r.t. ϵ leads to:

$$\begin{aligned}
\frac{\partial \alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)}{\partial \epsilon} &= \alpha_L \left(1 - \alpha_L\right) \hat{P}(0) + \left(1 - \alpha_L\right) \epsilon \frac{\partial \hat{P}(0)}{\partial \epsilon}, \\
&= \hat{P}(0) \alpha_L \left(1 - \alpha_L\right) \left[1 - \frac{\alpha_L \left(1 - \alpha_L\right) \epsilon}{\Psi}\right] \\
&- \alpha_L \left(1 - \alpha_L\right) \epsilon \frac{g}{\Psi} \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right] \frac{r^\star}{\xi + r^\star} \frac{\partial \frac{\Psi \Upsilon_G}{\Gamma}}{\partial \epsilon} \gtrless 0,
\end{aligned}$$

where $\frac{\partial \frac{\Psi \Upsilon_G}{\Gamma}}{\partial \epsilon} > 0$. The first term on the RHS of the above equation shows that the output share of non tradables further increases on impact when the degree of labor mobility captured by ϵ is higher. Conversely, the second term on the RHS reflects the fact that as ϵ increases, the shadow value of wealth rises further which in turn moderates the increase in the relative price of non tradables. While the sign of the above expression is ambiguous, the former effect is low when ϵ takes high values because $\hat{P}(0) > 0$ in front of the first term on the RHS is small so that the latter effect may predominate in this case.

declines following a rise in government consumption. In the same way as for non tradables, raising ϵ exerts two opposite effects on the impact response of the output share of tradables.

In the special case of perfect mobility of labor, the initial response of the output share of non tradables can be rewritten as follows:[29]

$$\lim_{\epsilon\to\infty} \alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) = \left[1 - \left(\frac{\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C}{\sigma_L + \omega_C\sigma_C}\frac{r^\star}{\xi + r^\star}\right)\right] g > 0. \tag{48}$$

As mentioned above, the magnitude of the rise in the output share of non tradables can be smaller with perfect mobility of labor than if labor mobility were limited. Intuitively, while workers can costlessly shift hours worked from one sector to another, because the shadow value of wealth has to increase more to drive down consumption as the consumption price index is fixed, excess demand in the non traded goods market is less. The latter influence may offset the former. This ambiguity will be addressed numerically.

How does the real consumption wage react to a fiscal shock? Because the traded wage must stick to the marginal product of labor, i.e., $W^T = 1$, W^T remains unchanged. In contrast, the non traded wage increases by the same proportion as the relative price of non tradables, i.e., $\hat{W}^N = \hat{P}$; it follows that a fiscal shock unambiguously raises the relative wage (i.e., $\Omega \equiv W^N/W^T$). Higher non traded wages increase the aggregate wage W in proportion to the non tradable content of labor compensation, i.e., $\hat{W} = \alpha_L\hat{P}$. Differentiating W/P_C, using the fact that $\hat{P}_C = \alpha_C\hat{P}$, the initial response in the real consumption wage is given by:

$$\mathrm{d}\left(\frac{W}{P_C}\right)(0) = \frac{W}{P_C}\left(\alpha_L - \alpha_C\right)\hat{P}(0) > 0. \tag{49}$$

As long as the non tradable content of labor compensation α_L is higher than the non tradable content of consumption expenditure α_C, the rise in the aggregate wage index more than offsets the increase in the consumption price index so that a fiscal shock raises initially the real consumption wage W/P_C, in line with the evidence.

We turn to the adjustment of the net foreign asset position. Following a temporary fiscal shock, agents decumulate financial wealth in order to avoid a large reduction in consumption and/or a large increase in labor supply. The decline in private savings triggers a current account deficit along the transitional path, whether labor is perfectly mobile across sectors or not. Differentiating (40) with respect to time leads to the current account in percentage of GDP:

$$\frac{\dot{B}(t)}{\tilde{Y}} = -\Upsilon_G \frac{\xi}{\xi + r^\star} g e^{-\xi t} < 0, \tag{50}$$

where $\Upsilon_G > 0$.

[29] First inserting (44) into eq. (47), letting ϵ tend toward infinity and applying l'Hôpital's rule that implies that $\lim_{\epsilon\to\infty} \frac{\Psi\Upsilon_G}{\Gamma} = \frac{1}{\sigma_L+\omega_C\sigma_C}$ together with $\lim_{\epsilon\to\infty} \frac{\alpha_L(1-\alpha_L)}{\Psi} = 1$ gives eq. (48).

4.3 Implications of a Rise in Public Purchases of Tradables

What are the implications of a rise in government consumption in tradables? Just as after a rise in G^N, an increase in public purchases of traded goods produces a negative wealth effect that encourages agents to lower consumption and supply more labor, both of which being split across sectors. The subsequent decline in consumption in non tradables and the higher hours worked in the non traded sector trigger an excess supply of non tradables, leading to a depreciation in the relative price of non tradables. As a result, labor shifts toward the traded sector. Thus, the output share of non tradables unambiguously declines while the rise in G^T pushes up the output share of tradables. In the special case where $\sigma_C = \phi = 1$, the non traded sector experiences a fall in labor as long as $\epsilon > \sigma_L$.[30] In contrast, the government spending shock, which is fully biased toward traded goods, has an expansionary effect on hours worked in the traded sector through the combined influence of the negative wealth effect and the reallocation of labor toward this sector. While L^T increases and C^T unambiguously declines, the rise in G^T leads to a current account deficit when the fiscal shock is in effect. Finally, because the aggregate wage falls in proportion to the non tradable content of labor compensation, α_L, the real consumption wage declines as long as $\alpha_L > \alpha_C$. In sum, with the exception of the current account deficit, the predictions of the model are at odds with the data when the rise in government consumption is fully biased toward traded goods.

In conclusion, the open economy version of the model can account for the evidence on the aggregate and sectoral effects of a government spending shock as long as public purchases are heavily concentrated on non tradables and labor is imperfectly mobile across sectors. In the following, we analyze numerically the implications of physical capital accumulation and show that the model can account for the evidence quantitatively as long as we allow for limited labor mobility along with capital adjustment costs.

5 Quantitative Analysis

In this section, we analyze quantitatively the effects of a temporary and unanticipated rise in government consumption. For this purpose we solve the model described in section 3 numerically.[31] First we discuss parameter values before turning to the short-term consequences of higher government consumption.

[30] Formally, the response of non traded labor is the result of two opposite effects. On the one hand, higher labor supply triggered by the negative wealth effect increases hours worked in the non traded sector. On the other hand, the depreciation in the relative price of non tradables and the consecutive shift of labor toward the traded sector exerts a negative impact on L^N. Assuming $\sigma_C = \phi = 1$, the latter effect more than offsets the former and thus a rise in G^T drives down hours worked in the non traded sector.

[31] Technically, the assumption $\beta = r^\star$ requires the joint determination of the transition and the steady state.

5.1 Calibration

To calibrate our model, we estimated a set of parameters so that the initial steady state is consistent with the key empirical properties of a representative OECD economy. Our sample covers the sixteen OECD economies in our dataset. Our reference period for the calibration corresponds to the period 1990-2007.[32] Since we calibrate a two-sector model with tradables and non tradables, we pay particular attention to ensure that the non tradable content of the model matches the data. Table 4 summarizes our estimates of the non tradable content of GDP, employment, consumption, gross fixed capital formation, government spending, labor compensation, and gives the share of government spending on the traded and non traded goods in their respective sectoral output, the shares of labor income in output in both sectors, for all countries in our sample. Moreover, columns 12-14 of Table 4 display investment expenditure and government spending as a percentage of GDP together with the labor income share, respectively, for the whole economy. To capture the key properties of a typical OECD economy, chosen as the baseline scenario, we take unweighted average values, as shown in the last line of Table 4. Some of the parameter values can be taken directly from the data, but others like φ, φ_J, ϑ, δ_K together with initial conditions (B_0, K_0) need to be endogenously calibrated to fit a set of aggregate and sectoral ratios.[33] We choose the model period to be one year and therefore set the world interest rate, $r^\star$, which is equal to the subjective time discount rate, β, to 4%.

In light of our discussion above, ϵ plays a key role in fiscal transmission. The degree of labor mobility captured by ϵ is set to 0.75, in line with the average of our estimates shown in the last line of Table 4.[34] Our estimates display a sharp dispersion across countries and we therefore conduct a sensitivity analysis with respect to this parameter. Excluding the estimates of ϵ for Denmark and Norway which are not statistically significant at 10%, estimates of ϵ range from a low of 0.22 for the Netherlands to a high of 1.39 for the U.S. and 1.64 for Spain.[35] Hence, we allow for ϵ to vary between 0.22 and 1.64 in the sensitivity analysis.

Building on our panel data estimates, the elasticity of substitution ϕ between traded

[32] The choice of this period was dictated by data availability for all countries in the sample.

[33] As detailed in a Technical Appendix, the steady-state can be reduced to four equations which jointly determine P (and thus α_C and α_J), Y^T/Y^N (and thus $\frac{L^N}{L}$), K/Y (and thus $\omega_J = \frac{P_J I}{Y}$) and $\upsilon_B = \frac{r^\star B}{Y^T}$ (and thus $\upsilon_{NX} = \frac{NX}{Y^T}$ where we denote net exports by NX). Among the 19 parameters that the model contains, 15 have empirical counterparts while the remaining 4, i.e., φ, φ_J, ϑ, δ_K together with initial conditions (B_0, K_0) must be set in order to match $\alpha_C = \frac{PC^N}{P_C C}$, $\alpha_J = \frac{PI^N}{P_J I}$, $\frac{L^N}{L}$, $\omega_J = \frac{P_J I}{Y}$, and $\upsilon_{NX} = \frac{NX}{Y^T}$ with $NX = Y^T - C^T - G^T - I^T$.

[34] Since estimates of ϵ for Denmark and Norway are not statistically significant at a standard threshold, the values are left blank and we set ϕ to 0.75 which corresponds to the average value. To estimate ϵ, we closely follow Horvath [2000]. We first derive a testable equation by combining first-order conditions for labor supply and labor demand. Details of the derivation of the equation we explore empirically can be found in the Technical Appendix. We next run the regression of the sectoral employment growth arising from labor reallocation across sectors on the ratio of labor compensation in that sector to overall labor compensation, see Appendix B.

[35] Horvath [2000] finds an estimate for ϵ of one for the United States by considering 36 sectors over the period 1948-1985.

and non traded goods is set to 0.77 in the baseline calibration since this value corresponds to the average of estimates shown in the last line of column 15 of Table 4.[36] The weight of consumption in non tradables $1-\varphi$ is set to 0.51 to target a non-tradable content in total consumption expenditure (i.e., α_C) of 53%, in line with the average of our estimates shown in the last line of column 2. We assume that the utility for consumption is logarithmic and thus set the intertemporal elasticity of substitution for consumption, σ_C, to 1.[37] In our baseline parametrization, we set intertemporal elasticity of substitution for labor supply σ_L to 0.4, in line with evidence reported by Fiorito and Zanella [2012], but conduct a sensitivity analysis with respect to this parameter. The weight of labor supply to the non traded sector, $1-\vartheta$, is set to 0.68 to target a non-tradable content of labor compensation of 66%, in line with the average of our estimates shown in the last line of column 6 of Table 4.

In order to assess to what extent our results depend on the assumption of separability in preferences between consumption and labor, we also consider a more general specification for preferences. The functional form is taken from Shimer [2011]:

$$\frac{C^{1-\sigma}V(L)^{\sigma}-1}{1-\sigma}, \quad \text{if} \quad \sigma \neq 1, \quad V(L) \equiv \left(1+(\sigma-1)\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}\right). \tag{51}$$

These preferences are characterized by two crucial parameters: σ_L is the Frisch elasticity of labor supply, and $\sigma > 0$ determines the substitutability between consumption and leisure; if $\sigma > 1$, the marginal utility of consumption increases in hours worked. In contrast, setting $\sigma = 1$ implies that preferences are separable in consumption and labor, as in (6). When we investigate the implications of non separability in preferences, we set $\sigma = 2$ while keeping other parameters unchanged.

We now describe the calibration of production-side parameters. We assume that physical capital depreciates at a rate δ_K of 6% to target an investment-to-GDP ratio of 21% (see column 12 of Table 4). The shares of sectoral labor income in output take two different values depending on whether the traded sector is more or less capital intensive than the non traded sector. If $k^T > k^N$, labor income shares in the traded (θ^T) and the non traded sector (θ^N) are set to 0.58 and 0.68, respectively, which correspond roughly to the averages for countries with $k^T > k^N$.[38] Such values, i.e., $\theta^T = 0.58$ and $\theta^N = 0.68$, give an aggregate labor income share of 64%, in line with the average value shown in the last line of column 14 of Table 4. When $k^N > k^T$, we use reverse but symmetric values, i.e., $\theta^T = 0.68$ and

[36] The average value is calculated by excluding estimates for Italy which are negative.

[37] We choose $\sigma_C = 1$ to be consistent with the general specification for preferences (51). Whereas in the baseline model, we assume separability in preferences between consumption and labor, we also allow for non separability when we conduct a sensitivity analysis. When we let $\sigma = 1$ in eq. (51), preferences turn out to be separable in consumption and labor, i.e., $\ln C(t) - \frac{1}{1+\frac{1}{\sigma_L}}L(t)^{1+\frac{1}{\sigma_L}}$, where instantaneous utility derived from consumption is logarithmic.

[38] Table 4 gives the labor share of sector j θ^j (with $j = T, N$) for the sixteen OECD countries in our sample. The values we have chosen for θ^T and θ^N correspond roughly to the averages for countries with $k^T > k^N$.

$\theta^N = 0.58$. In line with our evidence shown in the last column of Table 4, we assume that traded firms are 28 percent more productive than non traded firms; hence we set Z^T and Z^N to 1.28 and 1 respectively. We choose an elasticity of substitution, ϕ_J, between J^T and J^N of 1, in accordance with the empirical findings documented by Bems [2008] for OECD countries. The weight of non traded investment $(1-\varphi_I)$ is set to 0.64 to target a non-tradable content of investment expenditure of 64%. We choose the value of parameter κ so that the elasticity of I/K with respect to Tobin's q, i.e., Q/P_J, is equal to the value implied by estimates in Eberly, Rebelo, and Vincent [2008]. The resulting value of κ is equal to 17.[39]

We set government spending on non traded goods G^N and traded goods G^T so as to yield a non tradable share of government spending, ω_{G^N}, of 90%, and government spending as a share of GDP to 20%. The ratios G^T/Y^T and G^N/Y^N are 5% and 29% in the baseline calibration.

We choose initial conditions for B_0 and K_0 so that trade is initially balanced. Since net exports are nil and $\frac{P_J I}{Y} = 21\%$ and $\frac{G}{Y} = 20\%$, the accounting identity according to which GDP is equal to the sum of the final uses of goods and services, leads to a consumption-to-GDP ratio of $\frac{P_C C}{Y} = 59\%$.[40] It is worthwhile mentioning that the non tradable content of GDP is endogenously determined by the non tradable content of consumption, α_C, investment, α_J, and government expenditure, ω_{G^N}, along with the consumption-to-GDP ratio, ω_C, and the investment-to-GDP ratio, ω_J. More precisely, dividing the non traded good market clearing condition, i.e., $Y^N = C^N + G^N + I^N$, by Y leads to the non tradable content of GDP:

$$\frac{PY^N}{Y} = \omega_C\alpha_C + \omega_J\alpha_J + \omega_{G^N}\omega_G = 63\%, \tag{52}$$

where $\omega_C = 59\%$, $\alpha_C = 53\%$, $\omega_J = 21\%$, $\alpha_J = 64\%$, $\omega_{G^N} = 90\%$, and $\omega_G = 20\%$. According to (52), the ratios we target are consistent with a non tradable content of GDP of 63% found in the data, as reported in the last line of column 1 of Table 4.

In order to capture the endogenous response of government spending to exogenous fiscal shock, we assume that the dynamic adjustment of government consumption is governed by eq. (26). In the quantitative analysis, we set $g = 0.01$ so that government consumption increases by 1 percentage point of initial GDP. To calibrate ξ and χ that parametrize the shape of the dynamic adjustment of government consumption along with its persistence, we proceed as follows. Because $G(t)$ peaks after one year, we have $\frac{dG(1)}{Y} = \left[e^{-\xi} - (1-g)\, e^{-\chi}\right] = g' > g$ with $g' = 0.011265$ and $\frac{\dot{G}(1)}{Y} = -\left[\xi e^{-\xi} - \chi\,(1-g)\, e^{-\chi}\right] = 0$. Solving the system gives us $\xi = 0.408$ and $\chi = 0.415$. While government purchases fall on both non traded, G^N, and traded goods, G^T, our VAR evidence suggests that the rise in government con-

[39]Eberly, Rebelo, and Vincent [2008] run the regression $I/K = \alpha + \beta\,.\ln(q)$ and obtain a point estimate for β of 0.06. In our model, the steady-state elasticity of I/K with respect to Tobin's q is $1/\kappa$. Equating $1/\kappa$ to 0.06 gives a value for κ of 17.

[40]Remember that $J = I$ at the steady-state.

sumption is strongly biased toward non traded goods because the relative size of the non traded sector increases significantly. When we simulate the model, we thus consider a rise in government consumption by 1 percentage point of GDP which is split between non tradables and tradables in accordance with their respective share in government expenditure at 90% and 10%, respectively.[41]

As the baseline scenario, we take the model with imperfect mobility of labor across sectors, capital adjustments costs and separability in preferences between consumption and labor. In our baseline calibration we set $\epsilon = 0.75$, $\sigma_L = 0.4$, $\kappa = 17$, $\theta^T = 0.58$, $\sigma = 1$, but we also conduct a sensitivity analysis with respect to these four parameters by setting alternatively: ϵ to 0.22 and 1.64, σ_L to 1, κ to 0, σ to 2, and the labor income share θ^T to 0.68. In order to contrast our results with those obtained when imposing perfect mobility of labor across sectors, we let ϵ tend toward infinity.

5.2 Results

Before analyzing in detail the role of imperfect mobility of labor in shaping the dynamics of the open economy in response to a government spending shock, we recall the set of observations established in section 2. Our first set of findings indicates that a rise in government spending produces a simultaneous decline in investment and the current account, raises both hours worked and GDP and increases the real consumption wage on impact. The second set of findings relates to the sectoral impact. We find that a government spending shock increases non traded output significantly, causes the relative price of non tradables to appreciate along with the relative wage, and leads to a reallocation of resources toward the non traded sector, thus increasing its relative size at the expense of the traded sector.

Table 2 shows the simulated impact effects of an exogenous and unanticipated increase in government consumption by 1 percentage point of GDP while column 1 shows impact responses from our VAR model for comparison purposes.[42] Column 4 shows results for the baseline model which we contrast with those obtained when we impose perfect mobility of labor (i.e., we set $\epsilon \to \infty$) and abstract from capital installation costs (i.e., we set $\kappa = 0$) as well. Other columns give results for alternative scenarios discussed below. While in Table 2, we restrict our attention to impact responses, in Fig. 6 and 7 we show the dynamic adjustment to an increase in government consumption by 1% of GDP. Figures show the model predictions together with the respective VAR evidence. In each panel, the solid blue line displays the point estimate of the VAR model, with the dotted blue lines indicating 90%

[41] It is worthwhile mentioning that there is a threshold for the allocation of the rise in government consumption between tradables and non tradables which leaves the relative price of non tradables and thus the sectoral output shares unaffected. We find numerically that a rise in government consumption by 1% of GDP which is split between non tradables and tradables in the following proportions, $\bar{\omega}_{G^N} = 16.5\%$ and $\bar{\omega}_{G^T} = 83.5\%$ does not affect the relative size of sectors.

[42] For reasons of space, we do not show long-run effects since we believe that their interpretation is secondary.

confidence bounds. The solid black line shows the transitional paths obtained in a model with imperfect mobility of labor and capital adjustment costs. To gauge the importance of labor mobility across sectors for fiscal transmission, we contrast our baseline case featuring imperfect mobility with the perfect mobility case shown by the dashed black line. It is worth mentioning that the endogenous response of government spending to an exogenous fiscal shock that we generate theoretically in Figure 6(a) by specifying the law of motion (26) reproduces the dynamic adjustment from the VAR model remarkably well as the black line and the blue line cannot be differentiated.

5.2.1 Aggregate Effects

We begin with the aggregate effects of a government spending shock shown in panels A and B of Table 2. Contrasting the numerical results reported in columns 2 and 4 with the evidence shown in column 1, whether we assume perfect or imperfect mobility of labor, both models tend to understate the responses of real GDP and hours worked. However, the model performance improves with imperfect mobility of labor as the rise in GDP by 0.19% lies within the confidence interval, as shown in Figure 6(b). The reason is that with imperfect mobility of labor, the existence of workers' costs of switching sectors puts upward pressure on non traded wages and thus on the aggregate wage. This then amplifies the positive response of hours worked which increases on impact by 0.30% instead of 0.11% when the mobility cost is absent. Because agents supply more labor, real GDP rises by a larger amount as long as there is a difficulty in reallocating labor. While the real consumption wage is unaffected on impact when we let ϵ tend toward infinity, a government spending shock generates a rise in the wage rate which more than offsets the increase in the consumption price index and thus pushes up the real consumption wage by 0.07% in the baseline model where $\epsilon = 0.75$.

Turning to the dynamic adjustment of investment and the current account displayed in Fig. 6(d) and 6(f), a model assuming perfect mobility and abstracting from capital installation costs dramatically overstates the decline in investment and predicts a current account surplus in the short-run, contrary to the evidence. Because capital-labor ratios are fixed, the return on domestic capital remains unchanged as well. The substantial decline in private savings generates such a physical capital decumulation that the current account moves into surplus. In contrast, as long as we relax the assumption of perfect mobility of labor, the neoclassical model is able to produce the crowding out of investment along with the current account deficit in the short-run, as shown in column 7 of Table 2 where we abstract from capital installation costs to isolate the role of limited labor mobility. Intuitively, as long as there is a difficulty in reallocating labor across sectors, the capital-labor ratio falls in the traded sector as the workers' mobility costs moderate the shift of labor. Thus, the return on domestic capital increases, which in turn mitigates the fall in investment and produces a current account deficit. However, the model tends to overstate the crowding-out of investment and to understate the decline in the current account. In contrast, as shown in column 4, when we allow for capital installation costs along with imperfect mobility of labor, the model predicts a current account deficit of 0.34% of GDP, which accords well with our estimate, by further mitigating the decline in investment. We then ask whether both capital adjustments costs and imperfect mobility of labor are essential to account for the evidence. To answer this, column 3 considers a scenario where we assume that physical capital accumulation is subject to installation costs while hours worked are perfect substitutes across sectors. The model predicts a rise in investment instead of a decline and considerably overstates the current account deficit found in the data: while the shadow price of investment, Q, increases as in a model assuming imperfect mobility of labor, the rise in the investment price index, P_J, is not large enough to drive down Tobin's q. As will become clear below, perfect mobility of labor implies that the relative price of non tradables merely appreciates, thus hampering the increase in P_J.

Contrasting the model's predictions with VAR evidence in Fig. 6, the simulated responses lie within the confidence interval along the transitional adjustment, with the exception of the real consumption wage. Although quite stylized, the model is able to account for the time-series evidence on the aggregate effects of a government spending shock as long as we allow for both capital installation costs and a difficulty in reallocating labor.

< Please insert Table 2 about here >

< Please insert Figures 6-7 about here >

5.2.2 Sectoral Effects

Turning to the sectoral impact of a rise in government consumption, the baseline model can account reasonably well for the dynamic adjustment of the non traded sector and somewhat less well for the traded sector. Panels C and D of Table 2 show impact responses of labor and product market variables, respectively, while in Fig. 7, we report the model predictions together with the VAR evidence of selected sectoral variables.

Focusing first on impact responses, column 2 of Table 2, shows that a model assuming perfect mobility of labor fails to account for the evidence along a number of dimensions. More specifically, comparing the VAR evidence reported in column 1 with simulated impact effects, we find that a model abstracting from workers' mobility costs understates the expansionary effect of a government spending shock on non traded output, cannot generate an appreciation in the relative price of non tradables along with the rise in the non traded wage relative to the traded wage, and substantially understates the changes in sectoral output shares.

In contrast, as displayed in column 4, the performance of the neoclassical model improves as long as we allow for imperfect mobility of labor. To begin with, the baseline model which considers costs of switching sectors can account for the rise in the relative wage. Intuitively, because government spending is biased toward non tradables, non traded firms are encouraged to produce and thus to hire more to meet additional demand. As workers experience intersectoral mobility costs, non traded firms must pay higher wages to attract workers which raises the relative wage, Ω, by 1.44% as shown in the sixth line of panel C.

Because labor shifts toward the non traded sector, the baseline model predicts a rise in hours worked of non tradables by 0.44% which accords will the evidence shown in column 1. Labor reallocation pushes up non traded output by 0.50%, the response being almost double that obtained with perfect labor mobility (see column 2). The reason is twofold. First, the capital-labor ratio in the non traded sector increases as workers are reluctant to shift their hours worked across sectors. Second, because the aggregate wage increases when we allow for imperfect mobility of labor, workers supply more labor which further raises output in the non traded sector since it is relatively more labor intensive. While the baseline model is able to account pretty well for impact responses of hours worked and output of non tradables, it tends to somewhat overstate the contraction in hours worked and output of tradables which are fairly muted according to VAR evidence.

As long as there is a difficulty in reallocating labor across sectors, excess demand shows up in the non traded goods market. As a result, the price of non traded goods relative to traded goods appreciates by 0.88%, as shown in the fourth line of panel D. The appreciation in the relative price triggers a reallocation of resources toward the non traded sector, raising its output share by 0.38% of GDP, while that of tradables falls by exactly the same amount. As we move from column 5 to column 6 of Table 2, the utility loss resulting from the shift from one sector to another is reduced. As shown analytically in section 4, a rise in the degree of labor mobility exerts two opposite effects on sectoral output shares: while workers are more willing to shift across sectors, the relative price of non tradables appreciates less which mitigates the incentive for labor reallocation. We find numerically that raising the elasticity of labor supply across sectors, ϵ, from 0.22 to 1.64 amplifies the rise in the output share of non tradables from 0.26% to 0.49% of GDP, in accordance with our evidence documented in section 2.6. Thus, the former effect more than offsets the latter.[43]

Turning to the adjustment of sectoral variables following a government spending shock as shown in Fig. 7, the dynamics of the relative price and the relative wage are captured fairly well by the model. As government spending falls and is restored to its initial level, excess demand in the non traded goods market is reduced, which depreciates the relative price of non tradables along the transitional path, as shown in Fig. 7(a). Decreasing prices

[43] However, the latter influence may predominate if the values of ϵ are higher because the relative price merely appreciates in this case. In the polar case where ϵ tends toward infinity, the output share of non tradables increases by only 0.24%, a value that is much smaller than the estimated response of 0.35% of GDP.

of non tradables relative to tradables encourage non traded firms to reduce hours worked and thus to lower output, in line with the evidence in Fig. 7(h) and 7(g). Because non traded wages fall relative to traded wages during the transitional adjustment, as shown in Fig. 7(b), labor is reallocated toward the traded sector, which recovers gradually, while both hours worked and output remain below their initial levels for almost ten years. As shown in Fig. 7(e) and 7(d), the model tends to somewhat understate the contraction of labor and the output of tradables in the medium run.[44]

In order to further highlight the performance of the baseline model with imperfect mobility of labor and capital installation costs, it is useful to analyze the dynamic adjustment of sectoral variables when these two features are absent. The dotted line in Fig. 7 displays the model predictions if we let ϵ tend toward infinity, while the parameter governing the magnitude of adjustment cost, κ, is set to zero. First, a model assuming $\epsilon \to \infty$ and setting $\kappa = 0$ predicts a flat temporal path for the relative wage and the relative price which conflict with the evidence. Second, it substantially understates the impact responses of sectoral output shares while the simulated responses for the baseline model accord well with the evidence. Intuitively, the relative price of non tradables appreciates when ϵ takes intermediate values, which in turn amplifies the shift of capital toward the non traded sector. Third, the model imposing perfect mobility of labor considerably overstates the changes in sectoral output shares along the transitional path. The reason is that the capital stock falls sharply in the short-run and then recovers rapidly after two years, resulting in sharp changes in the relative size of sectors due to the Rybczynski effect.

5.2.3 Sensitivity Analysis

To gauge the relative role of limited labor mobility and capital adjustment costs, we also report results from two restricted versions of the model where one of the two features is, respectively, shutdown. Column 3 of Table 2 shows the predictions of a model imposing perfect mobility of labor along with capital installation costs while column 7 reports impact responses from a model assuming imperfect mobility while setting $\kappa = 0$.[45] Both models fail to account for the responses of sectoral output shares to a government spending shock. While introducing capital installation costs restore transitional dynamics for the relative price of non tradables, the restricted model where labor is perfectly mobile across sectors considerably overstates the responses of sectoral output shares. Intuitively, workers no longer experience a mobility cost and thus are willing to shift their whole time to the sector that pays the highest wage. As a result, sectoral labor and thus sectoral output

[44] The explanation is intuitive: the baseline model underpredicts the decumulation of physical capital along the transitional path while the traded sector is more capital intensive.

[45] To save space we develop intuition regarding the implications of imperfect mobility of labor and capital adjustment costs by restricting attention to impact responses. In a Technical Appendix, we contrast the dynamic adjustment from baseline model with the responses from the restricted model where one of the two features is shut down.

become unrealistically sensitive to a change in relative price, thus leading to a change in the sectoral output share which is about twice what is estimated empirically, as can be seen in column 3. In contrast, as reported in column 7, a model assuming imperfect mobility of labor while abstracting from capital installation costs tends to substantially understate the responses of sectoral output shares. As investment is crowded out by a larger amount than if capital were subject to adjustment costs, the excess demand in the non traded goods market is lower so that the relative price appreciates less, resulting in smaller shifts of labor and capital toward the non traded sector. In sum, to generate a sectoral impact of a government spending shock that is similar to that in the data, we have to allow for adjustment costs to physical capital accumulation along with imperfect mobility of labor across sectors.

Columns 8 and 9 show results when the elasticity of labor supply, σ_L, is set to 1, and σ is set to 2, respectively. As can be seen in column 8, raising σ_L from 0.4 to 1 amplifies the rise in hours worked triggered by the negative wealth effect and the increase in the aggregate wage, which further raises real GDP. Because larger labor supply benefits both sectors, hours worked (and subsequently output) increase more in the non traded sector while employment (and subsequently output) falls less in the traded sector. Since the non traded sector is more labor intensive, the rise in non traded labor is somewhat more pronounced. However, responses of sectoral output shares are almost unchanged compared with those obtained from the baseline model as the relative price of non tradables appreciates by a smaller amount, thus mitigating the shift of capital toward the non traded sector. Numerical results shown in column 9 indicate that non separability in preferences between consumption and labor amplifies the rise in the real consumption wage while hours and real GDP increase less. Additionally, the open economy runs a larger current account deficit. Intuitively, because non separability in preferences between consumption and labor increases the disutility from working, agents are less willing to supply labor while demanding higher wages. Because consumption increases with the aggregate wage, agents lower their expenditure less. Thus, private savings decline further, which in turn amplifies the decline in the current account. As the crowding out of private consumption is less, the relative price of non tradables appreciates by a larger amount, thus amplifying the responses of sectoral output shares. While the extension of the baseline model to non separability in preferences somewhat improves its performance in reproducing the responses of several sectoral variables, the extended model tends to substantially overstate the contraction in the traded sector and to overpredict the rise in the relative wage. In contrast, all simulated impact responses from the baseline model assuming separability in preferences lie within the confidence interval.

Finally, in the last two columns of Table 2, we investigate whether our conclusions hold if we assume a non traded sector that is more capital intensive than the traded sector.

While the predictions of the model are very sensitive to sectoral labor income shares if we let ϵ tend toward infinity, results are almost unaffected for the baseline model whether $\theta^T < \theta^N$ or $\theta^T > \theta^N$. As shown in column 10, the model imposing perfect mobility of labor fails to account for the evidence along a number of dimensions. In particular, the simulated responses of sectoral output shares are more than four times greater than those reported from the VAR model. The reason is that imposing perfect mobility makes labor and thus sectoral output highly sensitive to a change in relative price. Because investment is crowded in, the subsequent excess demand in the non traded goods market causes the relative price of non tradables to appreciate, thus leading to dramatic changes in the relative size of sectors. Since the model's predictions reported in column 11 are similar to those shown in column 4, they do not merit further comment.

5.3 Cross-Country Differences in Sectoral Impact: Taking the Model to Data

We have shown above that the performance of the neoclassical model in replicating the evidence related to fiscal transmission improves as long as we allow for imperfect mobility of labor and capital adjustment costs. We now move a step further and assess the ability of the model to generate a similar cross-country relationship between the degree of labor mobility and changes in the relative size of sectors to that in the data.

To compute numerically the impact responses of sectoral output shares to a government spending shock, we calibrate our model to match key characteristics of the 16 OECD economies in our sample, including the share of non traded hours worked to total hours worked, the non tradable content of consumption, investment and public expenditure, investment- and government spending-to-GDP ratios, and the degree of labor mobility across sectors. Table 4 summarizes the country-specific data for non tradable and GDP component shares. The elasticity of labor supply across sectors, ϵ, which plays a pivotal role in fiscal transmission, is set in accordance with our estimates shown in the last column of Table 4. As mentioned in section 5.1, φ, φ_J, ϑ, δ_K together with initial conditions (B_0, K_0) need to be endogenously calibrated to target α_C, α_J, L^N/L, ω_J along with $\upsilon_{NX} = NX/Y^T$ where $NX = Y^T - C^T - G^T - J^T$ corresponds to net exports. The remaining parameters are set to their empirical counterparts. Some parameters, such as the elasticity of labor supply, σ_L, and κ governing the magnitude of adjustment costs to physical capital accumulation, along with the world interest rate, are however kept constant for all countries. While we explore the sectoral effects of a rise in government consumption by 1% of GDP (i.e., g is set to 0.01) for each country in our sample, to be consistent with the calibration to a representative OECD economy described in section 5.1, we assume that the increase in public purchases is split between non tradables and tradables in accordance with their respective shares in government spending, i.e., ω_{G^N} and $1 - \omega_{G^N}$, respectively, where ω_{G^N}

is set in accordance with its country-specific value shown in column 4 of Table 4, except for Australia and Ireland.[46]

< Please insert Figures 8-9 about here >

To explore the cross-country relationship quantitatively, we first plot in Fig. 8 the simulated responses of sectoral output shares on the vertical axis against the degree of labor mobility captured by the parameter ϵ on the horizontal axis. Restricting our attention to countries where the rise in government consumption is biased toward non tradables, impact changes in non traded output relative to real GDP range from 0.26% of GDP for the Netherlands to 0.49% of GDP for Spain. Fig. 8(a) and 8(b) also show that these differences in the responses of sectoral output shares are correlated with the measure of the degree of labor mobility across sectors. As ϵ takes higher values, countries with a higher degree of labor mobility experience a larger decline in the relative size of the traded sector and a larger increase in the relative size of the non traded sector. These results thus reveal that **the sectoral impact of fiscal policy increases with the degree of labor mobility**, which accords with our evidence. Quantitatively, as we move along the trend line shown in Fig. 8(a), our model predicts that a country with a low degree of labor mobility as captured by a value of ϵ of 0.2 will experience a decline in the output share of tradables of 0.2% of GDP, while a country with a higher degree of labor mobility as captured by a value of ϵ of 1.2 will face a fall by 0.4% of GDP, a decline which is twice as strong. Hence, **cross-country differences in the degree of labor mobility generate a substantial dispersion in the sectoral impact of fiscal policy**.

In Fig. 9, we contrast the cross-country relationship from the calibrated baseline model shown by the solid blue line with the cross-country relationship from the VAR model shown by the solid black line. When we calibrate our model to cross-country data, we obtain a correlation between the responses of sectoral output shares and the measure of the degree of labor mobility of -0.206 for tradables ($t-stat = -2.238$) and 0.206 for non tradables ($t-stat = 2.238$). While it tends to understate the changes in the relative size of sectors since the cross-country relationship is higher for tradables and lower for non tradables, the model is able to generate a cross-country relationship between the responses of sectoral output shares and the degree of labor mobility which is quite similar to that in the data.

6 Conclusion

While the literature analyzing fiscal transmission mainly focuses on the aggregate effects of a rise in government consumption, our empirical results reveal that the impact of fiscal

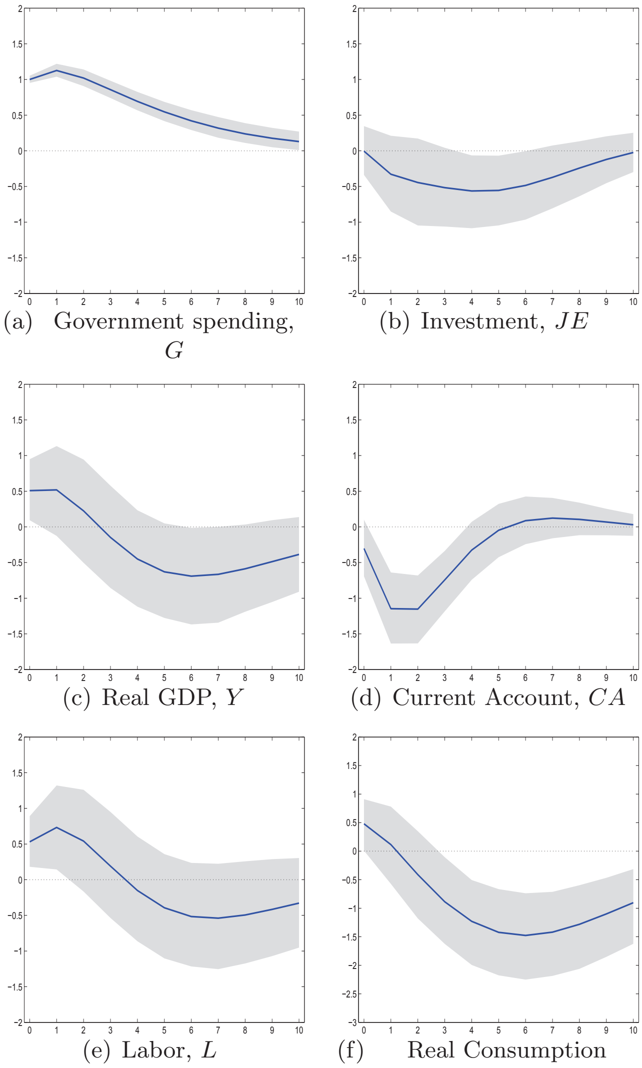
[46] For Australia and Ireland, we find empirically that the output share of tradables increases on impact while the relative size of the non traded sector declines. To be consistent with empirical evidence, we consider a rise in public purchases which is fully biased toward tradables. It is worthwhile mentioning that at the initial steady-state, we set the non tradable content of government spending, ω_{G^N}, to 0.90% and 0.89% for Australia and Ireland, respectively, in accordance with the shares reported in column 4 of Table 4.

policy varies significantly between sectors and across countries. Using a panel of 16 OECD countries over the period 1970-2007, we find empirically for the whole sample that a government spending shock has an expansionary effect on hours worked and output of non tradables, whereas it gives rise to contractions in hours worked and output of tradables. Such a finding along with the appreciation in the relative price of non tradables suggests that public purchases are biased toward non traded goods. Importantly, non traded output increases substantially relative to GDP (in real terms) while the reverse is true for the traded sector. This evidence thus highlights the fact that resources are shifted toward the non traded sector, with the reallocation of inputs contributing to 50% of non traded output growth. If labor were freely mobile across sectors, sectoral wages would equalize. However, we find empirically that non traded wages increase substantially relative to traded wages, thus suggesting the presence of labor mobility costs across sectors. Contrasting the sectoral impact across the economies in our sample, the output share of non tradables (in real terms) rises for the vast majority of the economies while its magnitude varies sharply across countries. Estimating the elasticity of labor supply across sectors for each country, we find that impact responses of output shares for tradables and non tradables are more pronounced in countries with lower mobility costs.

To rationalize our panel VAR evidence, we develop a two-sector open economy model with imperfect mobility of labor across sectors and adjustment costs to physical capital accumulation. As in Horvath [2000], agents cannot costlessly reallocate hours worked from one sector to another. Because mobility is costly in utility terms, workers demand higher wages in order to compensate for their cost of switching sectors. Abstracting first from capital accumulation, we find analytically that the model can account for our evidence as long as the rise in public purchases is biased toward non traded goods while the elasticity of labor supply across sectors takes finite values. In contrast, if we let the elasticity of labor supply across sectors tend toward infinity, both the relative price and the relative wage of non tradables remain unaffected. Turning to the sensitivity of the sectoral impact of a fiscal shock to the degree of labor mobility, our analytical results suggest a non monotonic relationship between the elasticity of labor supply across sectors and the magnitude of impact responses of sectoral output shares.

Calibrating the model to a representative OECD economy and considering a rise in government consumption biased toward non tradables, we find quantitatively that the open economy version of the neoclassical model with tradables and non tradables can account for the panel VAR evidence as long as we allow for imperfect mobility of labor across sectors together with adjustment costs to physical capital accumulation. The first feature mitigates the shift of labor toward the non traded sector and hence the subsequent increase in the supply of non tradables. The second feature moderates the crowding out of investment, resulting in a much smaller decline in private demand for tradables. Put together, these two ingredients trigger an excess demand for non tradables. The resulting appreciation in the relative price is key to generating a shift of hours worked and capital which generates a rise (a fall) in the output share of non tradables (tradables) by an amount that accords well with the data. We show that each of these features contributes to magnifying the aggregate and sectoral effects of a rise in government consumption. In contrast, the restricted version of the model where one of the two features is shut down fails to account for the evidence along a number of dimensions.

The final exercise we perform is to calibrate our baseline model with a difficulty in reallocating labor and costly capital accumulation to each OECD economy in our sample. Our numerical results reveal that international differences in the degree of labor mobility generate a large dispersion in the responses of sectoral output shares to a government spending shock: changes in the relative size of sectors are twice as strong in the country with the highest degree of labor mobility than in the economy with the lowest labor mobility. Finally, we find quantitatively that the model reproduces pretty well the cross-country relationship between the degree of labor mobility and the responses of sectoral output shares that we estimate empirically.



(a) Government spending, G

(b) Investment, JE

(c) Real GDP, Y

(d) Current Account, CA

(e) Labor, L

(f) Real Consumption Wage, W/P_C

Figure 1: Effects of Unanticipated Government Spending Shock on Aggregate Variables. Notes: Exogenous increase of government consumption by 1% of GDP. Aggregate variables include GDP (constant prices), total hours worked, private fixed investment, the current account and the real consumption wage. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (government spending, GDP, investment, current account), percentage deviation from trend in labor units (total hours worked), percentage deviation from trend (real consumption wage). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.

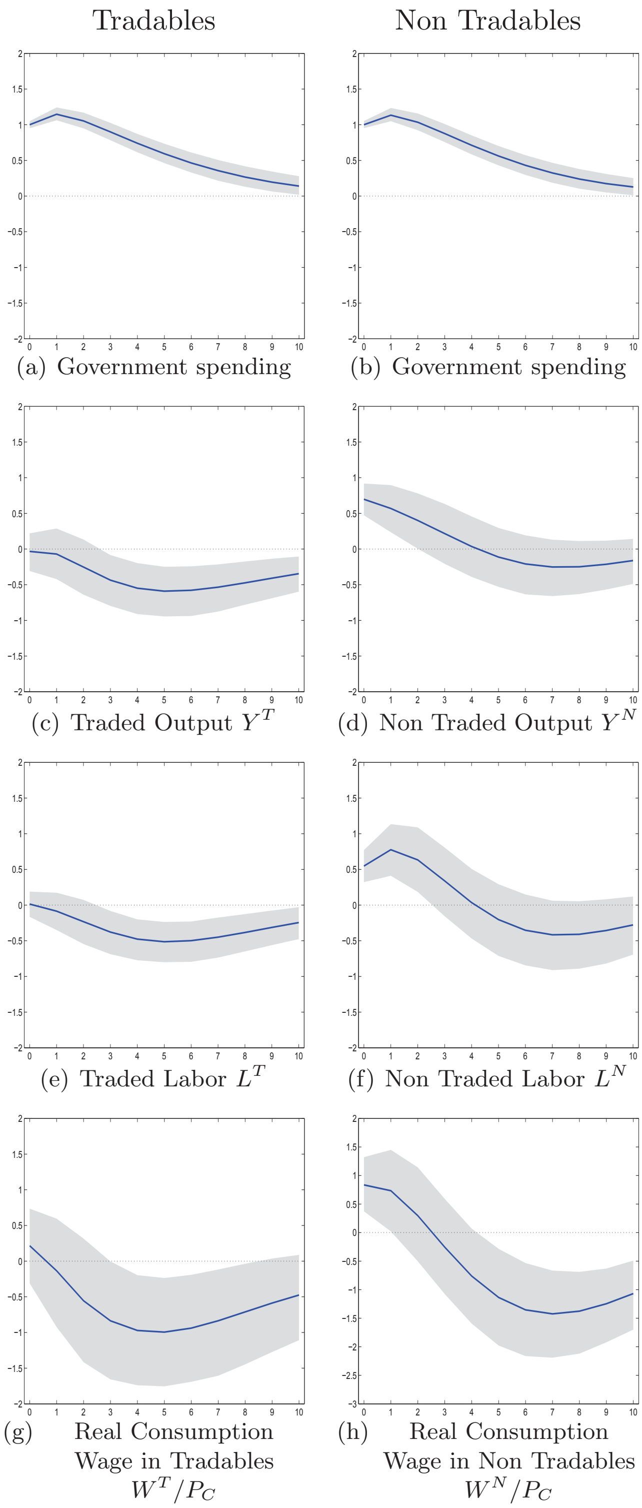
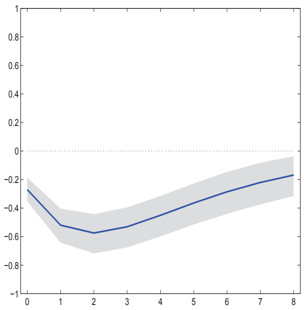
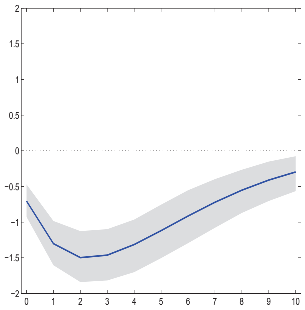


Figure 2: Effects of Unanticipated Government Spending Shock on Sectoral Variables. Notes: Exogenous increase of government consumption by 1% of GDP. Sectoral variables include sectoral valued added at constant prices, sectoral hours worked, and real consumption sectoral wages. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output), percentage deviation from trend in labor units (sectoral labor), percentage deviation from trend (real consumption sectoral wages). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.

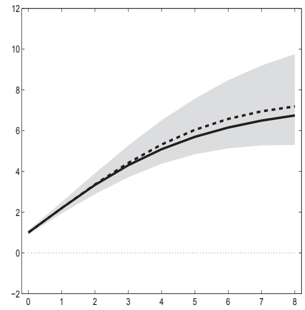
Sectoral Labor & Output Shares &	Labor Market Product Market	Labor Mobility



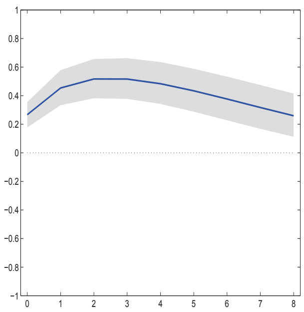
(a) Labor Share of Tradables L^T/L



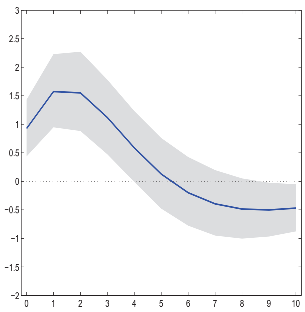
(b) Relative Hours Worked L^T/L^N



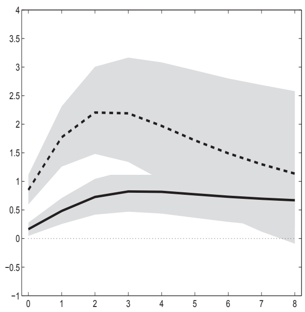
(c) Government spending



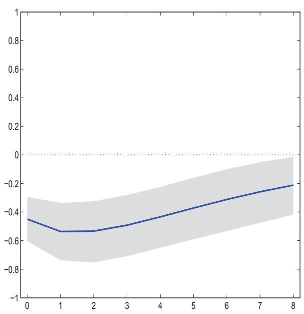
(d) Labor Share of Non Tradables L^N/L



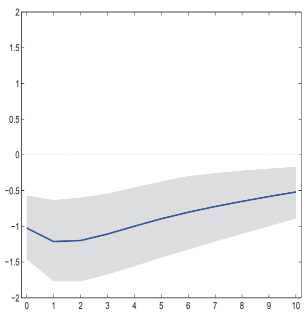
(e) Relative Wage, $\Omega = W^N/W^T$



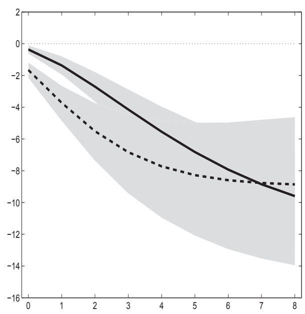
(f) Labor Reallocation, $LR(2)$



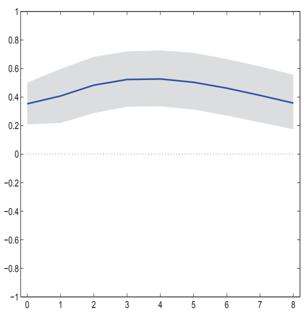
(g) Output Share of Tradables Y^T/Y



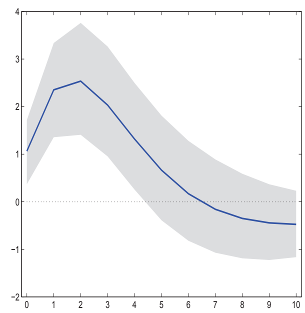
(h) Relative Output Y^T/Y^N



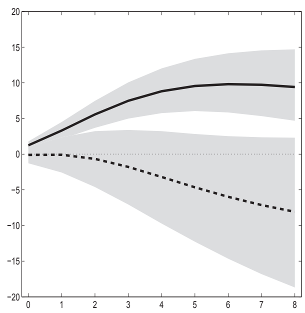
(i) Relative Hours Worked



(j) Output Share of Non Tradables Y^N/Y



(k) Relative Price of Non Tradables, $P = P^N/P^T$



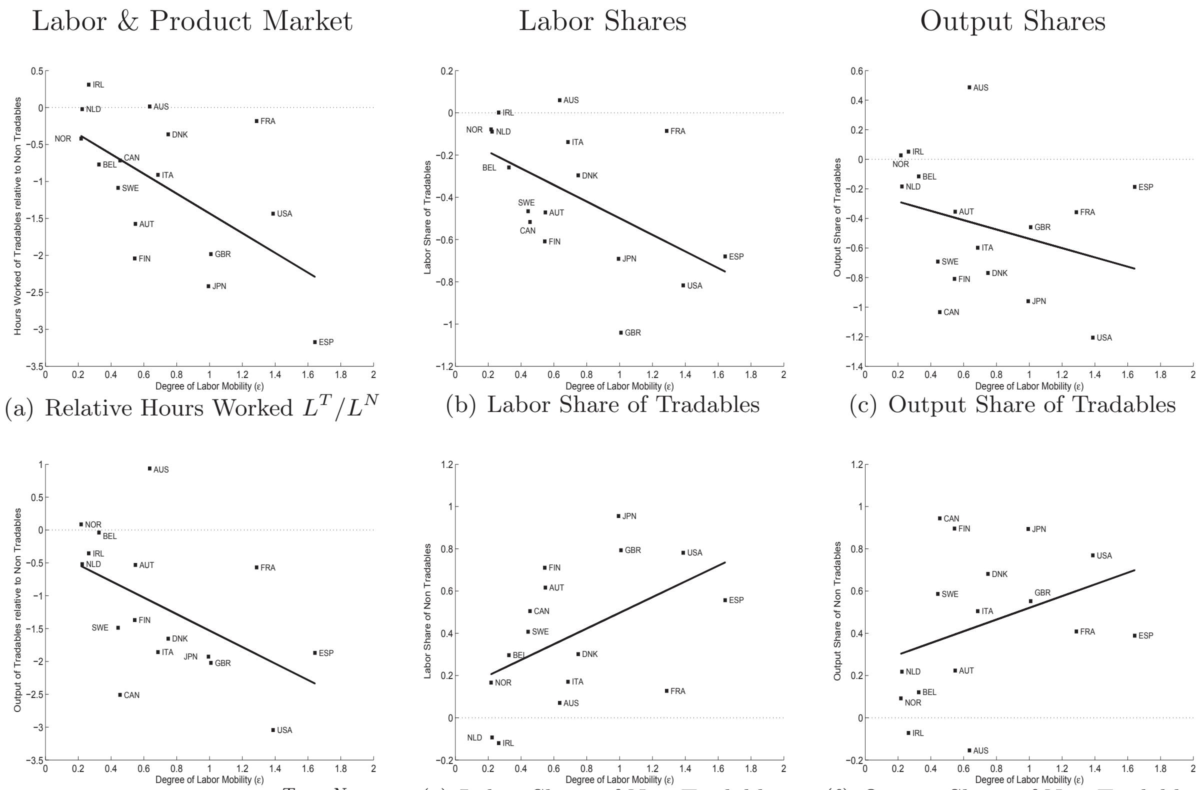
(l) Relative Wage, $\Omega = W^N/W^T$

Figure 3: Effects of Unanticipated Government Spending Shock on Sectoral Composition and Reallocation. Notes: Exogenous increase of government consumption by 1% of GDP. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output, sectoral output shares), percentage deviation from trend in labor units (sectoral labor, sectoral labor shares, intersectoral labor reallocation index), deviations from trend (ratio of traded value added to non traded value added, ratio of hours worked of tradables to hours worked of non tradables), and percentage deviation from trend (relative price, relative wage). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling. The third column shows the cumulative responses of government spending, labor reallocation across sectors, hours worked of tradables in terms of non tradables, and the relative wage in countries where the mobility of labor is low (solid line) and high (dashed line); sample: 16 OECD countries, 1970-2007, annual data.

Table 1: Responses to Government Spending Shock: Point Estimates

		A. Aggregate and Sectoral Effects					**B. Low Vs. High Labor Mobility**		
Variables	Horizon	Aggregate (1)	Tradables (2)	Non Tradables (3)	Variables	Horizon	All sample (4)	Low Mobility (5)	High Mobility (6)
Gov. spending	1	1.000*	1.000*	1.000*	Relative Labor	1	−0.705*	−0.346*	−1.770*
	2	2.127*	2.147*	2.134*	(L^T/L^N)	2	−2.007*	−1.303*	−3.972*
	4	4.004*	4.099*	4.044*		4	−4.968*	−3.950*	−7.299*
Output	1	0.508*	−0.033	0.697*	Relative Output	1	−1.025*	−0.674*	−1.936*
	2	1.026	−0.103	1.266*	(Y^T/Y^N)	2	−2.240*	−1.764*	−3.405*
	4	1.103	−0.792	1.882*		4	−4.547*	−4.293*	−5.389*
Labor	1	0.531*	0.014	0.547*	Mobility Indicator	1	0.304*	0.163*	0.851*
	2	1.263*	−0.071	1.323*	($LR(2)$)	2	0.754*	0.482*	1.772*
	4	1.994	−0.683	2.295*		4	1.110*	0.824*	2.191*
Real Wage	1	0.480*	0.215	0.835*	Relative Wage	1	0.939*	1.320*	−0.687
	2	0.595	0.080	1.569*	(W^N/W^T)	2	2.667*	3.603*	−1.307
	4	−0.703	−1.313	1.610		4	5.222*	7.683*	−5.248
Investment	1	−0.004							
	2	−0.332							
	4	−1.293							
Current Account	1	−0.303							
	2	−1.450*							
	4	−3.346*							

Notes: Horizon measured in year units. * denote significance at 10% level. Standard errors are bootstrapped with 10000 replications. The last three columns report, for selected horizons and samples, the cumulative responses of relative labor, relative output, the intersectoral labor reallocation index and relative wage to an increase in government spending by 1% of GDP. The response of relative labor (relative output resp.) is estimated from a 3-variable VAR that includes government spending, relative labor (relative output), L^T/L^N (Y^T/Y^N), and the relative wage of non tradables (relative price of non tradables), W^N/W^T (P^N/P^T). Finally, the response of labor reallocation (LR) is estimated from a 3-variable VAR that includes government spending, the intersectoral labor reallocation index, $LR(2)$, and the relative wage of non tradables, W^N/W^T.



(a) Relative Hours Worked L^T/L^N (b) Labor Share of Tradables (c) Output Share of Tradables

(d) Relative Output Y^T/Y^N (e) Labor Share of Non Tradables (f) Output Share of Non Tradables

Figure 4: Effect of Government Spending Shocks on Sectoral Composition against the Degree of Labor Mobility across Sectors. Notes: Figure 4 plots impact responses of traded hours worked relative to non traded hours worked, traded output relative to non traded output, sectoral labor and sectoral output shares. Impact responses shown in the vertical axis are obtained by running a VAR model for each country and are expressed in percentage point. Horizontal axis displays the elasticity of labor supply across sectors, ϵ, which captures the degree of labor mobility across sectors; panel data estimates for ϵ are taken from column 16 of Table 4.

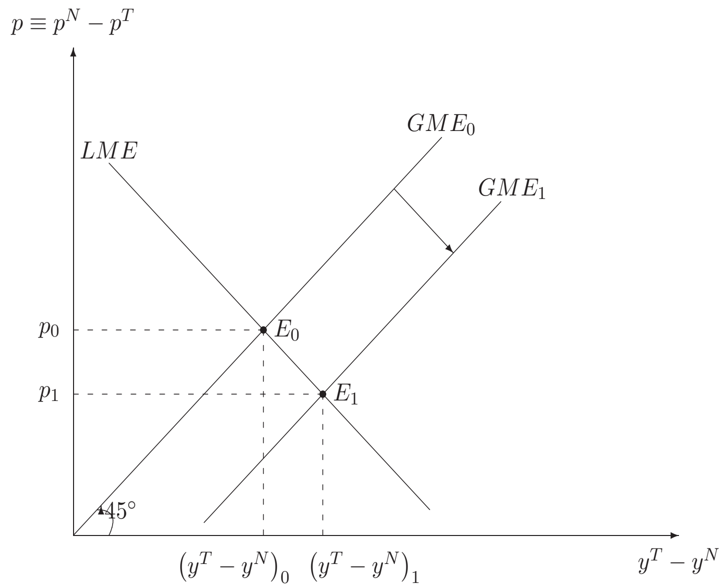
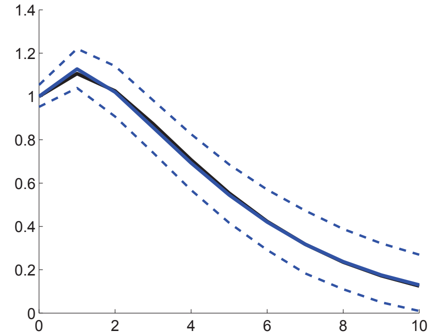


Figure 5: Steady-State Effects of an Unanticipated Temporary Rise in Government Spending in the $(y^T - y^N, p)$-space.

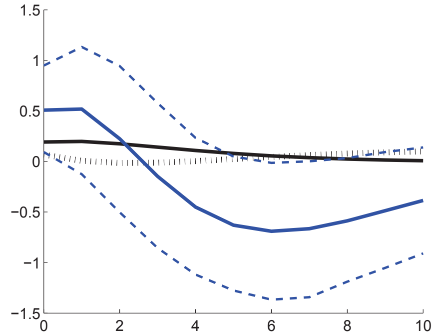
Table 2: Impact Responses of Aggregate and Sectoral Variables to of a Rise in Government Consumption (in %)

	Data	$1-\theta^T > 1-\theta^N$								$1-\theta^T < 1-\theta^N$	
		Perf. Mob.		Bench	Mobility		No Adj. Cost.	Lab. supply	Non sep.	Perf. Mob.	IML
		$(\kappa = 0)$	$(\kappa = 17)$	$(\epsilon = 0.75)$	$(\epsilon = 0.22)$	$(\epsilon = 1.64)$	$(\kappa = 0)$	$(\sigma_L = 1)$	$(\sigma = 2)$	$(\epsilon = \infty)$	$(\epsilon = 0.75)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A.Impact: GDP & Components											
Real GDP, $dY_R(0)$	0.51	0.07	0.09	0.19	0.22	0.16	0.15	0.34	0.17	0.00	0.16
Investment, $dI(0)$	-0.01	-0.84	0.04	-0.13	-0.17	-0.08	-0.41	-0.14	-0.14	1.49	-0.22
Current account, $dCA(0)$	-0.30	0.06	-0.75	-0.34	-0.22	-0.46	-0.12	-0.29	-0.50	-2.49	-0.35
B.Impact: Labor & Real Wage											
Labor, $dL(0)$	0.53	0.11	0.15	0.30	0.34	0.25	0.24	0.53	0.27	0.00	0.25
Real consumption wage, $d\left(W/P_C\right)(0)$	0.48	0.00	0.07	0.07	0.08	0.06	0.05	-0.04	0.12	-0.30	-0.05
C.Impact: Sectoral Labor											
Traded labor, $dL^T(0)$	0.01	-0.20	-0.68	-0.14	0.02	-0.29	-0.09	-0.04	-0.19	-1.94	-0.17
Non traded labor, $dL^N(0)$	0.54	0.30	0.83	0.44	0.32	0.55	0.33	0.57	0.45	1.95	0.42
Traded wage, $d\left(W^T/P_C\right)(0)$	0.22	0.00	0.07	-0.89	-1.18	-0.61	-0.65	-0.91	-1.00	-0.30	-0.96
Non traded wage, $d\left(W^N/P_C\right)(0)$	0.83	0.00	0.07	0.55	0.69	0.42	0.38	0.43	0.66	-0.30	0.54
Relative labor, $d\left(L^T/L^N\right)(0)$	-0.71	-0.53	-1.86	-0.52	-0.19	-0.86	-0.36	-0.50	-0.59	-5.83	-0.60
Relative wage, $d\left(W^N/W^T\right)(0)$	0.93	0.00	0.00	1.44	1.87	1.03	1.02	1.33	1.66	-0.00	1.49
Labor share of tradables, $d(L^T/L)(0)$	-0.27	-0.23	-0.74	-0.24	-0.09	-0.38	-0.17	-0.23	-0.27	-1.94	-0.27
Labor share of non tradables, $d(L^N/L)(0)$	0.27	0.23	0.74	0.24	0.09	0.38	0.17	0.23	0.27	1.94	0.27
D.Impact: Sectoral Output											
Traded output, $dY^T(0)$	-0.03	-0.22	-0.72	-0.31	-0.19	-0.43	-0.21	-0.24	-0.37	-1.87	-0.31
Non traded output, $dY^N(0)$	0.70	0.28	0.82	0.50	0.41	0.59	0.37	0.58	0.55	1.87	0.47
Relative output, $d\left(Y^T/Y^N\right)(0)$	-1.03	-0.62	-3.16	-0.97	-0.64	-1.30	-0.64	-0.97	-1.07	-4.93	-0.88
Relative price, $dP(0)$	1.06	0.00	0.02	0.88	1.13	0.64	0.62	0.79	1.02	0.08	1.01
Output share of tradables, $d(Y^T/Y_R)(0)$	-0.45	-0.24	-0.76	-0.38	-0.26	-0.49	-0.27	-0.37	-0.44	-1.87	-0.37
Output share of non tradables, $d(Y^N/Y_R)(0)$	0.35	0.24	0.76	0.38	0.26	0.49	0.27	0.37	0.44	1.87	0.37

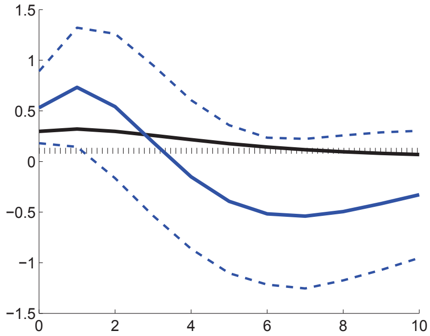
Notes: Effects of an unanticipated and temporary exogenous rise in government consumption by 1% of GDP. Panels A,B,C,D show the initial deviation in percentage relative to steady-state for aggregate and sectoral variables. Market product (aggregate and sectoral) quantities are expressed in percent of initial GDP while labor market (aggregate and sectoral) quantities are expressed in percent of initial total hours worked; θ^T and θ^N are the labor income share in the traded sector and non traded sector, respectively; ϵ measures the degree of substitutability in hours worked across sectors and captures the degree of labor mobility; σ_L is the Frisch elasticity of labor supply; κ governs the magnitude of adjustment costs to capital accumulation; σ determines the substitutability between consumption and leisure when preferences are non separable. In our baseline calibration (labelled 'Bench'), we set $\theta^T = 0.58$, $\theta^N = 0.68$, $\epsilon = 0.75$, $\phi = 0.77$, $\sigma_L = 0.4$, $\kappa = 17$, $\sigma = 1$. In column 11 ('IML' means Imperfect Mobility of Labor), we keep the same calibration as the baseline, except for θ^T and θ^N which are set to 0.68 and 0.58, respectively.



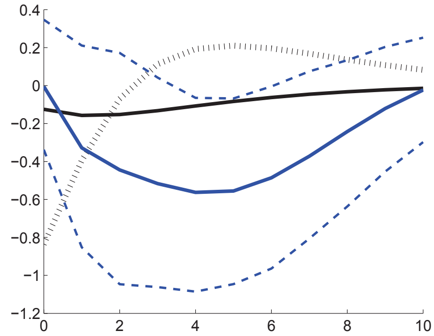
(a) Government Spending



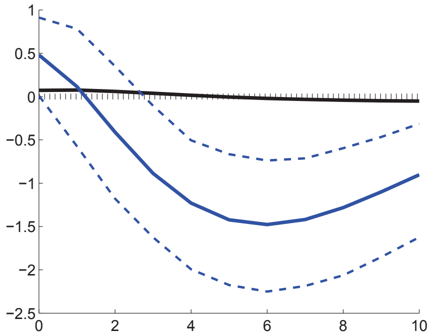
(b) Real GDP



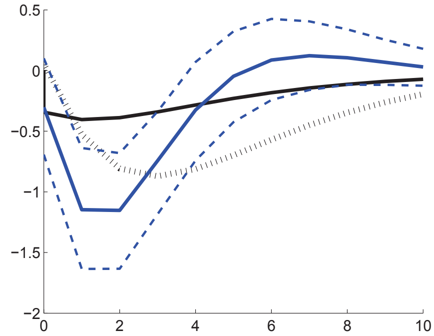
(c) Hours Worked



(d) Investment

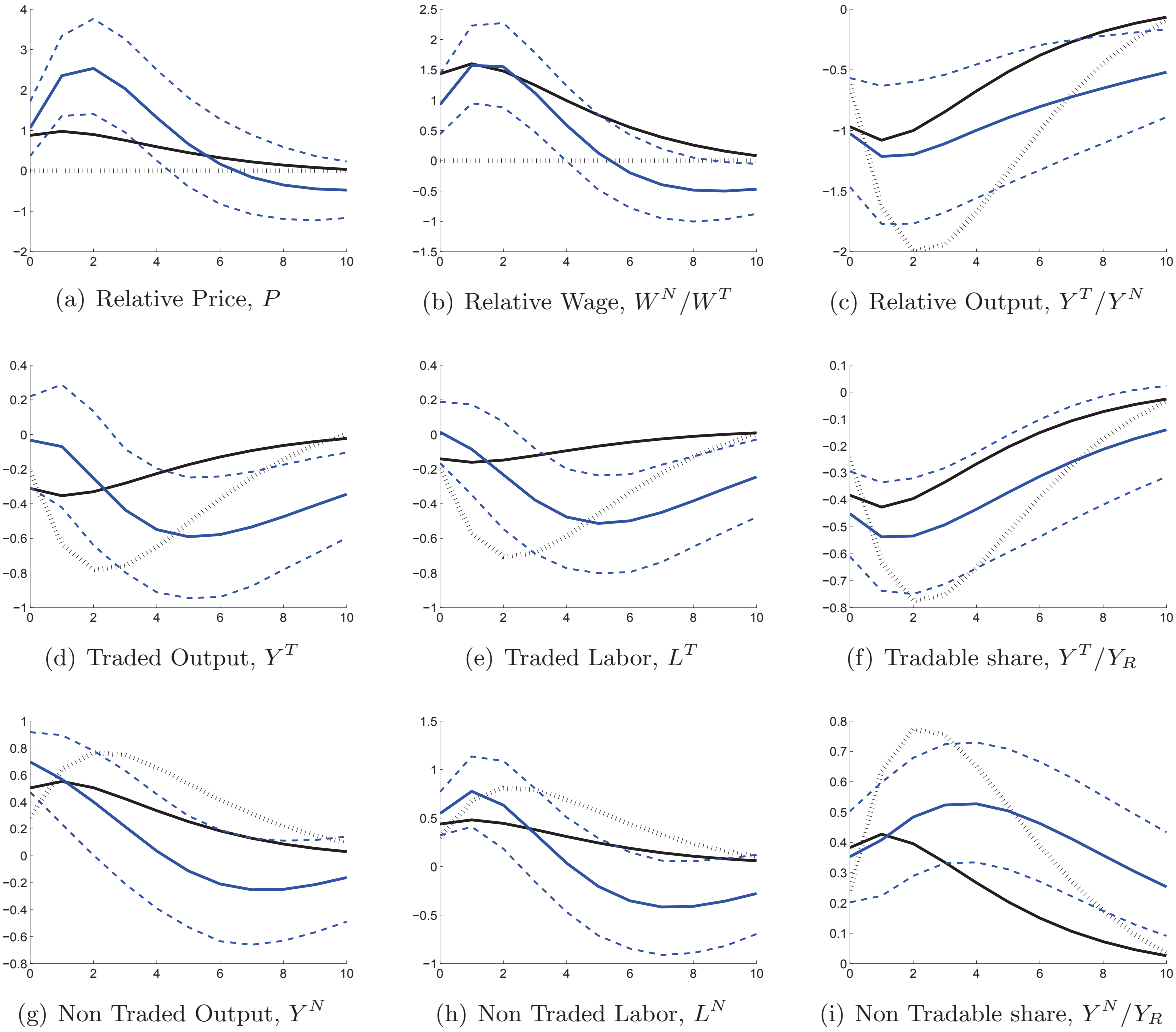


(e) Aggregate Real Wage



(f) Current Account

Figure 6: Dynamic Adjustment of Aggregate Variables to Unanticipated Government Spending Shock. Notes: Solid blue line displays point estimate of VAR model with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows predictions of the model imposing perfect mobility of labor ($\epsilon \to \infty$) and abstracting from capital adjustment costs ($\kappa = 0$).



(a) Relative Price, P

(b) Relative Wage, W^N/W^T

(c) Relative Output, Y^T/Y^N

(d) Traded Output, Y^T

(e) Traded Labor, L^T

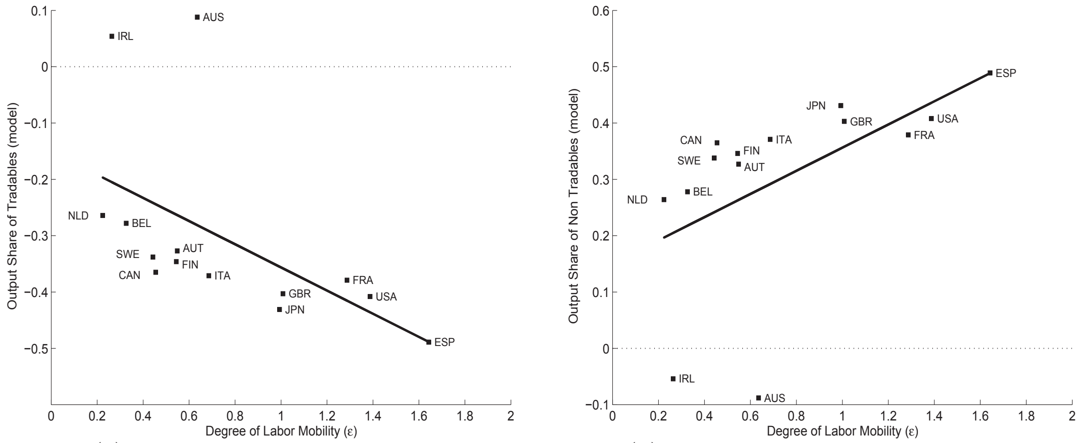
(f) Tradable share, Y^T/Y_R

(g) Non Traded Output, Y^N

(h) Non Traded Labor, L^N

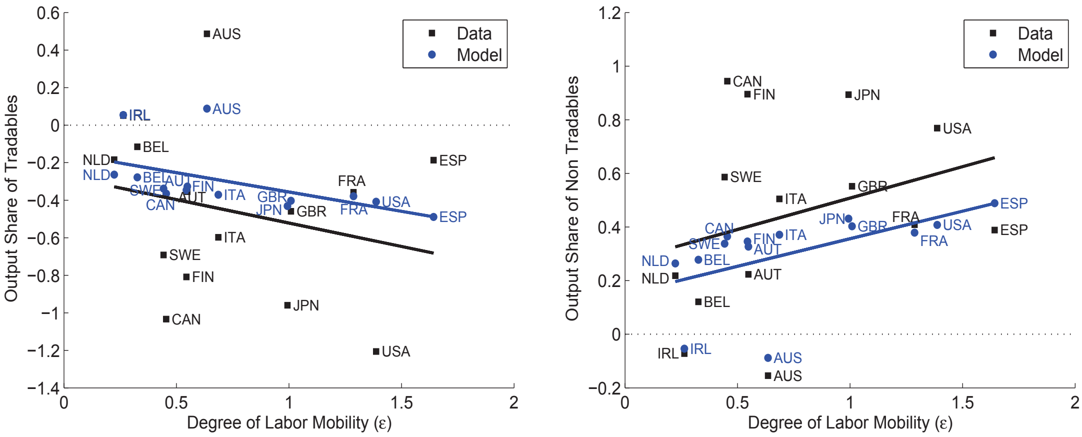
(i) Non Tradable share, Y^N/Y_R

Figure 7: Dynamic Adjustment of Sectoral Variables to Unanticipated Government Spending Shock. Notes: Solid blue line displays point estimate of VAR with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows predictions of the model imposing perfect mobility of labor ($\epsilon \to \infty$) and abstracting from capital adjustment costs ($\kappa = 0$).



(a) Output Share of Tradables (b) Output Share of Non Tradables

Figure 8: Cross-Country Relationship between the Responses of Sectoral Output Shares to Government Spending shock and the Degree of Labor Mobility across Sectors. Notes: Horizontal axes displays panel data estimates of the elasticity of labor supply across sectors, ϵ, taken from the last column of Table 4, which captures the degree of labor mobility across sectors. Vertical axes report simulated impact responses from the baseline model with imperfect mobility of labor across sectors and adjustments costs to capital accumulation.



(a) Output Share of Tradables (b) Output Share of Non Tradables

Figure 9: Cross-Country Relationship from Simulated Responses vs. Cross-Country Relationship from VAR Estimates. Notes: Horizontal axes displays panel data estimates of the elasticity of labor supply across sectors, ϵ, taken from the last column of Table 4, which captures the degree of labor mobility across sectors. Vertical axes report simulated responses from the baseline model (blue circles) and impact responses from the VAR model (black squares).

A Data Description for Empirical Analysis

Coverage: Our sample consists of a panel of 16 countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Spain (ESP), Sweden (SWE), the United Kingdom (GBR) and the United States (USA). The period is running from 1970 to 2007, except for Japan (1974-2007).

Sources: Our primary sources for sectoral data are the OECD and EU KLEMS databases. We use the EU KLEMS [2011] sectoral database (the March 2011 data release, available at `http://www.euklems.net`) which provides for all countries of our sample with the exceptions of Canada and Norway annual data for eleven 1-digit ISIC-rev.3 industries. For Canada and Norway, sectoral data are taken from the Structural Analysis (STAN) database provided by the OECD [2011]. In addition, expenditure aggregates are obtained from the Economic Outlook Database provided by the Organisation for Economic Cooperation and Development [2012b].

The eleven 1-digit ISIC-rev.3 industries are classified as tradables or non tradables. To do so, we adopt the classification proposed by De Gregorio et al. [1994]. Following Jensen and Kletzer [2006], we have updated this classification by treating "Financial Intermediation" as a traded industry. We construct traded and non traded sectors as follows (EU KLEMS codes are given in parentheses):

- **Traded Sector**: "Agriculture, Hunting, Forestry and Fishing" (AtB), "Mining and Quarrying" (C), "Total Manufacturing" (D), "Transport, Storage and Communication" (I) and "Financial Intermediation" (J).
- **Non Traded Sector**: "Electricity, Gas and Water Supply" (E), "Construction" (F), "Wholesale and Retail Trade" (G), "Hotels and Restaurants" (H), "Real Estate, Renting and Business Services" (K) and "Community Social and Personal Services" (LtQ).

Once industries have been classified as traded or non traded, for any macroeconomic variable X, its sectoral counterpart X^j for $j = T, N$ is constructed by adding the X_k of all sub-industries k classified in sector $j = T, N$ as follows $X^j = \sum_{k \in j} X_k$.

Relevant to our work, the EU KLEMS and OECD STAN databases provide data, for each industry and year, on value added at current and constant prices, permitting the construction of sectoral deflators of value added, as well as details on labor compensation and employment data, allowing the construction of sectoral wage rates. In the VAR models, with the exception of the current account, all quantity variables are in log levels and scaled by the working age population (15-64 years old), while price deflators and wage rates are in natural logs. Source: OECD ALFS Database for the working age population. We describe below the construction for the sectoral data employed in Section 2 (mnemonics are given in parentheses):

- **Sectoral output**, Y^j: sectoral value added at constant prices in sector $j = T, N$ (VA_QI). Sources: EU KLEMS and OECD STAN databases.
- **Relative output**, Y^T/Y^N: ratio of traded value added at constant prices to non traded value added at constant prices.
- **Sectoral output share**, $\nu^{Y,j}$: ratio of value added at constant prices in sector j to GDP at constant prices, i.e., $Y^j/(Y^T + Y^N)$ for $j = T, N$.
- **Relative price of non tradables**, P: ratio of the non traded value added deflator to the traded value added deflator, i.e., $P = P^N/P^T$. The sectoral value added deflator P^j for sector $j = T, N$ is calculated by dividing value added at current prices (VA) by value added at constant prices (VA_QI) in sector j. Sources: EU KLEMS and OECD STAN databases.
- **Sectoral labor**, L^j: total hours worked by persons engaged in sector j (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Relative labor**, L^T/L^N: ratio of hours worked in the traded sector to hours worked in the non traded sector.
- **Sectoral labor share**, $\nu^{L,j}$: ratio of hours worked in sector j to total hours worked, i.e., $L^j/(L^T + L^N)$ for $j = T, N$.
- **Sectoral real consumption wage**, W^j/CPI: nominal wage in sector j divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The sectoral nominal wage W^j for sector $j = T, N$ is calculated by dividing labor compensation in sector j (LAB) by total hours worked by persons engaged (H_EMP) in that sector. Sources: EU KLEMS and OECD STAN databases.
- **Relative wage**, Ω: ratio of the nominal wage in the non traded sector W^N to the nominal wage in the traded sector W^T, i.e., $\Omega = W^N/W^T$.

- **Labor reallocation index**, LR: measures the fraction of workers who are working in year t in a different sector than in year $t-2$ and is computed as:

$$LR_t(2) = 0.5 \sum_{j=T}^{N} \left| \frac{L_t^j}{\sum_{j=T}^{N} L_t^j} - \frac{L_{t-2}^j}{\sum_{j=T}^{N} L_{t-2}^j} \right|.$$

  Data for labor (H_EMP), used to compute LR, are taken from EU KLEMS and OECD STAN databases.

In the following, we provide details on data construction for aggregate variables (mnemonics are in parentheses):

- **Government spending**, G: real government final consumption expenditure (CGV). Source: OECD Economic Outlook Database.
- **Gross domestic product**, Y: real gross domestic product (GDPV). Source: OECD Economic Outlook Database.
- **Private investment**, JE: real private non-residential gross fixed capital formation (IBV). Source: OECD Economic Outlook Database.
- **Current account**, CA: ratio of the current account to the gross domestic product at current prices (CBGDPR). Source: OECD Economic Outlook Database.
- **Labor**, L: total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Real consumption wage**, W/CPI: nominal wage divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The nominal wage is calculated by dividing labor compensation (LAB) by total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.

Government spending, investment and GDP variables are deflated with their own deflators.

B Data for Calibration

Table 4 shows the non tradable content of GDP, consumption, investment, government spending, labor and labor compensation. In addition, it gives information about the share of government spending on the traded and non traded goods in the corresponding sectoral value added and the sectoral labor income shares. The column 11 shows the ratio of labor productivity of tradables to labor productivity of non tradables as we we use labor productivity to approximate technological change. Columns 12 to 14 display investment-to-GDP ratio and government spending in % of GDP and the labor income share, respectively, for the whole economy. Our sample covers the 16 OECD countries mentioned in Section A. Our reference period for the calibration corresponds to the period 1990-2007. The choice of this period has been dictated by data availability. Columns 15 and 16 report estimates for the elasticity of substitution in consumption between traded and non traded goods, ϕ, and the elasticity of labor supply across sectors, ϵ. In the following, statistics for the sample as a whole represent (unweighted) averages of the corresponding variables among the group.

To calculate the non tradable share of output, labor and labor compensation, we split the eleven industries into traded and non-traded sectors by adopting the classification proposed by De Gregorio et al. [1994] and updated by Jensen and Kletzer [2006]. Details about data construction for sectoral output and sectoral labor are provided in section A. We calculate the non-tradable share of labor compensation as the ratio of labor compensation in the non traded sector (i.e., $W^N L^N$) to overall labor compensation (i.e., WL). Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. The non tradable content of GDP, labor and labor compensation, shown in columns 1, 5 and 6 of Table 4, average to 63%, 67% and 66% respectively.

To split consumption expenditure (at current prices) into consumption in traded and non traded goods, we made use of the Classification of Individual Consumption by Purpose (COICOP) published by the United Nations (Source: United Nations [2011]). Among the twelve items, the following ones are treated as consumption in traded goods: "Food and Non-Alcoholic Beverages", "Alcoholic Beverages Tobacco and Narcotics", "Clothing and Footwear", "Furnishings, Household Equipment" and "Transport". The remaining items are treated as consumption in non traded goods: "Housing, Water, Electricity, Gas and Fuels", "Health", "Communication", "Recreation and Culture", "Education", "Restaurants and Hotels". Because the item "Miscellaneous Goods and Services" is somewhat problematic, we decided to consider it as both tradable (50%) and non tradable (50%) with equal shares. Data coverage: 1990-2007 for AUS, AUT, CAN, DNK, FIN, FRA, GBR, ITA, JPN, NLD, NOR and USA, 1993-2007 for SWE and 1995-2007 for BEL, ESP and IRL. The non-tradable share of consumption shown in column 2 of Table 4 averages to 53%.

To calculate the non tradable share of investment expenditure, we follow the methodology proposed by Burstein et al. [2004] who treat "Housing", "Other Constructions" and "Other Products" as non-tradable investment and "Products of Agriculture, Forestry, Fisheries and Aquaculture", "Metal Products and Machinery", "Transport Equipment" as tradable investment expenditure. Source: OECD Input-Output database [2012a]. Data coverage: 1990-2007 for AUT, CAN, ESP, FIN, GBR, IRL, JPN, NLD, and NOR, 1990-2006 for DNK, FRA, ITA and USA, and 1993-2007 for SWE. Data are not available for AUS and BEL. Non tradable share of investment shown in column 3 of Table 4 averages to 64%, in line with estimates provided by Burstein et al. [2004] and Bems [2008].

Sectoral government expenditure data (at current prices) were obtained from the Government Finance Statistics Yearbook (Source: IMF [2011]) and the OECD General Government Accounts database (Source: OECD [2012b]). Adopting Morshed and Turnovsky's [2004] methodology, the following four items were treated as traded: "Fuel and Energy", "Agriculture, Forestry, Fishing, and Hunting", "Mining, Manufacturing, and Construction", "Transport and Communications". Items treated as non traded are: "Government Public Services", "Defense", "Public Order and Safety", "Education", "Health", "Social Security and Welfare", "Environment Protection", "Housing and Community Amenities", "Recreation Cultural and Community Affairs". Data coverage: 1990-2007 for BEL, DNK, FIN, GBR, IRL, ITA, JPN, NOR and USA, 1990-2006 for CAN, 1995-2007 for AUT, ESP, FRA, NLD and SWE. Data are not available for AUS. The non tradable component of government spending shown in column 4 of Table 4 averages to 90%. Government spending on traded and non traded goods in % of the corresponding sectoral output, i.e., G^T/Y^T and G^N/Y^N, respectively, is shown in columns 7 and 8 of Table 4. They average 5% and 30%, respectively.

The labor income share for sector j denoted by θ^j is calculated as the ratio of labor compensation of sector j to value added of sector j at current prices. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. As shown in columns 9 and 10 of Table 4, θ^T and θ^N average 0.60 and 0.67, respectively. When $k^T > k^N$, the shares of labor income average 0.58 and 0.67 for the traded and the non traded sector, respectively, while if $k^N > k^T$, θ^T and θ^N average 0.70 and 0.64, respectively. In addition, column 14 of Table 4 gives the aggregate labor income share which averages 0.64 in our sample.

Column 11 of Table 4 displays the ratio of labor productivity in tradables to labor productivity in non tradables (Z^T/Z^N) averaged over the period 1990-2007. To measure labor productivity in sector $j = T, N$, we divide value added at constant prices in sector j (VA_QI) by total hours worked by persons engaged (H_EMP) in that sector. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries. As shown in column 11, the traded sector is in average 28 percent more productive than the non traded sector for the whole sample.

Columns 12 and 13 of Table 4 display gross capital formation and final consumption expenditure of general government as a share of GDP, respectively. Source: OECD National Accounts Database. Data coverage: 1990-2007 for all countries.

Column 1 of Table 3 shows our estimates of the elasticity of labor supply across sectors, ϵ, while columns 2-3 show our estimates of the elasticity of substitution in consumption between traded and non traded goods, ϕ. We detail our empirical strategy to estimate these two parameters.

Along the lines of Horvath [2000], we derive a testable equation by combining optimal rules for labor supply and labor demand and estimate ϵ by running the regression of the worker inflow in sector $j = T, N$ of country i at time t arising from labor reallocation across sectors computed as $\hat{l}^j_{i,t} - \hat{l}_{i,t}$ on the relative labor's share percentage changes in sector j, $\hat{\beta}^j_{i,t}$:[47]

$$\hat{l}^j_{i,t} - \hat{l}_{i,t} = f_i + f_t + \gamma_i \hat{\beta}^j_{i,t} + \nu^j_{i,t}, \tag{53}$$

where we denote logarithm in lower case and the deviation from initial steady-state by a hat; $\nu^j_{i,t}$ is an i.i.d. error term; country fixed effects are captured by country dummies, f_i, and common macroeconomic shocks by year dummies, f_t. The LHS term of (53) is calculated as the difference between changes (in percentage) in hours worked in sector j, $\hat{l}^j_{i,t}$, and in total hours worked, $\hat{l}_{i,t}$. The RHS term β^j corresponds to the fraction of labor's share of output accumulating to labor in sector j. Denoting by $P^j_t Q^j_t$ output at current prices in sector $j = T, N$ at time t, β^j_t is computed as $\frac{\xi^j P^j_t Q^j_t}{\sum_{j=N}^T \xi^j P^j_t Q^j_t}$ where ξ^j is labor's share in output in sector $j = T, N$ defined as the ratio of the compensation of employees to output in the jth sector, averaged over the period 1971-2007.[48] Because hours worked are aggregated by means of a CES function, total hours percentage change $\hat{l}_{i,t}$ is calculated as a weighted average of sectoral employment percentage changes, i.e., $\hat{l}_t = \sum_{j=N}^T \beta^j_{t-1} \hat{l}^j_t$. The parameter we are interested in, the degree of substitutability of hours worked across sectors, is given by $\epsilon_i = \gamma_i/(1-\gamma_i)$. In the regressions that follow, the parameter γ_i is alternatively assumed

[47] Details of derivation of the equation we explore empirically can be found in a Technical Appendix.

[48] As Horvath [2000], we use time series for output instead of value added so that our estimates can be compared with those documented by the author.

to be identical across countries when estimating for the whole sample ($\gamma_i = \gamma_{i'} \equiv \gamma$ for $i \neq i'$) or to be different across countries when estimating ϵ for each economy ($\gamma_i \neq \gamma_{i'}$ for $i \neq i'$). Data are taken from the EU KLEMS [2011] and STAN databases, and the sample includes the 16 OECD countries mentioned above over the period 1971-2007 (except for Japan: 1975-2007). Table 3 reports empirical estimates that are consistent with $\epsilon > 0$. All values are statistically significant at 10%, except for Denmark and Norway.[49]

To estimate the elasticity of substitution in consumption, ϕ, between traded and non traded goods, we first derive a testable equation by inserting the optimal rule for intra-temporal allocation of consumption (14) into the goods market equilibrium which gives $\frac{C^T}{C^N} = \frac{Y^T - NX - G^T - I^T}{Y^N - G^N - I^N} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}$ where $NX \equiv \dot{B} - r^{\star}B$ is net exports, I^j and G^j are investment in physical capital and government spending in sector j, respectively. Isolating $\left(Y^T - NX\right)/Y^N$ and taking logarithm yields $\ln\left(\frac{Y^T - NX}{Y^N}\right) = \alpha + \phi \ln P$. Adding an error term μ, we estimate ϕ by running the regression of the (logged) output of tradables adjusted with net exports at constant prices in terms of output of non tradables on the (logged) relative price of non tradables:

$$\ln\left(\frac{Y^T - NX}{Y^N}\right)_{i,t} = f_i + f_t + \alpha_i t + \phi_i \ln P_{i,t} + \mu_{i,t}, \tag{54}$$

where f_i and f_t are the country fixed effects and time dummies, respectively. Because the term $\alpha \equiv \ln \frac{\left(1-\upsilon_{G^N}-\upsilon_{I^N}\right)}{\left(1-\upsilon_{G^T}-\upsilon_{I^T}\right)} + \ln\left(\frac{\varphi}{1-\varphi}\right)$ is composed of ratios, denoted by υ_{G^j} and υ_{I^j}, of G^T (G^N) and I^T (I^N) to $Y^T - NX$ (Y^N) and hence may display a trend over time, we add country-specific linear trends, as captured by $\alpha_i t$.[50]

Instead of using time series for sectoral value added, we can alternatively make use of series for sectoral labor compensation by inserting the first-order condition equating the marginal revenue of labor and the sectoral wage, i.e., $\frac{\theta^j P^j Y^j}{L^j} = W^j$, into the goods market clearing condition. Eliminating Y^j, denoting by $\gamma^T = \left(W^T L^T - \theta^T P^T NX\right)$ and $\gamma^N = W^N L^N$, and taking logarithm yields $\ln\left(\frac{\gamma^T}{\gamma^N}\right) = \eta + \phi \ln P$ where η is a term composed of both preference (i.e., φ) and production (i.e., θ^j) parameters, and (logged) ratios of G^T (G^N) and I^T (I^N) to $W^T L^T - \theta^T P^T NX$ $(W^N L^N)$. We estimate ϕ by exploring alternatively the following empirical relationship:

$$\ln\left(\gamma^T/\gamma^N\right)_{i,t} = g_i + g_t + \sigma_i t + \phi_i \ln P_{i,t} + \zeta_{i,t}, \tag{55}$$

where g_i and g_t are the country fixed effects and time dummies, respectively, and we add country-specific trends, as captured by $\sigma_i t$, because η is composed of ratios that may display a trend over time.

Time series for sectoral value added at constant prices, labor compensation, and the relative price of non tradables are taken from EU KLEMS [2011] and STAN databases (see Section A). Net exports correspond to the external balance of goods and services at current prices taken from OECD Economic Outlook Database. To construct time series for net exports at constant prices, NX, data are deflated by the value added deflator of traded goods P_t^T.

Since LHS terms of (54) and (55) and relative price of non tradables display trends, we ran unit root and then cointegration tests. Having verified that these two assumptions are empirically supported, we estimate the cointegrating relationships by using fully modified OLS (FMOLS) procedure for cointegrated panel proposed by Pedroni [2000], [2001]. FMOLS estimates of (54) and (55) are reported in the second and the third column of Table 3 respectively. As a reference model, we consider eq. (54) which gives an estimate for the whole sample of $\phi = 0.66$. This value is roughly halfway between estimates documented by cross-section studies, notably Stockman and Tesar [1995] who find a value for ϕ of 0.44 and Mendoza [1995] who reports an estimate of 0.74.

[49] In a Technical Appendix, we address one potential econometric issue. While $\beta^j_{i,t}$ (i.e., the RHS term in eq. (53)) is constructed independently from the dependent variable (i.e., the LHS term in eq. (53)), if the labor's share is (almost) constant over time and thus is close from the average ξ^j, an endogeneity problem may potentially show up. Our empirical results reveal that for the majority of the countries in our sample, the dependent variable does not Granger-cause the explanatory variable.

[50] Because an endogeneity problem of relative prices may potentially affect our econometric results, we ran Granger causality tests. Our empirical results reveal that for the majority of the countries in our sample, the dependent variable does not Granger-cause the explanatory variable. Our results show that one can consider the regressor in eq. (54) as exogenous with respect to the dependent variable.

Table 3: Estimates of the Elasticity of Labor Supply across Sectors (ϵ) and the Elasticity of Substitution in Consumption between Tradables and Non Tradables (ϕ)

Country	Labor Mobility (ϵ)	Elasticity of Substitution (ϕ)	
	eq. (53)	eq. (54)	eq. (55)
	$\hat{\epsilon}_i$	$\hat{\phi}_i^{FMOLS}$	$\hat{\phi}_i^{FMOLS}$
AUS	0.635^a (3.55)	0.268^a (2.99)	0.409^b (2.52)
AUT	0.548^a (2.66)	0.986^a (3.09)	1.413^a (4.99)
BEL	0.326^b (2.51)	0.070 (0.41)	0.795^a (4.99)
CAN	0.454^a (3.41)	0.391^a (3.74)	0.582^a (5.53)
DNK	0.150 (1.46)	2.071^a (2.95)	1.323^a (2.93)
ESP	1.642^a (3.02)	0.783^a (4.96)	0.413^b (2.04)
FIN	0.544^a (3.62)	1.072^a (8.57)	1.421^a (8.12)
FRA	1.287^b (2.44)	0.937^a (6.22)	1.038^a (5.25)
GBR	1.008^a (3.79)	0.477^a (9.64)	1.164^a (14.07)
IRL	0.264^a (3.18)	0.374^c (1.71)	0.158 (0.35)
ITA	0.686^a (2.84)	-0.308 (-1.60)	-0.187 (-0.98)
JPN	0.993^a (2.87)	0.654^a (2.98)	0.676^a (4.33)
NLD	0.224^b (1.97)	0.709^b (2.33)	0.428 (1.18)
NOR	0.097 (1.49)	0.979^a (9.72)	2.056^a (13.66)
SWE	0.443^a (3.61)	0.356^a (4.02)	0.900^a (7.23)
USA	1.387^a (2.59)	0.668^a (2.81)	0.799^b (2.02)
Whole Sample	0.479^a (12.16)	0.656^a (16.13)	0.837^a (14.16)
Countries	16	16	16
Observations	1178	605	605
Data coverage	1971-200	1970-2007	1970-2007
Country fixed effects	yes	yes	yes
Time dummies	yes	yes	yes
Time trend	no	yes	yes

Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels; t-statistics are reported in parentheses.

Table 4: Data to Calibrate the Two-Sector Model (1990-2007)

Countries	Non tradable Share						G^j/Y^j		Labor Share		Product.	Aggregate ratios			Elasticities	
	Output	Consump.	Inv.	Gov. Spending	Labor	Lab. comp.	G^T/Y^T	G^N/Y^N	θ^T	θ^N	Z^T/Z^N	I/Y	G/Y	Labor Share	ϕ	ϵ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
AUS	0.63	0.56	n.a.	n.a.	0.68	0.67	n.a.	n.a.	0.55	0.66	1.30	0.25	0.18	0.62	0.27	0.64
AUT	0.64	0.52	0.62	0.90	0.64	0.64	0.05	0.27	0.65	0.66	1.05	0.24	0.19	0.65	0.99	0.55
BEL	0.65	0.53	n.a.	0.91	0.68	0.66	0.06	0.30	0.65	0.67	1.28	0.21	0.22	0.66	0.80	0.33
CAN	0.63	0.54	0.67	0.91	0.69	0.67	0.05	0.30	0.53	0.63	1.32	0.20	0.20	0.59	0.39	0.45
DNK	0.66	0.54	0.60	0.94	0.68	0.68	0.05	0.36	0.63	0.70	1.17	0.20	0.26	0.68	2.07	-
ESP	0.64	0.54	0.72	0.88	0.66	0.67	0.06	0.24	0.60	0.66	1.18	0.25	0.18	0.64	0.78	1.64
FIN	0.58	0.53	0.68	0.89	0.63	0.63	0.06	0.34	0.59	0.73	1.47	0.20	0.22	0.67	1.07	0.54
FRA	0.70	0.51	0.69	0.94	0.69	0.68	0.05	0.31	0.70	0.64	1.05	0.19	0.23	0.66	0.94	1.29
GBR	0.64	0.52	0.58	0.93	0.70	0.65	0.04	0.29	0.70	0.73	1.54	0.17	0.20	0.72	0.48	1.01
IRL	0.52	0.52	0.69	0.89	0.62	0.62	0.04	0.28	0.46	0.69	1.83	0.22	0.17	0.58	0.37	0.26
ITA	0.64	0.46	0.57	0.91	0.63	0.62	0.05	0.27	0.71	0.64	1.00	0.21	0.19	0.67	-	0.69
JPN	0.63	0.57	0.63	0.86	0.64	0.65	0.06	0.22	0.57	0.63	0.96	0.26	0.16	0.61	0.65	0.99
NLD	0.65	0.53	0.63	0.90	0.70	0.69	0.07	0.32	0.60	0.70	1.38	0.21	0.23	0.67	0.71	0.22
NOR	0.54	0.49	0.67	0.88	0.66	0.67	0.06	0.34	0.38	0.65	1.44	0.22	0.21	0.52	0.98	-
SWE	0.64	0.56	0.55	0.92	0.68	0.67	0.06	0.39	0.63	0.71	1.42	0.18	0.27	0.68	0.36	0.44
USA	0.69	0.63	0.64	0.90	0.73	0.69	0.05	0.20	0.61	0.63	1.12	0.19	0.16	0.62	0.67	1.39
Mean	0.63	0.53	0.64	0.90	0.67	0.66	0.05	0.30	0.60	0.67	1.28	0.21	0.20	0.64	0.77	0.75

Notes: G^j/Y^j is the share of government spending in good j in output of sector j; θ^j is the share of labor income in value added at current prices of sector $j = T, N$; Z^T/Z^N corresponds to the ratio of labor productivity of tradables to labor productivity of non tradables. I/Y is the investment-to-GDP ratio and G/Y is government spending as a share of GDP.

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IMPERFECT MOBILITY OF LABOR ACROSS SECTORS AND FISCAL TRANSMISSION

TECHNICAL APPENDIX

NOT MEANT FOR PUBLICATION

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- Section A presents the source and construction of the data used in the empirical and quantitative analysis, and empirical strategies to estimate the elasticity of substitution between traded and non traded goods and the elasticity of labor supply across sectors.
- Section B provides more VAR results and conduct a robustness check with respect to the classification of industries as tradables or non tradables, the exclusion of the public sector from aggregate and sectoral variables, the identifying assumption of government spending shocks.
- Section C give more details on the model without physical capital accumulation, sets out the approach taken to solve the model, provides formal solutions for temporary fiscal shocks, investigates the effects of a rise in government consumption on non tradables and tradables as well, analyzes the role of the degree of labor mobility across sectors, and provides the main steps leading to equations in the main text of section 4.
- Section D gives more details on the model with physical capital accumulation, determines first-order conditions and sets out the approach taken to solve the model.
- In section E, we characterize graphically the initial steady-state and analyze the long-run effects of a temporary increase in government consumption.
- Section F provides the main steps leading to formal solutions following a temporary rise in government consumption in a continuous time setup.
- Section G considers a more general form for preferences by relaxing the assumption of separability in preferences in consumption and leisure.
- Section H gives more details about the calibration of the model to data.
- Section I gives more numerical results. In this section, we explore the case of imperfect mobility of capital across sectors and we compare the theoretical responses from the baseline model with limited labor mobility and capital installation costs with those when one of these two features is shut down, together with the results from the VAR model.

A Data Description

In this section, we present a complete description of our data set. First, we provide details on the data sources and variables construction used in the empirical analysis and to calibrate the model. Then, we describe empirical strategies to estimate two parameters involved in our quantitative analysis: the elasticity of substitution in consumption between traded and non traded goods, ϕ, and the degree of substitutability of hours worked across sectors, ϵ.

A.1 Data Description for Empirical Analysis

Coverage: Our sample consists of a panel of 16 countries: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Spain (ESP), Sweden (SWE), the United Kingdom (GBR), and the United States (USA). The period is running from 1970 to 2007, with the exception of Japan (1974-2007) for which the starting date differs due to sectoral data availability. The choice of countries is restricted by the availability of sufficiently detailed data on sectoral variables over a long time horizon.

A.1.1 Data for Aggregate Variables: Source and Construction

Sources: All expenditure aggregates are obtained from the Economic Outlook Database provided by the Organisation for Economic Cooperation and Development [2012b].

Series for aggregate variables are government final consumption expenditure (G), GDP (Y), total hours worked (L), the real consumption wage (W/CPI), private non-residential investment (I), and the current account-to-GDP ratio (CA). The database contains annual observations for the period running from 1970 to 2007 for the 16 OECD countries mentioned above. In the following, we provide details on data construction for aggregate variables (mnemonics are in parentheses):

- **Government spending**, G: real government final consumption expenditure (CGV). Source: OECD Economic Outlook Database.
- **Gross domestic product**, Y: real gross domestic product (GDPV). Source: OECD Economic Outlook Database.
- **Private investment**, JE: real private non-residential gross fixed capital formation (IBV). Source: OECD Economic Outlook Database.
- **Current account**, CA: ratio of the current account to the gross domestic product at current prices (CBGDPR). Source: OECD Economic Outlook Database.
- **Labor**, L: total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Real Consumption wage**, W/CPI: nominal wage divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The nominal wage is calculated by dividing labor compensation (LAB) by total hours worked by persons engaged (H_EMP). Sources: EU KLEMS and OECD STAN databases.

For government spending, GDP and investment, we directly use the volumes as reported by the OECD (the series are deflated with their own deflators). All quantity variables, with the exception of the current account, enter in the VAR models in log levels and scaled by the working age population (15-64 years old), while the real consumption wage rate is in natural log. The data source for the working age population is the OECD ALFS database.

A.1.2 Data for Sectoral Variables: Source and Construction

Sources: Our primary data sources are the OECD and EU KLEMS databases. We use the EU KLEMS [2011] sectoral database (the March 2011 data release, available at `http://www.euklems.net`) which provides for all countries of our sample with the exception of Canada and Norway annual data for eleven 1-digit ISIC-rev.3 industries. For Canada and Norway, sectoral data are taken from the Structural Analysis (STAN) database provided by the OECD [2011].

The eleven 1-digit ISIC-rev.3 industries are classified as tradables or non tradables. To do so, we adopt the classification proposed by De Gregorio et al. [1994] who treat an industry as traded when it exports at least 10% of its output. Following Jensen and Kletzer [2006], we have updated the classification suggested by De Gregorio et al. [1994] by treating "Financial Intermediation" as a traded industry. Jensen and Kletzer [2006] use the geographic concentration of service activities within the United States to identify which service activities are traded domestically. The authors classify activities that are traded domestically as potentially traded internationally. The idea is that when a good or a service is traded, the production of the activity is concentrated in a particular region to take advantage of economies of scale in production.

Jensen and Kletzer [2006] use the two-digit NAICS (North American Industrial Classification System) to identify tradable and non tradable sectors. We map their classification into the NACE-ISIC-rev.3 used by the EU KLEMS and STAN databases. The mapping was clear for all sectors except for "Real Estate, Renting and Business Services". According to the EU KLEMS/STAN classification, the industry labelled "Real Estate, Renting and Business Services" is an aggregate of five sub-industries: "Real estate activities" (NACE code: 70), "Renting of Machinery and Equipment" (71), "Computer and Related Activities" (72), "Research and Development" (73) and "Other Business Activities" (74). While Jensen and Kletzer [2006] find that industries 70 and 71 can be classified as tradable, they do not provide information for industries 72, 73 and 74. We decided to classify "Real Estate, Renting and Business Services" as non tradable but conduct a robustness check by contrasting our empirical findings when "Real Estate, Renting and Business Services" is non traded with those when "Real Estate, Renting and Business Services" is traded. As shown in section B.2, our conclusions hold and remain unsensitive to the classification. We construct traded and non traded sectors as follows (EU KLEMS codes are given in parentheses):

- **Traded Sector**: "Agriculture, Hunting, Forestry and Fishing" (AtB), "Mining and Quarrying" (C), "Total Manufacturing" (D), "Transport, Storage and Communication" (I) and "Financial Intermediation" (J).
- **Non Traded Sector**: "Electricity, Gas and Water Supply" (E), "Construction" (F), "Wholesale and Retail Trade" (G), "Hotels and Restaurants" (H), "Real Estate, Renting and Business Services" (K) and "Community Social and Personal Services" (LtQ).

Once industries have been classified as tradables or non tradables, for any macroeconomic variable X, its sectoral counterpart X^j for $j = T, N$ is constructed by adding the X_k of all sub-industries k classified in sector $j = T, N$ as follows $X^j = \sum_{k \in j} X_k$.

Relevant to our work, EU KLEMS and OECD STAN database provide data, for each industry and year, on value added at current and constant prices, thus allowing us to construct series for sectoral value added deflators; the database also provide details on labor compensation and employment data, allowing the construction for sectoral wage rates. In the VAR models, with the exception of the current account, all quantity variables are in log levels and scaled by the working age population (15-64 years old), while price deflators and wage rates are in natural logs. Source: OECD ALFS Database for the working age population. We detail below the construction of sectoral data employed in section 2 (mnemonics are given in parentheses):

- **Sectoral output**, Y^j: sectoral value added at constant prices in sector $j = T, N$ (VA_QI). Sources: EU KLEMS and OECD STAN databases.
- **Relative output**, Y^T/Y^N: ratio of traded value added at constant prices to non traded value added at constant prices.
- **Sectoral output share**, $\nu^{Y,j}$: ratio of value added at constant prices in sector j to GDP at constant prices, i.e., $Y^j/(Y^T + Y^N)$ for $j = T, N$.
- **Relative price of non tradables**, P: ratio of the non traded value added deflator to the traded value added deflator, i.e., $P = P^N/P^T$. The sectoral value added deflator P^j for sector $j = T, N$ is calculated by dividing value added at current prices (VA) by value added at constant prices (VA_QI) in sector j. Sources: EU KLEMS and OECD STAN databases.
- **Sectoral labor**, L^j: total hours worked by persons engaged in sector j (H_EMP). Sources: EU KLEMS and OECD STAN databases.
- **Relative labor**, L^T/L^N: ratio of hours worked in the traded sector to hours worked in the non traded sector.
- **Sectoral labor share**, $\nu^{L,j}$: ratio of hours worked in sector j to total hours worked, i.e., $L^j/(L^T + L^N)$ for $j = T, N$.
- **Sectoral real consumption wage**, W^j/CPI: nominal wage in sector j divided by the consumer price index (CPI). Source: OECD Prices and Purchasing Power Parities for the consumer price index. The sectoral nominal wage W^j for sector $j = T, N$ is calculated by dividing labor compensation in sector j (LAB) by total hours worked by persons engaged (H_EMP) in that sector. Sources: EU KLEMS and OECD STAN databases.
- **Relative wage**, Ω: ratio of the nominal wage in the non traded sector W^N to the nominal wage in the traded sector W^T, i.e., $\Omega = W^N/W^T$.

- **Labor reallocation index**, LR: measures the fraction of workers who are working in year t in a different sector than in year $t-2$ and is computed as:

$$LR_t(2) = 0.5 \sum_{j=T}^{N} \left| \frac{L_t^j}{\sum_{j=T}^{N} L_t^j} - \frac{L_{t-2}^j}{\sum_{j=T}^{N} L_{t-2}^j} \right|.$$

Data for labor (H_EMP) are taken from EU KLEMS and STAN databases.

A.2 Data Description for Calibration

In the numerical analysis, we calibrate a set of parameters by choosing them so that the initial steady-state of the model matches key empirical properties of a representative OECD economy. In particular, we pay attention to the adequacy of the non tradable content of the model to the data. This section gives information on our estimates of the non tradable content of GDP, consumption, investment, government spending, labor and labor compensation. In addition, it gives information about the share of government spending on traded and non traded goods in the corresponding sectoral value added and the labor income shares in sector $j = T, N$.

Our sample covers the 16 OECD countries mentioned in section A.1. In the following, statistics for the sample as a whole represent (unweighted) averages of the corresponding variables among the group. Our reference period for the calibration corresponds to the period 1990-2007. The choice of this period has been dictated by data availability. In the following, we provide details on data construction for non tradable shares:

- **Output, labor and labor compensation**: we split the eleven industries into traded and non traded sectors by adopting the classification proposed by De Gregorio et al. [1994] and updated by Jensen and Kletzer [2006]. Details about data construction for output and labor are provided in Section A.1.2. We calculate the non tradable share of labor compensation as the ratio of labor compensation of non tradables, i.e., $W^N L^N$, to overall labor compensation, i.e., WL. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries.

- **Consumption**: to split consumption expenditure (at current prices) into consumption in traded and non traded goods, we made use of the Classification of Individual Consumption by Purpose (COICOP) published by the United Nations (Source: United Nations [2011]). Among the twelve items, the following ones are treated as consumption in traded goods: "Food and Non-Alcoholic Beverages", "Alcoholic Beverages Tobacco and Narcotics", "Clothing and Footwear", "Furnishings, Household Equipment" and "Transport". The remaining items are treated as consumption in non traded goods: "Housing, Water, Electricity, Gas and Fuels", "Health", "Communication", "Recreation and Culture", "Education", "Restaurants and Hotels". Because the item "Miscellaneous Goods and Services" is somewhat problematic, we decided to consider it as both tradable (50%) and non tradable (50%) with equal shares. Data coverage: 1990-2007 for AUS, AUT, CAN, DNK, FIN, FRA, GBR, ITA, JPN, NLD, NOR and USA, 1993-2007 for SWE and 1995-2007 for BEL, ESP and IRL.

- **Investment**: to map investment expenditure (at current prices) into expenditures on tradables and non tradables, we follow the classification proposed by Burstein et al. [2004], we consider "Housing", "Other Constructions" and "Other Products" as non tradable investment and "Products of Agriculture, Forestry, Fisheries and Aquaculture", "Metal Products and Machinery", "Transport Equipment" as tradable investment expenditure. Source: OECD Input-Output database [2012a]. Data coverage: 1990-2007 for AUT, CAN, ESP, FIN, GBR, IRL, JPN, NLD, and NOR, 1990-2006 for DNK, FRA, ITA and USA, and 1993-2007 for SWE. Data are not available for AUS and BEL. Thus, for these two countries, when we calibrate the model to each OECD country, we target a non tradable content of investment expenditure that is given by the unweighed average, i.e., 0.64.

- **Government spending**: information on the relative size of the traded and non traded goods in government expenditure (at current prices) is obtained from Government Finance Statistics Yearbook (IMF [2011]) and the OECD General Government Accounts database (OECD [2012b]). Adopting Morshed and Turnovsky's [2004] classification, the following four items were treated as traded: "Fuel and Energy", "Agriculture, Forestry, Fishing, and Hunting", "Mining, Manufacturing, and Construction", "Transport and Communications". Items treated as non traded are: "Government Public Services", "Defense", "Public Order and Safety", "Education", "Health", "Social Security and Welfare", "Environment Protection", "Housing and Community Amenities", "Recreation Cultural and Community Affairs". Data coverage: 1990-2007 for BEL, DNK, FIN, GBR, IRL, ITA, JPN, NOR and USA, 1990-2006 for CAN, 1995-2007 for AUT, ESP, FRA, NLD and SWE. Data are not available for AUS.

Thus, for this country, when we calibrate the model to each OECD country, we choose a non tradable content of government expenditure that is given by the unweighed average, i.e., 0.90.

Next, the labor income share for sector $j = T, N$, denoted by θ^j, is calculated as the ratio of labor compensation in sector j (LAB) to value added at current prices (VA_QI) in that sector, i.e., $\theta^j = (W^j L^j)/(P^j Y^j)$. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries.

Finally, we approximate technological change in sector j with labor productivity in this sector which we measure by dividing the value added at constant prices in sector j (VA_QI) by total hours worked by persons engaged (H_EMP) in this sector, i.e., $Z^j = Y^j/L^j$. The relative productivity, Z^T/Z^N, is calculated as the ratio of labor productivity of tradables, Z^T, to labor productivity of non tradables, Z^N. Sources: EU KLEMS [2011] and STAN databases. Data coverage: 1990-2007 for all countries.

Because data source and construction are heterogenous across variables as a result of different nomenclatures, Table 5 provides a summary of the classification adopted to split value added and its demand components as well intro traded and non traded goods.

A.3 Estimates of ϕ: Empirical Strategy

In this section, we detail our empirical strategy to estimate the elasticity of substitution between traded and non traded goods ϕ. Estimates of the elasticity of substitution ϕ by the existing literature are rather diverse. The cross-section studies report an estimate of ϕ ranging from 0.44 to 0.74, see e.g., Stockman and Tesar [1995] and Mendoza [1995], respectively.[51] The literature adopting the Generalized Method of Moments and the cointegration methods, see e.g. Ostry and Reinhart [1992] and Cashin and Mc Dermott [2003], respectively, reports a value in the range $[0.75, 1.50]$ for developing countries and in the range $[0.63, 3.50]$ for developed countries. Since estimates for ϕ display a sharp dispersion across empirical studies, we conduct an empirical analysis in order to estimate this parameter for each country in our sample.

A.3.1 Empirical Strategy

Using Time Series by Industry Taken from EU KLEMS and STAN

To estimate ϕ, we adopt the following strategy. To determine an empirical relationship, we combine the optimal rule for intra-temporal allocation of consumption (14) (that we repeat for clarity purposes)

$$\frac{C^T}{C^N} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}. \tag{56}$$

with the goods market equilibrium

$$\frac{C^T}{C^N} = \frac{Y^T - NX - G^T - I^T}{Y^N - G^N - I^N}, \tag{57}$$

where we used the fact that $\dot{B} - r^{\star} B = Y^T - C^T - G^T - I^T \equiv NX$. Inserting (56) into (57) leads to

$$\frac{Y^T - NX - G^T - I^T}{Y^N - G^N - I^N} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}. \tag{58}$$

According to the market clearing condition, we could alternatively use data for consumption or for sectoral value added along with times series for its demand components to estimate ϕ. Unfortunately, nomenclatures for valued added by industry and for consumption by items are different and thus it is most likely that C^T differs from $Y^T - NX - G^T - I^T$, and C^N from $Y^N - G^N - I^N$ as well. Because time series for traded and non traded consumption display a short time horizon for half countries of our sample while data for sectoral value added and net exports are available for the 16 OECD countries of our sample over the period running from 1970 to 2007 (except for Japan: 1974-2007), we find appropriate to estimate

[51] While the sample used by Stockman and Tesar [1995] covers 30 countries (including 17 developing and 13 industrialized), Mendoza [1995] uses exactly the same data set in his estimation but includes only the 13 industrialized countries. Note that the estimate of ϕ has been obtained by using the cross sectional dataset by Kravis, Heston and Summers for the year 1975.

Table 5: Construction of Variables and Data Sources

Variable	Countries covered	Period	Construction and aggregation	Database
Value added Y^T & Y^N (constant prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	T: Agriculture, Mining, Manufacturing, Transport, Finance Intermediation N: Electricity, Construction, Trade, Hotels, Real Estate, Personal Services	EU KLEMS & STAN
Value added P^TY^T & P^NY^N (current prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	T: Agriculture, Mining, Manufacturing, Transport, Finance Intermediation N: Electricity, Construction, Trade, Hotels, Real Estate, Personal Services	EU KLEMS & STAN
Labor L^T & L^N (total hours worked by persons engaged)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	T: Agriculture, Mining, Manufacturing, Transport, Finance Intermediation N: Electricity, Construction, Trade, Hotels, Real Estate, Personal Services	EU KLEMS & STAN
Labor compensation LAB^T & LAB^N (current prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	T: Agriculture, Mining, Manufacturing, Transport, Finance Intermediation N: Electricity, Construction, Trade, Hotels, Real Estate, Personal Services	EU KLEMS & STAN
Price P^T & P^N (value added deflator)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Value added at current prices (P^jY^j) over value added at constant prices (Y^j)	authors' calculations
Relative Price P (index 1995=100)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Value added deflator of non traded goods (P^N) over value added deflator of traded goods (P^T)	authors' calculations
Wage W^T & W^N (nominal and per hour)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Labor compensation (LAB^j) over total hours worked by persons engaged (L^j)	authors' calculations
Wage W (nominal and per hour)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Labor compensation (LAB) over total hours worked by persons engaged (L)	authors' calculations
Wage W^T/CPI & W^N/CPI (real and per hour)	AUS, AUT, BEL, CAN, ESP, DNK, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Nominal wage (W^j) divided by the consumer price index (CPI)	authors' calculations
Wage W/CPI (real and per hour)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Nominal wage (W) divided by the consumer price index (CPI)	authors' calculations
Relative Wage Ω (index 1995=100)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Nominal wage in non tradables (W^N) over nominal wage in tradables (W^T)	authors' calculations
Relative Productivity Z^T/Z^N	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (JPN: 74-07)	Real labor productivity in tradables (Z^T) over real labor productivity in non tradables (Z^N). Z^j is calculated as $Z^j = Y^j/L^j$	authors' calculations
Labor Reallocation Index LR	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1972-2007 (JPN: 76-07)	Fraction of workers who in year t are working in a different sector than in year $t-2$. Computed from Kambourov [2009]	authors' calculations
Consumer Price Index CPI (index 1995=100)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL , ITA, JPN, NLD, NOR, SWE, USA	1970-2007 (IRL: 76-07)	Consumer prices, all items index	OECD Prices
Government spending G (constant prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007	Log of real per capita government final consumption expenditure (CGV) Population is working age population (15-64 years old), source: OECD	OECD Outlook
Gross domestic product Y (constant prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007	Log of real per capita gross domestic product (GDPV)	OECD Outlook
Private investment I (constant prices)	AUS, AUT, BEL, CAN, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, SWE, USA	1970-2007	Log of real per capita private non-residential gross fixed capital formation (IBV)	OECD Outlook
Current account CA (in % of GDP)	AUS (70-07), AUT (70-07), BEL (75-07), CAN (70-07), DNK (88-07), ESP (75-07), FIN (75-07), FRA (73-07), GBR (70-07), IRL (90-07), ITA (71-07), JPN (70-07), NLD (70-07), NOR (75-07), SWE (75-07), USA (70-07)		Ratio of the current account balance to the gross domestic product at current prices (CBGDPR)	OECD Outlook
Investment P^TI^T & P^NI^N (current prices)	AUT (76-07), CAN (70-07), DNK (70-06), ESP (80-07), FIN (70-07), FRA (78-06), GBR (70-07), IRL (90-07), ITA (70-06), JPN (80-07), NLD (70-07), NOR (70-07), SWE (93-07), USA (77-06)		T: Products of Agriculture, Machinery, Transport N: Housing, Other Constructions, Other Products	OECD Input-Output
Consumption P^TC^T & P^NC^N (current prices)	AUS (70-07), AUT (76-07), BEL (95-07), CAN (70-07), DNK (70-07), ESP (95-07), FIN (75-07), FRA (70-07), GBR (90-07), IRL (95-07), ITA (70-07), JPN (80-07), NLD (80-07), NOR (70-07), SWE (93-07), USA (70-07)		T: Food, Beverages, Clothing, Furnishings, Transport, Other N: Housing, Health, Communication, Recreation, Education, Restaurants and Other (Other is defined as 50% tradable and 50% non tradable)	COICOP
Government spending P^TG^T & P^NG^N (current prices)	AUT (95-07), BEL (90-07), CAN (90-06), DNK (90-07), ESP (95-07), FIN (90-07), FRA (95-07), GBR (90-07), IRL (90-07), ITA (90-07), JPN (80-07), NLD (95-07), NOR (90-07), SWE (95-07), USA (70-07)		T: Energy, Agriculture, Manufacturing, Transport N: Public Services, Defense, Safety, Education, Health, Welfare, Housing, Environment, Recreation	OECD-FMI

Notes: times series for P^TI^T & P^NI^N are not available for AUS and BEL together with P^TG^T & P^NG^N for AUS.

ϕ by computing $Y^T - NX - G^T - I^T$ and $Y^N - G^N - I^N$. Yet, an additional difficulty shows up because the classification adopted to split government spending and investment expenditure into traded and non traded items is different from that adopted to break down value added into traded and non traded components. Moreover, the time horizon is short at a disaggregated level (for I^j and G^j) for most of the countries, especially for time series of G^j. To overcome these difficulties, we proceed as follows. Denoting by $\upsilon_{G^T} = \frac{P^T G^T}{P^T Y^T - P^T NX}$ and $\upsilon_{I^T} = \frac{P^T I^T}{P^T Y^T - P^T NX}$ the ratio of government and investment expenditure on tradables to traded value added adjusted with net exports at current prices, respectively, and by $\upsilon_{G^N} = \frac{P^N G^N}{P^N Y^N}$ and $\upsilon_{I^N} = \frac{P^N I^N}{P^N Y^N}$ the ratio of government and investment expenditure on non tradables to non traded value added at current prices, the goods market equilibrium can be rewritten as follows:

$$\frac{\left(P^T Y^T - P^T NX\right)\left(1 - \upsilon_{G^T} - \upsilon_{I^T}\right)}{P^N Y^N \left(1 - \upsilon_{G^N} - \upsilon_{I^N}\right)} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi - 1},$$

or alternatively

$$\frac{\left(Y^T - NX\right)\left(1 - \upsilon_{G^T} - \upsilon_{I^T}\right)}{Y^N \left(1 - \upsilon_{G^N} - \upsilon_{I^N}\right)} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}. \tag{59}$$

Setting

$$\alpha \equiv \ln \frac{\left(1 - \upsilon_{G^N} - \upsilon_{I^N}\right)}{\left(1 - \upsilon_{G^T} - \upsilon_{I^T}\right)} + \ln\left(\frac{\varphi}{1-\varphi}\right), \tag{60}$$

and taking logarithm, eq. (59) can be rewritten as follows:

$$\ln\left(\frac{Y^T - NX}{Y^N}\right) = \alpha + \phi \ln P. \tag{61}$$

Indexing time by t and countries by i, and adding an error term μ, we estimate ϕ by exploring the following empirical relationship:

$$\ln\left(\frac{Y^T - NX}{Y^N}\right)_{it} = f_i + f_t + \alpha_i t + \phi \ln P_{it} + \mu_{it}. \tag{62}$$

f_i captures the country fixed effects, f_t are time dummies, and μ_{it} are the i.i.d. error terms. Because the term (60) may display a trend over time, we add country-specific trends, as captured by $\alpha_i t$.

Because data to construct time series for traded (I^T) and non traded investment (I^N) are available for twelve countries over the sixteen in our sample over a time horizon varying between 37 years (1970-2007) and 27 years (1980-2007), we computed time series $Y^T - NX - I^T$ and $Y^N - I^N$. In this case, eq. (59) can be rewritten as follows:

$$\frac{\left(Y^T - NX - I^T\right)\left(1 - \upsilon_{G^T}\right)}{\left(Y^N - I^N\right)\left(1 - \upsilon_{G^N}\right)} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}. \tag{63}$$

Denoting by

$$\kappa \equiv \ln \frac{\left(1 - \upsilon_{G^N}\right)}{\left(1 - \upsilon_{G^T}\right)} + \ln\left(\frac{\varphi}{1-\varphi}\right), \tag{64}$$

where $\upsilon_{G^T} = \frac{P^T G^T}{P^T (Y^T - NX - I^T)}$ and $\upsilon_{G^N} = \frac{P^N G^N}{P^N (Y^N - I^N)}$ and taking logarithm, we explore alternatively the following relationship to estimate ϕ:

$$\ln\left(\beta^T/\beta^N\right)_{it} = f_i + f_t + \alpha_i t + \phi \ln P_{it} + \nu_{it}. \tag{65}$$

where $\beta^T = \left(Y^T - NX - I^T\right)$ and $\beta^N = \left(Y^N - I^N\right)$.

When determining (61), we can alternatively make use of first-order conditions equating the marginal revenue of labor and the sectoral wage:

$$\frac{\theta^j P^j Y^j}{L^j} = W^j, \tag{66}$$

where θ^j is labor's share in value added in sector $j = T, N$. Using (66) to eliminate the nominal sectoral value added, $P^j Y^j$, the goods market clearing condition can be rewritten as follows:

$$\frac{\left(W^T L^T - \theta^T P^T NX\right) \frac{\theta^N}{\theta^T} \left(1 - \upsilon_{G^T} - \upsilon_{I^T}\right)}{W^N L^N \left(1 - \upsilon_{G^N} - \upsilon_{I^N}\right)} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi - 1}. \tag{67}$$

We first set

$$\eta \equiv \ln \frac{\left(1 - \varrho_{G^N} - \varrho_{I^N}\right)}{\left(1 - \varrho_{G^T} - \varrho_{I^T}\right)} + \ln\left(\frac{\theta^T}{\theta^N}\right) + \ln\left(\frac{\varphi}{1-\varphi}\right), \tag{68}$$

where $\varrho_{G^T} = \frac{P^T G^T}{(W^T L^T - \theta^T P^T NX)}$ and $\varrho_{G^N} = \frac{P^N G^N}{W^N L^N}$, $\varrho_{I^T} = \frac{P^T I^T}{(W^T L^T - \theta^T P^T NX)}$ and $\varrho_{I^N} = \frac{P^N I^N}{W^N L^N}$. Denoting by $\gamma^T = \left(W^T L^T - \theta^T P^T NX\right)$ and $\gamma^N = W^N L^N$, and taking logarithm, eq. (68) can be rewritten as follows:

$$\ln\left(\frac{\gamma^T}{\gamma^N}\right) = \eta + (\phi - 1)\ln P. \tag{69}$$

Indexing time by t and countries by i, and adding an error term ζ, we estimate ϕ by exploring the following empirical relationship:

$$\ln\left(\gamma^T/\gamma^N\right)_{it} = g_i + g_t + \sigma_i t + \rho p_{it} + \zeta_{it}. \tag{70}$$

Because η_i (see eq. (68)) is composed of both preference (i.e., φ) and production (i.e., θ^j) parameters, and (logged) ratios which may display trend over time, we introduce country fixed effects g_i and add country-specific trends, as captured by $\sigma_i t$. Once we have estimated ρ, we can compute $\hat{\phi} = \hat{\rho} + 1$ where a hat refers to point estimate in this context.

Using Time Series for Consumption by Purpose Taken from COICOP

The cross-section studies by Stockman and Tesar [1995] and Mendoza [1995] estimate ϕ by running a regression of the (logged) ratio of consumption in non tradables to consumption in tradables on the (logged) relative price of non tradables:

$$\ln\left(\frac{C^N}{C^T}\right) = \ln\left(\frac{1-\varphi}{\varphi}\right) - \phi \ln P. \tag{71}$$

Note that when exploring the relationship (71) empirically, we abstract from the goods market clearing condition. Indexing time by t and countries by i, and adding an error term ι, we explore the following relationship empirically by using panel data:

$$\ln\left(C^N/C^T\right)_{it} = d_i + d_t + \zeta_i t - \phi \ln P_{C,it} + \iota_{it}, \tag{72}$$

where $P_{C,it} = P^N_{C,it}/P^T_{C,it}$ is the ratio of the price deflator for consumption in non traded goods ($P^N_{C,it}$) to the price deflator for consumption in traded goods ($P^T_{C,it}$); d_i are country fixed effects while d_t are time dummies; ι_{it} are the i.i.d. error terms. Because preferences may not be homothetic, there might be income effects in the relative demand for tradable and non tradable goods. Cross-section studies by Stockman and Tesar [1995] and Mendoza [1995] include GDP per capita in the regression to capture the wealth effect. Because it is likely that GDP per capita is correlated with the relative price of non tradables, we capture the wealth effect by time trend, i.e., $\zeta_i t$.

A.3.2 Data Construction and Source

Using Time Series by Industry Taken from EU KLEMS and STAN

We provide more details below on the construction of data employed to estimate equations (62), (65) and (70) (codes in EU KLEMS/STAN are reported in parentheses):

- Sectoral value added price deflator P^j_t ($j = T, N$): value added at current prices (VA) over value added at constant prices (VA_QI) in sector j. The relative price of non tradables, P_t, corresponds to the ratio of the non traded value added deflator to the traded value added deflator: $P_t = P^N_t/P^T_t$. Sources: EU KLEMS and OECD STAN databases. Data coverage: 1970-2007 except for JPN 1974-2007.

- Sectoral output Y_t^j ($j = T, N$): value added at constant prices in sector j (VA_QI). Sources: EU KLEMS and OECD STAN databases. Data coverage: 1970-2007 except for JPN 1974-2007.

- Net exports NX_t: net exports deflated by the traded value added deflator, P_t^T. Net exports correspond to the external balance of goods and services at current prices. Source: OECD Economic Outlook Database. Data coverage: 1970-2007 except for JPN 1974-2007.

- Sectoral investment I_t^j ($j = T, N$): Real investment in sector j, I_t^j, is investment expenditure in sector j deflated by the value added price index P_t^j defined above. Investment expenditure are gross capital formation at current prices; to split aggregate investment expenditure into tradables and non tradables, we use the methodology presented in section A.2 of the Technical Appendix. Source: OECD Input-Output database [2012a]. Data coverage: AUT (1976-2007), CAN (1970-2007), DNK (1970-2006), ESP (1980-2007), FIN (1970-2007), FRA (1978-2006), GBR (1970-2007), ITA (1970-2006), JPN (1980-2007), NLD (1970-2007), NOR (1970-2007) and USA (1977-2006). AUS and BEL (no data), and, IRL (1990-2007) and SWE (1993-2007) are excluded from the sample due to data limitation.

- Sectoral labor compensation $W_t^j L_t^j$ ($j = T, N$): labor compensation in sector j (LAB). Sources: EU KLEMS and OECD STAN databases. Data coverage: 1970-2007 except for JPN 1974-2007.

- Sectoral labor income share θ^j ($j = T, N$): labor compensation in sector j (LAB) over value added at current prices (VA) averaged over the period 1970-2007 (1974-2007 for JPN). Sources: EU KLEMS and OECD STAN databases.

We also use the time series described above to construct time series for $\frac{Y_t^T - NX_t}{Y_t^N}$, $\frac{\beta_t^T}{\beta_t^N}$, $\frac{\gamma_t^T}{\gamma_t^N}$, and P_t. When estimating equations (62), (65) and (70), all variables are converted into index 1995=100 and are expressed in log levels.

Using Time Series for Consumption By Purpose Taken from COICOP

Panel data estimations of ϕ are based upon a data set provided by the COICOP database. To split aggregate consumption expenditure into tradables and non tradables, we use the methodology detailed in Appendix A.2 where we provide detailed information about the construction of the non tradable share of consumption expenditure. The COICOP database provides annual data for the sixteen OECD countries of our sample but it has the disadvantage to be unbalanced. Only a few countries have long time series. For example, the US enters the panel with 38 observations, whereas the UK has merely 18. We therefore eschew countries providing no data for periods that extend before 1988 (i.e., countries with more than 20 years). We made this choice in order to ensure the consistency of the estimates of cointegrating vectors. Accordingly, the sample is restricted to eleven countries: AUS (1970-2007), AUT (1976-2007), CAN (1971-2007), DNK (1970-2007), FIN (1975-2007), FRA (1970-2007), ITA (1970-2007), JPN (1980-2007), NLD (1980-2007), NOR (1970-2007) and USA (1970-2007). The following countries: BEL (1995-2007), ESP (1995-2007), GBR (1990-2007), IRL (1995-2007) and SWE (1993-2007) are excluded from the sample due to data limitation.

We now provide information about the construction for the data used to estimate equation (72) :

- sectoral price deflator for consumption good j ($P_{C,t}^j$): consumption expenditure in good j at current prices over consumption expenditure in good j at constant prices. Source: COICOP database. The consumption relative price of non tradables, $P_{C,t}$, corresponds to the price deflator for consumption in non tradable goods over the price deflator for consumption in tradable goods: $P_t = P_{C,t}^N / P_{C,t}^T$.

- sectoral consumption expenditure C_t^j ($j = T, N$): final consumption expenditure of households in good j at constant prices (name in COICOP: P31DC). Source: COICOP database.

In equation (72), time series for $\left(C^N/C^T\right)_t$ and P_t^C are converted into index 1995=100 and are expressed in log levels.

A.3.3 Empirical Results

Since the set of variables of interest in regressions (62), (65), (70) and (72) display trends, we first run panel unit root tests, see Table 6. By and large, all tests, with the exceptions of Breitung and MW(PP) for the variable $\ln(Y^T - NX/Y^N)$, show that non stationarity is pervasive, making it clear that pursuing a cointegration analysis is appropriate. We thus implement the seven Pedroni's [2004] tests of the null hypothesis of no cointegration, see Table 7. Across almost all cases the null hypothesis of no cointegration is rejected but only at the 10% level. In small samples, Pedroni's [2004] simulations reveal that the group-mean parametric t-stat is the most powerful. Based on this result, in the three specifications, the null hypothesis of no cointegration is strongly rejected at the 5% level.

Table 6: Panel Unit Root Tests (p-values)

	LLC (t-stat)	Breitung (t-stat)	IPS (W-stat)	MW (ADF)	MW (PP)	Hadri (Z_μ-stat)
$\ln(P^{C,N}/P^{C,T})$	0.206	0.879	0.998	0.441	0.137	0.000
$\ln(C^N/C^T)$	0.156	0.844	0.255	0.132	0.293	0.000
$\ln(P^{VA,N}/P^{VA,T})$	0.670	0.370	1.000	0.976	0.889	0.000
$\ln(Y^T - NX/Y^N)$	0.322	0.000	0.164	0.061	0.028	0.000
$\ln(Y^T - NX - I^T)/(Y^N - I^N)$	0.616	0.799	0.938	0.959	0.960	0.000
$\ln(W^T L^T - \theta^T P^T NX)/(W^N L^N)$	0.843	0.854	1.000	1.000	1.000	0.000

Notes: For all tests, except for Hadri [2000], the null of a unit root is not rejected if p-value $\geq$ 0.05 at a 5% significance level. For Hadri [2000], the null of stationarity is rejected if p-value $\leq$ 0.05 at a 5% significance level.

Table 7: Panel Cointegration Tests (p-values)

Dependent variable	$\frac{C^N}{C^T}$	$\frac{Y^T - NX}{Y^N}$	$\frac{Y^T - NX - I^T}{Y^N - I^N}$	$\frac{W^T L^T - \theta^T P^T NX}{W^N L^N}$
Explanatory variable	$P^{C,N}/P^{C,T}$	$P^{VA,N}/P^{VA,T}$	$P^{VA,N}/P^{VA,T}$	$P^{VA,N}/P^{VA,T}$
Panel tests				
Non-parametric ν	0.274	0.065	0.000	0.009
Non-parametric ρ	0.441	0.001	0.006	0.011
Non-parametric t	0.347	0.000	0.001	0.004
Parametric t	0.006	0.048	0.000	0.040
Group-mean tests				
Non-parametric ν	0.059	0.047	0.383	0.232
Non-parametric t	0.245	0.000	0.311	0.021
Parametric t	0.000	0.068	0.001	0.021

Notes: the null hypothesis of no cointegration is rejected if the p-value is below 0.05 (0.10 resp.) at 5% (10% resp.) significance level.

To estimate the cointegrating vector, we use the group-mean fully modified OLS and the group-mean dynamic OLS estimators of Pedroni [2001]. Table 8 reports panel estimations of the coefficient ϕ, when running the regression (62), (65), (70) and (72) respectively; the three former empirical relationships are derived by taking into account the goods market equilibrium. Moreover, exploring alternatively the relationship (62) or (70) empirically has the advantage of allowing us to use time series for sectoral value added or labor compensation which are available over the period 1970-2007 for all countries of our sample (except JPN: 1974-2007).

The first column of Table 8 presents the results corresponding to eq. (72). The dependent variable in both cases is the log of consumption in non tradables in terms of tradables, i.e. $\ln(C^N/C^T)$. The regressor is the log of the ratio of the price deflator for consumption in non tradables to the price deflator for consumption in tradables. The estimated coefficient for ϕ of 0.579 (DOLS) and 0.615 (FMOLS) are highly significant with a t-statistic of 8.72

and 11.85 respectively. However, there is substantial evidence of parameter heterogeneity across countries of the sample. One drawback of this approach is that when determining the testable equation (72), we abstract from the goods market equilibrium.

Panel data estimates of ϕ when running the regression (62) where the dependent variable is $(Y^T - NX)/Y^N$, are shown in column 2 of Table 8. The regressor in this case (and for the rest of the analysis) is the log of the non traded value added deflator to the traded value added deflator. The sample covers all countries we are interested in. For the whole sample, the DOLS and FMOLS estimates give a significant value of ϕ of 0.680 and 0.656 respectively. The two estimated coefficients are statistically significant. The vast majority (14 out of 16) of the individual FMOLS estimated coefficients are statistically significant. They vary from a low of 0.070 for BEL to a high of 2.071 for DNK. In addition, we find that ϕ is larger than one in only two countries (DNK and FIN). Column 3 of Table 8 shows panel data estimations of ϕ when running the regression (65) which explicitly takes into account investment expenditures. This, however, reduces the size of the sample: the series for investment are not available for AUS and BEL, and, SWE and IRL are excluded from the sample due to data limitation. We find that both estimators provide positive and statistically significant ϕ coefficients about 0.590. Among the 12 countries, we find that 8 have positive and statistically significant ϕ coefficients according to the FMOLS estimator, ranging from a low of 0.252 (CAN) to a high of 1.758 (NLD). Note that the coefficient ϕ is found to be larger than one in 6 countries (AUT, FIN, FRA, NLD, NOR and USA). Three estimated coefficients are negative (DNK, ESP and ITA), although none of them are statistically significant. Due to data limitations and inconsistent estimates (i.e., negative or statistically insignificant at conventional level for several countries), we find that including investment expenditure does not improve the precision of our estimates, likely due to the classification of investment items which is different to that we used to classify value added and labor as tradables or non tradables.

The last column of Table 8 gives panel data estimates of ϕ when running the regression (70); the dependent variable is the (logged) ratio of the labor income in tradables adjusted with net exports at current prices to labor income in non tradables, i.e., $(W^T L^T - \theta^T P^T NX)/W^N L^N$. By and large, estimates are somewhat higher than those shown in columns 1-3 of Table 8: the DOLS and FMOLS estimates give a significant value of ϕ of 0.817 and 0.837, respectively. Focusing only on FMOLS estimates which are positive and statistically significant, we find large differences in estimated coefficients across countries. They vary from a low of 0.409 for AUS to a high of 2.056 for NOR.

To calibrate the model, we take FMOLS estimates shown in column 2 as they are in line with earlier studies and values of ϕ are consistent for almost all countries in sample, except for Belgium and Italy. Estimate of ϕ for Belgium is not statistically significant at a standard threshold while estimates of ϕ for Italy are negative. Running the regression (70) allows us to obtain a consistent estimate for ϕ for Belgium, i.e., 0.795. Thus, we use this value to calibrate the model to each country. In contrast, estimates of ϕ are all inconsistent for Italy. When we calibrate the model to each country, we set ϕ to the unweighed average, i.e., 0.77.

A.4 Estimates of ϵ: Empirical Strategy

In this section, we detail our empirical strategy to estimate the elasticity of labor supply across sectors, ϵ, which captures the degree of labor mobility across sectors.

A.4.1 Limited Substitutability of Hours Worked across Sectors and the Derivation of the Testable Equation

To determine the equation we explore empirically, we follow closely Horvath [2000]. The representative agent is endowed with one unit of time, supplies a fraction $L(t)$ as labor, and consumes the remainder $1 - L(t)$ as leisure. At any instant of time, households derive utility from their consumption and experience disutility from working. Assuming that the felicity function is additively separable in consumption and labor, the representative household

Table 8: DOLS and FMOLS Estimates of ϕ

Dependent variable	$\frac{C^N}{C^T}$		$\frac{Y^T - NX}{Y^N}$		$\frac{Y^T - NX - I^T}{Y^N - I^N}$		$\frac{W^T L^T - \theta^T P^T NX}{W^N L^N}$	
Sectoral prices	consumption		value-added		value-added		value-added	
	(1)		(2)		(3)		(4)	
	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS
AUS	1.013^{a} (7.53)	1.041^{a} (9.08)	0.290^{a} (2.93)	0.268^{a} (2.99)			0.286 (1.22)	0.409^{b} (2.52)
AUT	−0.008 (−0.01)	0.309 (0.57)	0.927^{b} (2.07)	0.986^{a} (3.09)	1.274 (0.73)	1.368^{c} (1.75)	1.337^{a} (3.92)	1.413^{a} (4.99)
BEL			0.073 (0.40)	0.070 (0.41)			0.800^{a} (6.80)	0.795^{a} (4.99)
CAN	-0.183^{b} (−2.56)	-0.212^{c} (−1.80)	0.437^{a} (4.17)	0.391^{a} (3.74)	0.550^{a} (5.02)	0.252^{b} (2.40)	0.625^{a} (6.21)	0.582^{a} (5.53)
DNK	0.515^{a} (2.77)	0.740^{a} (6.44)	2.234^{a} (2.72)	2.071^{a} (2.95)	2.036 (1.56)	−0.270 (−0.41)	1.036^{c} (1.74)	1.323^{a} (2.93)
ESP			0.745^{a} (3.71)	0.783^{a} (4.96)	−0.734 (−1.12)	−0.040 (−0.08)	0.372 (1.48)	0.413^{b} (2.04)
FIN	−0.461 (−0.43)	0.047 (0.06)	1.213^{a} (9.88)	1.072^{a} (8.57)	1.087^{a} (4.75)	1.471^{a} (4.72)	1.590^{a} (8.66)	1.421^{a} (8.12)
FRA	1.292^{a} (7.86)	0.922^{a} (8.94)	0.955^{a} (5.75)	0.937^{a} (6.22)	1.150^{a} (6.99)	1.031^{a} (6.31)	1.028^{a} (4.67)	1.038^{a} (5.25)
GBR			0.517^{a} (11.30)	0.477^{a} (9.64)	0.255^{a} (2.59)	0.289^{b} (2.19)	1.167^{a} (12.59)	1.164^{a} (14.07)
IRL			0.184 (0.63)	0.374^{c} (1.71)			0.070 (0.13)	0.158 (0.35)
ITA	−0.341 (−0.58)	−0.153 (−0.40)	-0.436^{a} (−2.92)	−0.308 (−1.60)	-0.729^{a} (−3.91)	−0.410 (−1.60)	-0.320^{b} (−2.55)	−0.187 (−0.98)
JPN	0.768^{b} (2.15)	0.856^{a} (2.81)	1.012^{a} (4.35)	0.654^{a} (2.98)	−0.371 (−1.02)	0.322 (1.34)	0.898^{a} (5.95)	0.676^{a} (4.33)
NLD	0.194 (1.38)	0.841^{a} (5.32)	0.820^{b} (1.99)	0.709^{b} (2.33)	1.910^{a} (3.00)	1.758^{a} (3.23)	0.529 (1.39)	0.428 (1.18)
NOR	0.308^{c} (1.72)	0.328^{b} (2.50)	0.992^{a} (8.38)	0.979^{a} (9.72)	1.329^{a} (3.77)	1.025^{a} (7.23)	1.957^{a} (10.29)	2.056^{a} (13.66)
SWE			0.330^{a} (3.69)	0.356^{a} (4.02)			0.907^{a} (7.31)	0.900^{a} (7.23)
USA	3.396^{a} (5.45)	3.269^{a} (6.41)	0.586 (1.57)	0.668^{a} (2.81)	0.794^{a} (2.81)	1.003^{a} (5.53)	0.786 (1.20)	0.799^{b} (2.02)
Whole Sample	0.579^{a} (8.72)	0.615^{a} (11.85)	0.680^{a} (15.15)	0.656^{a} (16.13)	0.595^{a} (6.69)	0.588^{a} (8.99)	0.817^{a} (16.59)	0.837^{a} (14.16)
Countries	11		16		12		16	
Observations	386		605		412		605	
Country fixed effects	yes		yes		yes		yes	
Time dummies	yes		yes		yes		yes	
Time trend	yes		yes		yes		yes	

Notes: all variables enter in regression in logarithms. ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels. Heteroskedasticity and autocorrelation consistent t-statistics are reported in parentheses.

maximizes the following objective function:

$$U = \int_0^\infty (1-\gamma)\ln C(t) + \gamma \ln (1-L(t))\, e^{-\rho t} \mathrm{d}t, \tag{73}$$

subject to

$$\dot{A}(t) = r^\star A(t) + W(t)L(t) - P_C\left(P(t)\right) C(t). \tag{74}$$

For the sake of clarity, we drop the time argument below when this causes no confusion. First-order conditions are:

$$\frac{1-\gamma}{C} = \left(P_C \lambda\right), \tag{75a}$$

$$\frac{\gamma}{1-L} = W\lambda, \tag{75b}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right). \tag{75c}$$

The economic system consists of M distinct sectors, indexed by $j = 0, 1, ..., M$ each producing a different good. Along the lines of Horvath [2000], the aggregate leisure index is assumed to take the form:

$$1 - L\,(.) = 1 - \left[\sum_{j=1}^{M} \left(L^j\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}. \tag{76}$$

The agent maximizes (76) subject to

$$\sum_{j=1}^{M} W^j L^j = X, \tag{77}$$

where L^j is labor supply in sector j, W^j the wage rate in sector j and X total labor income. Applying standard methods, we obtain labor supply L^j in sector j:

$$L^j = \left(\frac{W^j}{W}\right)^{\epsilon} L. \tag{78}$$

where we used the fact that $X = WL$.

Combining (75a) and (75b), the aggregate wage index is:

$$W = \frac{\gamma}{1-\gamma}\frac{P_C C}{1-L} \tag{79}$$

which allows us to rewrite (78) as follows:

$$L^j = \left(W^j\right)^{\epsilon} L \left(\frac{\gamma}{1-\gamma}\frac{P_C C}{1-L}\right)^{-\epsilon} \tag{80}$$

A quantity Q^j of good j is produced by combining capital, K^j, labor devoted to the sector, L^j, and intermediate inputs, IM^j, in a production process described by:

$$Q^j = Z^j \left(L^j\right)^{\xi^j} \left(K^j\right)^{\gamma^j} \left(IM^j\right)^{1-\xi^j-\gamma^j}, \tag{81}$$

where ξ^j (γ^j) is the share of labor (capital) income in gross output of sector j.

We assume that labor is imperfectly mobile across sectors, while capital can move freely across sectors. Perfectly competitive firms in sector j seek to maximize the profit function given by:

$$\Pi^j = P^j Q^j - W^j L^j - RK^j - P_{IM} IM^j, \tag{82}$$

where P^j is the price of gross output, R is the user capital cost, W^j the wage rate in sector j, and P_{IM} the price of intermediate inputs. Firms take the wage rate (capital rental cost) as given and equate marginal product of labor (capital) to the wage (capital rental rate) to determine demand. First-order conditions are:

$$P^j \frac{\xi^j Q^j}{L^j} = W^j, \quad P^j \frac{\gamma^j Q^j}{K^j} = R, \quad P^j \frac{\left(1 - \xi^j - \gamma^j\right) Q^j}{IM^j} = P_{IM}. \tag{83}$$

Eliminating the sectoral wage W^j into (80) by using labor demand given by (83), the equilibrium condition for labor is given by:

$$L^j = \left(\xi^j P^j Q^j\right)^{\frac{\epsilon}{\epsilon+1}} L^{\frac{1}{1+\epsilon}} \left(\frac{\gamma}{1-\gamma} \frac{P_C C}{1-L}\right)^{-\frac{\epsilon}{\epsilon+1}}. \tag{84}$$

Summing over the M sectors and using (76), we get:

$$\left(\frac{\gamma}{1-\gamma} \frac{P_C C}{1-L}\right) = \frac{\sum_{j=1}^{M} \theta^j P^j Q^j}{L}$$

Plugging this equation into (84) yields:

$$L^j = \left(\frac{\xi^j P^j Q^j}{\sum_{j=1}^{M} \xi^j P^j Q^j}\right)^{\frac{\epsilon}{\epsilon+1}} L. \tag{85}$$

As in Horvath [2000], we denote by β^j the fraction of labor's share of aggregate output accumulating to labor in sector j:

$$\beta^j = \frac{\xi^j P^j Q^j}{\sum_{j=1}^{M} \xi^j P^j Q^j}. \tag{86}$$

We introduce the time subscript to avoid confusion. Expressing (85) in percentage changes and adding an estimation error term ν results in the M estimation equations:

$$\hat{l}_t^j - \hat{l}_t = \frac{\epsilon}{\epsilon+1} \hat{\beta}_t^j + \nu_t^j, \quad j = 1, ..., M, \tag{87}$$

where

$$\hat{l}_t = \sum_{j=1}^{M} \beta_{t-1}^j \hat{l}_t^j. \tag{88}$$

To derive (88), we proceed as follows. Because we consider a traded and a non traded sectors, the labor index (76) can be rewritten as follows:

$$L\left(L_t^T, L_t^N\right) = \left[\left(L_t^T\right)^{\frac{\epsilon+1}{\epsilon}} + \left(L_t^N\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}. \tag{89}$$

Approximate changes in aggregate labor with differentials, we get:

$$\mathrm{d}L_t \equiv L_t - L_{t-1} = \left(L_{t-1}^T\right)^{\frac{1}{\epsilon}} \left(L_{t-1}\right)^{-\frac{1}{\epsilon}} \mathrm{d}L_t^T + \left(L_{t-1}^N\right)^{\frac{1}{\epsilon}} \left(L_{t-1}\right)^{-\frac{1}{\epsilon}} \mathrm{d}L_t^N. \tag{90}$$

Expressing (90) in percentage changes and inserting (85), i.e., $\left(\frac{L^j}{L}\right)^{\frac{\epsilon+1}{\epsilon}} = \beta^j$, we have:

$$\begin{aligned} \hat{l}_t \equiv \frac{L_t - L_{t-1}}{L_{t-1}} &= \left(\frac{L_{t-1}^T}{L_{t-1}}\right)^{\frac{\epsilon+1}{\epsilon}} \hat{l}_t^T + \left(\frac{L_{t-1}^N}{L_{t-1}}\right)^{\frac{\epsilon+1}{\epsilon}} \hat{l}_t^N, \\ &= \beta_{t-1}^T \hat{l}_t^T + \beta_{t-1}^N \hat{l}_t^N. \end{aligned} \tag{91}$$

According to eq. (91), the percentage change in total hours worked, $\hat{l}_t$, can be approximated by a weighted average of changes in sectoral hours worked $\hat{l}_t^j$ (in percentage), the weight being equal to β_{t-1}^j.

Combining optimal rules for labor supply and labor demand, we find that the change in employment in sector j is driven by the change in the fraction β^j of the labor's share of aggregate output accumulating to labor in sector j. We use panel data to estimate (87). Including country fixed effects captured by country dummies, f_i, and common macroeconomic shocks by year dummies, f_t, (87) can be rewritten as follows:

$$\hat{l}_{it}^{j} - \hat{l}_{it} = f_i + f_t + \gamma_i \hat{\beta}_{it}^{j} + \nu_{it}^{j}, \tag{92}$$

where $\gamma_i = \frac{\epsilon_i}{\epsilon_i + 1}$ and β_{it}^{j} is given by (86); j indexes the sector, i the country, and t indexes time. When exploring empirically (92), the coefficient γ is alternatively assumed to be identical, i.e., $\gamma_i = \gamma$, or to vary across countries. The LHS term of (92), i.e., $\hat{l}_{it}^{j} - \hat{l}_{it}$, gives the percentage change in hours worked in sector j driven by the pure reallocation of labor across sectors.

A.4.2 Data Description

Data are taken from EU KLEMS and STAN databases. EU KLEMS data provide yearly information for the period 1970-2007 (except for JPN: 1974-2007) for 16 countries of our sample (AUS, AUT, BEL, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD,SWE and USA). For CAN and NOR, annual sectoral data stems from the STAN database. To classify employment and gross output as traded or non traded, we adopt the classification described in subsection A.1.2. We provide more details below about the data used to estimate equation (92):

- Sectoral labor L_t^j ($j = T, N$): total hours worked by persons engaged in sector j (H_EMP). Sources: EU KLEMS and STAN databases.

- Sectoral nominal gross output $P_t^j Q_t^j$ ($j = T, N$): gross output at current prices in millions of national currency in sector j (GO). Sources: EU KLEMS and STAN databases.

- Sectoral share of labor income in gross output ξ^j for $j = T, N$: labor compensation in sector j (LAB) over gross output at current prices in that sector (GO) averaged over the period 1970-2007 (1974-2007 for JPN). Sources: EU KLEMS and STAN databases.

By combining ξ^j and $P_t^j Q_t^j$, we can construct time series β_t^j defined by (86).

A.4.3 Exogeneity of the Regressor

By using optimal rules for both labor supply (78) and labor demand (83), we avoid any endogeneity problem. To see it more clearly, when restricting our attention to the optimal labor supply schedule without using firms' first order conditions, eq. (78) in percentage changes is:

$$\hat{l}_t^j - \hat{l}_t = \epsilon \left(\hat{w}_t^j - \hat{w}_t \right). \tag{93}$$

where $\hat{l}_t$ is given by (91). An endogeneity problem may arise because to construct time series for sectoral wages W_t^j, we have to divide the labor compensation $W_t^j L_t^j$ in sector j by sectoral hours worked L_t^j; likewise, we have to divide the overall labor compensation $W_t L_t$ by total hours worked L_t to construct time series for the aggregate wage index W_t. A way to circumvent any endogeneity problem is to use labor demand $\frac{\xi^j P_t^j Q_t^j}{L_t^j} = W_t^j$ to eliminate the sectoral wage from eq. (93), and $W_t = \frac{\sum_j \xi^j P_t^j Q_t^j}{L_t}$ to eliminate the aggregate wage index; we get $L_t^j / L_t = \left(\frac{\xi^j P_t^j Q_t^j}{L_t^j} / \frac{\sum_j \xi^j P_t^j Q_t^j}{L_t} \right)^{\epsilon}$. Isolating L_t^j / L_t and differentiating yields (87). Because wages do not show up in eq. (87) as we use the labor income share which is constant over time and gross output (at current prices), we avoid any endogeneity problem. More precisely, the labor's share in gross output ξ^j in sector j is defined as the ratio of the compensation of employees to gross output in the jth sector, averaged over the period 1970-2007 so that the explanatory variable (i.e., the RHS term in eq. (92)) is constructed independently from the dependent variable (i.e., the LHS term in eq. (92)).

To check that endogeneity is not a major issue in eq. (92), we test for strict exogeneity of the regressor with respect to the dependent variable. Engle et al. [1983] refer to a variable x_t as strongly exogenous with respect to the variable y_t if y_t does not Granger-cause x_t (see Granger [1969]). Formally, y_t Granger causes x_t if its past value can help to predict the future value of x_t beyond what could have been done with the past value of x_t only. To implement the test of whether $(\hat{l}^j_{it} - \hat{l}_{it})$ (i.e., the LHS term in eq. (92)) Granger-causes $\hat{\beta}^j_{it}$ (i.e., the RHS term in eq. (92)) we run the following regression:

$$\hat{\beta}^j_{it} = \alpha^j_i + \sum_{k=1}^{k} a^j_{i,k} \hat{\beta}^j_{i,t-k} + \sum_{k=1}^{p} b^j_{i,k} \left(\hat{l}^j_{i,t-k} - \hat{l}_{i,t-k} \right) + u^j_{it}, \tag{94}$$

where p is the autoregressive lag length and u^j_{it} the error term. With respect to (94), in country i and sector j, the test of the null hypothesis that $(\hat{l}^j_{it} - \hat{l}_{it})$ does not Granger cause $\hat{\beta}^j_{it}$ is a F test of the form: $H_0 : b^j_{i,1} = b^j_{i,2} = \cdots = b^j_{i,p} = 0$. By not rejecting the null, one may conclude that the regressor in (92) is strictly exogenous to the dependent variable $(\hat{l}^j_{it} - \hat{l}_{it})$.

Table 9: Granger Causality Test (p-values)

Country	Sector	$p = 1$	$p = 2$	$p = 3$	Country	Sector	$p = 1$	$p = 2$	$p = 3$
AUS	T	0.946	0.833	0.935	GBR	T	0.216	0.508	0.505
AUS	N	0.215	0.132	0.088	GBR	N	0.087	0.247	0.399
AUT	T	0.893	0.665	0.091	IRL	T	0.470	0.511	0.819
AUT	N	0.099	0.040	0.014	IRL	N	0.252	0.535	0.798
BEL	T	0.263	0.934	0.206	ITA	T	0.481	0.303	0.054
BEL	N	0.655	0.962	0.176	ITA	N	0.362	0.262	0.022
CAN	T	0.070	0.118	0.258	JPN	T	0.049	0.019	0.051
CAN	N	0.179	0.098	0.218	JPN	N	0.130	0.070	0.112
DNK	T	0.172	0.494	0.006	NLD	T	0.239	0.533	0.703
DNK	N	0.230	0.491	0.015	NLD	N	0.285	0.426	0.615
ESP	T	0.015	0.024	0.022	NOR	T	0.359	0.652	0.712
ESP	N	0.018	0.020	0.021	NOR	N	0.773	0.799	0.647
FIN	T	0.191	0.120	0.160	SWE	T	0.344	0.218	0.204
FIN	N	0.341	0.153	0.107	SWE	N	0.133	0.111	0.096
FRA	T	0.727	0.844	0.796	USA	T	0.958	0.459	0.634
FRA	N	0.951	0.535	0.362	USA	N	0.832	0.632	0.885

Notes: the null hypothesis that $(\hat{l}^j_{it} - \hat{l}_{it})$ does not Granger-cause $(\hat{\beta}^j_{it})$ is rejected if p-value ≤ 0.05 at a 5% significance level.

The results of causality tests for $p = 1, 2, 3$ from the change in hours worked in sector j driven by the pure reallocation of labor across sectors $(\hat{l}^j_{it} - \hat{l}_{it})$ to the fraction of labor's share of aggregate output accumulating to labor in sector j $(\hat{\beta}^j_{it})$ are displayed in Table 9. The results for $p = 1$ show that, with the exception of JPN (sector T) and ESP (both sectors), there is no causality running from $(\hat{l}^j_{it} - \hat{l}_{it})$ to $\hat{\beta}^j_{it}$ at the 5% level of significance. Setting $p = 2$ and $p = 3$ leads to similar qualitative results (with the exceptions of the sector N in AUT for $p = 2, 3$ and in DNK and ITA for $p = 3$). By and large, these results show that one can consider the regressor in eq. (92) as exogenous with respect to the dependent variable.

A.4.4 Panel Data Estimates of ϵ

The parameter we are interested in, the degree of substitutability of hours worked across sectors, is given by $\epsilon_i = \gamma_i/(1 - \gamma_i)$. In the regressions that follow, the coefficient γ_i is alternatively assumed to be identical across countries when estimating for the whole sample ($\gamma_i = \gamma_{i'} \equiv \gamma$ for $i \neq i'$) or to be different across countries when estimating for each economy ($\gamma_i \neq \gamma_{i'}$ for $i \neq i'$). The sample is running from 1971 to 2007 but we run regression (92) over two sub-periods 1971-1989 and 1990-2007 as well in order to investigate whether our estimates of the degree of labor mobility are relatively stable across sub-periods.

Empirical results reported in Table 10 are consistent with $\epsilon > 0$. For the whole sample, we find $\hat{\gamma} = 0.324$ over the period 1971-2007. Using the fact that $\hat{\epsilon} = \frac{1}{1-\hat{\gamma}}$, we find empirically that an increase by 1 percentage point of the labor's share of aggregate output accumulating to labor in sector j shifts employment by 0.479 percentage point of total employment toward that sector. When estimating ϵ for each economy of our sample over the period 1971-2007, all coefficients are statistically significant, as shown in Table 10, except for DNK and NOR. Excluding these countries, we find that the degree of substitutability of hours worked across sectors ranges from a low of 0.224 for NLD to a high of 1.642 for ESP, with a mean value (across countries) of 0.746. Moreover, the panel data estimations of ϵ for the whole sample are quite similar whether the sample is running from 1971 to 2007 or is split into two sub-periods.

Table 10: Panel Data Estimate of ϵ (eq. (92))

	1971-2007				1971-1989				1990-2007			
	$\hat{\gamma}_i$	$\hat{\epsilon}_i$	$\hat{\gamma}$	$\hat{\epsilon}$	$\hat{\gamma}_i$	$\hat{\epsilon}_i$	$\hat{\gamma}$	$\hat{\epsilon}$	$\hat{\gamma}_i$	$\hat{\epsilon}_i$	$\hat{\gamma}$	$\hat{\epsilon}$
AUS	0.389^a (5.80)	0.635^a (3.55)			0.457^a (5.51)	0.841^a (2.99)			0.247^b (2.11)	0.327 (1.59)		
AUT	0.354^a (4.12)	0.548^a (2.66)			0.387^a (3.72)	0.632^b (2.28)			0.281^c (1.85)	0.391 (1.33)		
BEL	0.246^a (3.32)	0.326^b (2.51)			0.263^a (2.60)	0.357^c (1.92)			0.225^b (2.08)	0.290 (1.61)		
CAN	0.312^a (4.96)	0.454^a (3.41)			0.258^a (2.81)	0.348^b (2.08)			0.363^a (4.18)	0.571^a (2.66)		
DNK	0.131^c (1.67)	0.150 (1.46)			0.161 (1.57)	0.191 (1.32)			0.087 (0.72)	0.095 (0.66)		
ESP	0.622^a (7.97)	1.642^a (3.02)			0.828^a (6.14)	4.827 (1.05)			0.514^a (5.42)	1.059^a (2.63)		
FIN	0.352^a (5.59)	0.544^a (3.62)			0.502^a (4.78)	1.007^b (2.38)			0.264^a (3.34)	0.358^b (2.46)		
FRA	0.563^a (5.57)	1.287^b (2.44)			0.568^a (4.06)	1.314^c (1.75)			0.556^a (3.76)	1.252^c (1.67)		
GBR	0.502^a (7.61)	1.008^a (3.79)			0.400^a (4.94)	0.667^a (2.96)			0.714^a (6.15)	2.496^c (1.76)		
IRL	0.209^a (4.02)	0.264^a (3.18)			0.068 (0.79)	0.073 (0.73)			0.294^a (4.52)	0.417^a (3.19)		
ITA	0.407^a (4.79)	0.686^a (2.84)			0.423^a (3.81)	0.734^b (2.20)			0.383^a (2.86)	0.620^c (1.76)		
JPN	0.498^a (5.73)	0.993^a (2.87)			0.535^a (4.65)	1.149^b (2.16)			0.449^a (3.40)	0.815^c (1.87)		
NLD	0.183^b (2.41)	0.224^b (1.97)			0.107 (1.16)	0.120 (1.04)			0.354^a (2.60)	0.547^c (1.68)		
NOR	0.088 (1.63)	0.097 (1.49)			0.179^b (2.45)	0.217^b (2.01)			-0.024 (-0.30)	-0.023 (-0.31)		
SWE	0.307^a (5.20)	0.443^a (3.61)			0.280^a (3.45)	0.388^b (2.49)			0.339^a (3.94)	0.513^a (2.61)		
USA	0.581^a (6.18)	1.387^a (2.59)			0.578^a (5.12)	1.371^b (2.16)			0.588^a (3.46)	1.430 (1.42)		
Whole Sample			0.324^a (17.99)	0.479^a (12.16)			0.332^a (13.27)	0.496^a (8.87)			0.314^a (11.62)	0.457^a (7.97)
R-squared	0.276		0.226		0.307		0.238		0.272		0.208	
Observations	1178		1178		602		602		576		576	
Countries	16		16		16		16		16		16	
Sectors	2		2		2		2		2		2	
Country fixed effects	yes		yes		yes		yes		yes		yes	
Time dummies	yes		yes		yes		yes		yes		yes	
Time trend	no		no		no		no		no		no	

Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels; t-statistics are reported in parentheses.

B More VAR Results and Robustness Check

In this section, we provide more VAR results and conduct a robustness check. In particular, for reason of space, in the main text, we report results of selected variables. Subsection B.1 below reports results for all variables and all VAR models. Due to data availability, we use annual data for eleven 1-digit ISIC-rev.3 industries that we classify as tradables or non tradables. Because at this level of disaggregation, the classification is somewhat ambiguous as some sub-industries could be classified as tradables while other sub-industries are treated as non tradables, subsection B.2 investigates the sensitivity of our empirical results to the classification of industries as tradables or non tradables. In subsection B.3, we estimate the same VAR models as in the main text and investigate empirically the effects of government spending shocks on the business sector by excluding the public sector from aggregate and sectoral variables. Finally, in subsection B.3, since we are constrained to employ annual data as we wish to estimate the sectoral effects of a government spending shock, we investigate the extent to which our empirical results could be altered by our assumption that government spending is predetermined within the year.

B.1 Additional VAR Evidence for the Whole and the Split-Sample Analysis

In section 2, we present VAR evidence on the fiscal transmission. For reason of space and clarity purposes, when we consider the fourth VAR model that we estimate for the whole sample, we dot not show the responses of government spending. Panels A and B of Table 1 report the endogenous cumulative response of government spending for the 'labor market' (i.e., $z_{it}^W = \left[g_{it}, l_{it}^T - l_{it}^N, \omega_{it}\right]$) and the 'product market' specifications (i.e, $z_{it}^P = \left[g_{it}, y_{it}^T - y_{it}^N, p_{it}\right]$). Contrasting the endogenous cumulative response of government consumption displayed in column 1 of Table 1 with that reported in column 1 of Table 12, we can see immediately that the difference is very small while it shows somewhat higher degree of persistence in the latter case, so that the cumulative response is merely higher.

In section 2.6, we split the sample into two sub-samples: a sample of 'low mobility' economies and a sample of 'high mobility' economies. For each country in our sample, we estimate the elasticity of labor supply across sectors, denoted by ϵ, that captures the extent of workers' mobility costs across sectors: as ϵ takes higher values, workers support relatively less mobility costs and thus are more willing to shift their hours worked from one sector to another. The 'low mobility' economies comprise Australia, Austria, Belgium, Canada, Denmark, Finland, Italy, Ireland, Netherlands, Norway, Sweden, while 'high mobility' economies consist of France, Japan, Spain, United-Kingdom, United States.

In order to give some support for our measure of workers' mobility cost, we compute an intersectoral labor reallocation index for each country i, which we denote by $LR_{i,t}(\tau)$; we expect the labor reallocation index to increase less in countries where the elasticity of labor supply across sectors ϵ takes lower values. To estimate the labor reallocation effect of a government spending shock, we replace the (log) ratio of hours worked in the traded sector to hours worked in the non traded sector, i.e., $l_{it}^T - l_{it}^N$, with the labor reallocation index $LR_{i,t}(2)$, in the 'labor market' specification; this index measures the fraction of workers that shift from one sector to another between year t and year $t-2$. Our vector of endogenous variables for the 'labor reallocation' specification is thus given by: $z_{it}^W = [g_{it}, LR_{it}(2), \omega_{it}]$. In Table 1, we do not show the cumulative responses for neither government spending nor the relative wage to an exogenous fiscal shock by 1 percentage point of GDP. Panel C of Table 12 shows cumulates responses for these two variables and the labor reallocation index as well for selected horizons, i.e, at a first-, two-, four-year horizon. First, for the whole sample, we find that a government spending shock increases the labor reallocation across sectors above trend. As emphasized in the main text, contrasting the cumulative responses reported in columns 2 and 3 of Table 12, we find that countries with a smaller elasticity of labor supply across sectors experiences a lower increase in the fraction of workers that shift from one sector to another. Moreover, the responses of the relative wage shown in panels A and C are similar and and thus do not merit additional comments.

For reasons of space, figures in section 2 restrict attention to the responses of selected

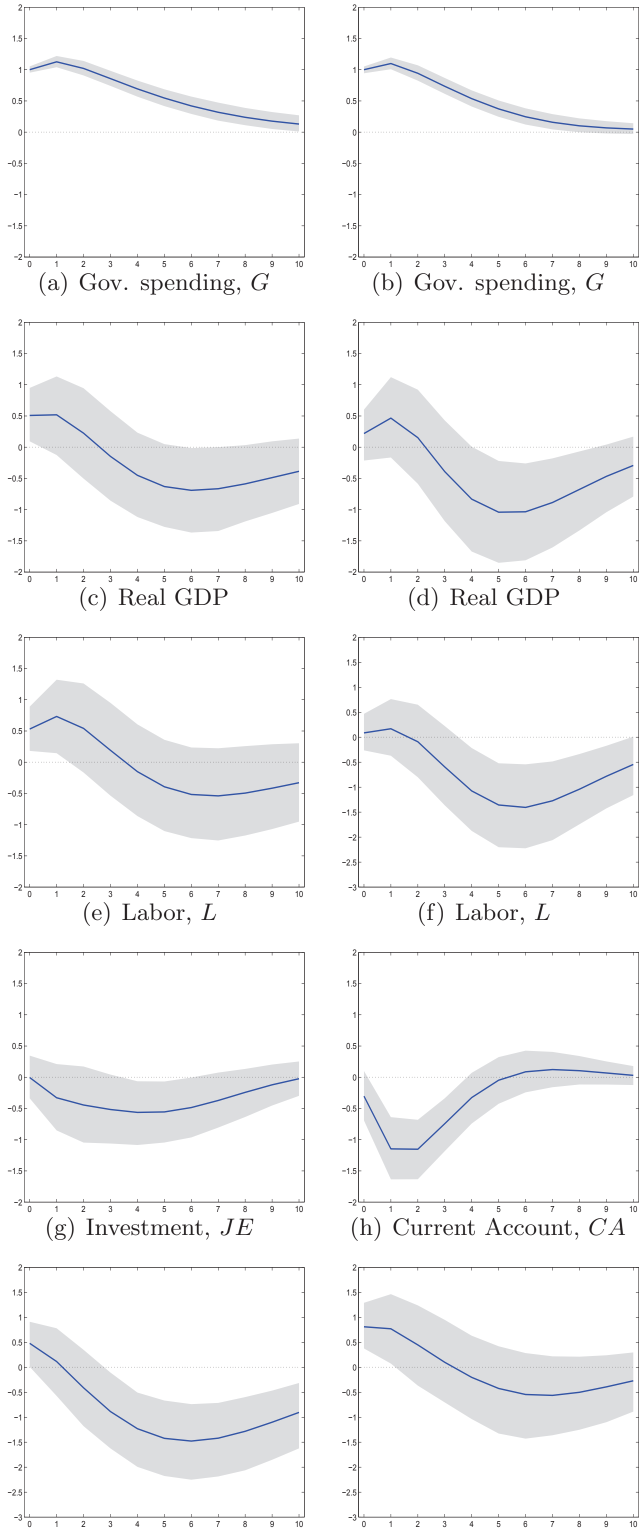
Table 11: Cumulative Responses to Spending Shock

Variables	Horizon	All sample (1)	Low Mobility (2)	High Mobility (3)
A.Labor Market				
Gov. spending	1	1.000^*	1.000^*	1.000^*
	2	2.190^*	2.214^*	2.213^*
	4	4.294^*	4.439^*	3.874^*
Relative Labor	1	-0.705^*	-0.362^*	-1.657^*
(L^T/L^N)	2	-2.007^*	-1.366	-3.719^*
	4	-4.968^*	-4.141	-6.835^*
Relative Wage	1	0.926^*	1.242^*	-0.099
(W^N/W^T)	2	2.500^*	3.311^*	-0.087
	4	5.169^*	7.483^*	-1.785
B.Product Market				
Gov. spending	1	1.000^*	1.000^*	1.000^*
	2	2.186^*	2.201^*	2.2113^*
	4	4.195^*	4.284^*	3.939^*
Relative Output	1	-1.025^*	-0.674^*	-1.936^*
(Y^T/Y^N)	2	-2.240^*	-1.764^*	-3.405^*
	4	-4.547^*	-4.293^*	-5.389^*
Relative Price	1	1.063^*	1.052^*	0.655
(P^N/P^T)	2	3.416^*	3.312^*	2.246
	4	7.984^*	8.340^*	4.023
C.Labor Reallocation				
Gov. spending	1	1.000^*	1.000^*	1.000^*
	2	2.207^*	2.199^*	2.198^*
	4	4.337^*	4.304^*	4.417^*
Mobility Indicator	1	0.304^*	0.163^*	0.851^*
(LR)	2	0.754^*	0.482^*	1.772^*
	4	1.110^*	0.824^*	2.191^*
Relative Wage	1	0.939^*	1.320^*	-0.687
(W^N/W^T)	2	2.667^*	3.603^*	-1.307
	4	5.222^*	7.683^*	-5.248

Notes: Horizon measured in year units. * denote significance at 10% level. Standard errors are bootstrapped with 10000 replications.

variables which are included in the VAR models. In this section, we document the effects of an exogenous fiscal shock on all variables which are included in the four specifications of VAR models:

- $z_{it} = [g_{it}, y_{it}, l_{it}, je_{it}, w_{C,it}]$ and $z_{it} = [g_{it}, y_{it}, l_{it}, ca_{it}, w_{C,it}]$ (see Fig. 10, columns 1 and 2 resp.);
- $z_{it}^T = \left[g_{it}, y_{it}^T, l_{it}^T, w_{C,it}^T\right]$, $z_{it}^N = \left[g_{it}, y_{it}^N, l_{it}^N, w_{C,it}^N\right]$, $z_{it}^{S,T} = \left[g_{it}, \nu_{it}^{Y,T}, \nu_{it}^{L,T}, w_{C,it}^T\right]$, and $z_{it}^{S,N} = \left[g_{it}, \nu_{it}^{Y,N}, \nu_{it}^{L,N}, w_{C,it}^N\right]$ (see Fig. 11, columns 1, 2, 3 and 4 resp.);
- $z_{it}^W = \left[g_{it}, l_{it}^T - l_{it}^N, \omega_{it}\right]$ and $z_{it}^P = \left[g_{it}, y_{it}^T - y_{it}^N, p_{it}\right]$ (see Fig. 12, columns 1 and 2 resp.);
- $z_{it}^W = \left[g_{it}, l_{it}^T - l_{it}^N, \omega_{it}\right]$ and $z_{it}^W = [g_{it}, LR_{it}(2), \omega_{it}]$ for the 'high' and 'low mobility' sub-samples (see Fig. 13, columns 1 and 2 resp.).



(a) Gov. spending, G (b) Gov. spending, G

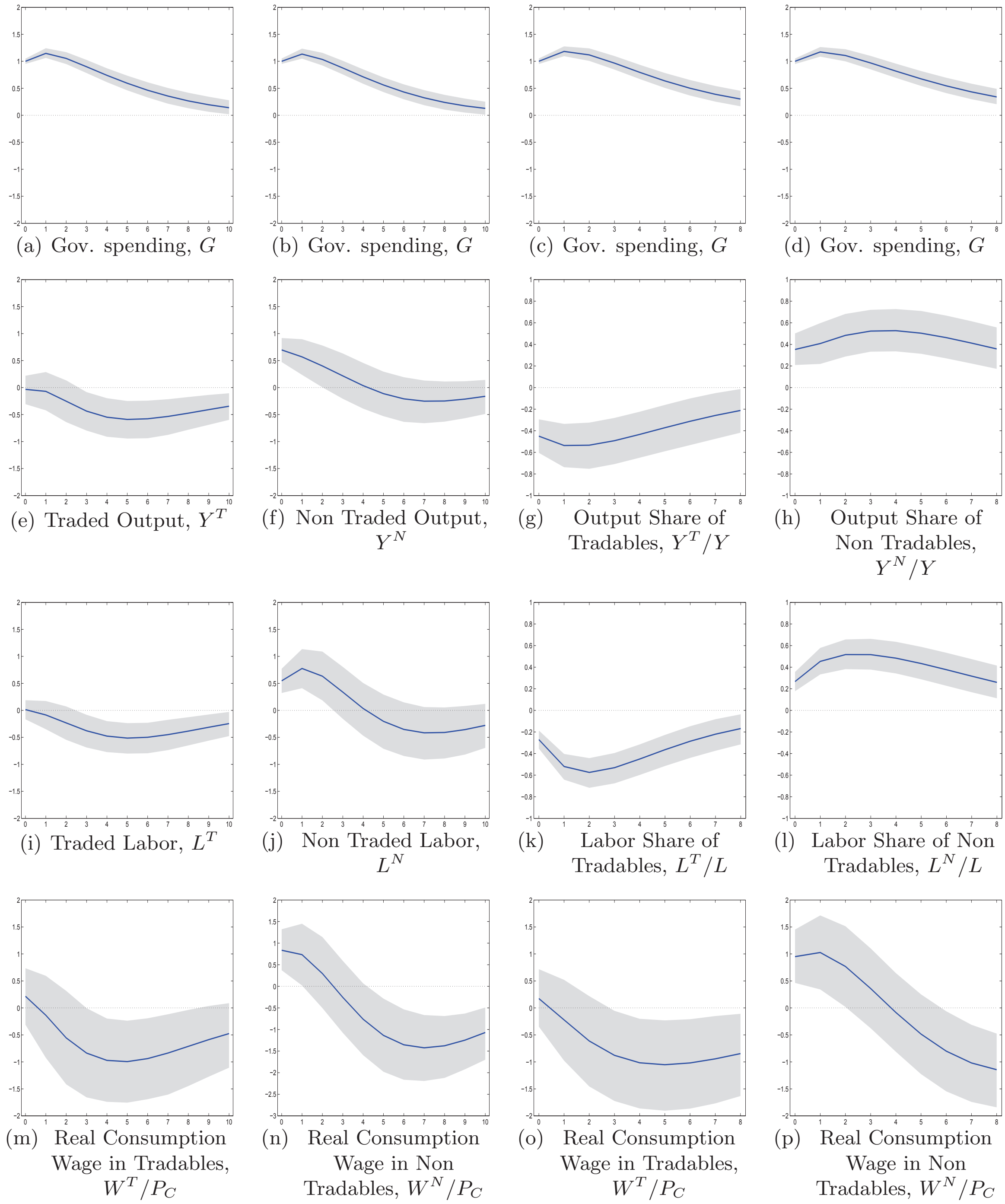
(c) Real GDP (d) Real GDP

(e) Labor, L (f) Labor, L

(g) Investment, JE (h) Current Account, CA

(i) Real Wage, W/P_C (j) Real Consumption Wage, W/P_C

Figure 10: Effects of Unanticipated Government Spending Shock on Aggregate Variables. Notes: Exogenous increase of government consumption by 1% of GDP. Aggregate variables include GDP (constant prices), total hours worked, private fixed investment, the current account and the real consumption wage. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (government spending, GDP, investment, current account), percentage deviation from trend in labor units (total hours worked), percentage deviations from trend (real consumption wage). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.



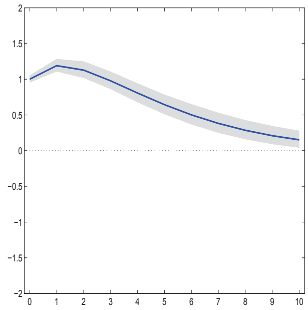
(a) Gov. spending, G (b) Gov. spending, G (c) Gov. spending, G (d) Gov. spending, G

(e) Traded Output, Y^T (f) Non Traded Output, Y^N (g) Output Share of Tradables, Y^T/Y (h) Output Share of Non Tradables, Y^N/Y

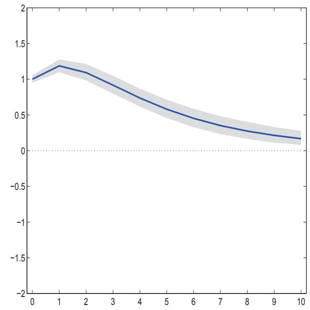
(i) Traded Labor, L^T (j) Non Traded Labor, L^N (k) Labor Share of Tradables, L^T/L (l) Labor Share of Non Tradables, L^N/L

(m) Real Consumption Wage in Tradables, W^T/P_C (n) Real Consumption Wage in Non Tradables, W^N/P_C (o) Real Consumption Wage in Tradables, W^T/P_C (p) Real Consumption Wage in Non Tradables, W^N/P_C

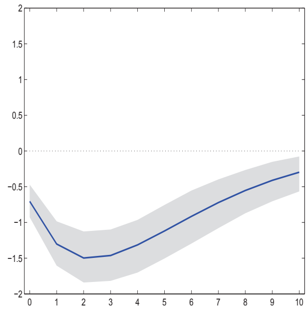
Figure 11: Effects of Unanticipated Government Spending Shock on Sectoral Variables. Notes: Exogenous increase of government consumption by 1% of GDP. Sectoral variables include sectoral valued added at constant prices, sectoral hours worked, sectoral labor and sectoral output shares, and real consumption sectoral wages. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (sectoral output, sectoral output share), percentage deviation from trend in labor units (sectoral labor, sectoral labor share), percentage deviations from trend (real consumption sectoral wages). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.



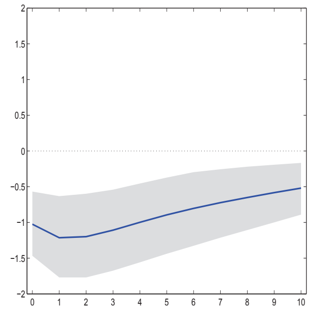
(a) Gov. spending, G



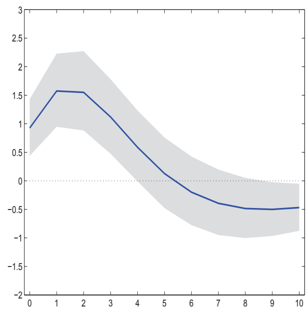
(b) Gov. spending, G



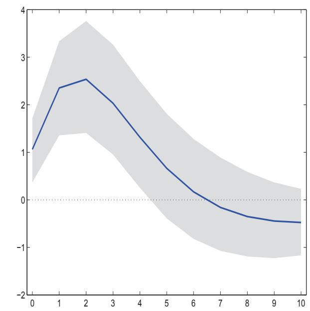
(c) Relative Hours Worked, L^T/L^N



(d) Relative Output Y^T/Y^N

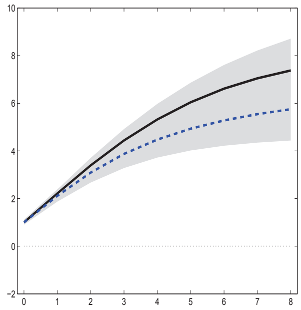


(e) Relative Wage, $\Omega = W^N/W^T$

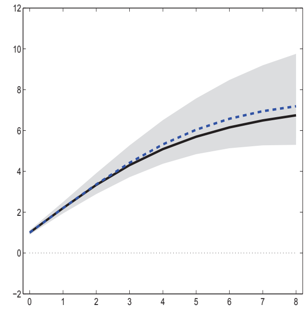


(f) Relative Price of Non Tradables, $P = P^N/P^T$

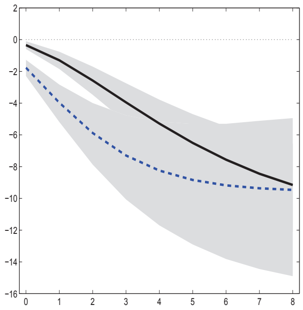
Figure 12: Effects of Unanticipated Government Spending Shock on Relative Price and Relative Wage. Notes: Exogenous increase of government consumption by 1% of GDP. Sectoral variables include hours worked of tradables in terms of non tradables, the relative wage, output of tradables in terms of non tradables, the relative price of non tradables. Horizontal axes indicate years. Vertical axes measure deviations from trend (ratio of traded value added to non traded value added, ratio of hours worked of tradables to hours worked of non tradables), and percentage deviations from trend (relative price, relative wage). Results for baseline specification are displayed by solid lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.



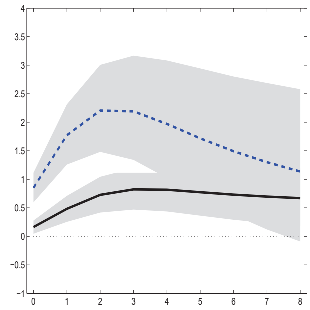
(a) Gov. spending, G



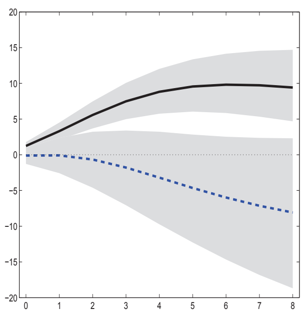
(b) Gov. spending, G



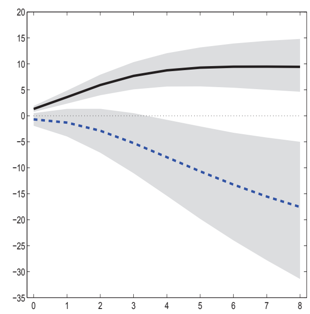
(c) Relative Hours Worked, L^T/L^N



(d) Labor Reallocation



(e) Relative Wage, $\Omega = W^N/W^T$



(f) Relative Wage, $\Omega = W^N/W^T$

Figure 13: Effects of Unanticipated Government Spending Shock on Labor Reallocation across Sectors. Notes: Exogenous increase of government consumption by 1% of GDP. Sectoral variables include hours worked of tradables in terms of non tradables, the relative wage, the intersectoral labor reallocation index. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in labor units (intersectoral labor reallocation index), deviations from trend (ratio of hours worked of tradables to hours worked of non tradables), and percentage deviations from trend (relative wage). Panels report cumulative responses for the 'high mobility' and the 'low mobility'countries' group in the black solid line and the blue dashed line, respectively, with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data.

B.2 Robustness Check: Sectoral Classification

This section explores the robustness of our findings to the classification of the eleven 1-digit ISIC-rev.3 industries as tradables or non tradables. When we conduct the robustness analysis, we modify the baseline classification in a number of ways to ensure that some industries with specific characteristics are not driving the results. In particular, the classification of items "Wholesale and Retail Trade", "Hotels and Restaurants", "Transport, Storage and Communication", "Financial Intermediation" and "Real Estate, Renting and Business Services" may display some ambiguity. In order to address this issue, we re-estimate the various VAR specifications for different classifications in which one of the five above industries initially marked as tradable (non tradable resp.) is classified as non tradable (tradable resp.), all other industries staying in their original sector. In doing so, the classification of only one industry is altered, allowing us to see if the results are sensitive to the inclusion of a particular industry in the traded or the non traded sector. The baseline and the five alternative classifications considered in this exercise are shown in Table 12.

Table 12: Robustness check: Classification of Industries as Tradables or Non Tradables

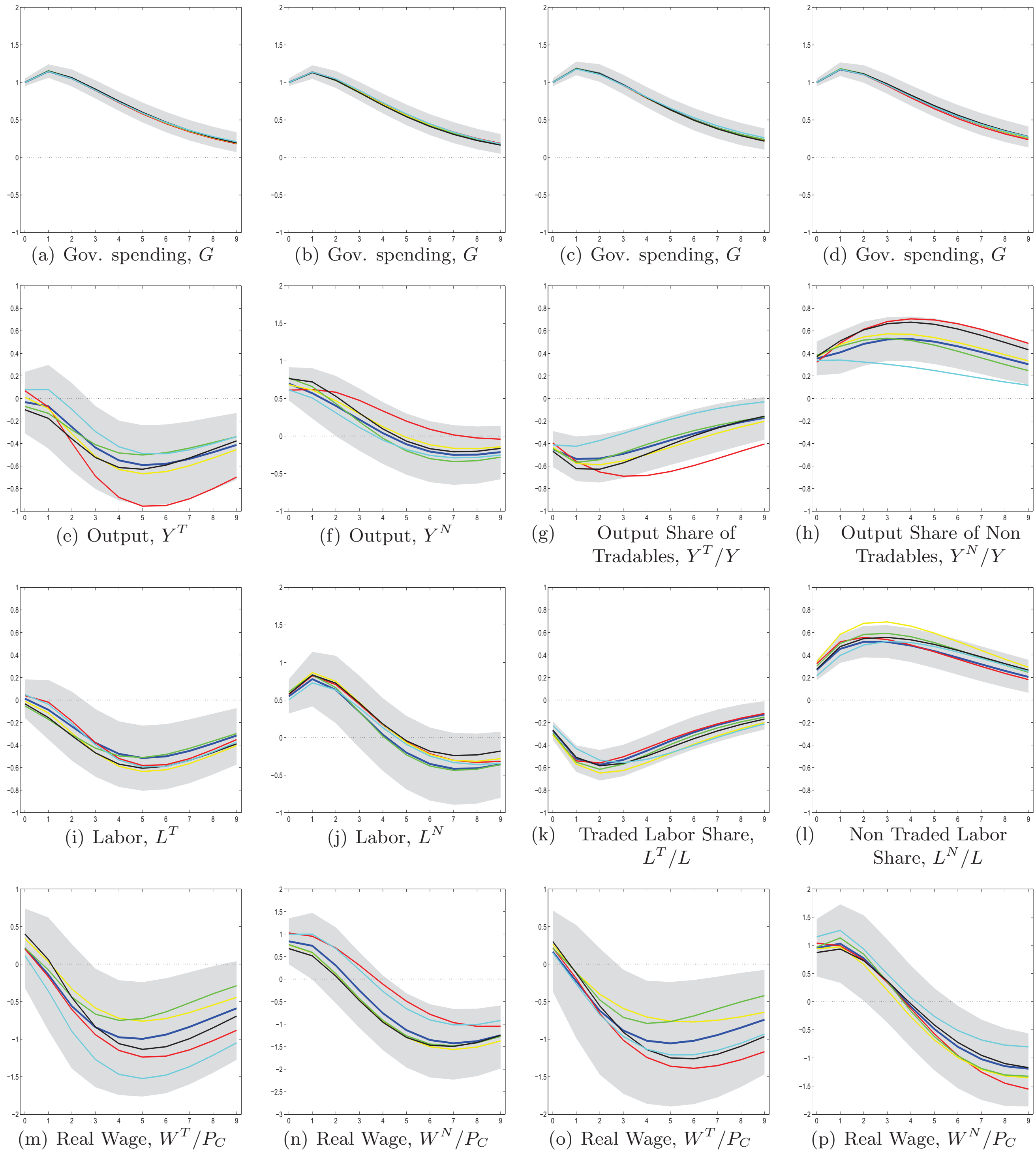
	KLEMS code	Classification					
		Baseline	#1	#2	#3	#4	#5
Agriculture, Hunting, Forestry and Fishing	AtB	T	T	T	T	T	T
Mining and Quarrying	C	T	T	T	T	T	T
Total Manufacturing	D	T	T	T	T	T	T
Electricity, Gas and Water Supply	E	N	N	N	N	N	N
Construction	F	N	N	N	N	N	N
Wholesale and Retail Trade	G	N	**T**	N	N	N	N
Hotels and Restaurants	H	N	N	**T**	N	N	N
Transport, Storage and Communication	I	T	T	T	**N**	T	T
Financial Intermediation	J	T	T	T	T	**N**	T
Real Estate, Renting and Business Services	K	N	N	N	N	N	**T**
Community Social and Personal Services	LtQ	N	N	N	N	N	N
Color line in Fig. 14 and 15		blue	red	yellow	green	black	cyan

Notes: T stands for the Traded sector and N for the Non traded sector.

Figures 14 and 15 report the responses of variables of interest to an exogenous increase in government spending by one percent of GDP. The solid blue line shows results for the baseline classification while the responses for alternative classifications are shown in the five colored lines. The last line of Table 12 provides the matching between the color line and the classification between tradables and non tradables. In each panel, the shaded area corresponds to the 90% confidence bounds.[52] Figure 14 contrasts the responses of sectoral output (Y^j), sectoral labor (L^j), sectoral output shares (Y^j/Y), sectoral labor shares (L^j/L), real consumption sectoral wages (W^j/P_C) for the baseline classification with those obtained for alternative classifications of industries as tradables or non tradables. Alternative responses are fairly close to those for the baseline classification as they lie within the confidence interval (for the baseline classification) for almost all the selected horizons (8 years). Figure 15 reports the effects of an exogenous increase in government consumption by 1% of GDP on the ratio of sectoral output (Y^T/Y^N), sectoral labor (L^T/L^N), the intersectoral labor reallocation index (LR), the relative price (P) and the relative wage (Ω). For LR, P and Ω, the responses are remarkably similar across the baseline and alternative classifications. While the pattern of the dynamic adjustment of Y^T/Y^N is similar across all classifications, the decline in output of tradables relative to non tradables is more pronounced when the industry "Wholesale and Retail Tarde" is treated as tradables (classification #1). We can also notice some differences in responses of L^T/L^N across the baseline and the five alternative classifications. For specifications #1 and #5, the response of L^T/L^N does not lie within the confidence interval of the baseline. Yet, across all classifications, L^T/L^N declines significantly on impact, and stay below trend for a number of periods. By and large, our main

[52] We do not report the responses for aggregate variables included since these variables, by construction, are unsensitive to the definition of traded and non traded sectors.

findings hold and remain unsensitive to the classification of one specific industry as tradable or non tradable; in sum, the specific treatment of "Wholesale and Retail Trade", "Hotels and Restaurants", "Transport, Storage and Communication", "Financial Intermediation" and "Real Estate, Renting and Business Services" does not drive the results.



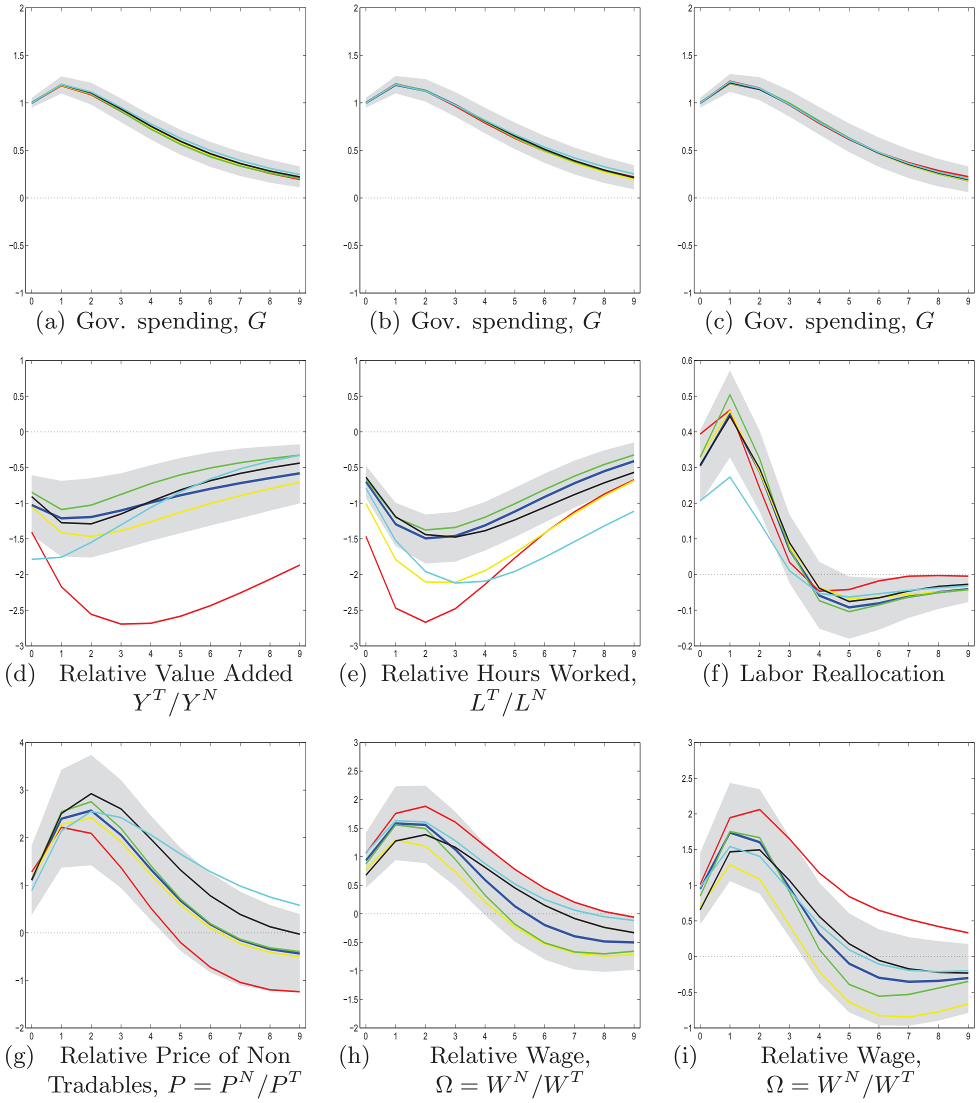
(a) Gov. spending, G (b) Gov. spending, G (c) Gov. spending, G (d) Gov. spending, G

(e) Output, Y^T (f) Output, Y^N (g) Output Share of Tradables, Y^T/Y (h) Output Share of Non Tradables, Y^N/Y

(i) Labor, L^T (j) Labor, L^N (k) Traded Labor Share, L^T/L (l) Non Traded Labor Share, L^N/L

(m) Real Wage, W^T/P_C (n) Real Wage, W^N/P_C (o) Real Wage, W^T/P_C (p) Real Wage, W^N/P_C

Figure 14: Sensitivity of the Effects of Unanticipated Government Spending Shock on Sectoral Variables to the Classification of Industries as Tradable or Non Tradable. Notes: The blue line shows results for the baseline classification. The red line and the yellow line show results when 'Whole and retail traded' and 'Hotels and restaurants' are treated as tradables, respectively. The green line and the black line show results when 'Transport, storage and communication' and 'Financial intermediation' are classified as tradables, respectively. The cyan line reports results when 'Real Estate, renting and business services' is treated as tradables.



(a) Gov. spending, G (b) Gov. spending, G (c) Gov. spending, G

(d) Relative Value Added Y^T/Y^N (e) Relative Hours Worked, L^T/L^N (f) Labor Reallocation

(g) Relative Price of Non Tradables, $P = P^N/P^T$ (h) Relative Wage, $\Omega = W^N/W^T$ (i) Relative Wage, $\Omega = W^N/W^T$

Figure 15: Sensitivity of the Effects of Unanticipated Government Spending Shock on Relative Price and Relative Wage to the Classification of Industries as Tradable or Non Tradable. Notes: The blue line shows results for the baseline specification. The red line and the yellow line show results when 'Whole and retail traded' and 'Hotels and restaurants' are treated as tradables, respectively. The green line and the black line show results when 'Transport, storage and communication' and 'Financial intermediation' are classified as tradables, respectively. The cyan line reports results when 'Real Estate, renting and business services' is treated as tradables.

B.3 Robustness Check: Excluding the Public Sector

As an additional robustness check, we exclude the industry "Community Social and Personal Services" from the non tradable industries' set. This robustness analysis is based on the presumption that among the eleven industries provided by the EU KLEMS and STAN databases, this industry is government-dominated. While this exercise is interesting on its own as it allows us to explore the size of the impact of a government spending shock on the business sector, we also purge for the potential and automatic link between non traded output and public spending because government purchases (to the extent that the government is the primary purchaser of goods from this industry) account for a significant part of non traded value added.[53]

Figures 16-18 report the effects of an exogenous increase in government consumption by 1% of GDP for the whole economy (baseline) together with the responses on the business sector (i.e., the public sector is excluded). In each case, the blue line reports the point estimate for the whole economy (with its 90% confidence interval) while the black line shows the point estimate for the business sector (i.e., the industry "Community Social and Personal Services" is excluded). Figure 16 shows the results of a rise in government consumption on GDP, hours worked, investment, the current account and the real consumption wage. We can notice that the dynamic adjustment of hours worked to an exogenous increase in government consumption is somewhat sensitive to the exclusion of the public sector. More precisely, when the public sector is excluded, hours worked increase less in Fig. 16(e) or even may decline on impact as displayed in Fig. 16(f). Whether we consider the whole economy or the business sector, the dynamic adjustment of hours worked displays a similar pattern whether "Community Social and Personal Services" is included or omitted: hours worked decline gradually before starting to recover after 5 years.

Figure 17 shows the results of a rise in government consumption by 1% of GDP on sectoral quantities, on sectoral labor and sectoral output shares, along with real consumption sectoral wages. In each panel, the blue solid line shows the results for the whole economy while the black solid line reports responses for the business sector. When excluding the public sector, we can notice that the contraction in hours worked and output of tradables is somewhat mitigated while the expansionary effect on non tradables is moderated. By and large, the shape of the dynamic adjustment of sectoral variables are similar and mostly lie within the confidence bounds of the baseline specification (i.e., for the whole economy). The third and fourth columns report the dynamic adjustment of output and labor shares of tradables and non tradables. As for sectoral output and sectoral labor in levels, the responses of sectoral output relative to GDP (in real terms) are mitigated when excluding the public sector. However, the conclusions we reach in the main text remain valid. In all instances, whether we use labor or output, the share of tradables falls while the share of non tradables rises. It is worthwhile mentioning that the differences in quantitative adjustments for output shares can be mostly attributed to the modifications of the initial share of each sector in terms of labor or total output. Technically, the responses of sectoral shares are measured as percentage deviation from trend in total output units for sectoral output shares or alternatively as percentage deviation from trend in total hours worked units for sectoral labor shares. Thus, percentage deviations from trend are multiplied by the corresponding share of sector j in the whole economy (for the baseline scenario) or alternatively in the business sector (for the alternative scenario where the industry "Community Social and Personal Services" is excluded). Since the initial share of non tradables is reduced when "Community Social and Personal Services" is excluded, the magnitude of the responses of labor and output share of non tradables are mitigated as well. In the baseline, non traded output and traded output as a share of GDP are 0.60 and 0.40 respectively, while in the alternative scenario where "Community Social and Personal Services" is excluded, the corresponding shares are 0.30 and 0.70. Results without these corrections (not shown) reveal that the differences in the responses of Y^T/Y and Y^N/Y across the two scenarios turn out to be substantially smaller. In the light of this result, it is unlikely that the omitted

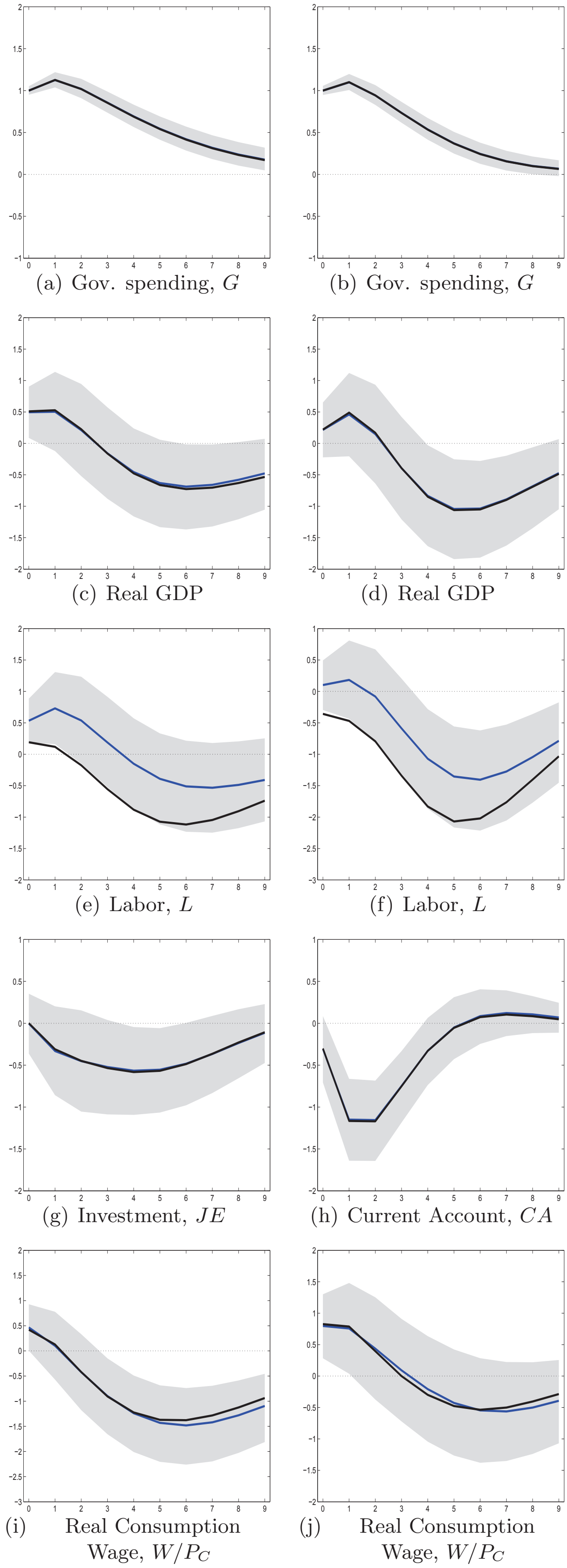
[53] This exercise has been conducted by Benetrix and Lane [2010] and Beetsma, Giuliodori, and Klaassen [2008], among others, in order to deal with the potential endogeneity of government purchases with respect to output.

industry plays a major role in explaining the responses of the output shares of tradables and non tradables to an increase in government spending.

Finally, Figure 18 compares the responses with and without the industry "Community Social and Personal Services" for the ratio of sectoral quantities (i.e., Y^T/Y^N, L^T/L^N), labor reallocation (LR), the relative price (P) and the relative wage (Ω). When excluding "Community Social and Personal Services", we find that the positive responses of the relative price of non tradables and the relative wage to an exogenous increase in government consumption are more pronounced and display more persistence over time. Because prices and wages are not really determined by the interplay of supply and demand in the public sector, it is not surprising that excluding this sector tends to magnify the responses of the relative wage and the relative price to a fiscal shock. While the ratio of hours worked of tradables relative to non tradables displays a similar magnitude, we may notice that the shift in the ratio of sectoral output is much more pronounced on impact and along the adjustment when we exclude "Community Social and Personal Services". As mentioned above, this behavior is mostly driven by the initial share of tradables which increases sharply.[54] Otherwise, the difference between the two instances would have been much smaller.

To conclude, the results presented in Figures 16-18 show that the conclusions which are drawn in the main text on the basis of the responses to an exogenous fiscal shock when we consider the whole economy remain valid when the industry "Community Social and Personal Services" is excluded.

[54]Recall that the percentage deviation from trend of Y^T/Y^N is multiplied by $\frac{P^T Y^T}{P^N Y^N}$ in order to express the result in percentage points and in the same units. For the baseline scenario (whole economy), the ratio Y^T/Y^N averages to 0.68. When "Community Social and Personal Services" is excluded, the ratio goes up to 2.40.



(a) Gov. spending, G (b) Gov. spending, G

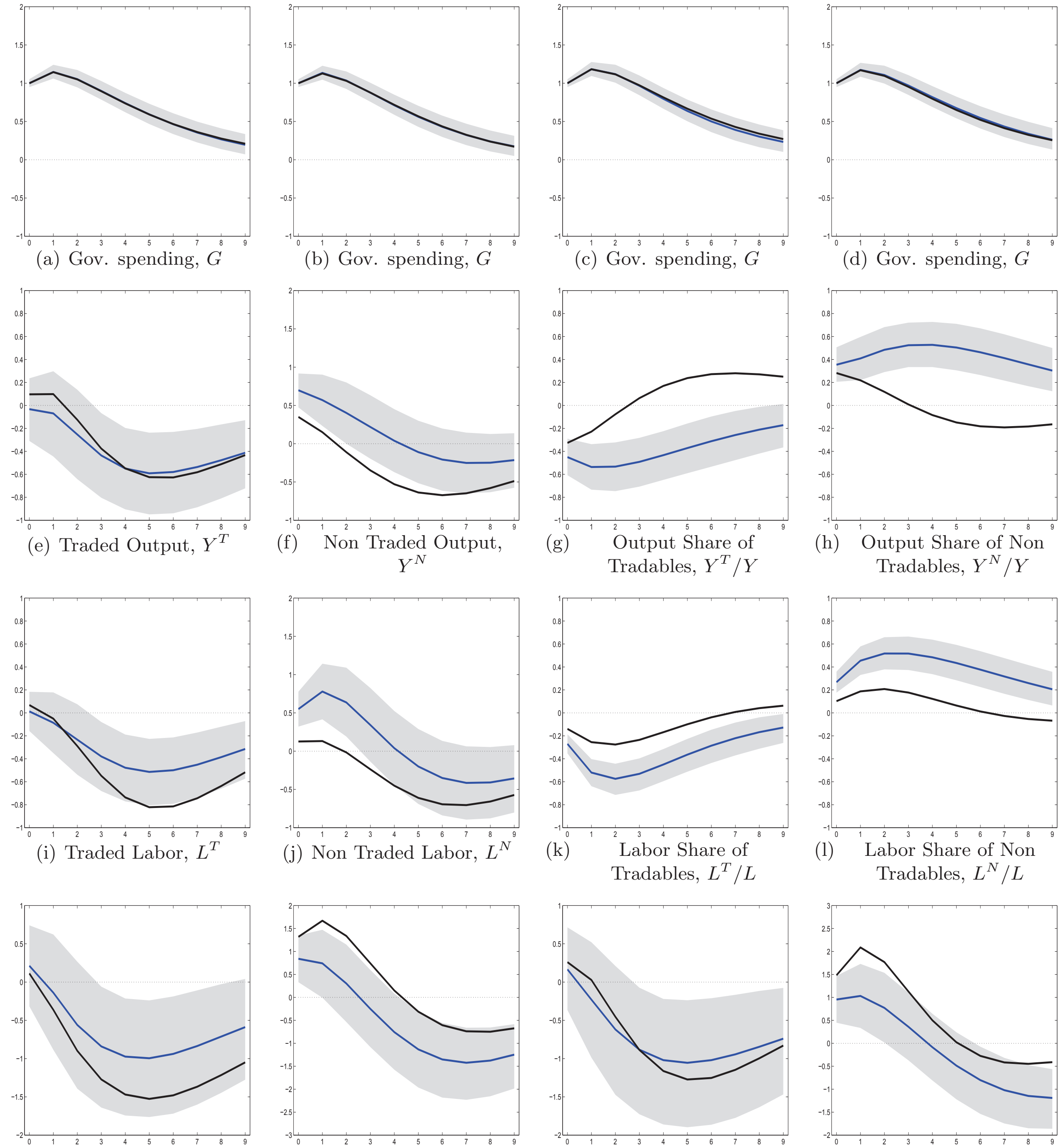
(c) Real GDP (d) Real GDP

(e) Labor, L (f) Labor, L

(g) Investment, JE (h) Current Account, CA

(i) Real Consumption Wage, W/P_C (j) Real Consumption Wage, W/P_C

Figure 16: Sensitivity of the Effects of Unanticipated Government Spending Shock on Aggregate Variables to Exclusion of the Public Sector. Notes: Impulse response functions to an exogenous increase in real government spending by one percent of GDP. Blue line: all sectors; shaded areas: 90 percent confidence intervals; black line: without ”Community Social and Personal Services”.



(a) Gov. spending, G

(b) Gov. spending, G

(c) Gov. spending, G

(d) Gov. spending, G

(e) Traded Output, Y^T

(f) Non Traded Output, Y^N

(g) Output Share of Tradables, Y^T/Y

(h) Output Share of Non Tradables, Y^N/Y

(i) Traded Labor, L^T

(j) Non Traded Labor, L^N

(k) Labor Share of Tradables, L^T/L

(l) Labor Share of Non Tradables, L^N/L

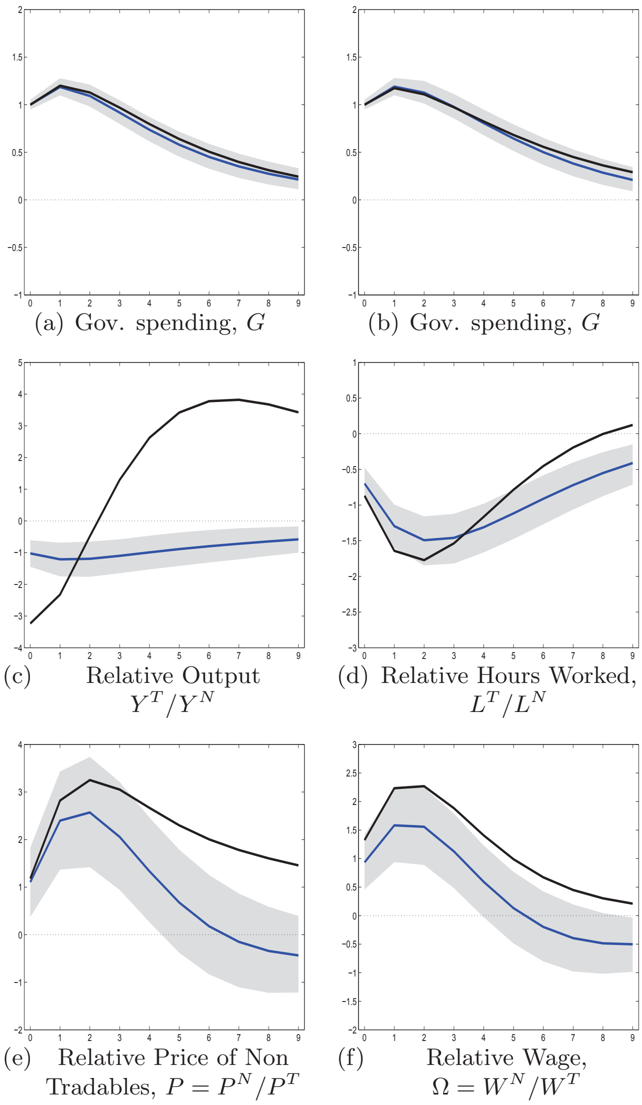
(m) Real Consumption Wage in Tradables, W^T/P_C

(n) Real Consumption Wage in Non tradables, W^N/P_C

(o) Real Consumption Wage in Tradables, W^T/P_C

(p) Real Consumption Wage in Non Tradables, W^N/P_C

Figure 17: Sensitivity of the Effects of Unanticipated Government Spending Shock on Sectoral Variables to Exclusion of the Public Sector. Notes: Impulse response functions to an exogenous increase in real government spending by one percent of GDP. Blue line: all sectors; shaded areas: 90 percent confidence intervals; black line: without "Community Social and Personal Services".



(a) Gov. spending, G

(b) Gov. spending, G

(c) Relative Output Y^T/Y^N

(d) Relative Hours Worked, L^T/L^N

(e) Relative Price of Non Tradables, $P = P^N/P^T$

(f) Relative Wage, $\Omega = W^N/W^T$

Figure 18: Sensitivity of the Effects of Unanticipated Government Spending Shock on Relative Price and Relative Wage to Exclusion of the Public Sector. Notes: Impulse response functions to an exogenous increase in real government spending by one percent of GDP. Blue line: all sectors; shaded areas: 90 percent confidence intervals; black line: without "Community Social and Personal Services".

B.4 Robustness Check: Identifying Assumption of Government Spending Shocks

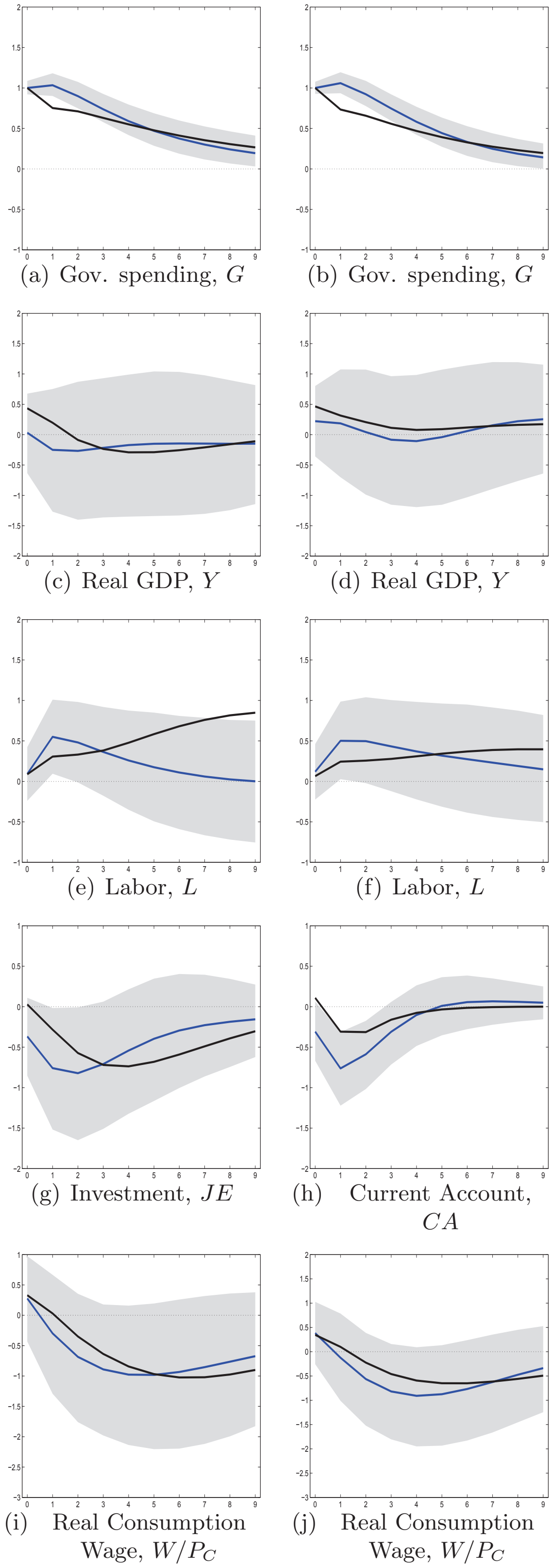
Like earlier studies, we adopt the identifying assumption of government spending shocks proposed by Blanchard and Perotti [2002] who assume that there is no contemporaneous response of government spending to macroeconomic aggregates, i.e. that government spending is predetermined. As summarized by Born and Müller [2012]: 'This requires that government spending does i) neither respond automatically to the economy, ii) nor that it is adjusted in a discretionary manner within the period. The first requirement is likely to be satisfied if government spending does not include transfers, but only government consumption and investment (a commonly used definition of government spending). Whether the second requirement is satisfied depends on the extent of decision lags in the policy process and thus on the data frequency'. While the identifying assumption is expected to hold for quarterly data, its fulfilment is less compelling when imposed at annual frequency. Recently, Beetsma, Giuliodori and Klaassen [2008] and Born and Muller [2012] provide evidence that imposing a zero within-year response of government spending to output to identify an annual SVAR is a reasonable identifying restriction for a panel of seven OECD countries and the US, respectively. While these conclusions are reassuring, we provide below additional support for our identifying assumption in annual data. We thus ask whether the assumption that government spending is predetermined within the year by using the largest available subset of the countries in our dataset for which we have sufficient quarterly data. For this purpose, we compare the annualized impulse responses from the quarterly VAR model in panel format with those obtained from a VAR model estimated in panel formal on annual data. Because sectoral data are only available at an annual frequency. we restrict the exercise to the VAR models including aggregate variables such as government spending, aggregate GDP, total hours worked, investment, the current account and the real consumption wage. We proceed below in two stages. First, we briefly discuss our data. Second, we compare results obtained on the basis of annual with those obtained with quarterly data.

Data are taken from the OECD Economic Outlook database. The country sample is Australia (AUS), Austria (AUT), Canada (CAN), France (FRA), Italy (ITA), Japan (JPN), the Netherlands (NLD), Sweden (SWE), the United Kingdom (GBR), and the United States (USA), for which quarterly and annual macroeconomic data are available. Given OECD quarterly statistics data, the country and period coverage (identical for the quarterly and annual data sets) is: AUS (1979Q1-2007Q4), AUT (1990Q1-2007Q4), CAN (1981Q1-2007Q4), FRA (1973Q1-2007Q4), ITA (1970Q1-2007Q4), JPN (1970Q1-2007Q4), NLD (1970Q1-2007Q4), SWE (1975Q1-2007Q4), GBR (1972Q1-2007Q4) and USA (1970Q1-2007Q4). Sources and data construction at a quarterly frequency are as follows:

- **Government spending**: real government final consumption expenditure (CGV). Source: OECD Economic Outlook Database.
- **Gross domestic product**: real gross domestic product (GDPV). Source: OECD Economic Outlook Database.
- **Labor**: hours worked per employee, total economy. Source: OECD Economic Outlook Database.
- **Private fixed investment**: real private non-residential gross fixed capital formation (IBV). Source: OECD Economic Outlook Database.
- **Current account**: current account balance (in % of GDP). Source: OECD Economic Outlook Database.
- **Real Consumption wage**: nominal wage rate (total economy) divided by the consumer price index (CPI). Sources: OECD Economic Outlook Database for the nominal wage and OECD Prices and Purchasing Power Parities for the consumer price index.

All data are seasonally adjusted and divided by the population, except for the current account balance and the real consumption wage. We consider per capita variables, and thus divide quantities by the working age population (15-64 years old) provided by OECD Economic Outlook Database (data for the population at quarterly frequency were interpolated from annual data). For government spending, GDP and investment, we directly use the volumes as reported by the OECD (the series are deflated with their own deflators).

In estimating the VAR models on quarterly data, we allow for four lags while the number of lags is set to two when data are at an annual frequency. In order to investigate consistently whether the assumption that government spending is predetermined within the year, we impose the restriction that government spending is predetermined with the year (the quarter) to identify government spending shocks when the model is estimated in panel format on annual (quarterly) data. Figure 19 reports the responses for the variables of interest from the VAR model estimated on annual data shown in the blue solid line and on quarterly data shown in the black solid line. The blue and the black solid lines display the point estimate with shaded areas indicating 90% confidence bounds obtained when the VAR model is estimated on annual data. We take the panel VAR model on annual data as the baseline model. For purposes of comparability, we annualize the responses of the quarterly baseline models. While some differences can be observed, the annualized responses obtained from the quarterly model are fairly close to those obtained from the baseline model as responses lie within the confidence interval of the baseline model for almost all time horizons. It is worthwhile mentioning that following an exogenous increase in government consumption, total hours worked displays much more persistence when the panel VAR model is estimated on quarterly data than on annual data. Note that hours worked revert to its inial level after several decades. We can notice that investment and the current account do not respond to the fiscal shock on impact with quarterly data while they both gradually decline and stay below trend for several years. While the responses somewhat display some minor quantitative differences, the panel VAR evidence is similar whether we assume that government spending does not respond to the other variables included in the VAR model within the year or alternatively within the quarter. In sum, we can conclude that the assumption according to which the fiscal shock is exogenous within the year is not as restrictive as one might think.



(a) Gov. spending, G (b) Gov. spending, G

(c) Real GDP, Y (d) Real GDP, Y

(e) Labor, L (f) Labor, L

(g) Investment, JE (h) Current Account, CA

(i) Real Consumption Wage, W/P_C (j) Real Consumption Wage, W/P_C

Figure 19: Impulse Response Functions from the Panel VAR Model on Annual Data vs. Quarterly Data. Notes: Exogenous increase of government consumption by 1% of GDP. Aggregate variables include GDP (constant prices), total hours worked, private fixed investment, the current account and the real consumption wage. Horizontal axes indicate years. Vertical axes measure percentage deviation from trend in output units (government spending, GDP, investment, current account), percentage deviation from trend in labor units (total hours worked), percentage deviations from trend (real consumption wage). Results for baseline specification are displayed by blue lines with shaded area indicating 90 percent confidence bounds obtained by bootstrap sampling; sample: 16 OECD countries, 1970-2007, annual data. Blue line: response from the panel VAR model on annual data; black line: annualized impulse responses from the panel VAR model on quarterly data.

C Solving the Two-Sector Model without Physical Capital

In this section, we provide the main steps to solve the two-sector model without capital accumulation. This enables us to shed some light on the implications of a difficulty in reallocating labor across sectors for the fiscal transmission. The small open economy produces a traded and a non traded good by means of a production technology described by linearly homogenous production functions that use labor only. As previously, the output of the non traded good (Y^N) can be used for private (C^N) and public consumption (G^N). The output of the traded good (Y^T) can be consumed by households (C^T) and the government (G^T), or can be exported with $Y^T - C^T - G^T$ corresponding to net exports. To avoid technical details, the reader can jump to subsection C.13 that solves the model in a friendly way by assuming that the endogenous response of government spending to an exogenous fiscal shock decreases monotonically.

Furthermore, to ease the interpretation of analytical results, we set the following assumption:

Assumption 1 *The elasticity of labor supply across sectors, ϵ, is higher than the intertemporal elasticity of substitution for labor, σ_L.*

First, our panel data estimates for ϵ average 0.75 while empirical studies usually report estimates for the Frisch elasticity of labor supply ranging from 0.4 to 0.6. Second, as will be clear below, such an assumption guarantees that an open economy without physical capital runs a current account deficit, in line with our VAR evidence.

C.1 Households

At each instant the representative agent consumes traded goods and non-traded goods denoted by C^T and C^N, respectively, which are aggregated by a constant elasticity of substitution function:

$$C\left(C^T, C^N\right) = \left[\varphi^{\frac{1}{\phi}}\left(C^T\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}}\left(C^N\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}. \tag{95}$$

The representative agent must also decide on worked hours in the traded and the non traded sector denoted by L^T and L^N at each instant of time which are aggregated by a constant elasticity of substitution function:

$$L\left(L^T, L^N\right) = \left[\vartheta^{-\frac{1}{\epsilon}}\left(L^T\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-\frac{1}{\epsilon}}\left(L^N\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}. \tag{96}$$

The agent is endowed with a unit of time and supplies a fraction $L(t)$ of this unit as labor, while the remainder, $1-L$, is consumed as leisure. At any instant of time, households derive utility from their consumption and experience disutility from working. Households decide on consumption and worked hours by maximizing lifetime utility:

$$U = \int_0^\infty \left\{\frac{1}{1-\frac{1}{\sigma_C}}C(t)^{1-\frac{1}{\sigma_C}} - \frac{1}{1+\frac{1}{\sigma_L}}L(t)^{1+\frac{1}{\sigma_L}}\right\} e^{-\beta t}\mathrm{d}t, \tag{97}$$

where β is the consumer's discount rate, $\sigma_C > 0$ is the intertemporal elasticity of substitution for consumption, and $\sigma_L > 0$ is the Frisch elasticity of labor supply.

Households decide on consumption and worked hours by maximizing lifetime utility (97) subject to the flow budget constraint which states that the real disposable consisting of interest receipts from traded bonds holding plus labor income less lump sum taxes, T, can be consumed or saved by accumulating traded bonds:

$$\dot{B}(t) + P_C\left(P(t)\right)C(t) = r^\star B(t) + W\left(W^T(t), W^N(t)\right)L(t) - T(t), \tag{98}$$

where the RHS term of (98) corresponds to household's real disposable income.

Denoting the co-state variable associated with eq. (98) by λ, the first-order conditions characterizing the representative household's optimal plans are:

$$C = (P_C\lambda)^{-\sigma_C}\,, \tag{99a}$$
$$L = (\lambda W)^{\sigma_L}\,, \tag{99b}$$
$$\dot{\lambda} = \lambda\left(\beta - r^{\star}\right), \tag{99c}$$

and the transversality condition $\lim_{t\to\infty} \bar{\lambda}B(t)e^{-\beta t} = 0$. In an open economy model with a representative agent having perfect foresight, a constant rate of time preference and perfect access to world capital markets, we impose $\beta = r^{\star}$ in order to generate an interior solution. This standard assumption made in the literature implies that the marginal utility of wealth, λ, will undergo a discrete jump when individuals receive new information and must remain constant over time from thereon, i.e. $\lambda = \bar{\lambda}$.

The homogeneity of $C(.)$ and $L(.)$ allows a two-stage decision: in the first stage, consumption and total hours worked are determined, and the intratemporal allocation between tradables and non tradables is decided at the second stage. Households split consumption between tradables and non tradables according to the following optimal rule:

$$\left(\frac{1-\varphi}{\varphi}\right)\frac{C^T}{C^N} = P^{\phi}. \tag{100}$$

The allocation of total hours worked between the traded and the non traded sector follows from the following optimal rule:

$$\left(\frac{\vartheta}{1-\vartheta}\right)\frac{L^N}{L^T} = \Omega^{\epsilon}, \tag{101}$$

where $\Omega \equiv W^N/W^T$.

Plugging (100) into total consumption expenditure, i.e., $E_C = C^T + PC^N$, one obtains the optimal demand for tradables and non tradables:

$$C^T = \frac{\varphi\;.E_C}{\left[\varphi + (1-\varphi)\;.(P)^{1-\phi}\right]}, \tag{102a}$$
$$C^N = \frac{(1-\varphi)\;.E_C}{(P)^{\phi}\left[\varphi + (1-\varphi)\;.(P)^{1-\phi}\right]}. \tag{102b}$$

Substituting (102a) and (102b) into the subutility function (95) while setting $C = 1$ leads to the consumption price index:

$$P_C = \left[\varphi + (1-\varphi)(P)^{1-\phi}\right]^{\frac{1}{1-\phi}}, \tag{103}$$

where $P'_C = \frac{\partial P_C}{\partial P} > 0$. Having defined the consumption price index, total consumption expenditure, E_C, can be rewritten as $P_C C$. Applying the Shephard's Lemma gives the optimal demand for non tradables:

$$C^N = \frac{\partial P_C}{\partial P}C. \tag{104}$$

Using the fact that $C^T = P_C C - PC^N$, on obtains the optimal demand for tradables:

$$C^T = \left(P_C - PP'_C\right).C. \tag{105}$$

Denoting by α_C the non tradable content of consumption expenditure defined by:

$$\alpha_C = \frac{(1-\varphi)(P)^{1-\phi}}{\varphi + (1-\varphi)(P)^{1-\phi}} = (1-\varphi)\left(\frac{P}{P_C}\right)^{1-\phi}, \tag{106a}$$
$$1-\alpha_C = \frac{\varphi}{\varphi + (1-\varphi)(P)^{1-\phi}} = \varphi P_C^{\phi-1}, \tag{106b}$$

one can express consumption in non tradables as a share α_C of total consumption expenditure:

$$PC^N = \frac{\partial P_C}{\partial P}\frac{P}{P_C}P_C C = \alpha_C P_C C. \tag{107}$$

The same logic applies to consumption in tradables:

$$C^T = \left(1 - \frac{\partial P_C}{\partial P}\frac{P}{P_C}\right)P_C C = \left(1-\alpha_C\right)P_C C. \tag{108}$$

The representative household maximizes $1 - L(.)$ where $L(.)$ is a CES function given by (96) with $\epsilon > 0$ the intratemporal elasticity of substitution between labor in the traded and non traded sector, given total labor income denoted by R_L measured in terms of the traded good:

$$R_L \equiv W^T L^T + W^N L^N, \tag{109}$$

where W^T is the wage rate in the traded sector and W^N is the wage rate in the non traded sector. The linear homogeneity of the subutility function $L(.)$ implies that total labor income can be expressed as $R_L = W\left(W^T, W^N\right)L$, with $W\left(W^T, W^N\right)$ is the unit cost function dual (or aggregate wage index) to L. The unit cost dual function, $W(.)$, is defined as the minimum total labor income, R_L, such that $L = L\left(L^T, L^N\right) = 1$, for a given level of the wage rates W^T and W^N. We derive below its expression.

Combining (101) together with total labor income denoted by R_L measured in terms of the traded good, i.e. $R_L \equiv W^T L^T + W^N L^N$, we are able to express labor supply to the traded and non traded sector, respectively, as functions of total labor income:

$$\begin{aligned} L^T &= (1-\vartheta)\left(W^T\right)^{-1}\left[(1-\vartheta) + \vartheta\left(\frac{W^N}{W^T}\right)^{\epsilon+1}\right]^{-1} R_L, \\ L^N &= \vartheta\left(W^T\right)^{-1}\left(\frac{W^N}{W^T}\right)^{\epsilon}\left[(1-\vartheta) + \vartheta\left(\frac{W^N}{W^T}\right)^{\epsilon+1}\right]^{-1} R_L. \end{aligned}$$

Plugging these equations into (96), setting $L = 1$ and $R_L = W$, yields the aggregate wage index:

$$W = \left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}. \tag{110}$$

Intratemporal allocation of hours worked between the traded and the non traded sector follows from Shephard's Lemma (or the envelope theorem):

$$L^T = \frac{\partial W}{\partial W^T}L = W_T L, \quad \text{and} \quad \frac{W^T L^T}{WL} = 1 - \alpha_L, \tag{111a}$$

$$L^N = \frac{\partial W}{\partial W^N}L = W_N L, \quad \text{and} \quad \frac{W^N L^N}{WL} = \alpha_L, \tag{111b}$$

where the non tradable and tradable content of total labor income, respectively, are:

$$\alpha_L = \frac{(1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]} = (1-\vartheta)\left(\frac{W^N}{W}\right)^{\epsilon+1}, \tag{112a}$$

$$1-\alpha_L = \frac{\vartheta\left(W^T\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]} = \vartheta\left(\frac{W^T}{W}\right)^{\epsilon+1}. \tag{112b}$$

We write out some useful properties:

$$\begin{aligned}
\frac{\partial W}{\partial W^T}\frac{W^T}{W} &= \left(1-\alpha_L\right), \quad \frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L, && (113a)\\
\frac{\partial W_T}{\partial W^T} &= \frac{\partial^2 W}{\partial \left(W^T\right)^2} = \vartheta\epsilon \left(W^T\right)^{\epsilon-1} W^{-\epsilon}\alpha_L, && (113b)\\
\frac{\partial W_T}{\partial W^T}\frac{W^T}{W_T} &= \epsilon\alpha_L > 0, && (113c)\\
\frac{\partial W_T}{\partial W^N}\frac{W^N}{W_T} &= -\epsilon\alpha_L < 0, && (113d)\\
\frac{\partial W_N}{\partial W^N}\frac{W^N}{W} &= \epsilon\left(1-\alpha_L\right) > 0, && (113e)\\
\frac{\partial W_N}{\partial W^T}\frac{W^T}{W} &= -\epsilon\left(1-\alpha_L\right) < 0, && (113f)
\end{aligned}$$

where $W_j = \frac{\partial W}{\partial W^j}$ (with $j = T, N$).

C.2 Firms

There are two sectors in the economy: a sector which produces a traded good denoted by the superscript T and a sector which produces a non traded good denoted by the superscript N. Both the traded and non traded sectors use labor, L^T and L^N, according to linearly homogenous production functions:

$$Y^T = L^T, \quad \text{and} \quad Y^N = L^N. \tag{114}$$

Both sectors face a labor cost equal to the wage rate, i.e., W^T and W^N, respectively. The traded sector and non traded sector are assumed to be perfectly competitive. The first order conditions derived from profit-maximization state that factors are paid to their respective marginal products:

$$1 = W^T, \quad \text{and} \quad P = W^N \tag{115}$$

Dividing the second equality by the first equality leads to a relationship between the relative price of non tradables, P, and the relative wage, $\Omega \equiv W^N/W^T$:

$$P = \Omega. \tag{116}$$

C.3 Short-Run Static Solutions for Consumption and Labor

In this subsection, we compute "short-run static solutions". This terminology refers to solutions of static optimality conditions which are inserted in dynamic optimality conditions in order to analyze the equilibrium dynamics. The term "short-run" refers to first-order conditions, and the term "static" indicates that the solution holds at each instant of time, and thus in the long-run.

Short-Run Static Solutions for Consumption and Labor

We begin with those for consumption and labor supply. Static efficiency conditions (99a) and (99b) can be solved for consumption and labor which of course must hold at any point of time:

$$C = C\left(\bar{\lambda}, P\right), \quad L = L\left(\bar{\lambda}, W^T, W^N\right), \tag{117}$$

with

$$\begin{aligned}
C_{\bar{\lambda}} &= \frac{\partial C}{\partial \bar{\lambda}} = -\sigma_C \frac{C}{\bar{\lambda}} < 0, && (118a)\\
C_P &= \frac{\partial C}{\partial P} = -\alpha_C\sigma_C \frac{C}{P} < 0, && (118b)\\
L_{\bar{\lambda}} &= \frac{\partial L}{\partial \bar{\lambda}} = \sigma_L \frac{L}{\bar{\lambda}} > 0, && (118c)\\
L_{W^T} &= \frac{\partial L}{\partial W^T} = \sigma_L L \frac{\left(1-\alpha_L\right)}{W^T} > 0, && (118d)\\
L_{W^N} &= \frac{\partial L}{\partial W^N} = \sigma_L L \frac{\alpha_L}{W^N} > 0, && (118e)
\end{aligned}$$

where we used the fact that $\frac{\partial W}{\partial W^T}\frac{W^T}{W} = (1-\alpha_L)$ and $\frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L$; σ_C and σ_L correspond to the intertemporal elasticity of substitution for consumption and labor, respectively.

Inserting first the short-run solution for consumption (117), (104) and (105) can be solved for C^T and C^N:

$$C^T = C^T\left(\bar{\lambda}, P\right), \quad C^N = C^N\left(\bar{\lambda}, P\right), \tag{119}$$

where the partial derivatives are

$$\begin{aligned} C^T_{\bar{\lambda}} &= -\sigma_C \frac{C^T}{\bar{\lambda}} < 0, & (120a)\\ C^T_P &= \alpha_C \frac{C^T}{P}\left(\phi - \sigma_C\right) \lesseqgtr 0, & (120b)\\ C^N_{\bar{\lambda}} &= -\sigma_C \frac{C^N}{\bar{\lambda}} < 0, & (120c)\\ C^N_P &= -\frac{C^N}{P}\left[\left(1-\alpha_C\right)\phi + \alpha_C\sigma_C\right] < 0, & (120d)\end{aligned}$$

where we used the fact that $-\frac{P''_C P}{P'_C} = \phi\left(1-\alpha_C\right) > 0$ and $P'_C C = C^N$.

Inserting first the short-run solution for labor (117), into $L^T = \frac{\partial W\left(W^T, W^N\right)}{\partial W^T} L$ and $L^N = \frac{\partial W\left(W^T, W^N\right)}{\partial W^N} L$, we are able to solve for L^T and L^N:

$$L^T = L^T\left(\bar{\lambda}, W^T, W^N\right), \quad L^N = L^N\left(\bar{\lambda}, W^T, W^N\right), \tag{121}$$

where the partial derivatives are

$$\begin{aligned} L^T_{\bar{\lambda}} &= \frac{\partial L^T}{\partial \bar{\lambda}} = \sigma_L \frac{L^T}{\bar{\lambda}} > 0, & (122a)\\ L^T_{W^T} &= \frac{\partial L^T}{\partial W^T} = \frac{L^T}{W^T}\left[\epsilon\alpha_L + \sigma_L\left(1-\alpha_L\right)\right] > 0, & (122b)\\ L^T_{W^N} &= \frac{\partial L^T}{\partial W^N} = \frac{L^T}{W^N}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, & (122c)\\ L^N_{\bar{\lambda}} &= \frac{\partial L^N}{\partial \bar{\lambda}} = \sigma_L \frac{L^N}{\bar{\lambda}} > 0, & (122d)\\ L^N_{W^N} &= \frac{\partial L^N}{\partial W^N} = \frac{L^N}{W^N}\left[\epsilon\left(1-\alpha_L\right) + \sigma_L\alpha_L\right] > 0, & (122e)\\ L^N_{W^T} &= \frac{\partial L^N}{\partial W^T} = \frac{L^N}{W^T}\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \gtrless 0, & (122f)\\ & & (122g)\end{aligned}$$

where we used the fact that $\frac{W_{TT}W^T}{W_T} = \epsilon\alpha_L$, $\frac{W_{TN}W^N}{W_T} = -\epsilon\alpha_L$, $\frac{W_{NN}W^N}{W_N} = \epsilon\left(1-\alpha_L\right)$, $\frac{W_{NT}W^T}{W_N} = -\epsilon\left(1-\alpha_L\right)$.

Short-Run Static Solutions for Sectoral Wages

First order conditions (115) can be solved for the sectoral wages:

$$W^T = \text{constant}, \quad W^N = W^N\left(P\right), \tag{123}$$

where the partial derivative is:

$$W^N_P = \frac{\partial W^N}{\partial P} = 1 = \frac{W^N}{P} > 0. \tag{124}$$

Inserting (123) into (121) yields:

$$L^T = L^T\left(\bar{\lambda}, P\right), \quad L^N = L^N\left(\bar{\lambda}, P\right), \tag{125}$$

where the partial derivatives are

$$\begin{aligned} L^T_P &= \frac{\partial L^T}{\partial P} = L^T_{W^N} W^N_P = \frac{L^T}{P}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, & (126a)\\ L^N_P &= \frac{\partial L^N}{\partial P} = L^N_{W^N} W^N_P = \frac{L^N}{P}\left[\epsilon\left(1-\alpha_L\right) + \sigma_L\alpha_L\right] > 0, & (126b)\end{aligned}$$

and $L^T_{\bar{\lambda}}$ and $L^N_{\bar{\lambda}}$ are given by (122a) and (122d), respectively.

C.4 Market Clearing Conditions

To fully describe the equilibrium, we impose goods market clearing conditions. The non traded good market clearing condition requires that non traded output is equalized with demand for non tradables:

$$Y^N = C^N + G^N. \tag{127}$$

Plugging this condition into the flow budget constraint (98) and using firms' optimal conditions (115) yields the market clearing condition for tradables or the current account equation:

$$\dot{B} = r^{\star} B + Y^T - C^T - G^T, \tag{128}$$

where the sum of the last three terms on the RHS, i.e., $Y^T - C^T - G^T \equiv NX$, corresponds to net exports denoted by NX.

Inserting short-run static solutions for C^N for L^N given by (119) and (125), respectively, into the non traded good market clearing condition (127) gives us:

$$L^N\left(\bar{\lambda}, P\right) = C^N\left(\bar{\lambda}, P\right) + G^N. \tag{129}$$

The non traded good market clearing condition can be solved for the relative price of non tradables by totally differentiating (129):

$$\alpha_L \hat{L}^N = \omega_C \alpha_C \hat{C}^N + \frac{P \mathrm{d} G^N}{Y}, \tag{130}$$

where we denote the ratio of consumption expenditure to GDP by $\omega_C = \frac{P_C C}{Y}$; to determine the LHS of (130), we used the fact that $Y = Y^T + PY^N = W^T L^T + W^N L^N = WL$ because $Y^T = L^T$ and $Y^N = L^N$; since $W^N = P$ together with the definition of α_L given by eq. (111b), we have

$$\frac{PY^N}{Y} = \frac{W^N L^N}{WL} = \alpha_L. \tag{131}$$

Inserting short-run static solutions and collecting terms yield:

$$\hat{P} = \frac{-\hat{\bar{\lambda}}\left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right] + \frac{P \mathrm{d} G^N}{Y}}{\Psi}, \tag{132}$$

where we set

$$\Psi = \alpha_L \left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right] + \omega_C \alpha_C \left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right] > 0. \tag{133}$$

Invoking the implicit functions theorem, eq. (132) leads to the short-run static solution for the relative price of non tradables:

$$P = P\left(\bar{\lambda}, G^N\right), \tag{134}$$

where $P_{\bar{\lambda}} < 0$ and $P_{G^N} > 0$.

C.5 Solutions for Sectoral Labor

Totally differentiating the short-run static solution for traded labor $L^T = L^T\left(\bar{\lambda}, P\right)$ given by (125) yields:

$$\hat{L}^T = \sigma_L \hat{\bar{\lambda}} + \alpha_L \left(\sigma_L - \epsilon\right) \hat{P}.$$

Inserting the short-run static solution for the relative price P given by (134) allows us to solve for traded labor:

$$\hat{L}^T = \frac{\left[\sigma_L \Psi + \alpha_L \left(\epsilon - \sigma_L\right)\left(\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right)\right] \hat{\bar{\lambda}}}{\Psi} + \frac{\alpha_L \left(\sigma_L - \epsilon\right)}{\Psi} \frac{P \mathrm{d} G^N}{Y}. \tag{135}$$

Eq. (135) solves for traded labor:

$$L^T = L^T\left(\bar{\lambda}, G^N\right), \tag{136}$$

where $L^T_{\bar{\lambda}} > 0$, and $L^T_{G^N} < 0$.

Totally differentiating the short-run static solution for traded labor $L^N = L^N\left(\bar{\lambda}, P\right)$ given by (125) leads to:

$$\hat{L}^N = \sigma_L \hat{\bar{\lambda}} + \left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right] \hat{P}.$$

Inserting the short-run static solution for the relative price P given by (134) allows us to solve for non traded labor:

$$\begin{aligned} \hat{L}^N &= \frac{\left\{\sigma_L \Psi - \left(\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right)\left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right]\right\} \hat{\bar{\lambda}}}{\Psi} \\ &+ \frac{\left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right]}{\Psi} \frac{P \mathrm{d} G^N}{Y}, \end{aligned} \tag{137}$$

where

$$\begin{aligned} & \sigma_L \Psi - \left(\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right)\left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right] \\ = \; & \omega_C \alpha_C \left\{\sigma_L\left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right] - \sigma_C\left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right]\right\} \gtrless 0. \end{aligned}$$

Eq. (137) solves for non traded labor:

$$L^N = L^N\left(\bar{\lambda}, G^N\right), \tag{138}$$

where $L^N_{\bar{\lambda}} \gtrless 0$, and $L^N_{G^N} > 0$.

C.6 Equilibrium Dynamics and Formal Solutions

Inserting the short-run static solution for L^T (136) and for C^T (119) into the current account equation (128) yields:

$$\dot{B}(t) = r^{\star} B(t) + L^T\left(\bar{\lambda}, G^N\right) - C^T\left(\bar{\lambda}, P\right) - G^T. \tag{139}$$

Remembering that P is fixed while the shadow value of wealth, λ, may jump when new information arrives but remains fixed over time, i.e., $\lambda = \bar{\lambda}$, and linearizing (139) in the neighborhood of the steady-state leads to:

$$\dot{B}(t) = r^{\star}\left(B(t) - \tilde{B}\right). \tag{140}$$

The general solution is:

$$B(t) = \tilde{B} + D_2 e^{r^{\star} t}, \tag{141}$$

where D_2 is an arbitrary constant determined by initial conditions. Invoking the transversality condition, i.e., $\lim_{t \to \infty} \bar{\lambda} B(t) e^{-r^{\star} t} = 0$, the stable solution is:

$$B(t) = \tilde{B}, \tag{142}$$

and the intertemporal solvency condition (ISC) reads:

$$\tilde{B} = B_0. \tag{143}$$

While a permanent fiscal shock does not affect the net foreign asset position, a temporary fiscal shock, by modifying initial conditions, permanently modifies the stock of foreign assets.

C.7 Steady-State

Inserting the ISC (143) and appropriate short-run static solutions which obviously hold in the long-run, the steady-state can be reduced to one equation

$$r^{\star} B_0 + L^T\left(\bar{\lambda}, G^N\right) - C^T\left[\bar{\lambda}, P\left(\bar{\lambda}, G^N\right)\right] - G^T = 0. \tag{144}$$

Equation (144) can be solved for the marginal utility of wealth:

$$\bar{\lambda} = \lambda \left(G^N, G^T \right). \tag{145}$$

Note that we concentrate below on a rise in government spending on non tradables G^N because empirical evidence indicate that the non-tradable content of public spending averages to 90% for OECD countries. At the end of the section, we investigate the effects of a temporary increase in G^T and show that the predictions of the model, in this configuration, are at odds with the panel VAR evidence.

Using the fact that the stock of traded bonds is initially predetermined and totally differentiating (144) yields:

$$(1-\alpha_L)\, \hat{L}^T = \omega_C (1-\alpha_C)\, \hat{C}^T + \frac{\mathrm{d}G^T}{Y}, \tag{146}$$

where we used the definition of α_L given by eq. (131).

We first solve for consumption in tradables by totally differentiating $C^T \left[\bar{\lambda}, P\left(\bar{\lambda}, G^N \right) \right]$:

$$\hat{C}^T = -\sigma_C \hat{\bar{\lambda}} + \alpha_C (\phi - \sigma_C)\, \hat{P}.$$

Inserting (132) allows us to solve for consumption in tradables:

$$C^T = C^T \left(\bar{\lambda}, G^N \right) \tag{147}$$

where partial derivatives are given by:

$$\hat{C}^T = -\left\{ \frac{\sigma_C \Psi + \alpha_C (\phi - \sigma_C) \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right]}{\Psi} \right\} \hat{\bar{\lambda}} + \frac{\alpha_C (\phi - \sigma_C)}{\Psi} \frac{P \mathrm{d}G^N}{Y}. \tag{148}$$

Plugging $\hat{C}^T = -\sigma_C \hat{\bar{\lambda}} + \alpha_C (\phi - \sigma_C)\, \hat{P}$ and $\hat{L}^T = \sigma_L \hat{\bar{\lambda}} + \alpha_L (\sigma_L - \epsilon)\, \hat{P}$, eq. (146) can be rewritten as follows:

$$\begin{aligned} & \hat{\bar{\lambda}} \left[(1-\alpha_L)\, \sigma_L + \omega_C (1-\alpha_C)\, \sigma_C \right] \\ & + \hat{P} \left[(1-\alpha_L)\, \alpha_L (\sigma_L - \epsilon) - \omega_C (1-\alpha_C)\, \alpha_C (\phi - \sigma_C) \right] = \frac{\mathrm{d}G^T}{Y}. \end{aligned}$$

Inserting (132) into the above equation and collecting terms, the change in the marginal utility of wealth is given by:

$$\hat{\lambda} = \frac{P \mathrm{d}G^N}{Y} \frac{\left[\omega_C (1-\alpha_C)\, \alpha_C (\phi - \sigma_C) + (1-\alpha_L)\, \alpha_L (\epsilon - \sigma_L) \right]}{\Gamma} + \frac{\mathrm{d}G^T}{Y} \frac{\Psi}{\Gamma}, \tag{149}$$

where Ψ is given by (132) and we set

$$\begin{aligned} \Gamma &= \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right] \left[\omega_C (1-\alpha_C)\, \alpha_C (\phi - \sigma_C) + (1-\alpha_L)\, \alpha_L (\epsilon - \sigma_L) \right] \\ &+ \left[(1-\alpha_L)\, \sigma_L + \omega_C (1-\alpha_C)\, \sigma_C \right] \Psi > 0. \end{aligned} \tag{150}$$

C.8 Derivation of Steady-State Solutions

In this subsection, we derive steady-state solutions. The steady-state reduces to two equations:

$$r^\star \tilde{B} + \tilde{L}^T - \tilde{C}^T - G^T = 0, \tag{151a}$$

together with the intertemporal solvency condition

$$\tilde{B} = B_0, \tag{151b}$$

which jointly solve for the stock of traded bonds $\tilde{B}$ and the marginal utility of wealth $\bar{\lambda}$.

We first solve the system (151a) for $\tilde{B}$ as a function of the marginal utility of wealth, $\bar{\lambda}$ and government spending on non tradables G^N and tradables G^T. To do so, substitute solutions for traded labor (135) and for consumption in tradables (147), into the traded good market clearing condition (151a):

$$r^{\star}\tilde{B} + L^{T}\left(\bar{\lambda}, G^{N}\right) - C^{T}\left(\bar{\lambda}, G^{N}\right) - G^{T} = 0. \tag{152}$$

Solving (152) for the steady-state value of B, we are able to express B as a function of the shadow value of wealth and government spending on non tradables, G^{N}, and tradables, G^{T}:

$$\tilde{B} = B\left(\bar{\lambda}, G^{N}, G^{T}\right), \tag{153}$$

with partial derivatives given by:

$$\begin{aligned}
B_{\bar{\lambda}} \equiv \frac{\partial \tilde{B}}{\partial \bar{\lambda}} &= -\frac{\left(L^{T}_{\bar{\lambda}} - C^{T}_{\bar{\lambda}}\right)}{r^{\star}}, \\
&= -\frac{Y}{r^{\star}}\left[(1-\alpha_L)\frac{\hat{L}^{T}}{\hat{\bar{\lambda}}} - \omega_C(1-\alpha_C)\frac{\hat{C}^{T}}{\hat{\bar{\lambda}}}\right]\hat{\bar{\lambda}}, \\
&= -\frac{Y}{r^{\star}\bar{\lambda}}\frac{\Gamma}{\Psi} < 0, \qquad\qquad (154a) \\
B_{G^N} \equiv \frac{\partial \tilde{B}}{\partial G^{N}} &= -\frac{\left(L^{T}_{G^N} - C^{T}_{G^N}\right)}{r^{\star}}, \\
&= -\frac{Y}{r^{\star}}\left[(1-\alpha_L)\frac{L^{T}_{G^N}}{L^{T}} - \omega_C(1-\alpha_C)\frac{C^{T}_{G^N}}{C^{T}}\right], \\
&= \frac{Y}{r^{\star}}\left[\frac{\omega_C(1-\alpha_C)\alpha_C(\phi-\sigma_C) + (1-\alpha_L)\alpha_L(\epsilon-\sigma_L)}{\Psi}\right]\frac{P}{Y} > 0, \qquad (154b)
\end{aligned}$$

where $\Psi > 0$ is given by (132) and $\Gamma > 0$ is given by (150) and we used the fact that $(1-\alpha_L)\frac{\hat{L}^{T}}{\hat{\bar{\lambda}}} - \omega_C(1-\alpha_C)\frac{\hat{C}^{T}}{\hat{\bar{\lambda}}} = \Gamma$.

Inserting (153) into the ISC (151b) yields:

$$B\left(\bar{\lambda}, G^{N}, G^{T}\right) = B_0. \tag{155}$$

Totally differentiating the above equation and collecting terms gives the change in the equilibrium value of the marginal utility of wealth:

$$\begin{aligned}
\left.\frac{\mathrm{d}\bar{\lambda}}{\mathrm{d}G^{N}}\right|_{perm} &= -\frac{B_{G^N}}{B_{\bar{\lambda}}}, \\
&= \frac{\bar{\lambda}\left[\omega_C(1-\alpha_C)\alpha_C(\phi-\sigma_C) + (1-\alpha_L)\alpha_L(\epsilon-\sigma_L)\right]}{\Gamma}\frac{P}{Y},
\end{aligned} \tag{156}$$

where the subscript *perm* refers to the effect of a permanent increase in government consumption.

C.9 Derivation of Steady-State Changes Following a Permanent Government Spending Shock

We now derive the steady-state changes of key macroeconomic variables following an unanticipated and exogenous permanent government spending shock. Inserting the change in the equilibrium value of the marginal utility of wealth given by (149) into (131) gives the steady-state change of the relative price of non tradables:

$$\hat{P} = \frac{\left[(1-\alpha_L)\sigma_L + \omega_C(1-\alpha_C)\sigma_C\right]}{\Gamma}\frac{P\mathrm{d}G^{N}}{Y} - \frac{\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]}{\Gamma}\frac{\mathrm{d}G^{T}}{Y}. \tag{157}$$

Hence, a permanent increase in G^{N} unambiguously appreciates the relative price of non tradables in the long-run while a permanent rise in G^{T} depreciates it.

Totally differentiating (135), inserting the change in the equilibrium value of the marginal utility of wealth given by (149) gives the steady-state change of traded labor:

$$\begin{aligned}
\hat{L}^{T} &= \frac{\omega_C(1-\alpha_C)\left[\alpha_C(\phi-\sigma_C)\sigma_L + \sigma_C\alpha_L(\sigma_L-\epsilon)\right]}{\Gamma}\frac{P\mathrm{d}G^{N}}{Y} \\
&+ \left\{\frac{\sigma_L\alpha_L\epsilon + \omega_C\alpha_C\left\{\sigma_L\left[(1-\alpha_C)\phi + \alpha_C\sigma_C\right] + \sigma_C\alpha_L(\epsilon-\sigma_L)\right\}}{\Gamma}\right\}\frac{\mathrm{d}G^{T}}{Y}.
\end{aligned} \tag{158}$$

In contrast to a model imposing perfect mobility of labor across sectors, traded labor does not necessarily fall. Yet, as shown later, the ratio L^T/L^N unambiguously declines.

Totally differentiating (136), inserting the change in the equilibrium value of the marginal utility of wealth given by (149) gives the steady-state change of non traded labor:

$$\begin{aligned}\hat{L}^N &= \left\{\frac{(1-\alpha_L)\,\sigma_L\epsilon + \omega_C\,(1-\alpha_C)\,\{\sigma_L\alpha_C\,(\phi-\sigma_C)+\sigma_C\,[\epsilon\,(1-\alpha_L)+\sigma_L\alpha_L]\}}{\Gamma}\right\}\frac{P\mathrm{d}G^N}{Y} \\ &- \frac{\omega_C\alpha_C}{\Gamma}\,\{\sigma_C\,[\epsilon\,(1-\alpha_L)+\sigma_L\alpha_L]-\sigma_L\,[(1-\alpha_C)\,\phi+\alpha_C\sigma_C]\}\,\frac{\mathrm{d}G^T}{Y}. \qquad (159)\end{aligned}$$

According to (159), a permanent rise in G^N unambiguously raises L^N in the long-run while a permanent increase in G^T may raise or lower L^N depending on whether the cost of shifting hours worked from one sector to another is high or low.

We now derive the steady-state in the consumption wage W/P_C. To do so, remembering that $W = W\left[W^T, W^N(P)\right]$, using the fact that $\frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L$ and $\frac{\partial W^N}{\partial P}\frac{P}{W^N} = 1$, the steady-state change in the aggregate wage index is:

$$\hat{W} = \alpha_L \hat{P} > 0, \qquad (160)$$

where $\hat{P}$ is given by (157). Moreover, the change in the consumption price index is given by $\hat{P}_C = \alpha_C\hat{P}$. Hence, using (160), the change in the consumption aggregate wage is given by:

$$\mathrm{d}\left(\frac{W}{P_C}\right) = \frac{W}{P_C}\,(\alpha_L-\alpha_C)\,\hat{P} > 0, \qquad (161)$$

where the sign follows from the fact that data indicate that $\alpha_L > \alpha_C$, i.e., the non tradable content of labor income is larger that the non tradable content of consumption expenditure.

C.10 Derivation of Formal Solutions after Temporary Fiscal Shocks

In thus subsection, we determine the solutions following a temporary fiscal expansion. In order to produce a hump-shaped response in line with the evidence, the endogenous response of government spending to an exogenous fiscal shocks is assumed to be governed by the following dynamic equation:

$$\frac{dG(t)}{Y} \equiv \frac{G(t)-\tilde{G}}{Y} = \left[e^{-\xi t} - (1-g)\,e^{-\chi t}\right], \qquad (162)$$

where Y is initial steady-state GDP, ξ and χ are positive parameters which satisfy the following inequality

$$\chi\,(1-g) > \xi > 0. \qquad (163)$$

Inequality (163) guarantees that government spending rises after its initial upward jump. Because the non tradable content of government spending averages 90% for the 15 OECD countries in our sample and thus changes in public expenditure are mostly reflected by changes in purchases of non tradables by the public sector, we further assume that the rise in government consumption is fully biased toward non tradables; in linearized form, we have:

$$\tilde{P}\left(G^N(t)-\tilde{G}^N\right) = G(t)-\tilde{G}, \qquad (164)$$

where we denote the long-term values with a tilde. In the quantitative analysis, we relax this assumption and consider a rise in government spending by 1 percentage point of GDP which is split between non tradables and tradables in accordance with their respective shares, at 90% and 10%, respectively.

Solution for the Net Foreign Asset Position $B(t)$

To begin with, we linearize the current account equation (139) in the neighborhood of the steady-state:

$$\dot{B}(t) = r^\star\left(B(t)-\tilde{B}\right) + \left(L^T_P - C^T_P\right)P_{G^N}\left(G^N(t)-\tilde{G}^N\right). \qquad (165)$$

Inserting $L_P^T = \frac{L^T}{P}\alpha_L(\sigma_L - \epsilon)$ (see eq. (126a)) and $\frac{C^T}{P}\alpha_C(\phi - \sigma_C)$ (see eq. (120b)), eq. (165) can be rewritten as follows:

$$\begin{aligned}\dot{B}(t) &= r^\star\left(B(t) - \tilde{B}\right) + \left[\tilde{L}^T\alpha_L(\sigma_L - \epsilon) - \tilde{C}^T\alpha_C(\phi - \sigma_C)\right]\frac{P_G^N}{P}\left(G^N(t) - \tilde{G}^N\right), \\ &= r^\star\left(B(t) - \tilde{B}\right) - \left[(1-\alpha_L)\alpha_L(\epsilon - \sigma_L) + (1-\alpha_C)\omega_C\alpha_C(\phi - \sigma_C)\right]\frac{\tilde{P}}{\Psi}\left(G^N(t) - \tilde{G}^N\right), \\ &= r^\star\left(B(t) - \tilde{B}\right) - \frac{\left[(1-\alpha_L)\alpha_L(\epsilon - \sigma_L) + (1-\alpha_C)\omega_C\alpha_C(\phi - \sigma_C)\right]}{\Psi}\left(G(t) - \tilde{G}\right), \quad (166)\end{aligned}$$

where $1-\alpha_L = \frac{W^T L^T}{WL} = \frac{L^T}{Y}$ (with $Y = Y^T + PY^N = W^T L^T + W^N L^N = WL$ and $W^T = 1$), we substituted $\frac{P_{GN}}{P} = \frac{\partial P}{\partial G^N}\frac{1}{P} = \frac{P}{Y}\frac{1}{\Psi}$ to obtain the second line and we used the fact that $dG^N(t) = \frac{dG(t)}{\tilde{P}}$ to get the third line. As long as $\epsilon > \sigma_L$ and $\phi \simeq \sigma_C$, a rise in government spending above trend tends to affect negatively the net foreign asset position.

Eq. (166) can be rewritten in a more compact form

$$\dot{B}(t) = r^\star\left(B(t) - \tilde{B}\right) - \Upsilon_G Y\left[e^{-\xi t} - (1-g)e^{-\chi t}\right], \quad (167)$$

where we have inserted (162) and set

$$\Upsilon_G \equiv -\frac{\partial \dot{B}(t)}{\partial G(t)} = \frac{\left[(1-\alpha_L)\alpha_L(\epsilon - \sigma_L) + (1-\alpha_C)\omega_C\alpha_C(\phi - \sigma_C)\right]}{\Psi} \gtrless 0. \quad (168)$$

Pre-multiplying by $e^{-r^\star\tau}$ and integrating over $(0,t)$ allow us to obtain the general solution for $B(t)$:

$$B(t) - \tilde{B} = \left[\left(B_0 - \tilde{B}\right) - \frac{\Upsilon_G Y}{\xi + r^\star}\left(1 - \Theta'\right)\right]e^{r^\star t} + \frac{\Upsilon_G Y}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right), \quad (169)$$

where we used the fact that $\int_0^t e^{-(\xi + r^\star)\tau}d\tau = \frac{\left(1 - e^{-(\xi + r^\star)t}\right)}{\xi + r^\star}$ and we set:

$$\Theta' = (1-g)\frac{\xi + r^\star}{\chi + r^\star} > 0. \quad (170)$$

Invoking the transversality condition, one obtains the 'stable' solution for the stock of foreign assets so that $B(t)$ converges toward its steady-state value $\tilde{B}$:

$$B(t) - \tilde{B} = \frac{\Upsilon_G Y}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right). \quad (171)$$

Eq. (169) gives the trajectory for for $B(t)$ consistent with the intertemporal solvency condition:

$$\left(\tilde{B} - B_0\right) = -\frac{\Upsilon_G Y}{\xi + r^\star}\left(1 - \Theta'\right), \quad (172)$$

where $1 - \Theta' > 0$ due to inequality (163). While the sign of Υ_G is ambiguous, we expect $\Upsilon_G > 0$ so that a temporary rise in government spending deteriorates the net foreign asset position, i.e., $d\tilde{B} < 0$. More specifically, invoking assumption 1, we have $\Upsilon_G > 0$ (see eq. (168)) as long as $\phi \simeq \sigma_C$; in other words, a rise in government consumption produces a decline in hours worked in the traded sector while consumption in tradables is merely affected.

Eq. (171) can be rewritten as follows:

$$B(t) - \tilde{B} = \Upsilon_G \int_t^\infty dG(\tau)e^{-r^\star(\tau - t)}d\tau, \quad (173)$$

where $\int_t^\infty dG(\tau)e^{-r^\star(\tau - t)}d\tau$ corresponds to the temporal path for government spending expressed in present value terms:

$$\begin{aligned}\int_t^\infty dG(\tau)e^{-r^\star(\tau - t)}d\tau &= \frac{Y e^{r^\star t}}{\xi + r^\star}\left[e^{-(\xi + r^\star)t} - \Theta' e^{-(\chi + r^\star)t}\right], \\ &= \frac{Y}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right). \quad (174)\end{aligned}$$

Differentiating (171) w.r.t. time gives the trajectory for the current account along the transitional path when government spending follows the temporal path given by eq. (162):

$$\dot{B}(t) = -\frac{\Upsilon_G Y}{\xi + r^\star}\left(\xi e^{-\xi t} - \chi\Theta' e^{-\chi t}\right). \tag{175}$$

As long as we impose assumption 1 along with $\phi \simeq \sigma_C$, we have $\Upsilon_G > 0$, so that the current account deteriorates monotonically since $\left(\xi e^{-\xi t} - \chi\Theta' e^{-\chi t}\right) > 0$ for $t \geq 0$.

Evaluating (175) at time $t = 0$ leads to the initial current account response, expressed as a percentage of initial GDP, following a temporary rise in government spending:

$$\left.\frac{\dot{B}(0)}{Y}\right|_{temp} = -\frac{\Upsilon_G}{\xi + r^\star}\left(\xi - \chi\Theta'\right) < 0, \tag{176}$$

where $\Upsilon_G > 0$ and $(\xi - \chi\Theta') > 0$. Note that $-[\xi - (1-g)\chi] > 0$ guarantees that government spending increases after initial rise $dG(0)$, i.e., $\dot{G}(0) > 0$, inequality $(\xi - \chi\Theta') > 0$ implies that the cumulative endogenous response of government spending to an exogenous fiscal shock is decreasing in present discounted value terms.

The Change in the Equilibrium Value of the Marginal Utility of Wealth

Eq. (172) gives the steady-state change in the foreign asset position following a temporary (denoted by the subscript *temp*) rise in government spending:

$$\left. d\tilde{B}\right|_{temp} = -\frac{\Upsilon_G Y}{\xi + r^\star}\left(1 - \Theta'\right) < 0. \tag{177}$$

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition for the traded good (152):

$$r^\star \left. d\tilde{B}\right|_{temp} + \left(L^T_\lambda - C^T_\lambda\right) \left. d\bar{\lambda}\right|_{temp} = 0.$$

Expressing the equation above in rate of change and dividing by initial GDP leads to:

$$\left.\frac{r^\star d\tilde{B}}{Y}\right|_{temp} + \left((1-\alpha_L)\frac{\hat{L}^T}{\hat{\bar{\lambda}}} - (1-\alpha_C)\,\omega_C\frac{\hat{C}^T}{\hat{\bar{\lambda}}}\right)\left.\frac{d\bar{\lambda}}{\bar{\lambda}}\right|_{temp} = 0, \tag{178}$$

where

$$\begin{aligned}
& (1-\alpha_L)\frac{\hat{L}^T}{\hat{\bar{\lambda}}} - \frac{\hat{C}^T}{\hat{\bar{\lambda}}} \\
= \; & \frac{(1-\alpha_L)}{\Psi}\left\{\sigma_L\Psi + \alpha_L(\epsilon - \sigma_L)\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\right\} \\
+ \; & \frac{(1-\alpha_C)\,\omega_C}{\Psi}\left\{\sigma_C\Psi + \alpha_C(\phi - \sigma_C)\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\right\} \\
= \; & \frac{\Gamma}{\Psi} > 0,
\end{aligned} \tag{179}$$

with $\Psi > 0$ given by (132) and $\Gamma > 0$ by (150). Using (179), eq. (178) can be rewritten as follows:

$$\begin{aligned}
\left.\frac{d\bar{\lambda}}{\bar{\lambda}}\right|_{temp} &= -\frac{\Psi}{\Gamma}\left.\frac{r^\star d\tilde{B}}{Y_0}\right|_{temp}, \\
&= \frac{\Psi}{\Gamma}\frac{r^\star}{\xi + r^\star}\Upsilon_G\left(1 - \Theta'\right), \\
&= \frac{\left[(1-\alpha_C)\,\omega_C\alpha_C(\phi - \sigma_C) + (1-\alpha_L)\,\alpha_L(\epsilon - \sigma_L)\right]}{\Gamma}\frac{r^\star}{\xi + r^\star}\left(1 - \Theta'\right),
\end{aligned} \tag{180}$$

where we have substituted the steady-state change $\left. d\tilde{B}\right|_{temp}$ given by (177) and Υ_G given by(168). Since the marginal utility of wealth increases across all scenarios, we impose from now on the following condition:

$$(1-\alpha_C)\,\omega_C\alpha_C(\phi - \sigma_C) + (1-\alpha_L)\,\alpha_L(\epsilon - \sigma_L) > 0. \tag{181}$$

Importantly, following a temporary fiscal shock, the marginal utility of wealth increases less than after a permanent rise in G^N.

Steady-State Effects

To determine the long-run effects of a temporary fiscal expansion, we approximate the steady-state changes for variable $X = L, C, P, L^T, L^N, B$ with the differentials:

$$\tilde{X} - \tilde{X}_0 \equiv X\left(\bar{\lambda}, G^N\right) - X\left(\lambda_0, G^N\right) = X_{\bar{\lambda}} \mathrm{d}\bar{\lambda}\Big|_{temp}, \tag{182}$$

where $\mathrm{d}\bar{\lambda}\Big|_{temp} \equiv \bar{\lambda} - \lambda_0$ given by eq. (180), and $dG^N = 0$ since government spending is restored to its initial level; note that λ_0 is the initial steady-state value for the shadow value of wealth.

Using the fact that $P = P\left(\bar{\lambda}, G^N\right)$ and because government spending is restored to its initial level, the relative price of non tradables must depreciate in the long-run:

$$\hat{P}\Big|_{temp} = -\frac{\left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right]}{\Psi} \hat{\bar{\lambda}}\Big|_{temp} < 0, \tag{183}$$

where we made use of (131) and $\hat{\bar{\lambda}}\Big|_{temp}$ is given by (180).

Totally differentiating $L^N = L^N\left(\bar{\lambda}, G^N\right)$ described by eq. (138), using the fact that $dG^N = 0$, and inserting (183) leads to the long-run adjustment of non traded employment following a temporary fiscal expansion:

$$\hat{L}^N\Big|_{temp} = \frac{\omega_C \alpha_C \left\{\sigma_L \left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right] - \sigma_C \left[\epsilon\left(1-\alpha_L\right) + \sigma_L \alpha_L\right]\right\}}{\Psi} \hat{\bar{\lambda}}\Big|_{temp}. \tag{184}$$

On the one hand, the rise in the marginal utility of wealth has an expansionary effect on labor supply and thus on employment in the non traded sector. On the other hand, by driving down consumption in non tradables, the wealth effect depreciates the relative price of non tradables which lowers the non traded wage and thus exerts a negative impact on L^N.

Totally differentiating $L^T = L^T\left(\bar{\lambda}, G^N\right)$ described by eq. (136), using the fact that $dG^N = 0$, and inserting (183) leads to the long-run adjustment of traded employment following a temporary fiscal expansion:

$$\hat{L}^T\Big|_{temp} = \frac{\sigma_L \alpha_L \epsilon + \omega_C \alpha_C \left\{\sigma_L \left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right] + \sigma_C \alpha_L \left(\epsilon - \sigma_L\right)\right\}}{\Psi} \hat{\bar{\lambda}}\Big|_{temp}. \tag{185}$$

The combined effect of the rise in the marginal utility of wealth and the depreciation in the relative price of non tradables raises employment in the traded sector. It is worthwhile noticing that (185) is unambiguously positive.

Denoting by NX net exports, differentiating the market clearing condition for the traded good in the long-run, i.e., $r^\star \tilde{B} + \tilde{NX} = 0$ and inserting (177) leads to the steady-state change in net exports expressed in percentage of initial GDP:

$$\frac{d\tilde{NX}|_{temp}}{Y} = -\frac{r^\star d\tilde{B}|_{temp}}{Y} = \frac{r^\star \Upsilon_G}{\xi + r^\star}\left(1 - \Theta'\right) > 0, \tag{186}$$

where $\Upsilon_G > 0$. In the long-run, a temporary fiscal expansion raises net exports. The reason is that the open economy decumulates traded bonds along the transitional path. To repay its debt, the economy must run a trade surplus.

Consumption unambiguously falls in the long-run:

$$\begin{aligned} \hat{C}\Big|_{temp} &= -\sigma_C \hat{\bar{\lambda}}\Big|_{temp} - \sigma_C \alpha_C \hat{P}\Big|_{temp}, \\ &= -\frac{\sigma_C \hat{\bar{\lambda}}|_{temp} \left\{\alpha_L \left[\left(1-\alpha_L\right)\epsilon + \sigma_L \left(\alpha_L - \alpha_C\right)\right] + \omega_C \alpha_C \left(1-\alpha_C\right)\phi\right\}}{\Psi} < 0, \end{aligned} \tag{187}$$

where the non tradable content of labor, α_L, is higher than the non tradable content of consumption expenditure, α_L, according to our evidence.

Using the fact that $\hat{W} = \alpha_L \hat{W}^N$ and $\hat{P}_C = \alpha_C \hat{P}$, a temporary fiscal expansion raises employment in the long-run:

$$\begin{aligned}\hat{L}\Big|_{temp} &= \sigma_L \hat{\bar{\lambda}}\Big|_{temp} + \sigma_L \alpha_L \hat{P}\Big|_{temp}, \\ &= \frac{\sigma_L \left\{\alpha_L \epsilon \left(1-\alpha_L\right) + \omega_C \alpha_C \left[\left(1-\alpha_C\right)\phi - \sigma_C \left(\alpha_L - \alpha_C\right)\right]\right\}}{\Psi} > 0. \end{aligned} \tag{188}$$

A temporary fiscal expansion unambiguously lowers the real consumption wage in the long-run:

$$\mathrm{d}\left(\frac{W}{P_C}\right)|_{temp} = \frac{W}{P_C}\left(\alpha_L - \alpha_C\right)\hat{P}|_{temp} < 0. \tag{189}$$

Since data indicate that $\alpha_L > \alpha_C$, the long-run depreciation in the relative price of non tradables drives down the real consumption wage.

Initial Responses of Sectoral Variables

To determine the initial reaction of selected variables, we linearize the short-run static solution of variable $X(t)$, i.e., $X(t) = X\left(\bar{\lambda}, G^N(t)\right)$, in the neighborhood of the steady-state:

$$X(t) - \tilde{X} = X_{G^N}\left(G^N(t) - \tilde{G}^N\right), \tag{190}$$

and evaluate its initial reaction relative to its initial steady-state value:

$$dX(0) \equiv X(0) - \tilde{X}_0 = \tilde{X} - \tilde{X}_0 + X_{G^N} dG^N(0). \tag{191}$$

Because a temporary fiscal expansion has long-run effects, variables are affected by (indirectly) the change in the shadow value of wealth $\bar{\lambda}$, as captured by $\tilde{X} - \tilde{X}_0$, and directly by the change in government spending G^N, as captured by $dG^N(0)$.

Since we are interested in responses of key macroeconomic variables in the short-run, we analyze the reactions of macroeconomic variables on impact. We first explore the response of the price of non traded goods in terms of traded goods. Evaluating (131) at time $t = 0$ yields the initial response of the relative price of non tradables:

$$\begin{aligned}\hat{P}(0)\big|_{temp} &= -\frac{\left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right]}{\Psi}\hat{\bar{\lambda}}\Big|_{temp} + \frac{1}{\Psi}\frac{P\mathrm{d}G^N(0)}{Y}, \\ &= -\frac{\left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right]}{\Psi}\hat{\bar{\lambda}}\Big|_{temp} + \frac{g}{\Psi} > \hat{P}(0)\big|_{perm} > 0, \end{aligned} \tag{192}$$

where $\Psi > 0$ and we used the fact that:

$$\frac{PdG^N(0)}{Y} = \frac{dG(0)}{Y} = 1 - (1-g) = g > 0. \tag{193}$$

Because the rise in the marginal utility of wealth is smaller after a temporary fiscal shock than after a permanent rise in G^N, i.e., $0 < \hat{\bar{\lambda}}|_{temp} < \hat{\bar{\lambda}}|_{perm}$, P increases more on impact after a temporary shock than after a permanent shock. Intuitively, as the wealth effect is smaller when the fiscal shock is temporary, consumption in non tradables falls less which in turn triggers a larger excess demand in the non traded goods market, thus causing the relative price of non tradables to appreciate more.

Using the fact that $\mathrm{d}L^N(t) = L^N(t) - \tilde{L}_0^N = L^N\left(\bar{\lambda}, G^N(t)\right) - L^N\left(\lambda_0, G_0^N\right)$ with $dG(t) = G(t) - G_0^N = 0$ and totally differentiating the short-run solution for non traded labor described by eq. (138), one obtains the initial response of non traded labor following an exogenous increase in government consumption:

$$\hat{L}^N(0)\Big|_{temp} = \frac{\partial L^N}{\partial \bar{\lambda}}\frac{\bar{\lambda}}{\tilde{L}^N}\hat{\bar{\lambda}}\Big|_{temp} + L^N_{G^N} dG^N(0) > 0. \tag{194}$$

While $L^N_{G^N} > 0$, the sign of $L^N_{\bar{\lambda}}$ can be positive or negative. If $L^N_{\bar{\lambda}} < 0$, because the marginal utility of wealth increases less after a temporary rise in G^N than after a permanent increase in G^N, the negative impact on L^N produced by the wealth effect (which reduces C^N) is smaller. Remembering that L^N rises after a permanent fiscal shock, we can infer from this that non traded labor increases more following a temporary fiscal shock. If $L^N_{\bar{\lambda}} > 0$, non traded labor increases less after a temporary shock than after a permanent shock.

Using (137), the change in non traded labor in the short-run following a temporary fiscal shock can be written as follows:

$$\begin{aligned}\hat{L}^N(0)\Big|_{temp} &= \hat{\bar{\lambda}}\Big|_{temp}\left\{\frac{\omega_C\alpha_C\left\{\sigma_L\left[(1-\alpha_C)\,\phi+\alpha_C\sigma_C\right]-\sigma_C\left[\epsilon\,(1-\alpha_L)+\sigma_L\alpha_L\right]\right\}}{\Psi}\right\} \\ &+ \frac{\left[\epsilon\,(1-\alpha_L)+\sigma_L\alpha_L\right]}{\Psi}\frac{P\mathrm{d}G^N}{Y}. \qquad (195)\end{aligned}$$

Because $\hat{L}^N = \sigma_L\hat{\bar{\lambda}}\big|_{temp} + \left[\epsilon\,(1-\alpha_L)+\alpha_L\sigma_L\right]\hat{P}\big|_{temp}$ where $\hat{\bar{\lambda}}\big|_{temp} > 0$ (see eq. (169)) together with condition (181)) and $\hat{P}\big|_{temp} > 0$ (see eq. (192)), non traded labor unambiguously increases on impact after a temporary rise in G^N. Intuitively, the negative wealth effect induces households to supply more labor while the appreciation in the relative price of non tradables pushes up the non traded wage W^N which encourages workers to shift hours worked toward the non traded sector.

Totally differentiating $L^T = L^T\left(\bar{\lambda}, P\right)$ and inserting the solution for the relative price given by (134), the initial reaction of L^T following a temporary fiscal expansion can be written as follows:

$$\begin{aligned}\hat{L}^T(0)\Big|_{temp} &= \sigma_L\hat{\bar{\lambda}}\Big|_{temp} + \alpha_L\left(\sigma_L-\epsilon\right)\hat{P}\Big|_{temp}, \\ &= \frac{\Psi\sigma_L+\alpha_L\left(\epsilon-\sigma_L\right)\left[\alpha_L\sigma_L+\omega_C\alpha_C\sigma_C\right]}{\Psi}\hat{\bar{\lambda}}\Big|_{temp} - \frac{\alpha_L\left(\epsilon-\sigma_L\right)g}{\Psi} \lessgtr 0, \qquad (196)\end{aligned}$$

where $\Psi > 0$ (see eq. (132)), $\hat{\bar{\lambda}}\big|_{temp} > 0$ is given by (180), and we used the fact that $\frac{PdG^N(0)}{Y} = g$ (see eq. (193)) to determine (173). Using the fact that $\hat{L}^T = \sigma_L\hat{\bar{\lambda}}\big|_{temp} + \alpha_L\left(\sigma_L-\epsilon\right)\hat{P}\big|_{temp}$, because both the shadow value of wealth $\bar{\lambda}$ and the relative price of non tradables P increase, we find that a rise in G^N raises L^T if $\sigma_L > \epsilon$, i.e., if labor is weakly mobile across sectors. Conversely, setting assumption 1, i.e., $\sigma_L < \epsilon$, traded labor falls because the cost of shifting hours worked from one sector to another is low enough.

Differentiating the short-run change in the real consumption wage, and using the fact that $\hat{W}^T = 0$, $\hat{W} = \alpha_L\hat{W}^N$ and $\hat{P}_C = \alpha_C\hat{P}$, yields:

$$\mathrm{d}\left(\frac{W}{P_C}\right)(0)\Big|_{temp} = \frac{W}{P_C}\left(\alpha_L-\alpha_C\right)\hat{P}(0)\Big|_{temp} > 0. \qquad (197)$$

Because P appreciates more after a temporary fiscal shock, the real consumption aggregate wage will increase by a larger amount than after a permanent fiscal shock.

C.11 Steady-State Effects of a Temporary Government Spending Shock: Graphical Apparatus

We characterize the equilibrium graphically which allows us to build up intuition on the long-run effects of a temporary rise in G^N. Because we focus on steady-state, we omit the tilde below for simplicity purposes when it does not cause confusion.

C.11.1 The Initial Steady-State

We denote by $NX = Y^T - C^T - G^T$ net exports. Hence, in the long-run, we have $r^\star B = -NX$. Dividing both sides by Y^T, we have: $\upsilon_B = -\upsilon_{NX}$. The initial equilibrium is thus defined by the following set of equations:

$$\begin{aligned}\left(\frac{1-\varphi}{\varphi}\right)\frac{C^T}{C^N} &= P^\phi, &(198a)\\ \left(\frac{1-\vartheta}{\vartheta}\right)\frac{L^T}{L^N} &= \Omega^{-\epsilon} &(198b)\\ P &= \Omega, &(198c)\\ \frac{Y^T\left(1-\upsilon_{NX}-\upsilon_{G^T}\right)}{Y^N\left(1-\upsilon_{G^N}\right)} &= \frac{C^T}{C^N}, &(198d)\end{aligned}$$

where $Y^T = L^T$, $Y^N = L^N$, $\Omega \equiv W^N/W^T$ is the ratio of the non traded wage to the traded wage ratio or the relative wage, and we denote by $\upsilon_{NX} \equiv NX/Y^T$ the ratio of net exports to traded output, and $\upsilon_{G^j} \equiv G^j/Y^j$ the ratio of government spending on good $j = T, N$ to output of sector $j = T, N$.

C.11.2 Graphical Apparatus

To build up intuition, we characterize the equilibrium graphically. We denote the logarithm of variables with lower-case letters. The steady state can be described by considering alternatively the goods market or the labor market.

Goods Market Equilibrium- and Labor Market Equilibrium-Schedules

The steady-state (198) can be summarized graphically in Figure 5 that traces out two schedules in the $(y^T - y^N, p)$-space. System (198a)-(198d) described above can be reduced to two equations. Substituting (198a) into eq. (198d) yields the goods market equilibrium (henceforth labelled GME) schedule:

$$\left(y^T - y^N\right)\Big|^{GME} = \phi p + \ln\left(\frac{1-\upsilon_{G^N}}{1-\upsilon_{NX}-\upsilon_{G^T}}\right) + x, \tag{199}$$

where $x = \ln\left(\frac{\varphi}{1-\varphi}\right)$. Since a rise in the relative price p raises consumption in tradables, the goods market equilibrium requires a rise in the traded output relative to non traded output. Hence the goods market equilibrium is upward-sloping in the $(y^T - y^N, p)$-space where the slope is equal to $1/\phi$.

Substituting (198b) into (198c) to eliminate ω yields the labor market equilibrium (henceforth LME) schedule:

$$\left(y^T - y^N\right)\Big|^{LME} = -\epsilon p + z, \tag{200}$$

where $z = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. A rise in the relative price p increases the relative wage ω which encourages agents to supply more labor in the non traded sector, and all the more so as the values of ϵ are higher. Hence the labor market equilibrium is downward-sloping in the $(y^T - y^N, p)$-space where the slope is equal to $-1/\epsilon$. Assuming that the shift of labor across sectors is costless, i.e., if we let ϵ tend toward infinity, wages are equalized across sectors. Graphically, the LME-schedule becomes a horizontal line. Conversely, as long as switching hours worked from one sector to another is costly, i.e., if ϵ takes finite values, the LME-schedule is negatively related to the relative price of non tradables in the $(y^T - y^N, p)$-space.

Labor Demand- and Labor Supply-Schedules

The steady-state (198) can be summarized graphically by focusing alternatively on the labor market. Eq. (198b) describes the labor supply-schedule (LS henceforth) in the $(l^T - l^N, \omega)$-space. Taking logarithm yields:

$$\left(l^T - l^N\right)\Big|^{LS} = -\epsilon\omega + z, \tag{201}$$

where $z = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. A rise in the non traded wage-traded wage ratio ω provides an incentive to shift labor supply from the traded sector towards the non traded sector. Hence the LS-schedule is downward-sloping in the $(l^T - l^N, \omega)$-space where the slope is equal to $-1/\epsilon$.

Inserting demand for traded goods in terms of non traded goods (198a) into the market clearing condition given by (198d) yields:

$$\frac{\tilde{Y}^T}{\tilde{Y}^N} = \left(\frac{\varphi}{1-\varphi}\right) P^\phi \left(\frac{1-\upsilon_{G^N}}{1-\upsilon_{NX}-\upsilon_{G^T}}\right). \tag{202}$$

Substituting first-order conditions from the firms' maximization problem and using production functions, i.e. $L^T = Y^T$ and $L^N = Y^N$, we get:

$$\frac{L^T}{L^N} = \left(\frac{\varphi}{1-\varphi}\right) \Omega^\phi \left(\frac{1-\upsilon_{G^N}}{1-\upsilon_{NX}-\upsilon_{G^T}}\right).$$

Taking logarithm yields the labor demand-schedule (LD henceforth) in the $(l^T - l^N, \omega)$-space is given by

$$\left(l^T - l^N\right)\Big|^{LD} = \phi\omega + \ln\left(\frac{1 - \upsilon_{G^N}}{1 - \upsilon_{NX} - \upsilon_{G^T}}\right) + x, \tag{203}$$

where $x = \ln\left(\frac{\varphi}{1-\varphi}\right)$. A rise in the relative wage ω raises the cost of labor in the non traded sector relative to the traded sector. To compensate for the increased labor cost, non traded firms charge prices which encourage agents to substitute traded for non traded goods and therefore produces an expansionary effect on labor demand in the traded sector. Hence the LD-schedule is upward-sloping in the $(l^T - l^N, \omega)$-space where the slope is equal to $1/\phi$.

In order to facilitate the interpretation of analytical results, it is useful to rewrite $\ln\left(\frac{1-\upsilon_{G^N}}{1+\upsilon_B-\upsilon_{G^T}}\right)$ by using a first-order Taylor approximation which implies:

$$\ln\left(1 - \upsilon_{NX} - \upsilon_{G^T}\right) - \ln\left(1 - \upsilon_{G^N}\right) \simeq -\upsilon_{NX} - \upsilon_{G^T} + \upsilon_{G^N}. \tag{204}$$

C.11.3 Long-Run Adjustments in the Relative Price and Relative Wage

We now analyze graphically and analytically the consequences on the relative price and the relative wage of a temporary increase in G^N. The initial long-run equilibrium is represented at E_0 in Figure 5. The long-run equilibrium is defined by the the system of equations (198).

Equating (199) and (200), differentiating and denoting by a hat the deviation in percentage from initial steady state, one obtains the long-run adjustment in the relative price of non tradables to an exogenous temporary rise in government consumption on non tradables:

$$\hat{p} = -\frac{\mathrm{d}\upsilon_{NX}}{\phi + \epsilon} < 0, \tag{205}$$

where we made use of the approximation given by (204) and $\mathrm{d}\upsilon_{NX} \equiv \frac{r^\star NX_1}{Y_1^T} - \frac{r^\star NX_0}{Y_0^T} > 0$ and $\mathrm{d}\upsilon_{G^N} = 0$. By raising net exports and thus the demand for tradables in the long-run, a temporary increase in government spending depreciates the relative price of non tradables.

Equating (201) and (203), differentiating and denoting by a hat the deviation from initial steady state in percentage terms, one obtains the long-run adjustment in the relative wage to an exogenous temporary rise in government consumption on non tradables:

$$\hat{\omega} = -\frac{\mathrm{d}\upsilon_{NX}}{\phi + \epsilon} < 0, \tag{206}$$

where we made use of the approximation given by (204); by raising net exports in the long-run, a rise in G^N shifts the LD-schedule to the right in the $(l^T - l^N, \omega)$-space and thus a temporary rise in G^N permanently lowers the non traded wage relative to the traded wage.

C.12 Solving the Model with Perfect Mobility of Labor across Sectors

In this subsection, we provide analytical results when assuming perfect mobility of labor across sectors. If we let ϵ tend toward infinity into eq. (96), hours worked across sectors become perfect substitutes:

$$L = L^T + L^N. \tag{207}$$

Because workers no longer experience a cost when shifting from one sector to another, hours worked in the traded and the non traded sector are perfect substitutes. Since workers are willing to devote their whole time to the sector that pays the highest wages, firms in both sectors must pay the same wage. Hence, $1 = W^T = W^N$. The wage equalization across sectors implies that $P = 1$. As a result, the relative price of non tradables remains unaffected by a government spending shock.

Inserting short-run static solutions for C^N given by (119) into the non-traded good market clearing condition gives us:

$$L^N = C^N\left(\bar{\lambda}, P\right) + G^N. \tag{208}$$

The non-traded good market clearing condition can be solved for non traded labor

$$L^N = L^N\left(\bar{\lambda}, G^N\right), \tag{209}$$

where partial derivatives are obtained by totally differentiating (208):

$$\hat{L}^N = -\frac{\omega_C \alpha_C \sigma_C}{\alpha_L}\hat{\bar{\lambda}} + \frac{1}{\alpha_L}\frac{P\mathrm{d}G^N}{Y}, \tag{210}$$

with the ratio of consumption expenditure to GDP denoted by $\omega_C = \frac{P_C C}{Y}$, and the non tradable content of GDP denoted by $\alpha_L = \frac{PY^N}{Y} = \frac{L^N}{L}$.

Inserting the short-run static solution for non traded labor (209) and the short-run static solution for aggregate labor supply given by

$$L = L\left(\bar{\lambda}\right), \quad \hat{L} = \sigma_L \hat{\bar{\lambda}}, \tag{211}$$

the resource constraint for labor given by (207) can be solved for traded labor:

$$L^T = L^T\left(\bar{\lambda}, G^N\right), \tag{212}$$

where partial derivatives are obtained by totally differentiating the resource constraint for labor given by (207):

$$\left(1-\alpha_L\right)\hat{L}^T = \sigma_L \hat{\bar{\lambda}} - \alpha_L \hat{L}^N.$$

Inserting the solution for non traded labor expressed in rate of change (210) allows us to solve for traded labor:

$$\left(1-\alpha_L\right)\hat{L}^T = \left(\sigma_L + \omega_C \alpha_C \sigma_C\right)\hat{\bar{\lambda}} - \frac{P\mathrm{d}G^N}{Y}. \tag{213}$$

Effects of a Permanent Rise in Government Spending

Inserting (212) into the current account equation, linearizing and solving yields the intertemporal solvency condition (ISC):

$$\tilde{B} = B_0. \tag{214}$$

Inserting the ISC (214) and appropriate short-run static solutions which obviously hold in the long-run, the steady-state can be reduced to one equation:

$$r^\star B_0 + L^T\left(\bar{\lambda}, G^N\right) - C^T\left(\bar{\lambda}, P\right) - G^T = 0, \tag{215}$$

where P remains constant. Equation (215) can be solved for the marginal utility of wealth:

$$\bar{\lambda} = \lambda\left(G^N, G^T\right). \tag{216}$$

Note that we concentrate below on a rise in government spending on non tradables G^N because empirical evidence indicate that the non-tradable content of public spending averages to 90% for OECD countries. Using the fact that the stock of traded bonds is initially predetermined and totally differentiating (215) yields:

$$\left(1-\alpha_L\right)\hat{L}^T = \omega_C\left(1-\alpha_C\right)\hat{C}^T + \frac{\mathrm{d}G^T}{Y}.$$

Inserting (213) and using the fact that P remains unaffected by a fiscal expansion, the change in the equilibrium value of the marginal utility of wealth is:

$$\hat{\bar{\lambda}} = \frac{\frac{P\mathrm{d}G^N}{Y} + \frac{\mathrm{d}G^T}{Y}}{\sigma_L + \omega_C \sigma_C}. \tag{217}$$

Inserting (217) into (210) yields the change in non traded labor following a permanent fiscal expansion:

$$\hat{L}^N = \frac{\sigma_L + \omega_C \sigma_C\left(1-\alpha_C\right)}{\alpha_L\left(\sigma_L + \omega_C \sigma_C\right)}\frac{P\mathrm{d}G^N}{Y} - \frac{\omega_C \alpha_C \sigma_C}{\alpha_L\left(\sigma_L + \omega_C \sigma_C\right)}\frac{\mathrm{d}G^T}{Y}. \tag{218}$$

Inserting (217) into (213) yields the change in traded labor following a permanent fiscal expansion:

$$\hat{L}^T = -\frac{\omega_C (1-\alpha_C)\sigma_C}{(1-\alpha_L)(\sigma_L+\omega_C\sigma_C)}\frac{P\mathrm{d}G^N}{Y} + \frac{\sigma_L+\omega_C\sigma_C\alpha_C}{(1-\alpha_L)(\sigma_L+\omega_C\sigma_C)}\frac{\mathrm{d}G^T}{Y}. \tag{219}$$

According to (218) and (219), a permanent fiscal expansion raises non traded labor and lowers traded labor, while wages, the relative price, and the net foreign asset position remain unchanged.

Effects of a Temporary Rise in Government Spending

Inserting first the short-run static solutions for traded labor (212) and consumption in tradables (119) into the market clearing condition for the traded good (128) yields:

$$\dot{B}(t) = r^\star B(t) + L^T\left(\bar{\lambda}, G^N(t)\right) - C^T\left(\bar{\lambda}, P\right) - G^T. \tag{220}$$

Linearizing the current account equation above around the steady-state gives us:

$$\dot{B}(t) = r^\star\left(B(t)-\tilde{B}\right) + L^T_{G^N}\left(G^N(t)-\tilde{G}^N\right). \tag{221}$$

Inserting $L^T_{G^N} = -\frac{\tilde{L}^T}{1-\alpha_L}\frac{\tilde{P}}{\tilde{Y}} = -\tilde{P}$ (see eq. (213)), eq. (221) can be rewritten as follows:

$$\dot{B}(t) = r^\star\left(B(t)-\tilde{B}\right) - \left(G(t)-\tilde{G}\right), \tag{222}$$

where we used the fact that $dG^N(t) = \frac{dG(t)}{P}$ since the relative price of non tradables remains constant over time as P must stick to the marginal product of labor (that reduces to 1).

Inserting the law of motion of government spending given by (162), eq. (222) can be rewritten as follows:

$$\dot{B}(t) = r^\star\left(B(t)-\tilde{B}\right) - Y\left[e^{-\xi t} - (1-g)\,e^{-\chi t}\right]. \tag{223}$$

Pre-multiplying by $e^{-r^\star\tau}$ and integrating over $(0,t)$ allow us to obtain the general solution for $B(t)$:

$$B(t)-\tilde{B} = \left[\left(B_0-\tilde{B}\right) - \frac{Y}{\xi+r^\star}\left(1-\Theta'\right)\right]e^{r^\star t} + \frac{Y}{\xi+r^\star}\left(e^{-\xi t}-\Theta' e^{-\chi t}\right), \tag{224}$$

where we used the fact that $\int_0^t e^{-(\xi+r^\star)\tau}d\tau = \frac{\left(1-e^{-(\xi+r^\star)t}\right)}{\xi+r^\star}$ and we set:

$$\Theta' = (1-g)\,\frac{\xi+r^\star}{\chi+r^\star} > 0. \tag{225}$$

Invoking the transversality condition, one obtains the 'stable' solution for the stock of foreign assets so that $B(t)$ converges toward its steady-state value $\tilde{B}$:

$$B(t)-\tilde{B} = \frac{Y}{\xi+r^\star}\left(e^{-\xi t}-\Theta' e^{-\chi t}\right). \tag{226}$$

Eq. (226) gives the trajectory for for $B(t)$ consistent with the intertemporal solvency condition:

$$\left(\tilde{B}-B_0\right) = -\frac{Y}{\xi+r^\star}\left(1-\Theta'\right), \tag{227}$$

where $1-\Theta' > 0$ due to inequality (163). According to (227), a temporary rise in government spending deteriorates the net foreign asset position, i.e., $d\tilde{B} < 0$.

Differentiating (226) w.r.t. time leads to the trajectory for the current account along the transitional path when government spending follows the temporal path given by eq. (162):

$$\dot{B}(t) = -\frac{Y}{\xi+r^\star}\left(\xi e^{-\xi t} - \chi\Theta' e^{-\chi t}\right). \tag{228}$$

According to (228), the net foreign asset position deteriorates monotonically since $\left(\xi e^{-\xi t} - \chi \Theta' e^{-\chi t}\right) > 0$ for $t \geq 0$.

Evaluating (228) at time $t = 0$ leads to the initial current account response, expressed as a percentage of initial GDP, following a temporary rise in government spending:

$$\frac{\dot{B}(0)}{Y} = -\left(\frac{\xi - \chi\Theta'}{\xi + r^{\star}}\right) < 0, \tag{229}$$

where $(\xi - \chi\Theta') > 0$.

The Change in the Equilibrium Value of the Marginal Utility of Wealth

Eq. (227) allows us to calculate the steady-state change in the foreign asset position following a temporary rise in government spending:

$$d\tilde{B}\Big|_{temp} = -\frac{Y}{\xi + r^{\star}}\left(1 - \Theta'\right). \tag{230}$$

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition for traded goods:

$$r^{\star} d\tilde{B}\Big|_{temp} + \left(L^T_{\lambda} - C^T_{\lambda}\right) d\bar{\lambda}\Big|_{temp} = 0.$$

Expressing the equation above in rate of change and dividing by initial GDP leads to:

$$\frac{r^{\star} d\tilde{B}}{Y}\Big|_{temp} + \left((1-\alpha_L)\frac{\hat{L}^T}{\hat{\bar{\lambda}}} - (1-\alpha_C)\,\omega_C\frac{\hat{C}^T}{\hat{\bar{\lambda}}}\right)\frac{d\bar{\lambda}}{\bar{\lambda}}\Big|_{temp} = 0, \tag{231}$$

where

$$(1-\alpha_L)\frac{\hat{L}^T}{\hat{\bar{\lambda}}} - (1-\alpha_C)\,\omega_C\frac{\hat{C}^T}{\hat{\bar{\lambda}}} = \sigma_L + \omega_C\sigma_C. \tag{232}$$

Inserting (230) and (232), eq. (231) can be solved for the change in the equilibrium value of the marginal utility of wealth:

$$\begin{aligned}
\frac{d\bar{\lambda}}{\bar{\lambda}}\Big|_{temp} &= -\frac{1}{\sigma_L + \omega_C\sigma_C}\frac{r^{\star} d\tilde{B}}{Y_0}\Big|_{temp}, \\
&= \frac{1}{\sigma_L + \omega_C\sigma_C}\frac{r^{\star}}{\xi + r^{\star}}\left(1 - \Theta'\right).
\end{aligned} \tag{233}$$

Following a temporary fiscal shock, the marginal utility of wealth increases less than after a permanent rise in G^N.

C.13 A Friendly Way to Solve the Model with Imperfect Mobility of Labor

In this subsection, we solve analytically the model with imperfect mobility of labor across sectors by keeping our assumption according to which the government spending shock is fully biased toward non tradables while assuming that the endogenous response of government spending to an exogenous fiscal shock is governed by the following dynamic equation:

$$dG(t) = \tilde{Y} g e^{-\xi t}. \tag{234}$$

According to (234), government spending rises initially by $g > 0$ percentage points of GDP and declines monotonically at rate $\xi > 0$. The latter feature simplifies substantially analytical expressions.

The short-run equilibrium can be rewritten as follows:

$$C = \left(P_C\bar{\lambda}\right)^{-\sigma_C}, \tag{235a}$$
$$L = \left(\bar{\lambda}W\right)^{\sigma_L}, \tag{235b}$$
$$L^N = \alpha_L \frac{W}{W^N} L, \tag{235c}$$
$$L^T = (1-\alpha_L)\frac{W}{W^T} L, \tag{235d}$$
$$C^N = \alpha_C \frac{P_C}{P} C, \tag{235e}$$
$$C^T = (1-\alpha_C) P_C C, \tag{235f}$$
$$W^T = 1, \tag{235g}$$
$$W^N = P, \tag{235h}$$
$$Y^N = C^N + G^N, \tag{235i}$$
$$\dot{B} = r^\star B + Y^T - C^T - G^T, \tag{235j}$$

where $Y^N = L^N$, $Y^T = L^T$, α_C is given by eq. (106a) and α_L is given by eq. (112a).

Short-Run Solutions

Substituting first (235a) into (235e), (235b) and (235h) into (235c), the market clearing condition (235i) for the non traded good can be rewritten as follows:

$$\frac{\alpha_L \bar{\lambda}^{\sigma_L} W^{1+\sigma_L}}{P} = \frac{\alpha_C P_C^{1-\sigma_C} \bar{\lambda}^{-\sigma_C}}{P} + G^N. \tag{236}$$

Eq. (236) corresponds to eq. (37) in the main text.

As will be useful later, we compute the change in percentage of the shares of non tradables and tradables into consumption and labor. Totally differentiating (106a)-(107), and (112a)-(112b) yields:

$$\begin{aligned} \hat{\alpha}_C &= (1-\phi)(1-\alpha_C)\hat{P}, & (237a)\\ (1 \hat{-} \alpha_C) &= (\phi-1)\alpha_C \hat{P}, & (237b)\\ \hat{\alpha}_L &= (\epsilon+1)(1-\alpha_L)\hat{P}, & (237c)\\ (1 \hat{-} \alpha_L) &= -(\epsilon+1)\alpha_L \hat{P}, & (237d) \end{aligned}$$

where we used the fact that $\hat{P}_C = \alpha_C \hat{P}$ (since $P^T = 1$), and $\hat{W} = \alpha_L \hat{P}$ (since $W^T = P^T = 1$ and $W^N = P$).

Totally differentiating (236), using (237a) et (237c), leads to:

$$\hat{\alpha}_L + \sigma_L \hat{\bar{\lambda}} + (1+\sigma_L)\hat{W} - \hat{P} = \frac{C^N}{L^N}\left[\hat{\alpha}_C + (1-\sigma_C)\hat{P}_C - \sigma_C\hat{\bar{\lambda}} - \hat{P}\right] + \frac{dG^N}{L^N},$$
$$\frac{PL^N}{Y}\left[\hat{\alpha}_L + \sigma_L \hat{\bar{\lambda}} + (1+\sigma_L)\hat{W} - \hat{P}\right] = \frac{PC^N}{Y}\left[\hat{\alpha}_C + (1-\sigma_C)\hat{P}_C - \sigma_C\hat{\bar{\lambda}} - \hat{P}\right] + \frac{PdG^N}{Y},$$
$$\alpha_L\left\{(1+\epsilon)(1-\alpha_L)\hat{P} + \left[(1+\sigma_L)\alpha_L - 1\right]\hat{P} + \sigma_L\hat{\bar{\lambda}}\right\}$$
$$= \alpha_C\omega_C\left\{(1-\phi)(1-\alpha_C)\hat{P} + \left[(1-\sigma_C)\alpha_C - 1\right]\hat{P} - \sigma_C\hat{\bar{\lambda}}\right\} + \frac{PdG^N}{Y},$$

where $\omega_C = \frac{P_C C}{Y}$, $\frac{PC^N}{P_C C} = \alpha_C$, $\frac{PL^N}{Y} = \frac{W^N L^N}{WL} = \alpha_L$. Collecting terms, the deviation in percentage from the initial steady-state for the relative price of non tradables is described by:

$$\hat{P} = \frac{-\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\hat{\bar{\lambda}} + \frac{1}{\Psi}\frac{PdG^N}{Y}, \tag{238}$$

where Ψ is given (133). **Eq. (238) corresponds to eq. (38) in the main text**.

Totally differentiating (235b) and using the fact that $\hat{W} = \alpha_L \hat{W}^N + (1-\alpha_L)\hat{W}^T$ with $\hat{W}^N = \hat{P}$ and $\hat{W}^T = 0$ leads to the response of employment in percentage deviation from initial steady-state:

$$\hat{L} = \sigma_L\hat{\bar{\lambda}} + \sigma_L\alpha_L\hat{P}. \tag{239}$$

Substituting (235c) and (235h) into (235c) leads to $L^T = (1-\alpha_L)(W)^{1+\sigma_L}\left(\bar{\lambda}\right)^{\sigma_L}$. Totally differentiating and using the fact that $\widehat{(1-\alpha_L)} = -(1+\epsilon)\hat{W}$ with $\hat{W} = \alpha_L \hat{P}$, one obtains:

$$\begin{aligned}
\hat{L}^T &= -(\epsilon - \sigma_L)\alpha_L \hat{P} + \sigma_L \hat{\bar{\lambda}}, \\
&= \left\{\frac{\sigma_L \Psi + \alpha_L(\epsilon - \sigma_L)\left[\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C\right]}{\Psi}\right\}\hat{\bar{\lambda}} - \frac{\alpha_L(\epsilon - \sigma_L)}{\Psi}\frac{PdG^N}{Y}. \qquad (240)
\end{aligned}$$

Substituting (235b) and (235h) into (235d) leads to $L^N = \frac{\alpha_L}{P}(W)^{1+\sigma_L}\bar{\lambda}^{\sigma_L}$. Totally differentiating yields:

$$\begin{aligned}
\hat{L}^N &= \left[(1+\epsilon)(1-\alpha_L) + (1+\sigma_L)\alpha_L - 1\right]\hat{P} + \sigma_L \hat{\bar{\lambda}}, \\
&= \left[\epsilon(1-\alpha_L) + \alpha_L \sigma_L\right]\hat{P} + \sigma_L \hat{\bar{\lambda}}, \\
&= \left\{\frac{\sigma_L \Psi - \left[\epsilon(1-\alpha_L) + \alpha_L \sigma_L\right]\left[\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C\right]}{\Psi}\right\}\hat{\bar{\lambda}} \\
&+ \frac{\left[\epsilon(1-\alpha_L) + \alpha_L \sigma_L\right]}{\Psi}\frac{PdG^N}{Y}. \qquad (241)
\end{aligned}$$

Solution for the Net Foreign Asset Position

Substituting $L^T = (1-\alpha_L)(W)^{1+\sigma_L}\left(\bar{\lambda}\right)^{\sigma_L}$ and $C^T = (1-\alpha_C)P_C^{1-\sigma_C}\bar{\lambda}^{-\sigma_C}$ into (235j) leads to:

$$\dot{B}(t) = r^\star B(t) + (1-\alpha_L(t))W(t)^{1+\sigma_L}\bar{\lambda}^{\sigma_L} - (1-\alpha_C(t))P_C(t)^{1-\sigma_C}\bar{\lambda}^{-\sigma_C} - G^T. \qquad (242)$$

Using the fact that both $\bar{\lambda}$ and G^T are constant over time, linearizing (242) in the neighborhood of the steady-state yields:

$$\begin{aligned}
\dot{B}(t) &= r^\star dB(t) - \tilde{L}^T \frac{\alpha_L(\epsilon - \sigma_L)}{\Psi}\frac{\tilde{P}dG^N(t)}{\tilde{Y}} - \tilde{C}^T \frac{\alpha_C(\phi - \sigma_C)}{\Psi}\frac{\tilde{P}dG^N(t)}{\tilde{Y}}, \\
&= r^\star dB(t) - \tilde{Y}\Upsilon_G g e^{-\xi t}.
\end{aligned}$$

where $\frac{\partial \dot{B}(t)}{\partial G(t)} = -\Upsilon_G = -\frac{\left[(1-\alpha_L)\alpha_L(\epsilon-\sigma_L) + (1-\alpha_C)\omega_C \alpha_C(\phi - \sigma_C)\right]}{\Psi} < 0$ is given by eq. (168). Substituting the law of motion of government spending (234) and solving leads to the general solution for the net foreign asset position:

$$B(t) - \tilde{B} = \left[\left(B_0 - \tilde{B}\right) - \frac{\Upsilon_G \tilde{Y}}{\xi + r^\star}g\right]e^{r^\star t} + \frac{\Upsilon_G \tilde{Y}}{\xi + r^\star}g e^{-\xi t}. \qquad (243)$$

Invoking the transversality condition gives the solution for $B(t)$:

$$B(t) - \tilde{B} = \frac{\Upsilon_G \tilde{Y}}{\xi + r^\star}g e^{-\xi t}, \qquad (244)$$

consistent with the intertemporal solvency condition

$$\left(\tilde{B} - B_0\right) = -\frac{\Upsilon_G \tilde{Y}}{\xi + r^\star}g. \qquad (245)$$

Eq. (244) corresponds to eq. (40) while eq. (245) corresponds to eq. (41) in the main text.

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition (242) for the traded good evaluated at the steady-state (i.e., $\dot{B}(t) = 0$), using the fact that in the long-run government spending reverts to its initial level (i.e., $dG^N = 0$):

$$\begin{aligned}
& r^\star \frac{d\tilde{B}}{\tilde{Y}} + (1-\alpha_L)\hat{\tilde{L}}^T = (1-\alpha_C)\omega_C \hat{\tilde{C}}^T, \\
& \hat{\bar{\lambda}} = -\frac{\Psi}{\Gamma}r^\star \frac{d\tilde{B}}{\tilde{Y}},
\end{aligned}$$

where $\Gamma > 0$ is given by eq. (150). Substituting (245) into the above equation leads to the change in the equilibrium value of the marginal utility of wealth:

$$\hat{\bar{\lambda}} = \frac{\Psi}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} \Upsilon_G g > 0, \tag{246}$$

where $\Gamma > 0$, $\Psi > 0$, $\Upsilon_G > 0$, $\xi > 0$, and $g > 0$. **Eq. (246) corresponds to eq. (42) in the main text**.

Before evaluating the short-run effects of the fiscal shock, it is useful to rewrite Γ given by eq. (150) as follows:

$$\begin{aligned} \Gamma &= \Psi \left\{ \left[(1-\alpha_L)\sigma_L + \omega_C (1-\alpha_C)\sigma_C \right] + \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right] \Upsilon_G \right\}, \\ &> \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right] \Upsilon_G \Psi, \end{aligned} \tag{247}$$

where we used the fact that $\Upsilon_G \Psi = \left[(1-\alpha_L)\alpha_L(\epsilon - \sigma_L) + (1-\alpha_C)\omega_C \alpha_C (\phi - \sigma_C) \right]$. Eq. (247) implies that the following inequality holds:

$$0 < \frac{\Psi \Upsilon_G}{\Gamma} \left(\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right) < 1, \tag{248}$$

where $\Gamma > 0$, $\Psi > 0$, and $\Upsilon_G > 0$.

Impact Effects of a Temporary Fiscal Expansion

Evaluating (238) at time $t = 0$, inserting (246), and using the fact that $\frac{\tilde{P}dG^N(0)}{\tilde{Y}} = \frac{dG(0)}{\tilde{Y}} = g > 0$, leads to the initial response of the relative price of non tradables:

$$\begin{aligned} \hat{P}(0) &= \frac{-\left[\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C \right]}{\Psi} \hat{\bar{\lambda}} + \frac{1}{\Psi} \frac{\tilde{P}dG^N(0)}{\tilde{Y}}, \\ &= \left\{ -\left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C \right] \frac{\Upsilon_G \Psi}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} + 1 \right\} \frac{g}{\Psi} > 0, \end{aligned} \tag{249}$$

where the term in braces is unambiguously positive due to inequality (248) and $0 < \frac{r^{\star}}{\xi + r^{\star}} < 1$. **Eq. (249) corresponds to eq. (44) in the main text**.

Substituting the change in the equilibrium value of the marginal utility of wealth given by eq. (246) into (241), and multiplying both sides by α_L leads to the initial reaction of non traded labor from initial steady-state in total labor units:

$$\begin{aligned} \alpha_L \hat{L}^N(0) &= \frac{\alpha_L \left[\epsilon (1-\alpha_L) + \alpha_L \sigma_L \right]}{\Psi} \left[1 - \left(\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C \right) \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} \right] g \\ &+ \alpha_L \sigma_L \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} g > 0, \end{aligned} \tag{250}$$

where the term in brackets $\left[1 - \left(\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C \right) \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} \right]$ is unambiguously positive due to inequality (248) and $0 < \frac{r^{\star}}{\xi + r^{\star}} < 1$; hence, labor in the non traded sector unambiguously increases. **Eq. (250) corresponds to eq. (45) in the main text.**

Substituting the change in the equilibrium value of the marginal utility of wealth given by eq. (246) into (240) and multiplying both sides by $1 - \alpha_L$ leads to the initial reaction of traded labor from initial steady-state in total labor units:

$$\begin{aligned} (1-\alpha_L) \hat{L}^T(0) &= -\frac{(1-\alpha_L)\alpha_L(\epsilon - \sigma_L)}{\Psi} \left[1 - \left(\alpha_L \sigma_L + \alpha_C \omega_C \sigma_C \right) \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} \right] g \\ &+ (1-\alpha_L)\sigma_L \frac{\Psi \Upsilon_G}{\Gamma} \frac{r^{\star}}{\xi + r^{\star}} g \lesseqgtr 0, \end{aligned} \tag{251}$$

where inequality (248) together with $0 < \frac{r^{\star}}{\xi + r^{\star}} < 1$ imply that the first term on the RHS is unambiguously negative as long as we set assumption 1. **Eq. (251) corresponds to eq. (46) in the main text.**

Differentiating (244) with respect to time leads to the response of the current account as a percentage of GDP:

$$\frac{\dot{B}(t)}{\tilde{Y}} = -\Upsilon_G \frac{\xi}{\xi + r^{\star}} g e^{-\xi t} < 0, \tag{252}$$

where $\Upsilon_G > 0$. **Eq. (252) corresponds to eq. (50) in the main text**.

We now investigate the impact of a government spending shock on sectoral output (or alternatively labor since $Y^j = L^j$) shares. To begin with, real GDP which we denote by Y_R is equal to the sum of value added at constant prices:

$$Y_R = Y^T + \tilde{P} Y^N, \tag{253}$$

where $\tilde{P}$ corresponds to the initial steady-state value of the relative price of non tradables. Using the fact that $Y^j = L^j$, totally differentiating (253) gives:

$$\hat{Y}_R = (1 - \alpha_L)\, \hat{L}^T + \alpha_L \hat{L}^N. \tag{254}$$

Using the fact that $\hat{L}^T = \sigma_L \hat{\bar{\lambda}} - \alpha_L (\epsilon - \sigma_L) \hat{P}$ and $\hat{L}^N = \sigma_L \hat{\bar{\lambda}} + [\epsilon (1 - \alpha_L) + \sigma_L \alpha_L] \hat{P}$, eq. (254) can be rewritten as follows:

$$\hat{Y}_R = \sigma_L \hat{\bar{\lambda}} + \alpha_L \sigma_L \hat{P}. \tag{255}$$

According to (255), a government spending shock impinges on real GDP through two channels; first, by inducing agents to supply more labor, the negative wealth effect pushes up output; second, since the relative price of non tradables appreciates, non traded firms are induced to produce and thus to hire more; as workers' experience mobility costs, non traded firms have to pay higher wages which increase the aggregate wage, W, in proportion to the non tradable content of labor compensation, α_L; consequently, agents are encouraged to increase hours worked more which pushes up further real GDP.

To compute the change in the sectoral output share calculated as the growth differential between sectoral output and real GDP in total output units, we divide both sides of eq. (253) by Y_R and totally differentiate:

$$0 = (1 - \alpha_L) \left(\hat{Y}^T - \hat{Y}_R \right) + \alpha_L \left(\hat{Y}^N - \hat{Y}_R \right). \tag{256}$$

The first and the second term on the RHS of eq. (256) corresponds to the response of output share in sector $j = T, N$ in total output units. More precisely, the change in the sectoral output share is measured by the product of the growth differential between output of sector j and real GDP and the share of sector j in GDP.

Using the fact that $\hat{L}^N = \sigma_L \hat{\bar{\lambda}} + [\epsilon (1 - \alpha_L) + \sigma_L \alpha_L] \hat{P}$, inserting (254), and evaluating at time $t = 0$, the response of the output share of non tradables is given by:

$$\alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0) \right) = \alpha_L (1 - \alpha_L)\, \epsilon \hat{P}(0), \tag{257}$$

where $\hat{P}(0)$ corresponds to the initial response of the relative price of non tradables in percentage deviation from trend (see eq. (249)). **Eq. (257) corresponds to eq. (47) in the main text**.

Using the fact that $\hat{L}^T = \sigma_L \hat{\bar{\lambda}} - \alpha_L (\epsilon - \sigma_L) \hat{P}$, inserting (254), and evaluating at time $t = 0$, the response of the output share of tradables is given by:

$$(1 - \alpha_L) \left(\hat{Y}^T(0) - \hat{Y}_R(0) \right) = -\alpha_L (1 - \alpha_L)\, \epsilon \hat{P}(0), \tag{258}$$

where the initial change in the relative price of non tradables relative to initial steady state in percent, $\hat{P}(0)$, is described by eq. (249). It is straightforward to see that (258) is exactly the opposite of eq. (257).

C.14 A Friendly Way to Solve the Model with Perfect Mobility of Labor

When assuming perfect mobility of labor, the short-run equilibrium reduces to:

$$C = \left(P_C\bar{\lambda}\right)^{-\sigma_C}, \tag{259a}$$
$$L = \left(\bar{\lambda}W\right)^{\sigma_L}, \tag{259b}$$
$$C^N = \alpha_C \frac{P_C}{P} C, \tag{259c}$$
$$C^T = (1-\alpha_C)\, P_C C, \tag{259d}$$
$$W^T = 1, \tag{259e}$$
$$W^N = P, \tag{259f}$$
$$W^N = W^T = W, \tag{259g}$$
$$L = L^T + L^N, \tag{259h}$$
$$Y^N = C^N + G^N, \tag{259i}$$
$$\dot{B} = r^\star B + Y^T - C^T - G^T, \tag{259j}$$

where $Y^N = L^N$, $Y^T = L^T$, and α_C is given by eq. (106a).

Short-Run Solutions

Substituting (259e) and (259f) into (259g) leads to:

$$P = 1. \tag{260}$$

Because sectoral wages must equalize while the marginal product of labor in the traded sector is fixed, the relative price of non tradables remains unaffected by a government spending shock, both in the short-run and the long-run.

Substituting first (259a) into (259c), the market clearing condition (127) for the non traded good can be rewritten as follows:

$$L^N = \frac{\alpha_C P_C^{1-\sigma_C}\bar{\lambda}^{-\sigma_C}}{P} + G^N. \tag{261}$$

Totally differentiating (261), using (260), leads to:

$$\alpha_L \hat{L}^N = -\alpha_C\omega_C\sigma_C\hat{\bar{\lambda}} + \frac{PdG^N}{Y}. \tag{262}$$

Inserting $L = \bar{\lambda}^{\sigma_L}$ (since $W = 1$) into (259h), differentiating and using (262) leads to:

$$(1-\alpha_L)\,\hat{L}^T = \left[\sigma_L + \alpha_C\omega_C\sigma_C\right]\hat{\bar{\lambda}} - \frac{PdG^N}{Y}. \tag{263}$$

Inserting $L^T = L - L^N$ together with $L^N = C^N + G^N$ and $L = \bar{\lambda}^{\sigma_L}$ (since $W = 1$) into (259j), the market clearing condition for the traded good can be written as follows:

$$\begin{aligned}\dot{B}(t) &= r^\star B(t) + L - P_C C - G^T - PG^N(t), \\ &= r^\star B(t) + \bar{\lambda}^{\sigma_L} - (1-\alpha_C)\, P_C^{1-\sigma_C}\bar{\lambda}^{-\sigma_C} - PG^N(t) - G^T.\end{aligned} \tag{264}$$

Using the fact that both $\bar{\lambda}$, G^T, and P are constant over time, linearizing (264) in the neighborhood of the steady-state leads to:

$$\dot{B}(t) = r^\star dB(t) - \tilde{P}dG^N(t).$$

Substituting the law of motion of government spending (234) and solving leads to the general solution for the net foreign asset position:

$$B(t) - \tilde{B} = \left[\left(B_0 - \tilde{B}\right) + \frac{\tilde{Y}}{\xi + r^\star}g\right]e^{r^\star t} - \frac{\tilde{Y}}{\xi + r^\star}ge^{-\xi t}. \tag{265}$$

Invoking the transversality condition gives the solution for $B(t)$:

$$B(t) - \tilde{B} = \frac{\tilde{Y}}{\xi + r^\star} g e^{-\xi t}, \tag{266}$$

consistent with the intertemporal solvency condition

$$\left(\tilde{B} - B_0\right) = -\frac{\tilde{Y}}{\xi + r^\star} g. \tag{267}$$

To determine the change in the equilibrium value of the marginal utility of wealth, we have to differentiate the market clearing condition (259j) for the traded good evaluated at the steady-state (i.e., $\dot{B}(t) = 0$), using the fact that government spending reverts to its initial level in the long-run (i.e., $dG^N = 0$):

$$\begin{aligned} & r^\star \frac{d\tilde{B}}{\tilde{Y}} + (1-\alpha_L)\,\hat{\tilde{L}}^T = (1-\alpha_C)\,\omega_C \hat{\tilde{C}}^T, \\ & \hat{\tilde{\lambda}} = -r^\star \frac{d\tilde{B}}{\tilde{Y}}, \end{aligned}$$

where we used (263) (setting $dG^N = 0$) and $\hat{\tilde{C}}^T = -\sigma_C \hat{\tilde{\lambda}}$. Substituting (267) into the above equation leads to the change in the equilibrium value of the marginal utility of wealth:

$$\hat{\tilde{\lambda}} = \frac{1}{\sigma_L + \omega_C \sigma_C} \frac{r^\star}{\xi + r^\star} g > 0, \tag{268}$$

where $\xi > 0$ and $g > 0$. According to (268), a temporary rise in government consumption generates a negative wealth effect reflected by an increase in the shadow value of wealth.

C.15 Perfect Mobility of Labor as a Special Case of a Model with Limited Substitutability in Hours Worked across Sectors

In order to generate barriers to mobility, we assume limited substitutability in hours worked across sectors along the lines of Horvath [2000]. The degree of substitutability of hours worked across sectors captures the extent of workers' mobility costs. As the elasticity of labor supply across sectors takes higher values, workers experience lower mobility costs and thus the degree of labor mobility increases. The advantage of this modelling strategy is that it allows us to consider the range of all degrees of labor mobility across sectors. Specifically, if we let ϵ be zero or tend toward infinity, total immobility ($\epsilon = 0$) and perfect mobility ($\epsilon \to \infty$), respectively, emerges as a special case. In this subsection, we investigate how the degree of labor mobility affects the magnitude of initial responses of sectoral variables to a government spending shock.

As will be useful later, we compute several expressions. Inserting the expression for Ψ given by (133) into the expression of Υ_G described by (168), letting ϵ tend toward infinity and applying l'Hôpital's rule leads to:

$$\begin{aligned} \lim_{\epsilon \to \infty} \Upsilon_G &= \lim_{\epsilon \to \infty} \frac{\left[(1-\alpha_L)\,\alpha_L\,(\epsilon - \sigma_L) + (1-\alpha_C)\,\omega_C \alpha_C\,(\phi - \sigma_C)\right]}{\alpha_L\left[\epsilon\,(1-\alpha_L) + \sigma_L \alpha_L\right] + \omega_C \alpha_C\left[(1-\alpha_C)\,\phi + \alpha_C \sigma_C\right]}, \\ &= \frac{\alpha_L\,(1-\alpha_L)}{\alpha_L\,(1-\alpha_L)} = 1. \end{aligned} \tag{269}$$

Using the expression for Γ given by eq. (247), letting ϵ tend toward infinity and applying l'Hôpital's rule leads to:

$$\begin{aligned} \lim_{\epsilon \to \infty} \frac{\Psi \Upsilon_G}{\Gamma} &= \lim_{\epsilon \to \infty} \frac{\Upsilon_G}{\left[(1-\alpha_L)\,\sigma_L + \omega_C\,(1-\alpha_C)\,\sigma_C\right] + \left[\alpha_L \sigma_L + \omega_C \alpha_C \sigma_C\right]\Upsilon_G}, \\ &= \frac{1}{\sigma_L + \omega_C \sigma_C}, \end{aligned} \tag{270}$$

where we used the fact that $\lim_{\epsilon\to\infty}\Upsilon_G = 1$ (see eq. (269)). Finally, we compute two additional expressions by inserting the expression for Ψ given by (133), letting ϵ tend toward infinity and applying l'Hôpital's rule:

$$\begin{aligned}
\lim_{\epsilon\to\infty}\frac{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]}{\Psi} &= \lim_{\epsilon\to\infty}\frac{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]}{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\sigma_L\alpha_L\right]+\omega_C\alpha_C\left[\left(1-\alpha_C\right)\phi+\alpha_C\sigma_C\right]},\\
&= \frac{\alpha_L\left(1-\alpha_L\right)}{\alpha_L\left(1-\alpha_L\right)}=1, \qquad (271a)\\
\lim_{\epsilon\to\infty}\frac{\left(1-\alpha_L\right)\alpha_L\left(\epsilon-\sigma_L\right)}{\Psi} &= \lim_{\epsilon\to\infty}\frac{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]}{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\sigma_L\alpha_L\right]+\omega_C\alpha_C\left[\left(1-\alpha_C\right)\phi+\alpha_C\sigma_C\right]},\\
&= \frac{\alpha_L\left(1-\alpha_L\right)}{\alpha_L\left(1-\alpha_L\right)}=1. \qquad (271b)
\end{aligned}$$

Letting ϵ tend toward infinity into eq. (250) and using (269) together with (271a), the initial response of hours worked in the non traded sector relative to the initial steady-state in total labor units can be rewritten as follows:

$$\begin{aligned}
\lim_{\epsilon\to\infty}\alpha_L\hat{L}^N(0) &= \lim_{\epsilon\to\infty}\frac{\alpha_L\left[\epsilon\left(1-\alpha_L\right)+\alpha_L\sigma_L\right]}{\Psi}\left[1-\left(\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C\right)\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}\right]g\\
&+ \lim_{\epsilon\to\infty}\alpha_L\sigma_L\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}g>0,\\
&= \left[1-\frac{\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}\right]g+\frac{\alpha_L\sigma_L}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g,\\
&= \left[1-\frac{\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}\right]g>0. \qquad (272)
\end{aligned}$$

Eq. (272) gives the initial response of hours worked in the non traded sector to an exogenous temporary increase in G^N when labor can freely move from one sector to another. As discussed below, the magnitude of the rise in non traded labor on impact, i.e., $\alpha_L\hat{L}^N(0)>0$, can be larger or lower than that with a difficulty in reallocating labor across sectors. Intuitively, in the latter case, the relative price of non tradables appreciates which exerts a strong positive impact on the reallocation of labor toward the non traded sector.

Letting ϵ tend toward infinity into eq. (251) and using (269) together with (271a), the initial response of hours worked in the traded sector relative to the initial steady-state in total labor units can be rewritten as follows:

$$\begin{aligned}
\lim_{\epsilon\to\infty}\left(1-\alpha_L\right)\hat{L}^T(0) &= \lim_{\epsilon\to\infty}-\frac{\left(1-\alpha_L\right)\alpha_L\left(\epsilon-\sigma_L\right)}{\Psi}\left[1-\left(\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C\right)\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}\right]g\\
&+ \lim_{\epsilon\to\infty}\left(1-\alpha_L\right)\sigma_L\frac{\Psi\Upsilon_G}{\Gamma}\frac{r^\star}{\xi+r^\star}g\lesseqgtr 0,\\
&= -\left[1-\frac{\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}\right]g+\frac{\left(1-\alpha_L\right)\sigma_L}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g,\\
&= -\left[1-\frac{\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}\right]g<0. \qquad (273)
\end{aligned}$$

Summing (272) and (273) leads to:

$$\begin{aligned}
\lim_{\epsilon\to\infty}\alpha_L\hat{L}^N(0)+\lim_{\epsilon\to\infty}\left(1-\alpha_L\right)\hat{L}^T(0) &= \frac{\sigma_L}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g,\\
&= \lim_{\epsilon\to\infty}\hat{L}(0), \qquad (274)
\end{aligned}$$

where the last equality is derived by letting ϵ tend toward infinity into eq. (239).

We now investigate the relationship between the magnitude of responses of sectoral labor and the degree of labor mobility across sectors captured by ϵ. To do so, we have to first rewrite $\frac{\Psi\Upsilon_G}{\Gamma}$ (see the first line of eq. (270)) as follows

$$\frac{\Psi\Upsilon_G}{\Gamma}=\frac{\Upsilon_G}{\left[\left(1-\alpha_L\right)\sigma_L+\omega_C\left(1-\alpha_C\right)\sigma_C\right]+\left[\alpha_L\sigma_L+\omega_C\alpha_C\sigma_C\right]\Upsilon_G}, \qquad (275)$$

and to determine whether $\frac{\Psi \Upsilon_G}{\Gamma}$ increases or decreases as the degree of labor mobility rises. To do so, we have to determine the relationship between Υ_G described by (168) and ϵ:

$$\frac{\partial \Upsilon_G}{\partial \epsilon} = \frac{(1-\alpha_L)\,\alpha_L\,(\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C)}{\Psi^2} > 0, \tag{276}$$

where Ψ is given by eq. (133). When $\epsilon = 0$, Υ_G described by (168) becomes:

$$\Upsilon_G\big|_{\epsilon=0} = 1 - \frac{(\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C)}{(\alpha_L)^2\,\sigma_L + \omega_C\alpha_C\left[(1-\alpha_C)\,\phi + \alpha_C\sigma_C\right]} \lesseqgtr 0. \tag{277}$$

In sum, Υ_G can take negative values when ϵ is close to 0, is increasing with ϵ and takes a maximum value of 1 when we let $\epsilon \to \infty$. Differentiating (275) with respect to ϵ leads to:

$$\begin{aligned}
\frac{\partial \frac{\Psi\Upsilon_G}{\Gamma}}{\partial \epsilon} &= \frac{\frac{\partial \Upsilon_G}{\partial \epsilon}\left[(1-\alpha_L)\,\sigma_L + \omega_C\,(1-\alpha_C)\,\sigma_C\right]}{\left\{\left[(1-\alpha_L)\,\sigma_L + \omega_C\,(1-\alpha_C)\,\sigma_C\right] + \left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\Upsilon_G\right\}^2} > 0, \\
&= \frac{(1-\alpha_L)\,\alpha_L\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\left[(1-\alpha_L)\,\sigma_L + \omega_C\,(1-\alpha_C)\,\sigma_C\right]}{\Gamma^2} > 0.
\end{aligned} \tag{278}$$

Because $\frac{\Psi\Upsilon_G}{\Gamma}$ and Ψ are both positive and increasing with ϵ while $\lim_{\epsilon\to\infty}\frac{\Psi\Upsilon_G}{\Gamma} = \frac{1}{\sigma_L + \omega_C\sigma_C}$ (see eq. 270) and $\lim_{\epsilon\to\infty}\Psi = \infty$, the initial reaction of the relative price to a government spending shock is unambiguously decreasing with ϵ; differentiating (249) with respect to ϵ leads to:

$$\begin{aligned}
\frac{\partial \hat{P}(0)}{\partial \epsilon} &= -\frac{g}{\Psi}\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\frac{r^\star}{\xi + r^\star}\frac{\partial \frac{\Psi\Upsilon_G}{\Gamma}}{\partial \epsilon} \\
&- \left\{1 - \left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\frac{r^\star}{\xi + r^\star}\frac{\Psi\Upsilon_G}{\Gamma}\right\}\frac{g}{\Psi^2}\frac{\partial \Psi}{\partial \epsilon} < 0.
\end{aligned} \tag{279}$$

A rise in ϵ mitigates the appreciation in the relative price of non tradables by amplifying the increase in the supply of non tradables and by reducing the excess of demand for non tradables. First, in countries where labor is more mobile across sectors, a government spending shock biased toward non tradables leads to a larger increase in non traded output which mitigates the appreciation in the relative price of non tradables. Second, as ϵ takes higher values, the wealth effect becomes larger so that private consumption is crowded out by a larger amount which results in a lower excess demand of non tradables.

Totally differentiating the response of output share of non tradables to a government spending shock described by eq. (257) with respect to ϵ and making use of eq. (279):

$$\begin{aligned}
\frac{\partial \alpha_L\left(\hat{Y}^N(0) - \hat{Y}_R(0)\right)}{\partial \epsilon} &= \alpha_L\,(1-\alpha_L)\,\hat{P}(0) + (1-\alpha_L)\,\epsilon\frac{\partial \hat{P}(0)}{\partial \epsilon}, \\
&= \hat{P}(0)\alpha_L\,(1-\alpha_L)\left[1 - \frac{\alpha_L\,(1-\alpha_L)\,\epsilon}{\Psi}\right] \\
&- \alpha_L\,(1-\alpha_L)\,\epsilon\frac{g}{\Psi}\left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]\frac{r^\star}{\xi + r^\star}\frac{\partial \frac{\Psi\Upsilon_G}{\Gamma}}{\partial \epsilon},
\end{aligned} \tag{280}$$

where $0 < \frac{\alpha_L(1-\alpha_L)\epsilon}{\Psi} < 1$ and $\frac{\partial \frac{\Psi\Upsilon_G}{\Gamma}}{\partial \epsilon} > 0$ (see eq. (278)). According to (280), the relationship between the positive response of output share of non tradables and the degree of labor mobility across sectors is ambiguous. On the one hand, as shown by the first term on the RHS of (280), a rise in the parameter ϵ on the RHS of the above equation amplifies the reallocation of labor toward the non traded sector and thus raises further the output share of non tradables. On the other hand, the rise in the degree of labor mobility also mitigates the rise in the output share as higher mobility increases further the shadow value of wealth which amplifies the crowding out of private consumption by public spending and thus moderates excess demand in the non traded goods market. Consequently, the relative price of non tradables appreciates by a lower amount which reduces the incentive to increase non traded output. We address this ambiguity numerically in the main text. Because its expression is exactly the opposite of eq. (257), a rise in the degree of labor mobility across sectors may amplify or mitigate the decline in the output share of tradables following a rise in government consumption in non tradables.

We now investigate the magnitude of the response of the output share of tradables when imposing perfect mobility of labor across sectors. Letting ϵ tend toward infinity into eq. (257), using (270) together with the fact that $\lim_{\epsilon\to\infty} \frac{\alpha_L(1-\alpha_L)}{\Psi} = 1$, and applying l'Hôpital's rule, the initial response of the output share of non tradables can be rewritten as follows:

$$\begin{aligned}\lim_{\epsilon\to\infty} \alpha_L \left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) &= \lim_{\epsilon\to\infty} \alpha_L \left(1-\alpha_L\right) \epsilon \hat{P}(0), \\ &= \left[1 - \left(\frac{\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C}{\sigma_L + \omega_C\sigma_C}\right)\frac{r^\star}{\xi + r^\star}\right] g > 0, \qquad (281)\end{aligned}$$

where $0 < \left(\frac{\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\right) < 1$. **Eq. (281) corresponds to eq. (48) in the main text**.

Applying the same logic to the output share of tradables described by eq. (258), the response of the traded output relative to GDP in percent of output when assuming perfect mobility of labor across sectors is:

$$\begin{aligned}\lim_{\epsilon\to\infty} \left(1-\alpha_L\right) \left(\hat{Y}^T(0) - \hat{Y}_R(0)\right) &= -\alpha_L \left(1-\alpha_L\right) \epsilon \hat{P}(0), \\ &= -\lim_{\epsilon\to\infty} \alpha_L \left(1-\alpha_L\right) \epsilon \hat{P}(0), \\ &= -\left[1 - \left(\frac{\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C}{\sigma_L + \omega_C\sigma_C}\right)\frac{r^\star}{\xi + r^\star}\right] g < 0. \qquad (282)\end{aligned}$$

C.16 Elasticity of Labor Supply and the Share of Non Tradables: Sensitivity Analysis

In this subsection, we investigate how the elasticity of labor supply, σ_L, and the non tradable content of consumption expenditure, α_C, influence the magnitude of the sectoral impact of a government spending shock.

C.16.1 Sensitivity to the Intertemporal Elasticity for Labor Supply

We first investigate the implications of the Frisch elasticity of labor supply for the responses of the marginal utility of wealth and the relative price of non tradables which are described by (246) and (249), respectively. To do so, we have to explore the relationship between $\frac{\Psi\Upsilon_G}{\Gamma}$ and σ_L. Differentiating Υ_G w.r.t. σ_L leads to:

$$\frac{\partial \Upsilon_G}{\partial \sigma_L} = -\frac{\alpha_L}{\Psi^2}\left\{\alpha_L\left(1-\alpha_L\right)\epsilon + \omega_C\sigma_C\left[\left(1-\alpha_C\right)\phi - \left(\alpha_L-\alpha_C\right)\sigma_C\right]\right\} \lesseqgtr 0. \qquad (283)$$

While the sign of $\frac{\partial\Upsilon_G}{\partial\sigma_L}$, is ambiguous, when ϕ is close to σ_C, we find that $\frac{\partial\Upsilon_G}{\partial\sigma_L} < 0$. Eq. (275) can be rewritten as follows:

$$\frac{\Psi\Upsilon_G}{\Gamma} = \frac{1}{\frac{\left[(1-\alpha_L)\sigma_L + \omega_C(1-\alpha_C)\sigma_C\right]}{\Upsilon_G} + \left[\alpha_L\sigma_L + \omega_C\alpha_C\sigma_C\right]}. \qquad (284)$$

Because the denominator is higher as the values of σ_L increase, the marginal utility of wealth rises by a smaller amount (see eq. (246)). Intuitively, because agents supply more labor following a rise in government consumption, private savings falls by a smaller amount which results in a lower current account deficit. Thus, the marginal utility of wealth must increase less for the intertemporal solvency condition to hold. According to (249), increasing σ_L exerts opposite effects on $\hat{P}(0)$. First, because the marginal utility of wealth increases less, consumption in non tradables falls less while hours worked rises more in the non traded sector as agents supply more labor. If both effects offset each other, excess demand in the non traded goods market is unchanged. On the other hand, raising σ_L makes the relative price more responsive to the excess demand in the non traded goods market following a rise in G^N as reflected by larger values in Ψ (see eq. (133)). Overall, one may expect that the last effect predominates so that the relative price of non tradables appreciates less when the elasticity σ_L is high. As a result, the responses of sectoral labor and thus sectoral output shares described by (257) for non tradables and (258) for tradables, respectively, should be less pronounced as the relative price appreciates less.

C.16.2 Sensitivity to Non Tradable Share

We first investigate the implications of increasing α_C for the responses of the marginal utility of wealth and the relative price of non tradables which are described by (246) and (249), respectively. To do so, we first evaluate Υ_G when we let α_C tend toward zero and one, respectively:

$$\lim_{\alpha_C \to 0} \Upsilon_G = \frac{(1-\alpha_L)\,\alpha_L\,(\epsilon - \sigma_L)}{\alpha_L\left[\epsilon\,(1-\alpha_L) + \alpha_L\sigma_L\right]}, \tag{285a}$$

$$\lim_{\alpha_C \to 1} \Upsilon_G = \frac{(1-\alpha_L)\,\alpha_L\,(\epsilon - \sigma_L)}{\alpha_L\left[\epsilon\,(1-\alpha_L) + \alpha_L\sigma_L\right] + \omega_C\sigma_C}. \tag{285b}$$

It is straightforward to see that the following inequality holds:

$$\lim_{\alpha_C \to 0} \Upsilon_G > \lim_{\alpha_C \to 1} \Upsilon_G > 0. \tag{286}$$

Then, we evaluate $\frac{\Psi \Upsilon_G}{\Gamma}$ when we let α_C tend toward zero and one, respectively:

$$\lim_{\alpha_C \to 0} \frac{\Psi \Upsilon_G}{\Gamma} = \frac{1}{\frac{\left[(1-\alpha_L)\sigma_L + \omega_C\sigma_C\right]}{\lim_{\alpha_C \to 0}\Upsilon_G} + \alpha_L\sigma_L}, \tag{287a}$$

$$\lim_{\alpha_C \to 1} \frac{\Psi \Upsilon_G}{\Gamma} = \frac{1}{\frac{(1-\alpha_L)\sigma_L}{\lim_{\alpha_C \to 1}\Upsilon_G} + \alpha_L\sigma_L + \omega_C\sigma_C}. \tag{287b}$$

Substituting (285a) into (287a) and (285b) into (287b), after tedious computations, it can be shown analytically that:

$$\left\{\frac{\left[(1-\alpha_L)\,\sigma_L + \omega_C\sigma_C\right]}{\lim_{\alpha_C \to 0}\Upsilon_G} + \alpha_L\sigma_L\right\} - \left\{\frac{(1-\alpha_L)\,\sigma_L}{\lim_{\alpha_C \to 1}\Upsilon_G} + \alpha_L\sigma_L + \omega_C\sigma_C\right\} > 0, \tag{288}$$

and thus

$$\lim_{\alpha_C \to 1} \frac{\Psi \Upsilon_G}{\Gamma} > \lim_{\alpha_C \to 0} \frac{\Psi \Upsilon_G}{\Gamma} > 0. \tag{289}$$

Intuitively, as α_C takes higher values, the share of tradables falls. At the final steady-state, net exports must be larger for the open economy to be solvent. To improve the balance of trade in the long-run, output of tradables must be higher while consumption in tradables must be lower. Because the share of tradables in the economy is lower, the marginal utility of wealth must increase by a larger amount to lower consumption in tradables and thus to increase net exports.

As the negative wealth effect is stronger, excess demand for non tradables and thus the subsequent appreciation in the relative price P are smaller which mitigates the shift of resources toward the non traded sector and thus moderates the fall in traded output and the rise in non traded output.

C.17 Effects of a Rise in Government Consumption on Tradables, G^T

In this subsection, we explore the effects of a rise in government consumption on tradables, G^T, while keeping fixed public purchases of non tradables, G^N. Since G^N is unchanged, eq. (238) reduces to:

$$\hat{P} = \frac{-\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\hat{\bar{\lambda}}, \tag{290}$$

where $\Psi = \alpha_L\left[\epsilon\,(1-\alpha_L) + \sigma_L\alpha_L\right] + \omega_C\alpha_C\left[(1-\alpha_C)\,\phi + \alpha_C\sigma_C\right] > 0$ (see eq. (133)).

Inserting (290) into $\hat{L}^T = -\alpha_L\,(\epsilon - \sigma_L)\,\hat{P} + \sigma_L\hat{\bar{\lambda}}$ leads to the change in traded labor relative to initial steady-state:

$$\hat{L}^T = \left\{\sigma_L + \frac{\alpha_L\,(\epsilon - \sigma_L)\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\right\}\hat{\bar{\lambda}}. \tag{291}$$

Inserting (290) into $\hat{L}^N = [\epsilon(1-\alpha_L) + \alpha_L\sigma_L]\hat{P} + \sigma_L\hat{\bar{\lambda}}$ leads to the change in non traded labor from initial steady-state:

$$\hat{L}^N = \left\{\sigma_L - \frac{[\epsilon(1-\alpha_L) + \alpha_L\sigma_L][\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C]}{\Psi}\right\}\hat{\bar{\lambda}}, \tag{292}$$

where the term in braces is positive if and only if:

$$\sigma_L[(1-\alpha_C)\phi + \alpha_C\sigma_C] > \sigma_C[\epsilon(1-\alpha_L) + \alpha_L\sigma_L].$$

One interesting case is that where $\sigma_C = \phi = 1$. Eq. (292) can be rewritten as follows:

$$\hat{L}^N = -\left\{\frac{\alpha_C\omega_C(1-\alpha_L)(\epsilon-\sigma_L)}{\Psi'}\right\}\hat{\bar{\lambda}} < 0, \tag{293}$$

where the sign follows from assumption 1 and we used the fact that $\Psi' = \Psi\big|_{\phi=\sigma_C=1} = \alpha_L[\epsilon(1-\alpha_L) + \sigma_L\alpha_L] + \omega_C\alpha_C > 0$ to derive (293).

Applying the theorem of implicit functions, eqs. (290)-(292), leads to the short-run static solutions for the relative price, both traded and non traded labor which depend exclusively on the shadow value of wealth:

$$P = P(\bar{\lambda}), \quad L^T = L^T(\bar{\lambda}), \quad L^N = L^N(\bar{\lambda}). \tag{294}$$

Inserting (290) into $\hat{C}^T = \alpha_C(\phi-\sigma_C)\hat{P} - \sigma_C\hat{\bar{\lambda}}$ leads to the response of consumption in tradables in percentage relative to initial steady-state:

$$\hat{C}^T = \left\{\sigma_C + \frac{\alpha_C(\phi-\sigma_C)[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C]}{\Psi}\right\}\hat{\bar{\lambda}}. \tag{295}$$

Inserting (290) into $\hat{C}^N = [\phi(1-\alpha_C) + \alpha_C\sigma_C]\hat{P} - \sigma_C\hat{\bar{\lambda}}$ leads to the response of consumption in non tradables in percentage relative to initial steady-state:

$$\begin{aligned}\hat{C}^N &= -\left\{\sigma_C - \frac{[\phi(1-\alpha_C) + \alpha_C\sigma_C][\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C]}{\Psi}\right\}\hat{\bar{\lambda}}, \\ &= -\frac{\alpha_L\{\sigma_C[\epsilon(1-\alpha_L) + \alpha_L\sigma_L] - \sigma_L[\phi(1-\alpha_C) + \alpha_C\sigma_C]\}}{\Psi}\hat{\bar{\lambda}}. \end{aligned} \tag{296}$$

If $\phi = \sigma_C = 1$, consumption in non tradables falls under assumption 1. Applying the theorem of implicit functions, eqs. (295)-(296), leads to the short-run static solution for consumption in tradables and consumption in non tradables which depend exclusively on the shadow value of wealth:

$$C^T = C^T(\bar{\lambda}), \quad C^N = C^N(\bar{\lambda}). \tag{297}$$

Substituting short-run static solutions for traded labor, i.e., $L^T = L^T(\bar{\lambda})$ and $C^T = C^T(\bar{\lambda})$, into (235j) leads to:

$$\dot{B}(t) = r^\star B(t) + L^T(\bar{\lambda}) - C^T(\bar{\lambda}) - G^T(t). \tag{298}$$

Using the fact that both $\bar{\lambda}$ and G^N are both constant over time, linearizing (298) in the neighborhood of the steady-state yields:

$$\begin{aligned}\dot{B}(t) &= r^\star\left(B(t) - \tilde{B}\right) - \left(G(t) - \tilde{G}\right) \\ &= r^\star\left(B(t) - \tilde{B}\right) - \tilde{Y}ge^{-\xi t}.\end{aligned}$$

where we used the fact that $G^T(t) - \tilde{G}^T = G(t) - \tilde{G} = \tilde{Y}ge^{-\xi t}$. Solving leads to the general solution for the net foreign asset position:

$$B(t) - \tilde{B} = \left[\left(B_0 - \tilde{B}\right) - \frac{\tilde{Y}g}{\xi + r^\star}\right]e^{r^\star t} + \frac{\tilde{Y}g}{\xi + r^\star}e^{-\xi t}. \tag{299}$$

Invoking the transversality condition gives the solution for $B(t)$:

$$B(t) - \tilde{B} = \frac{\tilde{Y}g}{\xi + r^{\star}} e^{-\xi t}, \tag{300}$$

consistent with the intertemporal solvency condition

$$\left(\tilde{B} - B_0\right) = -\frac{\tilde{Y}g}{\xi + r^{\star}}. \tag{301}$$

Setting $\dot{B}(t) = 0$ into (298), totally differentiating and inserting (292) together with (295) allow us to determine the change in the equilibrium value of the marginal utility of wealth:

$$r^{\star}\frac{d\tilde{B}}{\tilde{Y}} + (1-\alpha_L)\,\hat{\tilde{L}}^T = (1-\alpha_C)\,\omega_C \hat{\tilde{C}}^T,$$

$$\hat{\tilde{\lambda}} = -\frac{\Psi}{\Gamma} r^{\star}\frac{d\tilde{B}}{\tilde{Y}},$$

where $\Gamma > 0$ is given by eq. (150). Substituting (301) into the above equation leads to the change in the equilibrium value of the marginal utility of wealth:

$$\hat{\tilde{\lambda}} = \frac{\Psi}{\Gamma}\frac{r^{\star}}{\xi + r^{\star}} g > 0, \tag{302}$$

where $\Gamma > 0$, $\Psi > 0$, $\Upsilon_G > 0$, $\xi > 0$, and $g > 0$. According to (302), an unanticipated temporary rise in G^T increases the shadow value of wealth and thus produces a negative wealth effect.

Inserting (302) into eq. (290) leads to the once-and-for-all decline in the relative price of non tradables:

$$\hat{P}(0) = \hat{\tilde{P}} = -\frac{\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\frac{\Psi}{\Gamma}\frac{r^{\star}}{\xi + r^{\star}} g < 0. \tag{303}$$

The depreciation in the relative price of non tradables along with the negative wealth effect which induces agents to supply more labor increase unambiguously traded hours worked:

$$\hat{L}^T(0) = \hat{\tilde{L}}^T = \left\{\sigma_L + \frac{\alpha_L\left(\epsilon - \sigma_L\right)\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\right\}\frac{\Psi}{\Gamma}\frac{r^{\star}}{\xi + r^{\star}} g > 0, \tag{304}$$

where we substituted (302) into (292). While the negative wealth effect exerts a positive impact on non traded hours worked, the depreciation in the relative price of non tradables has a negative effect on non traded hours worked:

$$\hat{L}^N = \left\{\sigma_L - \frac{\left[\epsilon\left(1-\alpha_L\right) + \alpha_L\sigma_L\right]\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\right\}\frac{\Psi}{\Gamma}\frac{r^{\star}}{\xi + r^{\star}} g \lesseqgtr 0. \tag{305}$$

In the special case where $\phi = \sigma_C = 1$, non traded labor unambiguously falls under assumption 1 according to which $\epsilon > \sigma_L$.

Differentiating (300) with respect to time leads to the response of the current account:

$$\frac{\dot{B}(t)}{\tilde{Y}} = -\frac{\xi}{\xi + r^{\star}} g e^{-\xi t} < 0. \tag{306}$$

According to (306), a rise in G^T triggers a current account deficit and thus permanently lowers the net foreign asset position in the long-run.

Turning to the responses of sectoral output shares, the depreciation in the relative price of non tradables unambiguously lowers the output share of non tradables and increases the output share of tradables. Inserting (303) into (257) leads to the response of the output share of non tradables to a rise in G^T:

$$\begin{aligned}
\alpha_L\left(\hat{Y}^N(0) - \hat{Y}_R(0)\right) &= \alpha_L\left(1-\alpha_L\right)\epsilon\hat{P}(0), \\
&= -\alpha_L\left(1-\alpha_L\right)\epsilon\frac{\left[\alpha_L\sigma_L + \alpha_C\omega_C\sigma_C\right]}{\Psi}\frac{\Psi}{\Gamma}\frac{r^{\star}}{\xi + r^{\star}} g < 0.
\end{aligned} \tag{307}$$

Inserting (303) into (258) leads to the response of the output share of tradables to a rise in G^T:

$$\begin{aligned}
(1-\alpha_L)\left(\hat{Y}^T(0)-\hat{Y}_R(0)\right) &= -\alpha_L(1-\alpha_L)\,\epsilon\hat{P}(0), \\
&= \alpha_L(1-\alpha_L)\,\epsilon\frac{[\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C]}{\Psi}\frac{\Psi}{\Gamma}\frac{r^\star}{\xi+r^\star}g>0. \quad (308)
\end{aligned}$$

Finally, inserting (290) into (255) yields the one-for-and-all change in real GDP:

$$\begin{aligned}
\hat{Y}_R &= \frac{\sigma_L}{\Psi}\left\{\Psi-\alpha_L\left[\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C\right]\right\}, \\
&= \frac{\sigma_L}{\Psi}\left\{\alpha_L(1-\epsilon_L)+\omega_C\alpha_C\left[(1-\alpha_C)\phi-(\alpha_L-\alpha_C)\sigma_C\right]\right\}\gtrless 0, \quad (309)
\end{aligned}$$

where we have inserted Ψ given by eq. (133).

Pre-multiplying eqs. (304) and (305) by $1-\alpha_L$ and α_L, respectively, and letting ϵ tend toward infinity lead to:

$$\lim_{\epsilon\to\infty}\alpha_L\hat{L}^N(0) = -\frac{\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g<0, \quad (310a)$$

$$\lim_{\epsilon\to\infty}(1-\alpha_L)\,\hat{L}^T(0) = \frac{\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g>0. \quad (310b)$$

Letting ϵ tend toward infinity into eqs. (307) and (308) leads to the responses of output shares of non tradables and tradables, respectively, when we impose perfect mobility of labor across sectors:

$$\lim_{\epsilon\to\infty}\alpha_L\left(\hat{Y}^N(0)-\hat{Y}_R(0)\right) = -\frac{\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g<0, \quad (311a)$$

$$\lim_{\epsilon\to\infty}(1-\alpha_L)\left(\hat{Y}^T(0)-\hat{Y}_R(0)\right) = \frac{\alpha_L\sigma_L+\alpha_C\omega_C\sigma_C}{\sigma_L+\omega_C\sigma_C}\frac{r^\star}{\xi+r^\star}g>0. \quad (311b)$$

D Solving the Model with Physical Capital

This section extends the two-sector model with imperfect mobility of labor to physical capital accumulation which is subject to installation costs.

D.1 Intertemporal Maximization Problem

The representative household chooses consumption, decides on labor supply, and investment that maximizes his/her lifetime utility:

$$U=\int_0^\infty\left\{\frac{1}{1-\frac{1}{\sigma_C}}C(t)^{1-\frac{1}{\sigma_C}}-\frac{1}{1+\frac{1}{\sigma_L}}L(t)^{1+\frac{1}{\sigma_L}}\right\}e^{-\beta t}\mathrm{d}t, \quad (312)$$

subject to the flow budget constraint:

$$\dot{B}(t)=r^\star B(t)+R(t)K(t)+W(t)L(t)-T(t)-P_C\left(P(t)\right)C(t)-P_J\left(P(t)\right)J(t), \quad (313)$$

and capital accumulation which evolves as follows:

$$\dot{K}(t)=I(t)-\delta K(t), \quad (314)$$

where I is investment and $0\leq\delta_K<1$ is a fixed depreciation rate. The first term on the RHS of (313) $r^\star B(t)+R(t)K(t)+W\left(W^T(t),W^N(t)\right)L(t)-T(t)$ is the representative household's real disposable income while the second term on the RHS $P_C\left(P(t)\right)C(t)+P_J\left(P(t)\right)J(t)$ corresponds to consumption and investment expenditure including capital installation costs. More specifically, we assume that capital accumulation is subject to increasing and convex cost of net investment, $I(t)-\delta_K K(t)$:

$$J(t)=I(t)+\Psi\left(I(t),K(t)\right)K(t), \quad (315)$$

where $\Psi(.)$ is increasing (i.e., $\Psi'(.) > 0$), convex (i.e., $\Psi''(.) > 0$), is equal to zero at δ_K (i.e., $\Psi(\delta_K) = 0$), and has first partial derivative equal to zero as well at δ_K (i.e., $\Psi'(\delta_K) = 0$). We suppose the following functional form for the adjustment cost function:

$$\Psi\left(I(t), K(t)\right) = \frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)^2. \tag{316}$$

Using (316), partial derivatives of total investment expenditure are:

$$\frac{\partial J(t)}{\partial I(t)} = 1 + \kappa\left(\frac{I(t)}{K(t)} - \delta_K\right), \tag{317a}$$

$$\frac{\partial J(t)}{\partial K(t)} = -\frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)\left(\frac{I(t)}{K(t)} + \delta_K\right). \tag{317b}$$

Denoting the co-state variables associated with (313) and (314) by λ and Q', respectively, the first-order conditions characterizing the representative household's optimal plans are:

$$C(t) = \left(P_C(t)\lambda\right)^{-\sigma_C}, \tag{318a}$$

$$L(t) = \left(W(t)\lambda\right)^{\sigma_L}, \tag{318b}$$

$$Q(t) = P_J(t)\left[1 + \kappa\left(\frac{I(t)}{K(t)} - \delta_K\right)\right], \tag{318c}$$

$$\dot{\lambda}(t) = \lambda\left(\beta - r^\star\right), \tag{318d}$$

$$\dot{Q}(t) = \left(r^\star + \delta_K\right)Q(t) - \left\{R(t) + P_J(t)\frac{\kappa}{2}\left(\frac{I(t)}{K(t)} - \delta_K\right)\left(\frac{I(t)}{K(t)} + \delta_K\right)\right\}, \tag{318e}$$

and the transversality conditions $\lim_{t\to\infty} \bar{\lambda}B(t)e^{-\beta t} = 0$ and $\lim_{t\to\infty} Q(t)K(t)e^{-\beta t} = 0$; to derive (318c) and (318e), we used the fact that $Q(t) = Q'(t)/\lambda(t)$.

Once households decided on aggregate consumption, they decide on the allocation of expenditure between traded and non traded goods according to the following optimal rule:

$$\left(\frac{\varphi}{1-\varphi}\right)\frac{C^N}{C^T} = P^{-\phi}, \tag{319}$$

where P is the relative price of non-tradables and ϕ captures the extent to which consumers are willing to raise C^T/C^N when P rises by 1%.

Once households decided on aggregate labor supply, they allocate hours worked to the traded and the non traded sector according to the following optimal rule:

$$\left(\frac{\vartheta}{1-\vartheta}\right)\frac{L^N}{L^T} = \Omega^\epsilon, \tag{320}$$

where $\Omega \equiv W^N/W^T$ is the relative wage and ϵ captures the extent to which workers are willing to shift hours worked toward the non traded sector when Ω rises by 1%..

D.2 Household's Intratemporal Maximization Problem

In this subsection, we derive the consumption and investment price index and determine the aggregate wage index.

At each instant of time, the representative household consumes traded and non traded goods denoted by C^T and C^N, respectively, which are aggregated by means of a CES function:

$$C = \left[\varphi^{\frac{1}{\phi}}\left(C^T\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}}\left(C^N\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{321}$$

where $0 < \varphi < 1$ is the weight of the traded good in the overall consumption bundle and ϕ corresponds to the elasticity of substitution between traded goods and non traded goods.

As in De Cordoba and Kehoe [2000], the investment good is produced using inputs of the traded good and the non traded good according to a constant-returns-to-scale function which is assumed to take a CES form:

$$J \equiv I\left(J^T, J^N\right) = \left[\varphi_J^{\frac{1}{\phi_J}}\left(J^T\right)^{\frac{\phi_J-1}{\phi_J}} + (1-\varphi_J)^{\frac{1}{\phi_J}}\left(J^N\right)^{\frac{\phi_J-1}{\phi_J}}\right]^{\frac{\phi_J}{\phi_J-1}}, \tag{322}$$

where φ_J is the weight of the investment traded input ($0 < \varphi_J < 1$) and ϕ_J corresponds to the intratemporal elasticity of substitution in investment between traded and non traded inputs.

Following Horvath [2000], we assume that hours worked in the traded and the non traded sectors are aggregated by means of a CES function:

$$L = \left[\vartheta^{-1/\epsilon}\left(L^T\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-1/\epsilon}\left(L^N\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}, \tag{323}$$

and $0 < \vartheta < 1$ is the weight of labor supply to the traded sector in the labor index $L(.)$ and ϵ measures the ease with which hours worked can be substituted for each other and thereby captures the degree of labor mobility across sectors.

Consumption Price Index

The traded and the consumption good are aggregated by means of a CES function given by (321) with $\phi > 0$ the intratemporal elasticity of substitution between consumption of traded and non traded goods. At the first stage, the household minimizes the cost or total expenditure measured in terms of traded goods:

$$E_C \equiv C^T + PC^N, \tag{324}$$

for a given level of subutility, $C(t)$, where $P(t)$ is the price of non traded goods in terms of traded goods. For any chosen $C(t)$, the optimal basket $(C^T(t), C^N(t))$ is a solution to:

$$P_C\left(P(t)\right)C(t) = \min_{\{C^T(t),C^N(t)\}}\left\{C^T(t) + P(t)C^N(t) : C\left(C^T(t), C^N(t)\right) \geq C(t)\right\}. \tag{325}$$

The subutility function $C(.)$ is linear homogeneous which implies that total expenditure in consumption goods can be expressed as $E_C(t) = P_C\left(P(t)\right)C(t)$, where $P_C\left(P(t)\right)$ is the unit cost function dual (or consumption-based price index) to C. The unit cost dual function, $P_C(.)$, is defined as the minimum total expense in consumption goods, E_C, such that $C = C\left(C^T(t), C^N(t)\right) = 1$, for a given level of the relative price of non tradables, P. Its expression is given by

$$P_C = \left[\varphi + (1-\varphi)P^{1-\phi}\right]^{\frac{1}{1-\phi}}. \tag{326}$$

The minimized unit cost function depends on relative price of non tradables with the following properties:

$$P_C' = (1-\varphi)P^{-\phi}\left(P_C\right)^{\phi} > 0, \tag{327a}$$

$$-\frac{P_C''P}{P_C'} = \phi\left[1 - \frac{(1-\varphi)P^{1-\phi}}{P_C^{1-\phi}}\right] = \phi\left(1-\alpha_C\right). \tag{327b}$$

Intratemporal allocation between non tradable goods and tradable goods follows from Shephard's Lemma (or the envelope theorem) applied to (325):

$$C^N = \frac{\partial P_C}{\partial P}C = P_C'C = (1-\varphi)\left(\frac{P}{P_C}\right)^{-\phi}C, \quad \text{and} \quad \frac{PC^N}{P_CC} = \alpha_C, \tag{328a}$$

$$C^T = \left[P_C - PP_C'\right]C = \varphi\left(\frac{1}{P_C}\right)^{-\phi}C, \quad \text{and} \quad \frac{C^T}{P_CC} = \left(1-\alpha_C\right), \tag{328b}$$

where the non tradable and tradable shares in total consumption expenditure are:

$$\alpha_C = \frac{(1-\varphi)P^{1-\phi}}{\varphi + (1-\varphi)P^{1-\phi}},, \tag{329a}$$

$$1-\alpha_C = \frac{\varphi}{\varphi + (1-\varphi)P^{1-\phi}}. \tag{329b}$$

Investment Price Index

At each instant, the investment sector minimizes the cost or total expenditure measured in terms of traded goods:

$$E_J \equiv PJ^N + J^T, \tag{330}$$

for a given level of output, $J(t)$; $P(t)$ is the relative price of non traded goods. For any chosen $J(t)$, the optimal basket $(J^T(t), J^N(t))$ is a solution to:

$$P_J\left(P(t)\right)J(t) = \min_{\{J^T(t),J^N(t)\}} \left\{J^T(t) + P(t)J^N(t)(t) : J\left(J^T(t), J^N(t)\right) \geq J(t)\right\}. \quad (331)$$

The aggregator function $J\left(.\right)$ is linear homogeneous implies that total expenditure in investment inputs can be expressed as $E_J(t) = P_J\left(P(t)\right)J(t)$, where $P_J\left(P(t)\right)$ the unit cost function dual (or investment-based price index) to J. The unit cost dual function, $P_J\left(.\right)$, is defined as the minimum total expense in investment inputs, E_J, such that $J = J\left(J^T(t), J^N(t)\right) = 1$, for a given level of the relative price of non tradables, P. Its expression is given by

$$P_J = \left[\varphi_J + \left(1-\varphi_J\right)P^{1-\phi_J}\right]^{\frac{1}{1-\phi_J}}. \quad (332)$$

Intratemporal allocation between non tradable goods and tradable goods follows from Shephard's Lemma (or the envelope theorem) applied to (331):

$$J^N = P_J'J = \left(1-\varphi_J\right)\left(\frac{P}{P_J}\right)^{-\phi_J}J, \quad \text{and} \quad \frac{PI^N}{P_JJ} = \alpha_J, \quad (333a)$$

$$J^T = \left[P_J - PP_J'\right]I = \varphi_J\left(\frac{1}{P_J}\right)^{-\phi_J}J, \quad \text{and} \quad \frac{J^T}{P_JJ} = \left(1-\alpha_J\right), \quad (333b)$$

where the non tradable and tradable shares in total investment expenditure are:

$$\alpha_J = \frac{\left(1-\varphi_J\right)P^{1-\phi_J}}{\varphi_J + \left(1-\varphi_J\right)P^{1-\phi_J}}, \quad (334a)$$

$$1-\alpha_J = \frac{\varphi_J}{\varphi_J + \left(1-\varphi_J\right)P^{1-\phi_J}}. \quad (334b)$$

Aggregate Wage Index

The representative household maximizes $1-L(.)$ where $L(.)$ is a CES function given by (323) with $\epsilon > 0$ the elasticity of labor supply across sectors, given total labor income denoted by R_L measured in terms of the traded good:

$$R_L \equiv W^TL^T + W^NL^N, \quad (335)$$

where W^T is the wage rate in the traded sector and W^N is the wage rate in the non traded sector. The linear homogeneity of the subutility function $L\left(.\right)$ implies that total labor income can be expressed as $R_L = W\left(W^T, W^N\right)L$, where $W\left(W^T, W^N\right)$ is the unit cost function dual (or aggregate wage index) to L. The unit cost dual function, $W\left(.\right)$, is defined as the minimum total labor income, R_L, such that $L = L\left(L^T, L^N\right) = 1$, for a given level of the wage rates W^T and W^N. We derive below its expression.

Combining (320) together with total labor income (335) measured in terms of the traded good, we are able to express labor supply to the traded and the non traded sector, respectively, as functions of total labor income:

$$L^T = (1-\vartheta)\left(W^T\right)^{-1}\left[(1-\vartheta) + \vartheta\left(\frac{W^N}{W^T}\right)^{\epsilon+1}\right]^{-1}R_L,$$

$$L^N = \vartheta\left(W^T\right)^{-1}\left(\frac{W^N}{W^T}\right)^{\epsilon}\left[(1-\vartheta) + \vartheta\left(\frac{W^N}{W^T}\right)^{\epsilon+1}\right]^{-1}R_L.$$

Plugging these equations into (323), setting $L = 1$ and $R_L = W$, yields the aggregate wage index:

$$W = \left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}. \quad (336)$$

Intratemporal allocation of hours worked between the traded and the non traded sector follows from Shephard's Lemma (or the envelope theorem):

$$L^T = \frac{\partial W}{\partial W^T}L = W_TL, \quad \text{and} \quad \frac{W^TL}{WL} = 1-\alpha_L, \quad (337a)$$

$$L^N = \frac{\partial W}{\partial W^N}L = W_NL, \quad \text{and} \quad \frac{W^NL}{WL} = \alpha_L, \quad (337b)$$

where the non tradable and tradable content of total labor income are:

$$\alpha_L = \frac{(1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]},, \tag{338a}$$

$$1-\alpha_L = \frac{\vartheta\left(W^T\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]}. \tag{338b}$$

D.3 Firm's Maximization Problem

Both the traded and non-traded sectors use physical capital, K^T and K^N, and labor, L^T and L^N, according to constant returns to scale production functions $Y^T = Z^T F\left(K^T, L^T\right)$ and $Y^N = Z^N H\left(K^N, L^N\right)$ which are assumed to take a Cobb-Douglas form:

$$Y^T = Z^T\left(L^T\right)^{\theta^T}\left(K^T\right)^{1-\theta^T}, \tag{339a}$$

$$Y^N = Z^N\left(L^N\right)^{\theta^N}\left(K^N\right)^{1-\theta^N}, \tag{339b}$$

where θ^j is the labor income share in sector j and Z^j corresponds to the total factor productivity index which is introduced for calibration purposes. Both sectors face two cost components: a capital rental cost equal to R, and a labor cost equal to the wage rate, i.e., W^T in the traded sector and W^N in the non traded sector. Both sectors are assumed to be perfectly competitive.

Since capital can move freely between the two sectors while the shift of labor across sectors is costly, only marginal products of capital in the traded and the non traded sector equalize:

$$Z^T\left(1-\theta^T\right)\left(k^T\right)^{-\theta^T} = PZ^N\left(1-\theta^N\right)\left(k^N\right)^{-\theta^N} \equiv R, \tag{340a}$$

$$Z^T\theta^T\left(k^T\right)^{1-\theta^T} \equiv W^T, \tag{340b}$$

$$PZ^N\theta^N\left(k^N\right)^{1-\theta^N} \equiv W^N, \tag{340c}$$

where the capital-labor ratio for sector $j = T, N$ is denoted by $k^j \equiv K^j/L^j$. These static efficiency conditions state that the value of the marginal product of labor in sector j is equal to the labor cost W^j while the value of the marginal product of capital in the traded and the non traded sector must be equal to the capital rental cost, R.

Aggregating over the two sectors gives us the resource constraint for capital:

$$K^T + K^N = K. \tag{341}$$

D.4 Solving the Model

Before linearizing, we have to determine short-run static solutions. Static efficiency conditions (318a) and (318b) can be solved for consumption and labor which of course must hold at any point of time:

$$C = C\left(\bar{\lambda}, P\right), \quad L = L\left(\bar{\lambda}, W^T, W^N\right), \tag{342}$$

with

$$C_{\bar{\lambda}} = \frac{\partial C}{\partial \bar{\lambda}} = -\sigma_C\frac{C}{\bar{\lambda}} < 0, \tag{343a}$$

$$C_P = \frac{\partial C}{\partial P} = -\alpha_C\sigma_C\frac{C}{P} < 0, \tag{343b}$$

$$L_{\bar{\lambda}} = \frac{\partial L}{\partial \bar{\lambda}} = \sigma_L\frac{L}{\bar{\lambda}} > 0, \tag{343c}$$

$$L_{W^T} = \frac{\partial L}{\partial W^T} = \sigma_L L\frac{(1-\alpha_L)}{W^T} > 0, \tag{343d}$$

$$L_{W^N} = \frac{\partial L}{\partial W^N} = \sigma_L L\frac{\alpha_L}{W^N} > 0, \tag{343e}$$

where we used the fact that $\frac{\partial W}{\partial W^T}\frac{W^T}{W} = (1-\alpha_L)$ and $\frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L$ (see (122e)); σ_C and σ_L correspond to the intertemporal elasticity of substitution for consumption and labor, respectively. A rise in the shadow value of wealth induces agents to cut their real expenditure and to supply more labor. By raising the consumption price index, an appreciation in the relative price of non tradables drives down consumption. A rise in sectoral wage rates increases the aggregate wage index which provides an incentive to increase hours worked.

Inserting first the short-run solution for consumption (342) into (328a) and (328b) gives the short-run static solutions for C^T and C^N:

$$C^T = C^T\left(\bar{\lambda}, P\right), \quad C^N = C^N\left(\bar{\lambda}, P\right), \tag{344}$$

with partial derivatives given by

$$\begin{aligned}
C^T_{\bar{\lambda}} &= -\sigma_C \frac{C^T}{\bar{\lambda}} < 0, && (345a)\\
C^T_P &= \alpha_C \frac{C^T}{P}\left(\phi - \sigma_C\right) \lesseqgtr 0, && (345b)\\
C^N_{\bar{\lambda}} &= -\sigma_C \frac{C^N}{\bar{\lambda}} < 0, && (345c)\\
C^N_P &= -\frac{C^N}{P}\left[\left(1-\alpha_C\right)\phi + \alpha_C\sigma_C\right] < 0, && (345d)
\end{aligned}$$

where we used the fact that $-\frac{P_C'' P}{P_C'} = \phi\left(1-\alpha_C\right) > 0$ and $P_C' C = C^N$. A rise in the shadow value of wealth lowers both C^T and C^N. An appreciation in P lowers unambiguously C^N and increases C^T if $\phi > \sigma_C$.

Inserting first the short-run solution for labor (342), into $L^T = \frac{\partial W\left(W^T, W^N\right)}{\partial W^T} L$ and $L^N = \frac{\partial W\left(W^T, W^N\right)}{\partial W^N} L$, allows us to solve for L^T and L^N:

$$L^T = L^T\left(\bar{\lambda}, W^T, W^N\right), \quad L^N = L^N\left(\bar{\lambda}, W^T, W^N\right), \tag{346}$$

with partial derivatives given by:

$$\begin{aligned}
L^T_{\bar{\lambda}} &= \frac{\partial L^T}{\partial \bar{\lambda}} = \sigma_L \frac{L^T}{\bar{\lambda}} > 0, && (347a)\\
L^T_{W^T} &= \frac{\partial L^T}{\partial W^T} = \frac{L^T}{W^T}\left[\epsilon\alpha_L + \sigma_L\left(1-\alpha_L\right)\right] > 0, && (347b)\\
L^T_{W^N} &= \frac{\partial L^T}{\partial W^N} = \frac{L^T}{W^N}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, && (347c)\\
L^N_{\bar{\lambda}} &= \frac{\partial L^N}{\partial \bar{\lambda}} = \sigma_L \frac{L^N}{\bar{\lambda}} > 0, && (347d)\\
L^N_{W^N} &= \frac{\partial L^N}{\partial W^N} = \frac{L^N}{W^N}\left[\epsilon\left(1-\alpha_L\right) + \sigma_L\alpha_L\right] > 0, && (347e)\\
L^N_{W^T} &= \frac{\partial L^N}{\partial W^T} = \frac{L^N}{W^T}\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \gtrless 0, && (347f)\\
& && (347g)
\end{aligned}$$

where we used the fact that $\frac{W_{TT}W^T}{W_T} = \epsilon\alpha_L$, $\frac{W_{TN}W^N}{W_T} = -\epsilon\alpha_L$, $\frac{W_{NN}W^N}{W_N} = \epsilon\left(1-\alpha_L\right)$, $\frac{W_{NT}W^T}{W_N} = -\epsilon\left(1-\alpha_L\right)$. The interpretation of these results deserves attention. A rise in the shadow value of wealth induces agents to supply more labor in both sectors. When the traded sector pays higher wages, i.e., W^T rises, workers supply more labor in that sector. Higher wages in the traded sector exerts opposite effects on L^N. On the one hand, because increased W^T raises the aggregate wage index in proportion to $(1-\alpha_L)$, workers are encouraged to supply more labor which in turn increases L^N (and L^T). On the other hand, if the cost of switching sectors is not too high, i.e., if the values of ϵ are not too low, workers are encouraged to reallocate hours worked toward the traded sector. If $\epsilon > \sigma_L$, a rise in W^T lowers L^N. The same logic applies when analyzing the effect of a rise in W^N.

Plugging the short-run static solutions for L^T and L^N given by (346) into the resource constraint for capital (341), the system of four equations consisting of (340a)-(340c) together with (341) can be solved for the sectoral wage rates W^j and sectoral capital-labor ratios k^j. Keeping TFPs unchanged, denoting by $\xi^N \equiv K^N/K$ the share of non traded capital in the aggregate stock of physical capital and log-differentiating (340a)-(340c) and (341) yields in matrix form:

$$\begin{pmatrix} -\theta^T & \theta^N & 0 & 0 \\ \left(1-\theta^T\right) & 0 & -1 & 0 \\ 0 & \left(1-\theta^N\right) & 0 & -1 \\ (1-\xi) & \xi & \Psi_{W^T} & \Psi_{W^N} \end{pmatrix} \begin{pmatrix} \hat{k}^T \\ \hat{k}^N \\ \hat{W}^T \\ \hat{W}^N \end{pmatrix}$$

$$= \begin{pmatrix} \hat{P} \\ 0 \\ -\hat{P} \\ \hat{K} - \Psi_{\bar{\lambda}} \hat{\bar{\lambda}} \end{pmatrix}, \tag{348}$$

where we set:

$$\Psi_{W^T} = \left(1-\xi^N\right) \frac{L^T_{W^T} W^T}{L^T} + \xi^N \frac{L^N_{W^T} W^T}{L^N}, \tag{349a}$$

$$\Psi_{W^N} = \left(1-\xi^N\right) \frac{L^T_{W^N} W^N}{L^T} + \xi^N \frac{L^N_{W^N} W^N}{L^N}, \tag{349b}$$

$$\xi^N \equiv \frac{k^N L^N}{K}, \tag{349c}$$

$$\Psi_{\bar{\lambda}} = \left(1-\xi^N\right) \sigma_L + \xi^N \sigma_L = \sigma_L. \tag{349d}$$

The determinant of (348) is:

$$G \equiv -\left\{\theta^T \left[\left(1-\theta^N\right) \Psi_{W^N} + \xi^N\right] + \theta^N \left[\left(1-\theta^T\right) \Psi_{W^T} + \left(1-\xi^N\right)\right]\right\} \lesseqgtr 0, \tag{350}$$

where

$$\Psi_{W^T} = \left(1-\xi^N\right) \epsilon + \left(1-\alpha_L\right) \left(\sigma_L - \epsilon\right), \tag{351a}$$

$$\Psi_{W^N} = \xi^N \epsilon + \alpha_L \left(\sigma_L - \epsilon\right), \tag{351b}$$

$$\Psi_{W^T} + \Psi_{W^N} = \sigma_L. \tag{351c}$$

The sign of G depends on $\epsilon \gtreqless \sigma_L$; for the baseline calibration, we have $\epsilon > \sigma_L$; because the discrepancy is small, we find it convenient to assume $\sigma_L \simeq \epsilon$ so that a rise in W^T (W^N) does not affect L^N (L^T). Hence, we have $G < 0$. In the following, for clarity purposes, when discussing the results, we assume that $\sigma_L \simeq \epsilon$ so that determinant G given by eq. (350) is negative. Note that all our statements below also hold when $\epsilon > \sigma_L$.

The short-run static solutions for sectoral wages are:

$$W^T = W^T\left(\bar{\lambda}, K, P\right), \quad W^N = W^N\left(\bar{\lambda}, K, P\right), \tag{352}$$

with

$$\frac{\hat{W}^T}{\hat{K}} = -\frac{\left(1-\theta^T\right)\theta^N}{G} > 0, \tag{353a}$$

$$\frac{\hat{W}^N}{\hat{K}} = -\frac{\left(1-\theta^N\right)\theta^T}{G} > 0, \tag{353b}$$

$$\frac{\hat{W}^T}{\hat{P}} = \frac{\left(1-\theta^T\right)\left(\Psi_{W^N} + \xi^N\right)}{G} < 0, \tag{353c}$$

$$\frac{\hat{W}^N}{\hat{P}} = -\frac{\left\{\theta^T \xi^N + \left[\left(1-\xi^N\right) + + \left(1-\theta^T\right)\Psi_{W^T}\right]\right\}}{G} > 0, \tag{353d}$$

$$\frac{\hat{W}^T}{\hat{\bar{\lambda}}} = \frac{\sigma_L \left(1-\theta^T\right)\theta^N}{G} < 0, \tag{353e}$$

$$\frac{\hat{W}^N}{\hat{\bar{\lambda}}} = \frac{\sigma_L \left(1-\theta^N\right)\theta^T}{G} < 0, \tag{353f}$$

$$\tag{353g}$$

The short-run static solutions for capital-labor ratios are:

$$k^T = k^T(\lambda, K, P), \quad k^N = k^N(\bar{\lambda}, K, P), \tag{354}$$

with

$$\begin{aligned}
\frac{\hat{k}^T}{\hat{K}} &= -\frac{\theta^N}{G} > 0, && (355a)\\
\frac{\hat{k}^N}{\hat{K}} &= -\frac{\theta^T}{G} > 0, && (355b)\\
\frac{\hat{k}^T}{\hat{P}} &= \frac{\Psi_{W^N} + \xi^N}{G} < 0, && (355c)\\
\frac{\hat{k}^N}{\hat{P}} &= \frac{\left\{\theta^T \Psi_{W^N} - \left[\left(1-\theta^T\right)\Psi_{W^T} + \left(1-\xi^N\right)\right]\right\}}{G} > 0, && (355d)\\
\frac{\hat{k}^T}{\hat{\bar{\lambda}}} &= \frac{\sigma_L \theta^N}{G} < 0, && (355e)\\
\frac{\hat{k}^N}{\hat{\bar{\lambda}}} &= \frac{\sigma_L \theta^T}{G} < 0. && (355f)\\
& && (355g)
\end{aligned}$$

An increase in the capital stock K raises capital-labor ratios and thereby wage rates in both sectors. A rise in λ encourages agents to supply more labor which reduces sectoral capital-labor ratios and thereby wage rates in both sectors. In the standard model assuming perfect mobility of labor across sectors, an appreciation in the relative price of non tradables shifts resources toward the non traded sector and increases (lowers) k^N and k^T if the traded sector is more (less) capital intensive than the non-traded sector. In a model with limited labor mobility, k^N increases as P appreciates irrespective of whether the traded sector is more or less capital intensive than the non traded sector.

Inserting first sectoral wages (352), sectoral employment (346) can be solved as functions of the shadow value of wealth, the capital stock and the relative price of non tradables:

$$L^T = L^T(\bar{\lambda}, K, P), \quad L^N = L^N(\bar{\lambda}, K, P), \tag{356}$$

where the partial derivatives are not shown as we cannot determine the sign of analytical expressions in the general case. Yet, when assuming $\sigma_L \simeq \epsilon$ and using the fact that $\hat{W}^T = \left(1-\theta^T\right)\hat{k}^T$ we have

$$\hat{L}^T = \sigma_L \hat{\lambda} + \left[\epsilon \alpha_L + \sigma_L(1-\alpha_L)\right]\left(1-\theta^T\right)\hat{k}^T.$$

Using (355), we find that traded labor is increasing with the capital stock K and decreasing with the relative price of non tradables. Adopting a similar reasoning for non traded labor, we have:

$$\hat{L}^N = \sigma_L \hat{\lambda} + \left[\epsilon(1-\alpha_L) + \sigma_L \alpha_L\right]\hat{W}^N.$$

Using (355), we find that non traded labor is increasing with both the capital stock K and the relative price of non tradables.

Production functions (339) can be rewritten ad follows:

$$Y^T = Z^T L^T \left(k^T\right)^{1-\theta^T}, \quad \text{and} \quad Y^N = Z^N L^N \left(k^N\right)^{1-\theta^N}. \tag{357}$$

Inserting first short-run static solutions for sectoral capital-labor ratios (354) and sectoral labor (356) into the production functions of the traded and non traded sectors yields:

$$Y^T = Y^T(\bar{\lambda}, K, P), \quad Y^N = Y^N(\bar{\lambda}, K, P), \tag{358}$$

where the partial derivatives are not shown as we cannot determine the sign of expressions. In the standard two-sector model imposing perfect mobility of labor across sectors, the Rybczynski effect implies that a rise in K raises the output of the sector which is relatively more capital intensive. With a difficulty in reallocating labor across sectors, the Rybczynski effect does no hold as a rise in K now increases both traded and non traded outputs. The reason is that due to imperfect mobility of labor, increasing the capital stock raises capital-labor labor ratios in both sectors so that both Y^T and Y^N rise. As in the standard model assuming perfect mobility of labor, an appreciation in the relative price of non tradables shifts resources toward the non traded sector, but all the less so as labor is less mobile across sectors.

The Return on Domestic Capital, R

The return on domestic capital is:

$$R = Z^T \left(1-\theta^T\right)\left(k^T\right)^{-\theta^T}. \tag{359}$$

Inserting first the short-run static solution for the capital-labor ratio k^T given by (354), eq. (359) can be solved for the return on domestic capital:

$$R = R\left(\bar{\lambda}, K, P\right), \tag{360}$$

where partial derivatives are given by:

$$R_K = \frac{\partial R}{\partial K} = -\theta^T \frac{R}{k^T} k_K^T < 0, \tag{361a}$$

$$R_P = \frac{\partial R}{\partial P} = -\theta^T \frac{R}{k^T} k_P^T > 0. \tag{361b}$$

Optimal Investment Decision, I/K

Eq. (318c) can be solved for the investment rate:

$$\frac{I}{K} = v\left(\frac{Q}{P_I(P)}\right) + \delta_K, \tag{362}$$

where

$$v\left(.\right) = \frac{1}{\kappa}\left(\frac{Q}{P_J} - 1\right), \tag{363}$$

with

$$v_Q = \frac{\partial v(.)}{\partial Q} = \frac{1}{\kappa}\frac{1}{P_J} > 0, \quad v_P = \frac{\partial v(.)}{\partial P} = -\frac{Q}{\kappa}\frac{\alpha_J}{P_J P} < 0. \tag{364}$$

Inserting (362) into (315), investment including capital installation costs can be rewritten as follows:

$$\begin{aligned} J &= K\left[\frac{I}{K} + \frac{\kappa}{2}\left(\frac{I}{K} - \delta_K\right)^2\right], \\ &= K\left[v(.) + \delta_K + \frac{\kappa}{2}\left(v(.)\right)^2\right]. \end{aligned} \tag{365}$$

The Relative Price of Non Tradables, P

Finally, we have to solve for the relative price of non tradables by using the non traded goods market clearing condition:

$$Y^N = C^N + G^N + J^N. \tag{366}$$

Remembering that the non traded input J^N used to produce investment goods is equal to $P_J' J$, inserting short-run static solutions for C^N and Y^N given by (344) and (358), respectively, and substituting (365), the non traded goods market clearing condition (366) can be rewritten as follows:

$$Y^N\left(\bar{\lambda}, K, P\right) = C^N\left(\bar{\lambda}, P\right) + G^N + P_J' K\left[v(.) + \delta_K + \frac{\kappa}{2}\left(v(.)\right)^2\right]. \tag{367}$$

Eq. (367) can be solved for the relative price of non tradables:

$$P = P\left(\bar{\lambda}, K, Q, G^N\right), \tag{368}$$

with partial derivatives given by:

$$\begin{aligned}
P_K &= \frac{\partial P}{\partial K} = \frac{-\frac{Y_K^N}{P_J'} + \frac{J}{K}}{\Psi^P} \lesseqgtr 0, && (369a)\\
P_Q &= \frac{\partial P}{\partial Q} = \frac{K v_Q \left[1+\kappa v(.)\right]}{\Psi^P} > 0, && (369b)\\
P_{G^N} &= \frac{1}{P_J' \Psi^P} > 0, && (369c)
\end{aligned}$$

where we set

$$\Psi^P = \left[\left(Y_P^N - C_P^N\right) + \frac{J^N \phi_J \left(1-\alpha_J\right)}{P}\right] \frac{1}{P_J'} - K v_P \left[1+\kappa v(.)\right] > 0. \tag{370}$$

D.5 Equilibrium Dynamics

Remembering that the non traded input J^N used to produce the capital good is equal to $P_J' J$, using the fact that $J^N = Y^N - C^N - G^N$ and inserting $I = \dot{K} + \delta_K$, the capital accumulation equation can be rewritten as follows:

$$\dot{K} = \frac{Y^N - C^N - G^N}{P_J'} - \delta_K K - \frac{\kappa}{2}\left(\frac{I}{K} - \delta_K\right)^2 K. \tag{371}$$

Inserting short-run static solutions for non traded output (358), consumption in non tradables (344), and optimal investment decision (362) into the physical capital accumulation equation (371) and the dynamic equation for the relative price of non tradables (317b), the dynamic system is:

$$\begin{aligned}
\dot{K} \equiv \Upsilon\left(K, P, Q, G^N\right) &= \frac{Y^N\left(K, P(.), \bar{\lambda}\right) - C^N\left(\bar{\lambda}, P(.)\right) - G^N}{P_J'\left(P(.)\right)}\\
&\quad -\delta_K K - \frac{K}{2\kappa}\left[\frac{Q}{P_J\left(P(.)\right)} - 1\right]^2, && (372a)\\
\dot{Q} \equiv \Sigma\left(K, P, Q, G^N\right) &= \left(r^\star + \delta_K\right) Q - \left[R\left(K, P(.)\right) + P_J \frac{\kappa}{2} v(.)\left(v(.) + 2\delta_K\right)\right]. && (372b)
\end{aligned}$$

As will be useful, let us denote by Υ_K, Υ_Q, and Υ_P the partial derivatives evaluated at the steady-state of the capital accumulation equation w.r.t. K and Q (for given P), respectively, and P:

$$\begin{aligned}
\Upsilon_K\Big|_{\text{P fixed}} &\equiv \frac{\partial \dot{K}}{\partial K}\Big|_{\text{P fixed}} = \left(\frac{Y_K^N}{P_J'} - \delta_K\right) > 0, && (373a)\\
\Upsilon_P &\equiv \frac{\partial \dot{K}}{\partial P} = \left[\left(Y_P^N - C_P^N\right) + \frac{\tilde{I}^N \phi_J \left(1-\alpha_J\right)}{\tilde{P}}\right] \frac{1}{P_J'} > 0, && (373b)\\
\Upsilon_Q\Big|_{\text{P fixed}} &\equiv \frac{\partial \dot{K}}{\partial Q}\Big|_{\text{P fixed}} = 0, && (373c)
\end{aligned}$$

where we used the fact that in the long-run, $\tilde{J}^N = \tilde{I}^N$ and $\tilde{Q} = P_J\left(\tilde{P}\right)$.

Let us denote by Σ_K, Σ_Q, and Σ_P the partial derivatives evaluated at the steady-state of the dynamic equation for the marginal value of an additional unit of capital w.r.t. K and Q (for given P), respectively, and P:

$$\begin{aligned}
\Sigma_K\big|_{\text{P fixed}} &\equiv \frac{\partial \dot{Q}}{\partial K}\Big|_{\text{P fixed}} = -R_K > 0, && (374a)\\
\Sigma_P &\equiv \frac{\partial \dot{Q}}{\partial P} = -R_P - P_J \kappa v_P \delta_K \lesseqgtr 0, && (374b)\\
\Sigma_Q\big|_{\text{P fixed}} &\equiv \frac{\partial \dot{Q}}{\partial Q}\Big|_{\text{P fixed}} = \left(r^\star + \delta_K\right) - P_J \kappa v_Q \delta_K = r^\star > 0, && (374c)
\end{aligned}$$

where R_K given by (361a) is evaluated at the steady-state, i.e., $-P_J\left(r^\star+\delta_K\right)\theta^T \frac{k_K^T}{\tilde{k}^T}<0$, and $R_P=-P_J\left(r^\star+\delta_K\right)\theta^T \frac{k_P^T}{\tilde{k}^T}>0$ (see eq. (361b)); to derive (374c), we inserted $v_Q=\frac{1}{\kappa P_J}$ given by (364).

Denoting steady-state values with a tilde, linearizing (372a)-(372b) in the neighborhood of the steady-state yields in matrix form:

$$\left(\begin{array}{c} \dot{K}(t) \\ \dot{Q}(t) \end{array}\right)=\left(\begin{array}{cc} a_{11} & a_{12} \\ a_{21} & a_{22} \end{array}\right)\left(\begin{array}{c} K(t)-\tilde{K} \\ Q(t)-\tilde{Q} \end{array}\right), \tag{375}$$

where the coefficients of the Jacobian matrix J are given by:

$$a_{11} = \Upsilon_K\big|_{\text{P fixed}}+\Upsilon_P P_K>0, \tag{376a}$$
$$a_{12} = \Upsilon_P P_Q>0, \tag{376b}$$
$$a_{21} = \Sigma_K\big|_{\text{P fixed}}+\Sigma_P P_K>0, \tag{376c}$$
$$a_{22} = r^\star+\Sigma_P P_Q>0, \tag{376d}$$

with partial derivatives being evaluated at the steady-state; we used the fact that at the steady-state $\tilde{J}/\tilde{K}=\tilde{I}/\tilde{K}=\delta_K$ and $\tilde{R}=Z^T\left(1-\theta^T\right)\left(\tilde{k}^T\right)^{-\theta^T}=P_J\left(r^\star+\delta_K\right)$.

Saddle path stability requires the determinant of the Jacobian matrix Det$J$ given by $a_{11}a_{22}-a_{21}a_{12}$ to be negative. While the term $a_{21}a_{12}$ is always positive, regardless of sectoral capital intensities, the term $a_{11}a_{22}$ can be positive or negative. Because both the elasticity k^N with respect to P and the tradable content of investment expenditure $(1-\alpha_J)$ are smaller than one and exert opposite effects on the marginal product of capital, the term $a_{11}a_{22}$ is small so that the saddle-path stability condition is fulfilled regardless of sectoral capital intensities. When investment expenditure are traded only, i.e., $\alpha_J=0$, we have $a_{22}<0$ while $a_{11}>0$; as a result, the determinant of the Jacobian matrix given by $a_{11}a_{22}-a_{21}a_{12}$ is always negative in this case so that the equilibrium is saddle-path. When $0<\alpha_J<1$, the sign of the Jacobian matrix is ambiguous; for all plausible sets of parametrization, we find that the long-run equilibrium is saddle path.

Assuming that the saddle-path stability condition is fulfilled, and denoting the negative eigenvalue by ν_1 and the positive eigenvalue by ν_2, the general solutions for K and Q are:

$$K(t)-\tilde{K}=D_1 e^{\nu_1 t}+D_2 e^{\nu_2 t}, \quad Q(t)-\tilde{Q}=\omega_2^1 D_1 e^{\nu_1 t}+\omega_2^2 D_2 e^{\nu_2 t}, \tag{377}$$

where K_0 is the initial capital stock and $\left(1,\omega_2^i\right)'$ is the eigenvector associated with eigenvalue ν_i:

$$\omega_2^i=\frac{\nu_i-a_{11}}{a_{12}}. \tag{378}$$

Because $\nu_1<0$, $a_{11}>0$ and $a_{12}>0$, we have $\omega_2^1<0$, regardless of sectoral capital intensities, which implies that the shadow value of investment and the stock physical capital move in opposite direction along a stable path.

Remembering that $J^T=\left(1-\alpha_J\right)P_J J$, the current account equation is given by:

$$\begin{aligned} \dot{B}\equiv\Xi\left(B,K,Q,G\right) &= r^\star B+Y^T-C^T-G^T-\left(1-\alpha_J\right)P_J J, \\ &= r^\star B+Y^T-C^T-G^T-\left(\frac{1-\alpha_J}{\alpha_J}\right)P\left(Y^N-C^N-G^N\right), \end{aligned} \tag{379}$$

where we used the fact that $P_J' J=Y^N-C^N-G^N$. As will be useful later, let us denote by Ξ_K and Ξ_P the partial derivatives of the accumulation equation for traded bonds w.r.t. K (for given P) and P:

$$\Xi_K\big|_{\text{P fixed}} \equiv \frac{\partial\dot{B}}{\partial K}\Big|_{\text{P fixed}}=Y_K^T-\left(\frac{1-\alpha_J}{\alpha_J}\right)\tilde{P}Y_K^N\geq 0, \tag{380a}$$
$$\Xi_P \equiv \frac{\partial\dot{B}}{\partial P}=\left(Y_P^T-C_P^T\right)-\left(\frac{1-\alpha_J}{\alpha_J}\right)\tilde{P}\left(Y_P^N-C_P^N\right)-\phi_J\left(\frac{1-\alpha_J}{\alpha_J}\right)\tilde{I}^N<0, \tag{380b}$$

where we used the fact that $\frac{\partial\left(\frac{1-\alpha_J}{\alpha_J}\right)}{\partial P} = -\frac{1}{P}\left[\left(\frac{1-\alpha_J}{\alpha_J}\right) - \phi_J\left(\frac{1-\alpha_J}{\alpha_J}\right)\right]$ and at the steady-state, we have $\tilde{J}^N = \tilde{I}^N$ since capital installation costs are absent in the long run.

Inserting first the short-run static solutions for traded output (358) and consumption in tradables (344) into the accumulation equation of foreign bonds (379), linearizing, substituting the solutions for $K(t)$ and $Q(t)$ given by (377) yields the general solution for traded bonds:

$$B(t) = \tilde{B} + \left[\left(B_0 - \tilde{B}\right) - \Psi_1 D_1 - \Psi_2 D_2\right] e^{r^\star t} + \Psi_1 D_1 e^{\nu_1 t} + \Psi_2 D_2 e^{\nu_2 t}, \tag{381}$$

where B_0 is the initial stock of traded bonds and we set

$$\Xi_K = \Xi_K\big|_{\text{P fixed}} + \Xi_P P_K, \tag{382a}$$
$$\Xi_Q = \Xi_P P_Q, \tag{382b}$$
$$N_i = \Xi_K + \Xi_Q \omega_2^i, \tag{382c}$$
$$\Psi_i = \frac{N_i}{\nu_i - r^\star}. \tag{382d}$$

Invoking the transversality condition leads to the linearized version of the nations's intertemporal solvency condition:

$$\tilde{B} - B_0 = \Psi_1\left(\tilde{K} - K_0\right), \tag{383}$$

where K_0 is the initial stock of physical capital.

D.6 Derivation of the Accumulation Equation of Financial Wealth

Remembering that the stock of financial wealth $A(t)$ is equal to $B(t)+Q(t)K(t)$, differentiating w.r.t. time, i.e., $\dot{A}(t) = \dot{B}(t) + \dot{Q}(t)K(t) + Q(t)\dot{K}(t)$, plugging the dynamic equation for the marginal value of capital (318e), inserting the accumulation equations for physical capital (314) and traded bonds (313), yields the accumulation equation for the stock of financial wealth or the dynamic equation for private savings:

$$\dot{A}(t) = r^\star A(t) + W(t)L(t) - T(t) - P_C\left(P(t)\right)C(t). \tag{384}$$

We first determine short-run static solutions for aggregate labor supply and aggregate wage index. Inserting short-run static solutions for sectoral wages (352) into the short-run static solution for aggregate labor supply (340), we can solve for total hours worked:

$$L = L\left(\bar{\lambda}, K, P\right), \tag{385}$$

where partial derivatives are given by

$$L_K \equiv \frac{\partial L}{\partial K} = L_{W^T}W_K^T + L_{W^N}W_K^N > 0, \tag{386a}$$
$$L_P \equiv \frac{\partial L}{\partial P} = L_{W^T}W_P^T + L_{W^N}W_P^N \gtrless 0. \tag{386b}$$

Substituting short-run static solutions for sectoral wages (352) into the aggregate wage index $W \equiv W\left(W^T, W^N\right)$, we can solve for the aggregate wage index:

$$W = W\left(\bar{\lambda}, K, P\right), \tag{387}$$

where partial derivatives are given by

$$W_K \equiv \frac{\partial W}{\partial K} = W_{W^T}W_K^T + W_{W^N}W_K^N, \tag{388a}$$
$$W_P \equiv \frac{\partial W}{\partial P} = W_{W^T}W_P^T + W_{W^N}W_P^N, \tag{388b}$$

with $W_{W^T} = \left(W/W^T\right)(1-\alpha_L)$ and $W_{W^N} = \left(W/W^N\right)\alpha_L$.

As will be useful, let us denote by Λ_K and Λ_P the partial derivatives of the accumulation equation for financial wealth w.r.t. K (for given P) and P:

$$\begin{aligned}
\Lambda_K &\equiv \left.\frac{\partial \dot{A}}{\partial K}\right|_{\text{P fixed}} = \left(W_K \tilde{L} + \tilde{W} L_K\right) > 0, && \text{(389a)}\\
\Lambda_P &\equiv \frac{\partial \dot{A}}{\partial P} = \left(W_P \tilde{L} + \tilde{W} L_P\right) - \left(\tilde{C}^N + P_C C_P + G^N\right) \lesseqgtr 0, && \text{(389b)}
\end{aligned}$$

where all partial derivatives are evaluated at the steady-state.

Inserting short-run static solutions for aggregate labor supply (385), for the aggregate wage index (387) and consumption (342) into the accumulation equation of financial wealth (384), linearizing around the steady-state, and solving yields the general solution for the stock of financial wealth:

$$A(t) = \tilde{A} + \left[\left(A_0 - \tilde{A}\right) - \Delta_1 D_1 - \Delta_2 D_2\right] e^{r^\star t} + \Delta_1 D_1 e^{\nu_1 t} + \Delta_2 D_2 e^{\nu_2 t}, \tag{390}$$

where A_0 is the initial stock of financial wealth and we set

$$\begin{aligned}
A_K &= \Lambda_K + \Lambda_P P_K, && \text{(391a)}\\
A_Q &= \Lambda_P P_Q, && \text{(391b)}\\
M_i &= A_K + A_Q \omega_2^i, && \text{(391c)}\\
\Delta_i &= \frac{M_i}{\nu_i - r^\star}. && \text{(391d)}
\end{aligned}$$

The linearized version of the representative household's intertemporal solvency condition is:

$$\tilde{A} - A_0 = \Delta_1 \left(\tilde{K} - K_0\right), \tag{392}$$

where K_0 is the initial stock of physical capital.

D.7 The Steady-State

In the next section, we use a specific procedure to solve for the steady-state which allows us to summarize graphically the long-run equilibrium. Below, we characterize the whole steady-state and use tilde to denote long-run values. Setting $\dot{K} = \dot{P} = \dot{B} = 0$ into (372a), (372b) and (376a), and inserting short-run static solutions for k^N, Y^N and Y^T, C^N and C^T derived above, the steady-state can be summarized by four equations:

$$\begin{aligned}
Z^T \left(1-\theta^T\right) \left[k^T \left(\tilde{K}, \tilde{P}, \bar{\lambda}\right)\right]^{-\theta^T} &= P_J\left(\tilde{P}\right)\left(r^\star + \delta\right), && \text{(393a)}\\
Y^N \left(\tilde{K}, \tilde{P}, \bar{\lambda}\right) &= C^N\left(\tilde{P}, \bar{\lambda}\right) + P_J'\left(\tilde{P}\right)\delta_K \tilde{K} + G^N, && \text{(393b)}\\
r^\star \tilde{B} + Y^T \left(\tilde{K}, \tilde{P}, \bar{\lambda}\right) &= C^T\left(\tilde{P}, \bar{\lambda}\right) + \left(1-\alpha_J\right) P_J\left(\tilde{P}\right)\delta_K \tilde{K} + G^T, && \text{(393c)}\\
\tilde{B} - B_0 &= \Psi_1 \left(\tilde{K} - K_0\right). && \text{(393d)}
\end{aligned}$$

These four equations jointly determine $\tilde{P}$, $\tilde{K}$, $\tilde{B}$ and $\bar{\lambda}$.

E Solving for the Steady-State

In this section, we characterize the long-run equilibrium graphically.

E.1 Rewriting the Steady-State

In order to summarize graphically the long-run equilibrium and to build up intuition on the long-run effects of fiscal shocks, it is convenient to rewrite the steady-state as follows:

$$\frac{\tilde{C}^T}{\tilde{C^N}} = \frac{\varphi}{1-\varphi}\tilde{P}^{\phi}, \tag{394a}$$

$$\frac{\tilde{L}^T}{\tilde{L^N}} = \frac{\vartheta}{1-\vartheta}\tilde{\omega}^{-\epsilon}, \tag{394b}$$

$$\frac{\tilde{Y}^T\left(1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}\right)}{\tilde{Y}^N\left(1-\upsilon_{J^N}-\upsilon_{G^N}\right)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{394c}$$

$$\tilde{P}\left(1-\theta_N\right)\left(\tilde{k}^N\right)^{-\theta_N} = P_J\left(\tilde{P}\right)\left(r^\star+\delta\right), \tag{394d}$$

$$Z^T\left(1-\theta_T\right)\left(\tilde{k}^T\right)^{-\theta_T} = \tilde{P}Z^N\left(1-\theta_N\right)\left(\tilde{k}^N\right)^{-\theta_N} = \tilde{R}, \tag{394e}$$

$$\theta_T\left(\tilde{k}^T\right)^{1-\theta_T} = \tilde{W}^T, \tag{394f}$$

$$P\theta_N\left(\tilde{k}^N\right)^{1-\theta_N} = \tilde{W}^N, \tag{394g}$$

where $\tilde{\Omega} = \tilde{W}^N/\tilde{W}^T$ is the steady-state relative wage and $\tilde{R} = P_J\left(r^\star+\delta\right)$ is the steady-state value of the capital rental cost. We denote by $\upsilon_{J^N} \equiv \frac{\tilde{J}^N}{\tilde{Y}^N}$ ($\upsilon_{J^T} \equiv \frac{\tilde{J}^T}{\tilde{Y}^T}$) the ratio of non traded (traded) investment to non traded (traded) output, by $\upsilon_B \equiv \frac{r^\star\tilde{B}}{\tilde{Y}^T}$ the ratio of interest receipts to traded output, by $\upsilon_{G^j} \equiv \frac{G^j}{\tilde{Y}^j}$ the ratio of government spending in good $j = T, N$ to output of sector $j = T, N$.

Before analyzing the long-run effects of a rise in G^N, we characterize the steady state graphically. We denote the logarithm of variables with lower-case letters. Because we restrict ourselves to the analysis of the long-run run equilibrium, the tilde is suppressed for the purposes of clarity. The steady state can be described by considering alternatively the goods or the labor market.

E.2 Goods Market Equilibrium

To begin with, we characterize the goods market equilibrium. The steady state can be summarized graphically in Figure 5. The figure traces out two schedules in the $(y^T - y^N, p)$-space which are derived below. To avoid unnecessary complications, we normalize sectoral TFPs, i.e., Z^T and Z^N, to 1.

Combining (394a) and the market clearing condition (394c) yields:

$$\frac{C^T}{C^N} = \frac{\varphi}{1-\varphi}P^{\phi} = \frac{Y^T\left(1+\upsilon_B-\upsilon_{J^T}-\upsilon_{G^T}\right)}{Y^N\left(1-\upsilon_{J^N}-\upsilon_{G^N}\right)}. \tag{395}$$

The ratio of traded output to non traded output is:

$$\frac{Y^T}{Y^N} = \frac{\left(1-\upsilon_{J^N}-\upsilon_{G^N}\right)}{\left(1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}\right)}\frac{\varphi}{1-\varphi}P^{\phi}. \tag{396}$$

Taking logarithm yields the GME-equilibrium:

$$\left(y^T-y^N\right)\Big|^{GME} = \phi p + x', \tag{397}$$

where $x' = \ln\left(\frac{\varphi}{1-\varphi}\right) + \ln\left(\frac{1-\upsilon_{J^N}-\upsilon_{G^N}}{1+\upsilon_B-\upsilon_{J^T}-\upsilon_{G^T}}\right)$. According to (397), the goods market equilibrium is upward-sloping in the $(y^T - y^N, p)$-space and the slope of the GME-schedule is equal to $1/\phi$.

In order to facilitate the interpretation of analytical results, it is useful to rewrite the market clearing condition described by eq. (394c). To do so, take logarithm to $\left(\frac{1-\upsilon_{J^N}-\upsilon_{G^N}}{1+\upsilon_B-\upsilon_{J^T}-\upsilon_{G^T}}\right)$ which gives $\ln\left(1+\upsilon_B-\upsilon_{J^T}-\upsilon_{G^T}\right) - \ln\left(1-\upsilon_{J^N}-\upsilon_{G^N}\right)$, use a Taylor approximation at a first order which implies $\ln(1+\upsilon_B-\upsilon_{J^T}-\upsilon_{G^T})-\ln(1-\upsilon_{J^N}-\upsilon_{G^N})\simeq \upsilon_B-\upsilon_{J^T}-\upsilon_{G^T}+\upsilon_{I^N}+\upsilon_{G^N}$. Remembering that at the steady state the traded good market clearing condition is $r^\star B+Y^T-J^T-C^T-G^T=0$, denoting net exports by NX with $NX=Y^T-J^T-C^T-G^T$ or alternatively $-NX=r^\star B$. Dividing the LHS and the RHS by Y^T leads to the ratio of net exports to traded output, $\upsilon_B=-\upsilon_{NX}$. Totally differentiating eq. (397) and remembering that government spending in non tradables is restored to its initial level so that $d\upsilon_{G^N}=0$, leads to:

$$\left(\hat{y}^T-\hat{y}^N\right)\Big|^{GME}=\phi\hat{p}+\left(d\upsilon_{NX}-d\upsilon_{J^N}+d\upsilon_{J^T}\right). \tag{398}$$

In the long-run, investment expenditure are higher and thus, $d\upsilon_{J^j}>0$ since government spending has returned to its initial level while consumption expenditure are lowered due to the negative wealth effect. In the long-run, the ratio of net exports to traded output increases, i.e., $d\upsilon_{NX}>0$. Furthermore, the improvement in the trade balance must exceed the investment boom in the non traded sector because along the transitional path, the current account deficit caused by reduced savings more than offsets the fall in investment. The deterioration in the net foreign position in the long-run must be offset by a rise in net exports for the intertemporal solvency condition to hold. Hence, a temporary rise in government spending biased toward non tradables, shifts to the right the GME-schedule in the long-run.

To obtain closed-form solutions, we assume that the aggregator function for inputs of the investment good is Cobb-Douglas since data suggest that the elasticity of substitution ϕ_J is equal to one.

Combining (394b) with the steady-state relative wage given by (394f)-(394g), and using the production functions for the traded sector and non traded sectors which imply $L^T=\frac{Y^T}{(k^T)^{1-\theta^T}}$ and $L^N=\frac{Y^N}{(k^N)^{1-\theta^N}}$, yields:

$$\frac{Y^T}{Y^N}=P^{-\epsilon}\left(\frac{\theta^T}{\theta^N}\right)^{\epsilon}\left[\frac{\left(k^T\right)^{1-\theta^T}}{\left(k^N\right)^{1-\theta^N}}\right]^{1+\epsilon}.$$

Combining (394d) and (394e) yields:

$$\frac{\left(k^N\right)^{1-\theta_N}}{\left(k^T\right)^{1-\theta_T}}=P^{\frac{1-\theta_N}{\theta_N}}\left[P_J\left(r^\star+\delta_K\right)\right]^{\frac{1-\theta_T}{\theta_T}-\frac{1-\theta_N}{\theta_N}}\frac{\left[(1-\theta_N)\right]^{\frac{1-\theta_N}{\theta_N}}}{\left[(1-\theta_T)\right]^{\frac{1-\theta_T}{\theta_T}}}. \tag{399}$$

Inserting (399) to eliminate sectoral capital-labor ratios yields the LME-schedule:

$$\frac{Y^T}{Y^N}=P^{-\left[\epsilon+\left(\frac{1-\theta_N}{\theta_N}\right)(1+\epsilon)\right]}P_J^{\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)(1+\epsilon)}\Pi, \tag{400}$$

where we set

$$\Pi=\frac{\vartheta}{1-\vartheta}\left(r^\star+\delta\right)^{\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)(1+\epsilon)}\frac{\left[\left(\theta_T\right)^{\epsilon\theta_T}\left(1-\theta_T\right)^{(1-\theta_T)(1+\epsilon)}\right]^{1/\theta_T}}{\left[\left(\theta_N\right)^{\epsilon\theta_N}\left(1-\theta_N\right)^{(1-\theta_N)(1+\epsilon)}\right]^{1/\theta_N}}>0. \tag{401}$$

Taking logarithm, (400) can be rewritten as follows:

$$\left(y^T-y^N\right)\Big|^{LME}=-\left\{\epsilon+(1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right)-\left(1-\varphi_J\right)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}p+\ln\Pi, \tag{402}$$

where Π is given by (401).

In a model abstracting from physical capital, we have $\theta^T=1$, so that the LME-schedule described by eq. (402) reduces to:

$$\left(y^T-y^N\right)\Big|^{LME}_{\theta^T=1}=-\epsilon p+\ln\Pi. \tag{403}$$

In a model with physical capital (i.e., $0 < \theta^T < 1$) but abstracting from traded investment (i.e., $\varphi_J = 0$), the GME-schedule described by eq. (400) reduces to:

$$\left(y^T - y^N\right)\Big|_{\varphi_J=0}^{LME} = -\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]p + \ln\Pi. \tag{404}$$

If $\theta^T < 1$, the LME-schedule becomes flatter than that in a model abstracting from physical capital in the $(y^T - y^N, p)$-space. The LME-schedule is downward-sloping in the $(y^T - y^N, p)$-space with a slope equal to $-1/\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]$. A rise in the relative price of non tradables p allows the non traded sector to pay higher wages. Because the relative wage ω rises, workers are encouraged to shift hours worked from the traded to the non traded sector. As a result, the ratio of sectoral outputs Y^T/Y^N declines. Introducing capital rotates to the left the LME-schedule due to the shift of capital across sectors triggered by a change in P. Following an appreciation in P, the non traded sector experiences a capital inflow which amplifies the expansionary effect on non traded output triggered by the reallocation of labor, which results in a flatter LME-schedule.

E.3 The Labor Market

The steady-steady can be characterized alternatively by focusing on the labor market in the $(l^T - l^N, \omega)$-space.

Taking logarithm to (394b) yields the labor supply-schedule (henceforth LS-schedule):

$$\left(l^T - l^N\right)\Big|^{LS} = -\epsilon\ln\omega + d, \tag{405}$$

where $d = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. According to (405), as in the model without capital, a rise in the non traded wage-traded wage ratio ω provides an incentive to shift labor supply from the traded sector towards the non traded sector. Hence the LS-schedule is downward-sloping in the $(l^T - l^N, \omega)$-space where the slope is equal to $-1/\epsilon$.

We turn to the derivation of the labor demand-schedule (henceforth LD-schedule). Dividing (394g) by (394f) yields:

$$\frac{P\theta^N\left(\tilde{k}^N\right)^{1-\theta^N}}{\theta^T\left(\tilde{k}^T\right)^{1-\theta^T}} = \Omega. \tag{406}$$

To eliminate the sectoral capital-labor ratios, we use eqs. (394d)-(394e), i.e.

$$\frac{\left(k^N\right)^{1-\theta^N}}{\left(k^T\right)^{1-\theta^T}} = P^{\frac{1-\theta^T}{\theta^T}}\left(r^\star+\delta\right)^{\frac{1-\theta^T}{\theta^T}-\frac{1-\theta^N}{\theta^N}}\frac{\left[\left(1-\theta^N\right)\right]^{\frac{1-\theta^N}{\theta^N}}}{\left[\left(1-\theta^T\right)\right]^{\frac{1-\theta^T}{\theta^T}}}. \tag{407}$$

To eliminate the relative price of non tradables, we combine the market-clearing condition (394c) and the demand for tradables in terms of non traded goods (394a) together with production functions (339):

$$P = \left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}}{1-\upsilon_{J^N}-\upsilon_{G^N}}\frac{L^T\left(k^T\right)^{1-\theta^T}}{L^N\left(k^N\right)^{1-\theta^N}}\right]^{\frac{1}{\phi}}. \tag{408}$$

Substituting (408) into (407) yields:

$$\begin{aligned}\frac{\left(k^N\right)^{1-\theta^N}}{\left(k^T\right)^{1-\theta^T}} &= \left(r^\star+\delta\right)^{\frac{\phi\left(\theta^N-\theta^T\right)}{\theta^N\left[1+\theta^T(\phi-1)\right]}}\left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}}{1-\upsilon_{J^N}-\upsilon_{G^N}}\frac{L^T}{L^N}\right]^{\frac{\left(1-\theta^T\right)}{\left[1+\theta^T(\phi-1)\right]}} \\ &\times\left[\frac{\left(1-\theta^N\right)^{\frac{\left(1-\theta^N\right)\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{\frac{\phi}{\left[1+\theta^T(\phi-1)\right]}}.\end{aligned} \tag{409}$$

Plugging (409) into (406) allows us to relate the relative labor demand to the relative wage:

$$\frac{L^T}{L^N}\Theta\left(\frac{1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}}{1-\upsilon_{J^N}-\upsilon_{G^N}}\right)=\Omega^{\left[1+\theta^T(\phi-1)\right]}, \tag{410}$$

where we set

$$\Theta=(r^\star+\delta)^{\frac{\left(\theta^N-\theta^T\right)(\phi-1)}{\theta^N}}\left(\frac{1-\varphi}{\varphi}\right)\left(\frac{\theta^N}{\theta^T}\right)^{\left[1+\theta^T(\phi-1)\right]}\left[\frac{\left(1-\theta^N\right)^{\left(1-\theta^N\right)\frac{\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{(\phi-1)}. \tag{411}$$

Taking logarithm to (410) yields the LD-schedule:

$$\left(l^T-l^N\right)\Big|^{LD}=\left[1+\theta^T\left(\phi-1\right)\right]\omega+\ln\frac{\left(1-\upsilon_{I^N}-\upsilon_{G^N}\right)}{\left(1+\upsilon_B-\upsilon_{J^T}+\upsilon_{G^T}\right)}-\ln\Theta. \tag{412}$$

Eq. (412) states that the LD-schedule is upward-sloping in the (l^T-l^N,ω)-space since an increase in ω induces non traded producers to set higher prices, increasing the demand for traded goods and therefore labor demand in that sector relative to the non traded sector. When $\theta^T<1$, the LD-schedule is steeper or flatter than that in a model abstracting from physical capital (i.e., when $\theta^T=1$) depending on whether ϕ is larger or smaller than one. In both cases, following an increased non tradable labor cost, the non traded sector is induced to use more capital which raises non traded output and thereby produces a decline in p. Depending on whether ϕ is larger or smaller than one, the share of non tradables in total expenditure increases or decreases, as a result of the shift of capital towards the non traded sector. Hence, a given rise in ω produces a smaller or a larger expansionary effect on labor demand in the traded sector depending on whether ϕ exceeds or falls below unity.

Adopting the same methodology described above, the LD-schedule given by eq. (412) can be rewritten in percentage deviation from the initial steady-state in order to facilitate the discussion of the effects of a fiscal shock:

$$\left(\hat{l}^T-\hat{l}^N\right)\Big|^{LD}=\left[1+\theta^T\left(\phi-1\right)\right]\hat{\omega}+\left(d\upsilon_{NX}+d\upsilon_{J^T}-d\upsilon_{J^N}\right). \tag{413}$$

As mentioned previously, a fiscal shock deteriorates the current account in the short-run. The short-run current account deficit must be matched in the long-run by a rise in net exports which shifts the LD-schedule to the right, as captured by an increase in υ_{NX} by such an amount that $d\upsilon_{NX}+d\upsilon_{J^T}-d\upsilon_{J^N}>0$. At the final steady-state, the relative wage Ω is lower while the ratio L^T/L^N is higher.

F Solving for Temporary Fiscal Shocks

In this section, we provide the main steps for the derivation of formal solutions following a temporary fiscal shock.

F.1 The Government Spending Shock

Because the endogenous response of government spending to an exogenous fiscal shock is hump-shaped, we assume that government consumption as a percentage of GDP evolves according to the following dynamic equation:

$$\frac{dG(t)}{\tilde{Y}}\equiv\frac{G(t)-\tilde{G}}{\tilde{Y}}=\left[e^{-\xi t}-(1-g)\,e^{-\chi t}\right], \tag{414}$$

where $\xi>0$ and $\chi>0$ are (positive) parameters which are set in order to capture the endogenous response of $G(t)$. Setting $t=0$ into (414) yields:

$$\frac{dG(0)}{\tilde{Y}}\equiv\frac{G(0)-\tilde{G}}{\tilde{Y}}=g. \tag{415}$$

In the quantitative analysis, we set $g=0.01$ so that government consumption increases initially by 1 percentage point of initial GDP, $\tilde{Y}$.

In the quantitative analysis we assume that the rise in government consumption is split between non traded and traded goods in accordance with their respective shares, $\omega_{G^N} = \frac{PG^N}{G}$ and $\omega_{G^T} = \frac{G^T}{G}$, respectively. Formally, we thus have:

$$\frac{dG(t)}{\tilde{Y}} = \omega_{G^N}\frac{dG^N}{\tilde{Y}} + \omega_{G^T}\frac{dG^T}{\tilde{Y}}.$$

Totally differentiating the balanced budget condition, government expenditure in good $j = T, N$ can be solved for overall government consumption as follows:

$$G^N(t) = \mathsf{G}^N\left(G(t)\right), \quad G^T = \mathsf{G}^T\left(G(t)\right), \tag{416}$$

where $\frac{\partial G^N}{\partial G} = \frac{\omega_{G^N}}{\tilde{P}}$ and $\frac{\partial G^T}{\partial G} = \omega_{G^T}$ with ω_{G^j} corresponding to the share of expenditure on good j in total government spending.

F.2 Formal Solutions for $K(t)$ and $Q(t)$

The adjustment of the open economy towards the steady-state is described by a dynamic system which comprises two equations. Inserting first the short-term static solution for the relative price of non tradables (368) together with (416) into (371), the accumulation equation for physical capital that clears the non-traded goods market along the transitional path can be rewritten as follows:

$$\begin{aligned}\dot{K} \equiv \Upsilon\left(K, Q, G\right) &= \frac{Y^N\left(\bar{\lambda}, K, P(.)\right) - C^N\left(\bar{\lambda}, P(.)\right) - \mathsf{G}^N\left(G\right)}{P'_J\left(P(.)\right)} - \delta_K K \\ &- \frac{K(t)}{2\kappa}\left[\frac{Q}{P'_J\left(P(.)\right)} - 1\right]^2,\end{aligned} \tag{417}$$

where $P = P\left(\bar{\lambda}, K, Q, G\right)$. Inserting first the optimal choice for the investment rate (362) and the short-term static solution for the relative price of non tradables (368) together with (416) into (318e), the dynamic equation for the shadow price of investment that equalizes the return on domestic capital and traded bonds $r^\star$ can be rewritten as follows:

$$\dot{Q} \equiv \Sigma\left(K, P, Q, G\right) = \left(r^\star + \delta_K\right)Q - \left[R\left(K, P(.)\right) + P_J(.)\frac{\kappa}{2}v(.)\left(v(.) + 2\delta_K\right)\right], \tag{418}$$

where $P = P\left(\bar{\lambda}, K, Q, G\right)$ and $v(.) = \frac{1}{\kappa}\left(\frac{Q}{P_J(P(.))} - 1\right)$ (see eq. (363)). **Eqs. (417) and (418) correspond to eq. (23a) and (23b) in the text, respectively**.

The linearized system can be written in a matrix form:

$$\begin{pmatrix} \dot{K}(t) \\ \dot{Q}(t) \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}\begin{pmatrix} K(t) - \tilde{K} \\ Q(t) - \tilde{Q} \end{pmatrix} + \begin{pmatrix} \varepsilon_K\left(G(t) - \tilde{G}\right) \\ \varepsilon_Q\left(G(t) - \tilde{G}\right) \end{pmatrix}, \tag{419}$$

where the coefficients of the Jacobian matrix are given by (376) which we repeat for convenience:

$$a_{11} = \Upsilon_K = \left(\frac{Y_K^N}{P'_J} - \delta_K\right) + \left[\left(Y_P^N - C_P^N\right) + \frac{\tilde{I}^N\phi_J\left(1-\alpha_J\right)}{\tilde{P}}\right]\frac{P_K}{P'_J} \lessgtr 0, \tag{420a}$$

$$a_{12} = \Upsilon_Q = \left[\left(Y_P^N - C_P^N\right) + \frac{\tilde{I}^N\phi_J\left(1-\alpha_J\right)}{\tilde{P}}\right]\frac{P_Q}{P'_J} > 0, \tag{420b}$$

$$a_{21} = \Sigma_K = -R_K - \left(R_P + P_J\kappa v_P\delta_K\right)P_K > 0, \tag{420c}$$

$$a_{22} = \Sigma_Q = r^\star - \left(R_P + P_J\kappa v_P\delta_K\right)P_Q > 0, \tag{420d}$$

and the direct effects of an exogenous change in government consumption on K and Q are described by:

$$\varepsilon_K = \left\{\left[\left(Y_P^N - C_P^N\right) + \frac{\tilde{I}^N\phi_J\left(1-\alpha_J\right)}{\tilde{P}}\right]\frac{P_{G^N}}{P'_J} - \frac{1}{P'_J}\right\}\frac{\omega_{G^N}}{\tilde{P}}, \tag{421a}$$

$$\varepsilon_Q = -\left(R_P + P_J\kappa v_P\delta_K\right)\frac{P_{G^N}\omega_{G^N}}{\tilde{P}}, \tag{421b}$$

where we used the fact that $\frac{\partial G^N}{\partial G} = \frac{\omega_{GN}}{\tilde{P}}$. **Eq. (419) corresponds to eq. (25) in the main text**.

We denote by $V = \left(V^1, V^2\right)$ the matrix of eigenvectors (given by (378)) with $V^{i,\prime} = \left(1, \omega_2^i\right)$ and we denote by V^{-1} the inverse matrix of V. Let us define:

$$\left(\begin{array}{c} X_1(t) \\ X_2(t) \end{array} \right) \equiv V^{-1} \left(\begin{array}{c} K(t) - \tilde{K} \\ Q(t) - \tilde{Q} \end{array} \right). \tag{422}$$

Differentiating w.r.t. time, one obtains:

$$\begin{aligned} \left(\begin{array}{c} \dot{X}_1(t) \\ \dot{X}_2(t) \end{array} \right) &= \left(\begin{array}{cc} \nu_1 & 0 \\ 0 & \nu_2 \end{array} \right) \left(\begin{array}{c} X_1(t) \\ X_2(t) \end{array} \right) + V^{-1} \left(\begin{array}{c} \varepsilon_K dG(t) \\ \varepsilon_Q dG(t) \end{array} \right), \\ &= \left(\begin{array}{c} \nu_1 X_1(t) \\ \nu_2 X_2(t) \end{array} \right) + \frac{1}{\nu_1 - \nu_2} \left(\begin{array}{c} \Phi_1 dG(t) \\ -\Phi_2 dG(t) \end{array} \right), \end{aligned} \tag{423}$$

where $dG(t) = G(t) - \tilde{G}$ and we set

$$\Phi_1 = \left[\left(a_{11} - \nu_2\right) \varepsilon_K + a_{12} \varepsilon_Q \right], \tag{424a}$$
$$\Phi_2 = \left[\left(a_{11} - \nu_1\right) \varepsilon_K + a_{12} \varepsilon_Q \right]. \tag{424b}$$

As will be useful later, in order to express solutions in a compact form, we set:

$$\Gamma_1 = -\frac{\Phi_1 \tilde{Y}}{\nu_1 - \nu_2} \frac{1}{\nu_1 + \xi}, \tag{425a}$$
$$\Gamma_2 = -\frac{\Phi_2 \tilde{Y}}{\nu_1 - \nu_2} \frac{1}{\nu_2 + \xi}, \tag{425b}$$
$$\Theta_1 = (1 - g) \frac{\nu_1 + \xi}{\nu_1 + \chi}, \tag{425c}$$
$$\Theta_2 = (1 - g) \frac{\nu_2 + \xi}{\nu_2 + \chi}. \tag{425d}$$
$$\tag{425e}$$

Solving for $X_1(t)$ gives:

$$\begin{aligned} X_1(t) &= e^{\nu_1 t} \left\{ X_1(0) + \frac{\Phi_1}{\nu_1 - \nu_2} \int_0^t dG(\tau) e^{-\nu_1 \tau} d\tau \right\}, \\ &= e^{\nu_1 t} \left\{ X_1(0) + \frac{\Phi_1 \tilde{Y}}{\nu_1 - \nu_2} \int_0^t \left[e^{-(\xi + \nu_1)\tau} - (1 - g)\, e^{-(\chi + \nu_1)\tau} \right] d\tau \right\}, \\ &= e^{\nu_1 t} X_1(0) + \frac{\Phi_1 \tilde{Y}}{\nu_1 - \nu_2} \left[\left(\frac{e^{\nu_1 t} - e^{-\xi t}}{\nu_1 + \xi} \right) - (1 - g) \left(\frac{e^{\nu_1 t} - e^{-\chi t}}{\nu_1 + \chi} \right) \right], \\ &= e^{\nu_1 t} \left[X_1(0) - \Gamma_1 \left(1 - \Theta_1\right) \right] + \Gamma_1 \left(e^{-\xi t} - \Theta_1 e^{-\chi t} \right), \end{aligned} \tag{426}$$

where Γ_1 and Θ_1 are given by (425a) and (425c), respectively.

Solving for $X_2(t)$ gives:

$$X_2(t) = e^{\nu_2 t} \left\{ X_2(0) - \frac{\Phi_2}{\nu_1 - \nu_2} \int_0^t dG(\tau) e^{-\nu_2 \tau} d\tau \right\}. \tag{427}$$

Because $\nu_2 > 0$, for the solution to converge to the steady-state, the term in brackets must be nil when we let t tend toward infinity:

$$\begin{aligned} X_2(0) &= \frac{\Phi_2 \tilde{Y}}{\nu_1 - \nu_2} \int_0^\infty \left[e^{-(\xi + \nu_2)\tau} - (1 - g)\, e^{-(\chi + \nu_2)\tau} \right] d\tau, \\ &= \frac{\Phi_2 \tilde{Y}}{\nu_1 - \nu_2} \left[\frac{1}{\xi + \nu_2} - (1 - g) \frac{1}{\chi + \nu_2} \right], \\ &= -\Gamma_2 \left(1 - \Theta_2\right), \end{aligned} \tag{428}$$

where Γ_2 and Θ_2 are given by (425b) and (425d), respectively.

Inserting first $X_2(0)$, the 'stable' solution for $X_2(t)$, i.e., consistent with convergence toward the steady-state when t tends toward infinity, is thus given by:

$$
\begin{aligned}
X_2(t) &= e^{\nu_2 t}\frac{\Phi_2\tilde{Y}}{\nu_1-\nu_2}\int_t^\infty\left[e^{-(\xi+\nu_2)\tau}-(1-g)\,e^{-(\chi+\nu_2)\tau}\right]d\tau, \\
&= e^{\nu_2 t}\frac{\Phi_2\tilde{Y}}{\nu_1-\nu_2}\left[\frac{e^{-(\xi+\nu_2)t}}{\xi+\nu_2}-(1-g)\,\frac{e^{-(\chi+\nu_2)t}}{\chi+\nu_2}\right], \\
&= -\Gamma_2\left(e^{-\xi t}-\Theta_2 e^{-\chi t}\right). \qquad (429)
\end{aligned}
$$

Eq. (429) corresponds to eq. (28b) in the main text.

Using the definition of $X_i(t)$ (with $i=1,2$) given by (422), we can recover the solutions for $K(t)$ and $Q(t)$:

$$K(t)-\tilde{K}=X_1(t)+X_2(t), \qquad (430a)$$

$$Q(t)-\tilde{Q}=\omega_2^1 X_1(t)+\omega_2^2 X_2(t). \qquad (430b)$$

Eqs. (430) correspond to eqs. (27) in the main text.

Setting $t=0$ into (430a) gives $X_1(0)=\left(K(0)-\tilde{K}\right)-X_2(0)$; inserting (428) leads to:

$$X_1(t)=e^{\nu_1 t}\left[\left(K(0)-\tilde{K}\right)+\Gamma_2\left(1-\Theta_2\right)-\Gamma_1\left(1-\Theta_1\right)\right]+\Gamma_1\left(e^{-\xi t}-\Theta_1 e^{-\chi t}\right). \qquad (431)$$

Eq. (431) corresponds to eq. (28a) in the main text.

F.3 Formal Solution for the Net Foreign Asset Position, $B(t)$

To determine the formal solution for the net foreign asset position, we first linearize the current account equation (379) in the neighborhood of the steady-state and substitute the solutions for $K(t)$ and $Q(t)$:

$$\dot{B}(t)=r^\star\left(B(t)-\tilde{B}\right)+N_1X_1(t)+N_2X_2(t)+\Xi_G dG(t), \qquad (432)$$

where N_i (with $i=1,2$) is given by (382b), and Ξ_G is given by:

$$\Xi_G=\left\{\left[\Xi_P P_{G^N}+\left(\frac{1-\alpha_J}{\alpha_J}\right)\tilde{P}\right]\frac{\omega_{G^N}}{\tilde{P}}-\omega_{G^T}\right\}, \qquad (433)$$

where $\Xi_P<0$ and $P_{G^N}>0$ are given by (380b) and (369c), respectively.

Substituting $X_1(t)$ given by eq. (431) and X_2 given by eq. (429) into (432) leads to:

$$
\begin{aligned}
\dot{B}(t) &= r^\star\left(B(t)-\tilde{B}\right)+\omega_B^1 e^{\nu_1 t}+N_1\Gamma_1\left(e^{-\xi t}-\Theta_1 e^{-\chi t}\right) \\
&- N_2\Gamma_2\left(e^{-\xi t}-\Theta_2 e^{-\chi t}\right)+\Xi_G\tilde{Y}\left(e^{-\xi t}-(1-g)\,e^{-\chi t}\right), \qquad (434)
\end{aligned}
$$

where Γ_1 and Γ_2 are given by (425a) and (425b), respectively, and we set:

$$\omega_B^1=N_1\left[\left(K(0)-\tilde{K}\right)+\Gamma_2\left(1-\Theta_2\right)-\Gamma_1\left(1-\Theta_1\right)\right]. \qquad (435)$$

Pre-multiplying by $e^{-r^\star\tau}$ and integrating over $(0,t)$ allow us to obtain the general solution for $B(t)$:

$$
\begin{aligned}
B(t)-\tilde{B} &= \left\{\left(B_0-\tilde{B}\right)-\frac{\omega_B^1}{\nu_1-r^\star}+\frac{\Xi_G\tilde{Y}}{\xi+r^\star}\left(1-\Theta'\right)+\frac{N_1\Gamma_1}{\xi+r^\star}\left(1-\Theta_1'\right)-\frac{N_2\Gamma_2}{\xi+r^\star}\left(1-\Theta_2'\right)\right\}e^{r^\star t} \\
&+ \frac{\omega_B^1}{\nu_1-r^\star}e^{\nu_1 t}-\frac{\Xi_G\tilde{Y}}{\xi+r^\star}\left(e^{-\xi t}-\Theta' e^{-\chi t}\right)-\frac{N_1\Gamma_1}{\xi+r^\star}\left(e^{-\xi t}-\Theta_1' e^{-\chi t}\right) \\
&+ \frac{N_2\Gamma_2}{\xi+r^\star}\left(e^{-\xi t}-\Theta_2' e^{-\chi t}\right), \qquad (436)
\end{aligned}
$$

where we set:

$$
\begin{aligned}
\Theta' &= (1-g)\,\frac{\xi + r^\star}{\chi + r^\star}, &\text{(437a)}\\
\Theta'_1 &= \Theta_1 \frac{\xi + r^\star}{\chi + r^\star}, &\text{(437b)}\\
\Theta'_2 &= \Theta_2 \frac{\xi + r^\star}{\chi + r^\star}. &\text{(437c)}
\end{aligned}
$$

Invoking the transversality condition, one obtains the 'stable' solution for the stock of foreign assets so that $B(t)$ converges toward its steady-state value $\tilde{B}$:

$$
\begin{aligned}
B(t) - \tilde{B} &= \frac{\omega_B^1}{\nu_1 - r^\star} e^{\nu_1 t} - \frac{\Xi_G \tilde{Y}}{\xi + r^\star}\left(e^{-\xi t} - \Theta' e^{-\chi t}\right) - \frac{N_1 \Gamma_1}{\xi + r^\star}\left(e^{-\xi t} - \Theta'_1 e^{-\chi t}\right)\\
&+ \frac{N_2 \Gamma_2}{\xi + r^\star}\left(e^{-\xi t} - \Theta'_2 e^{-\chi t}\right). \qquad (438)
\end{aligned}
$$

Eq. (437) corresponds to eq. (30) in the main text.

Eq. (438) gives the trajectory for for $B(t)$ consistent with the intertemporal solvency condition:

$$
\left(\tilde{B} - B_0\right) = -\frac{\omega_B^1}{\nu_1 - r^\star} + \frac{\omega_B^2}{\xi + r^\star} \qquad (439)
$$

where we set

$$
\omega_B^2 = \Xi_G \tilde{Y}\left(1 - \Theta'\right) + N_1 \Gamma_1 \left(1 - \Theta'_1\right) - N_2 \Gamma_2 \left(1 - \Theta'_2\right). \qquad (440)
$$

Eq. (439) corresponds to eq. (31) in the main text.

Differentiating (430a) w.r.t. time gives the trajectory for the current account along the transitional path when government spending follows the temporal path given by eq. (414):

$$
\begin{aligned}
\dot{B}(t) &= \nu_1 \frac{\omega_B^1}{\nu_1 - r^\star} e^{\nu_1 t} + \frac{\Xi_G \tilde{Y}}{\xi + r^\star}\left(\xi e^{-\xi t} - \chi \Theta' e^{-\chi t}\right) + \frac{N_1 \Gamma_1}{\xi + r^\star}\left(\xi e^{-\xi t} - \chi \Theta'_1 e^{-\chi t}\right)\\
&- \frac{N_2 \Gamma_2}{\xi + r^\star}\left(\xi e^{-\xi t} - \chi \Theta'_2 e^{-\chi t}\right). \qquad (441)
\end{aligned}
$$

F.4 Formal Solution for the Stock of Financial Wealth, $A(t)$

To determine the formal solution for the stock of financial wealth, we first linearize the private savings equation (384) in the neighborhood of the steady-state and substitute the solutions for $K(t)$ and $Q(t)$:

$$
\dot{A}(t) = r^\star \left(A(t) - \tilde{A}\right) + M_1 X_1(t) + M_2 X_2(t) + A_G dG(t), \qquad (442)
$$

where M_i (with $i = 1, 2$) is given by (391c), and A_G is given by:

$$
A_G = \Lambda_P \frac{P_G^N \omega_{GN}}{\tilde{P}} - 1, \qquad (443)
$$

where Λ_P is given by eq. (389b).

Substituting $X_1(t)$ given by eq. (431) and X_2 given by eq. (429) into (442) leads to:

$$
\begin{aligned}
\dot{A}(t) &= r^\star \left(A(t) - \tilde{A}\right) + \omega_A^1 e^{\nu_1 t} + M_1 \Gamma_1 \left(e^{-\xi t} - \Theta_1 e^{-\chi t}\right)\\
&- M_2 \Gamma_2 \left(e^{-\xi t} - \Theta_2 e^{-\chi t}\right) + A_G \tilde{Y}\left(e^{-\xi t} - (1-g)\, e^{-\chi t}\right), \qquad (444)
\end{aligned}
$$

where Γ_1 and Γ_2 are given by (420c) and (420d), respectively, and we set:

$$
\omega_A^1 = M_1 \left[\left(K(0) - \tilde{K}\right) + \Gamma_2 \left(1 - \Theta_2\right) - \Gamma_1 \left(1 - \Theta_1\right)\right]. \qquad (445)
$$

Pre-multiplying by $e^{-r^\star \tau}$ and integrating over $(0,t)$ allow us to obtain the general solution for $A(t)$:

$$\begin{aligned}
A(t)-\tilde{A} &= \left\{\left(A_0-\tilde{A}\right)-\frac{\omega_A^1}{\nu_1-r^\star}+\frac{A_G\tilde{Y}}{\xi+r^\star}\left(1-\Theta'\right)+\frac{M_1\Gamma_1}{\xi+r^\star}\left(1-\Theta_1'\right)-\frac{M_2\Gamma_2}{\xi+r^\star}\left(1-\Theta_2'\right)\right\}e^{r^\star t} \\
&+ \frac{\omega_A^1}{\nu_1-r^\star}e^{\nu_1 t}-\frac{A_G\tilde{Y}}{\xi+r^\star}\left(e^{-\xi t}-\Theta' e^{-\chi t}\right)-\frac{M_1\Gamma_1}{\xi+r^\star}\left(e^{-\xi t}-\Theta_1' e^{-\chi t}\right) \\
&+ \frac{M_2\Gamma_2}{\xi+r^\star}\left(e^{-\xi t}-\Theta_2' e^{-\chi t}\right), \qquad (446)
\end{aligned}$$

where Θ', Θ_1', Θ_2' are given by (437)-(437).

Invoking the transversality condition, one obtains the 'stable' solution for the stock of financial wealth so that $A(t)$ converges toward its steady-state value $\tilde{A}$:

$$\begin{aligned}
A(t)-\tilde{A} &= \frac{\omega_A^1}{\nu_1-r^\star}e^{\nu_1 t}-\frac{A_G\tilde{Y}}{\xi+r^\star}\left(e^{-\xi t}-\Theta' e^{-\chi t}\right)-\frac{M_1\Gamma_1}{\xi+r^\star}\left(e^{-\xi t}-\Theta_1' e^{-\chi t}\right) \\
&+ \frac{M_2\Gamma_2}{\xi+r^\star}\left(e^{-\xi t}-\Theta_2' e^{-\chi t}\right). \qquad (447)
\end{aligned}$$

Eq. (447) gives the trajectory for for $A(t)$ consistent with the intertemporal solvency condition:

$$\left(\tilde{A}-A_0\right)=-\frac{\omega_A^1}{\nu_1-r^\star}+\frac{\omega_A^2}{\xi+r^\star} \qquad (448)$$

where we set

$$\omega_A^2 = A_G\tilde{Y}\left(1-\Theta'\right)+M_1\Gamma_1\left(1-\Theta_1'\right)-M_2\Gamma_2\left(1-\Theta_2'\right). \qquad (449)$$

Differentiating (447) w.r.t. time gives the trajectory for the current account along the transitional path when government spending follows the temporal path given by eq. (414):

$$\begin{aligned}
\dot{A}(t) &= \nu_1\frac{\omega_A^1}{\nu_1-r^\star}e^{\nu_1 t}+\frac{A_G\tilde{Y}}{\xi+r^\star}\left(\xi e^{-\xi t}-\chi\Theta' e^{-\chi t}\right)+\frac{M_1\Gamma_1}{\xi+r^\star}\left(\xi e^{-\xi t}-\chi\Theta_1' e^{-\chi t}\right) \\
&- \frac{M_2\Gamma_2}{\xi+r^\star}\left(\xi e^{-\xi t}-\chi\Theta_2' e^{-\chi t}\right). \qquad (450)
\end{aligned}$$

G Introducing Non-Separability between Consumption and Labor

In this section, we consider a more general form for preferences taken from Shimer [2011]. Since such preferences do not affect the first-order conditions from profit maximization, we do not repeat them and indicate major changes when solving the model.

In the baseline model, we assume that preferences are separable in consumption and leisure. We relax this assumption which implies that consumption and leisure can be substitutes. In particular, this more general specification implies that consumption can be affected by the wage rate while labor supply can be influenced by the change in the relative price of non tradables. As previously, the household's period utility function is increasing in its consumption C and decreasing in its labor supply L, with functional form:

$$\frac{C^{1-\sigma}V(L)^{\sigma}-1}{1-\sigma}, \quad \text{if} \quad \sigma\neq 1, \quad V(L)\equiv\left(1+(\sigma-1)\gamma\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}\right), \qquad (451)$$

and

$$\log C-\gamma\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}, \quad \text{if} \quad \sigma=1. \qquad (452)$$

These preferences are characterized by two pivotal parameters: σ_L which is the Frisch elasticity of labor supply, and $\sigma>0$ that determines the substitutability between consumption and leisure; it is worth noticing that if $\sigma>1$, the marginal utility of consumption is increasing in hours worked.

The representative household maximizes lifetime utility subject to the flow budget constraint (313) and the accumulation of physical capital (314). Denoting the co-state variables associated with (313) and (314) by λ and Q', respectively, the first-order conditions characterizing the representative household's optimal plans are:

$$C^{-\sigma}V(L)^{\sigma} = P_C\lambda, \tag{453a}$$

$$C^{1-\sigma}\sigma\gamma L^{1/\sigma_L}V(L)^{\sigma-1} = W\lambda, \tag{453b}$$

along with (318c)-(318e) and transversality conditions.

First-order conditions (453a) and (453b) can be solved for consumption and labor as follows:

$$C = C\left(\bar{\lambda}, P, W\right), \quad L = L\left(\bar{\lambda}, P, W\right). \tag{454}$$

To derive the partial derivatives, we take logarithm and totally differentiate the system which yields in matrix form:

$$\begin{pmatrix} -\sigma & \sigma\left(\frac{1+\sigma_L}{\sigma_L}\right)\left[\frac{V(L)-1}{V(L)}\right] \\ (1-\sigma) & \left\{\frac{1}{\sigma_L} + (\sigma-1)\left(\frac{1+\sigma_L}{\sigma_L}\right)\left[\frac{V(L)-1}{V(L)}\right]\right\} \end{pmatrix} \begin{pmatrix} \hat{C} \\ \hat{L} \end{pmatrix} \begin{pmatrix} \hat{\bar{\lambda}} + \alpha_C\hat{P} \\ \hat{\bar{\lambda}} + \hat{W} \end{pmatrix}, \tag{455}$$

where we denote by a hat the deviation in percentage.

Partial derivatives are:

$$\frac{\hat{C}}{\hat{\bar{\lambda}}} = \frac{(1+\sigma_L)}{\sigma}\left[\frac{V(L)-1}{V(L)}\right] - \frac{1}{\sigma} < 0, \tag{456a}$$

$$\frac{\hat{L}}{\hat{\bar{\lambda}}} = \frac{\sigma_L}{\sigma} > 0, \tag{456b}$$

$$\frac{\hat{C}}{\hat{W}} = (1+\sigma_L)\left[\frac{V(L)-1}{V(L)}\right] > 0, \tag{456c}$$

$$\frac{\hat{L}}{\hat{W}} = \sigma_L > 0, \tag{456d}$$

$$\frac{\hat{C}}{\hat{P}} = -\frac{\alpha_C}{\sigma}\left\{1 + (\sigma-1)(1+\sigma_L)\left[\frac{V(L)-1}{V(L)}\right]\right\} < 0, \tag{456e}$$

$$\frac{\hat{L}}{\hat{P}} = -\alpha_C\frac{(\sigma-1)\sigma_L}{\sigma} < 0. \tag{456f}$$

Using the fact that $W = W\left(W^T, W^N\right)$ with $\frac{\partial W}{\partial W^T}\frac{W^T}{W} = (1-\alpha_L)$ and $\frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L$, we get:

$$L = L\left(\bar{\lambda}, P, W^T, W^N\right), \tag{457}$$

where

$$\frac{\hat{L}}{\hat{W}^T} = (1-\alpha_L)\sigma_L > 0, \tag{458a}$$

$$\frac{\hat{L}}{\hat{W}^N} = \sigma_L\alpha_L > 0. \tag{458b}$$

Inserting first the short-run static solution for consumption given by (454) into $C^N = P_C'C$ and $C^T = \left[P_C - PP_C'\right]C$, one can solve for C^T and C^N as follows:

$$C^T = C^T\left(\bar{\lambda}, P, W^T, W^N\right), \quad C^N = C^N\left(\bar{\lambda}, P, W^T, W^N\right), \tag{459}$$

where partial derivatives are given by:

$$C_P^T = \frac{C^T}{P}\left(\alpha_C\phi + \frac{C_P P}{C}\right) \lessgtr 0, \tag{460a}$$

$$C_P^N = -\frac{C^N}{P}\left[(1-\alpha_C)\,\phi - \frac{C_P P}{C}\right] < 0, \tag{460b}$$

$$C_{W^T}^T = \frac{C^T}{W^T}(1-\alpha_L)\frac{C_W W}{C} > 0, \tag{460c}$$

$$C_{W^T}^N = \frac{C^N}{W^T}(1-\alpha_L)\frac{C_W W}{C} > 0, \tag{460d}$$

$$C_{W^N}^T = \frac{C^T}{W^N}\alpha_L\frac{C_W W}{C} > 0, \tag{460e}$$

$$C_{W^N}^N = \frac{C^N}{W^N}\alpha_L\frac{C_W W}{C} > 0. \tag{460f}$$

Inserting first the short-run solution for labor (457), into $L^T = \frac{\partial W(W^T,W^N)}{\partial W^T}L$ and $L^N = \frac{\partial W(W^T,W^N)}{\partial W^N}L$, allows us to solve for L^T and L^N:

$$L^T = L^T\left(\bar{\lambda}, W^T, W^N, P\right), \quad L^N = L^N\left(\bar{\lambda}, W^T, W^N, P\right), \tag{461}$$

where partial derivatives w.r.t. W^T and W^N are given by (145) and partial derivatives w.r.t. P are:

$$\frac{\hat{L}^T}{\hat{P}} = \frac{L^T}{P}\alpha_C(1-\sigma)\frac{\sigma_L}{\sigma} > 0, \tag{462a}$$

$$\frac{\hat{L}^N}{\hat{P}} = \frac{L^N}{P}\alpha_C(1-\sigma)\frac{\sigma_L}{\sigma} > 0. \tag{462b}$$

$$\tag{462c}$$

G.1 Solving the Model

Plugging the short-run static solutions for L^T and L^N given by (461) into the resource constraint for capital (341), the system of four equations which comprises (340a)-(340c) together with (341) can be solved for sectoral wages and sectoral capital-labor ratios. Taking logarithm and differentiating (340a)-(340c) and (341) yields in matrix form:

$$\begin{pmatrix} -\theta^T & \theta^N & 0 & 0 \\ \left(1-\theta^T\right) & 0 & -1 & 0 \\ 0 & \left(1-\theta^N\right) & 0 & -1 \\ (1-\xi) & \xi & \Psi_{W^T} & \Psi_{W^N} \end{pmatrix} \begin{pmatrix} \hat{k}^T \\ \hat{k}^N \\ \hat{W}^T \\ \hat{W}^N \end{pmatrix} = \begin{pmatrix} \hat{P} \\ 0 \\ -\hat{P} \\ \hat{K} - \Psi_{\bar{\lambda}}\hat{\bar{\lambda}} - \Psi_P\hat{P} \end{pmatrix}, \tag{463}$$

where Ψ_{W^T} and Ψ_{W^N} are given by (349a) and (349b), respectively, $\xi \equiv \frac{k^N L^N}{K}$ and we set:

$$\Psi_P = (1-\xi)\frac{L_P^T P}{L^T} + \xi\frac{L_P^N P}{L^N} = -\alpha_C\frac{(\sigma-1)\,\sigma_L}{\sigma} < 0. \tag{464}$$

Only the partial derivatives w.r.t. P are modified when preferences are non separable in consumption and leisure. Hence, we thus restrict attention to these partial derivatives. Short-run static solutions for sectoral wages are:

$$W^T = W^T\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad W^N = W^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{465}$$

with

$$\frac{\hat{W}^T}{\hat{P}} = -\frac{\left(1-\theta^T\right)\left(\Psi_{W^N} + \theta^N\Psi_P + \xi\right)}{G} < 0, \tag{466a}$$

$$\frac{\hat{W}^N}{\hat{P}} = -\frac{\left\{1 + \left(1-\theta^T\right)\Psi_{W^T} - \left(1-\theta^T\right)\xi - \theta^T\left(1-\theta^N\right)\Psi_P\right\}}{G} > 0, \tag{466b}$$

and sectoral capital-labor ratios:

$$k^T = k^T \left(\lambda, K, P, Z^T, Z^N\right), \quad k^N = k^N \left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{467}$$

with

$$\frac{\hat{k}^T}{\hat{P}} = \frac{\Psi_{W^N} + \xi + \theta^N \Psi_P}{G} < 0, \tag{468a}$$

$$\frac{\hat{k}^N}{\hat{P}} = \frac{\left\{\theta^T \left(\Psi^{W^N} + \Psi_P\right) - \left[\left(1-\theta^T\right) \Psi_{W^T} + (1-\xi)\right]\right\}}{G} > 0, \tag{468b}$$

$$\tag{468c}$$

To solve the model, insert first short-run static solutions for sectoral wages (465) into sectoral labor (461), then substitute the resulting solutions for sectoral labor and capital-labor ratios (468), production functions can be solved for sectoral outputs.

H Calibration Procedure

In this section, we provide more details about the calibration to a representative OECD economy and to data from 16 OECD countries. Section A presents the source and construction of data.

H.1 Initial Steady-State

Normalizing total factor productivity (TFP henceforth) for the non traded sector Z^N to 1, the calibration reduces to 19 parameters: $r^\star$, β, σ_C, σ_L, ϵ, ϑ, ϕ, φ, ϕ_I, φ_I, κ, δ_K, θ^T, θ^N, Z^T, ω_G $(=\frac{G}{Y})$, ω_{G^N} $(=\frac{PG^N}{G})$, ξ, χ, and initial conditions B_0, K_0.

Since we focus on the long-run equilibrium, the tilde is suppressed for the purposes of clarity. The steady-state of the open economy comprises 18 equations:

$$C = \left(P_C \bar{\lambda}\right)^{-\sigma_C}, \tag{469a}$$

$$L = \left(W \bar{\lambda}\right)^{\sigma_L}, \tag{469b}$$

$$C^N = (1-\varphi)\left(\frac{P}{P_C}\right)^{-\phi} C, \tag{469c}$$

$$C^T = (1-\varphi)\left(\frac{1}{P_C}\right)^{-\phi} C, \tag{469d}$$

$$L^N = (1-\vartheta)\left(\frac{W^N}{W}\right)^{\epsilon} L, \tag{469e}$$

$$L^T = \vartheta\left(\frac{W^T}{W}\right)^{\epsilon} L \tag{469f}$$

$$I^N = (1-\varphi_J)\left(\frac{P}{P_J}\right)^{-\phi_J} I, \tag{469g}$$

$$I^T = (1-\varphi_J)\left(\frac{1}{P_J}\right)^{-\phi_J} I, \tag{469h}$$

$$I = \delta_K K, \tag{469i}$$

$$\frac{G}{Y} = \omega_G, \tag{469j}$$

$$Z^T\left(1-\theta^T\right) = P_J\left(r^\star + \delta_K\right), \tag{469k}$$

$$Z^T\left(1-\theta^T\right)\left(k^T\right)^{-\theta^T} = PZ^N\left(1-\theta^N\right)\left(k^N\right)^{-\theta^N}, \tag{469l}$$

$$Z^T\theta^T\left(k^T\right)^{1-\theta^T} = W^T, \tag{469m}$$

$$PZ^N\theta^N\left(k^N\right)^{1-\theta^N} = W^N, \tag{469n}$$

$$k^T L^T + k^N L^N = K, \tag{469o}$$

$$Z^N L^N\left(k^N\right)^{1-\theta^N} = C^N + G^N + I^N, \tag{469p}$$

$$r^\star B + Z^T L^T\left(k^T\right)^{1-\theta^T} - C^T - G^T, \tag{469q}$$

and the intertemporal solvency condition

$$B - B_0 = \Psi_1\left(K - K_0\right), \tag{469r}$$

where we used the fact that at the steady-state $I^j = J^j$ (with $j = T, N$), and we also have

$$G^N = \left(\omega_{G^N}/P\right) G, \tag{470a}$$

$$G^T = \left(1-\omega_{G^N}\right) G, \tag{470b}$$

$$P_C = \left[\varphi + (1-\varphi)(P)^{1-\phi}\right]^{\frac{1}{1-\phi}}, \tag{470c}$$

$$P_J = \left[\varphi_J + (1-\varphi_J) P^{1-\phi_J}\right]^{\frac{1}{1-\phi_J}}, \tag{470d}$$

$$W = \left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}, \tag{470e}$$

$$Y = Y^T + PY^N = Z^T L^T\left(k^T\right)^{1-\theta^T} + PZ^N L^N\left(k^N\right)^{1-\theta^N}. \tag{470f}$$

Using (470), the system (469) jointly determines the following 18 variables C, L, C^N, C^T, L^N, L^T, I^N, I^T, I, G, k^T, k^N, W^T, W^N, K, P, B, $\bar{\lambda}$.

Some of the values of parameters can be taken directly from data, but others need to be endogenously calibrated to fit a set of an average OECD economy features. Among the 19 parameters, 4 parameters, i.e., φ, φ_J, ϑ, δ_K together with initial conditions (B_0, K_0) must be set in order to match key properties of a typical OECD economy. More precisely, the parameters φ, φ_J, ϑ, δ_K together with the set of initial conditions are set to target α_C, α_J, α_L, υ_{NX}, I/Y. We denote by $\upsilon_{G^j} = G^j/Y^j$ and $\upsilon_{J^j} = J^j/Y^j$ the ratio of government spending and investment expenditure on good j to output in sector j, respectively, and

$\upsilon_B = \frac{r^\star B}{Y^T}$ the ratio of interest receipts from traded bonds holding to traded output. The steady-state can be reduced to the following four equations:

$$\frac{Y^T}{Y^N}\frac{(1+\upsilon_B - \upsilon_{J^T} + \upsilon_{G^T})}{(1-\upsilon_{J^N} - \upsilon_{G^N})} = \frac{\varphi}{1-\varphi}P^{\phi}, \tag{471a}$$

$$\frac{Y^T}{Y^N} = P^{-\left\{\epsilon + (1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right) - (1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}}\Pi, \tag{471b}$$

$$\left(1-\theta^T\right)\frac{Y^T}{Y} + \left(1-\theta^N\right)\frac{PY^N}{Y} = P^{(1-\varphi_I)}\left(r^\star + \delta_K\right)\frac{K}{Y}, \tag{471c}$$

$$\upsilon_B = \upsilon_{B_0} + r^\star \frac{Y}{Y^T}\Psi_1\left(\frac{K}{Y} - \upsilon_{K_0}\right), \tag{471d}$$

where $\upsilon_{K_0} = \frac{K_0}{Y}$ and Π is a term composed of parameters described by:

$$\begin{aligned}\Pi \quad &\equiv \quad \frac{\left(Z^T\right)^{\frac{1+\epsilon}{\theta_T}}}{\left(Z^N\right)^{\frac{1+\epsilon}{\theta_N}}}\frac{\vartheta}{1-\vartheta}\left(r^\star+\delta\right)^{\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)(1+\epsilon)} \\ &\times \quad \frac{\left[\left(\theta_T\right)^{\epsilon\theta_T}\left(1-\theta_T\right)^{(1-\theta_T)(1+\epsilon)}\right]^{1/\theta_T}}{\left[\left(\theta_N\right)^{\epsilon\theta_N}\left(1-\theta_N\right)^{(1-\theta_N)(1+\epsilon)}\right]^{1/\theta_N}}.\end{aligned} \tag{472}$$

The system (471) consisting of four equations determine P, Y^T/Y^N, K/Y and υ_B. The four equations (471a)-(471d) described the goods market equilibrium, the labor market equilibrium, the resource constraint for capital, and the intertemporal solvency condition.

Dividing the market clearing condition for the traded good (469q) by the market clearing condition for the non traded good (469p) and equating the resulting expression with the demand of tradables in terms of non tradables obtained by calculating the ratio of (469d) to (469c), i.e., $\frac{C^T}{C^N} = \frac{\varphi}{1-\varphi}P^{\phi}$, leads to **the goods market equilibrium (471a)**. The derivation of the labor market equilibrium requires more steps. As mentioned below, we assume that the aggregator function for inputs of the investment good is Cobb-Douglas since data suggest that $\phi_J = 1$. In this case, the investment price index simplifies, i.e., $P_J = (P)^{1-\varphi_J}$. First, combining (469k) and (469l) leads to:

$$\begin{aligned}\frac{\left(k^T\right)^{1-\theta^T}}{\left(k^N\right)^{1-\theta^N}} \quad &= \quad P^{\frac{1-\theta_N}{\theta_N}}\left[P_I\left(r^\star+\delta_K\right)\right]^{\frac{1-\theta_T}{\theta_T}-\frac{1-\theta_N}{\theta_N}}\frac{\left[Z^N\left(1-\theta_N\right)\right]^{\frac{1-\theta_N}{\theta_N}}}{\left[Z^T\left(1-\theta_T\right)\right]^{\frac{1-\theta_T}{\theta_T}}}, \\ &= \quad P^{\left[\left(\frac{1-\theta_N}{\theta_N}\right)-(1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]}\frac{\left[Z^N\left(1-\theta_N\right)\right]^{\frac{1-\theta_N}{\theta_N}}}{\left[Z^T\left(1-\theta_T\right)\right]^{\frac{1-\theta_T}{\theta_T}}}.\end{aligned} \tag{473}$$

Dividing (469f) by (469e) leads to the supply of hours worked in the traded sector relative to the non traded sector, i.e., $\frac{L^T}{L^N} = \frac{\vartheta}{1-\vartheta}\Omega^{-\epsilon}$. Dividing (469n) by (469m) leads to the relative wage, i.e., $\Omega = \frac{PZ^N\theta^N\left(k^N\right)^{1-\theta^N}}{Z^T\theta^T\left(k^T\right)^{1-\theta^T}}$. Inserting the latter expression into the former and using the production functions for the traded sector and non traded sectors which imply $L^T = \frac{Y^T}{Z^T\left(k^T\right)^{1-\theta^T}}$ and $L^N = \frac{Y^N}{Z^N\left(k^N\right)^{1-\theta^N}}$, one obtains:

$$\frac{Y^T}{Y^N} = \frac{\vartheta}{1-\vartheta}\left(\frac{Z^T}{Z^N}\right)^{\epsilon+1}P^{-\epsilon}\left(\frac{\theta^T}{\theta^N}\right)^{\epsilon}\left[\frac{\left(k^T\right)^{1-\theta^T}}{\left(k^N\right)^{1-\theta^N}}\right]^{1+\epsilon}.$$

Inserting (473) into the above expression leads to **the labor market equilibrium (471b)** while we set Π to eq. (472) in order to write the equation in compact form. To determine (471c), use the fact that $K^j = k^jL^j$, multiply both sides of (469o) by $\frac{R}{Y}$ where $R = P_J\left(r^\star+\delta_K\right)$ is the capital rental cost; we get:

$$\frac{RK^T}{Y^T}\frac{Y^T}{Y} + \frac{RK^N}{PY^N}\frac{PY^N}{Y} = \frac{RK}{Y}.$$

Using the fact that the capital income share $\frac{RK^j}{P^jY^j}$ in sector j is equal to $\left(1-\theta^j\right)$ and remembering that the investment price index reduces to $P_J = (P)^{1-\varphi_J}$, one obtains **the resource constraint for capital described by eq. (471c)**. Finally, to get (471d), multiply both sides of (471d) by $\frac{r^\star}{Y^T}$, denote the ratio of interest receipts from the initial stock of traded bonds to traded output by $\upsilon_{B_0} = \frac{r^\star B_0}{Y^T}$ and the ratio of the initial capital stock to GDP by $\upsilon_{K_0} = \frac{K_0}{Y}$ leads to **eq. (471d) that describes the intertemporal solvency condition**.

Because the ratios we wish to target are different from the macroeconomic aggregates, i.e., P, Y^T/Y^N, K/Y and υ_B, that are jointly determined by the system of equations (471), we have to relate the latter ratios with the former. First, the relative price of non tradables P determines the non tradable content of consumption expenditure by setting φ:

$$\alpha_C = \frac{(1-\varphi) P^{1-\phi}}{\varphi + (1-\varphi) P^{1-\phi}}. \tag{474}$$

The ratio K/Y along with the relative price of non tradables, P, determines the investment-to-GDP ratio $P_J I/Y$ by setting δ_K (see eq. (469i)):

$$\frac{P_J I}{Y} = P_J \frac{\delta_K K}{Y}. \tag{475}$$

The ratio of net interest receipts from traded bonds holding to traded output, i.e., υ_B, determines the ratio of net exports to traded output, i.e. $\upsilon_{NX} = \frac{NX}{Y^T}$ with $NX = Y^T - C^T - G^T - J^T$; dividing both sides of the traded goods market clearing condition (469q) leads to:

$$\upsilon_{NX} = -\upsilon_B. \tag{476}$$

Finally, we show that Y^T/Y^N (together with P) determines L^N/L by setting ϑ. To do so, using the definition of the aggregate wage index (336), the ratio of the aggregate wage to the non traded wage can be rewritten as follows:

$$\begin{aligned}
\left(\frac{W}{W^N}\right)^{\epsilon+1} &= \frac{\vartheta \left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left(W^N\right)^{\epsilon+1}}, \\
&= \vartheta \left(\frac{W^T}{W^N}\right)^{\epsilon+1} + (1-\vartheta),
\end{aligned}$$

and by solving, we get

$$\frac{W}{W^N} = \left[\vartheta \left(\frac{W^T}{W^N}\right)^{\epsilon+1} + (1-\vartheta)\right]^{\frac{1}{\epsilon+1}}. \tag{477}$$

Since θ^j is the labor income share in sector j, the ratio of the traded wage to the non traded wage can be written as follows:

$$\frac{W^T}{W^N} = \frac{\theta^T}{\theta^N} \frac{1}{P} \frac{Y^T}{Y^N} \frac{L^N}{L^T}. \tag{478}$$

Dividing (469f) by (469e) leads to a positive relationship between the supply of hours worked to the traded sector relative to the non traded sector and the traded wage relative to the non traded wage, i.e., $\frac{L^T}{L^N} = \frac{\vartheta}{1-\vartheta}\left(\frac{W^T}{W^N}\right)^{\epsilon}$. Substituting the latter equation, eq. (478) can be solved for W^T/W^N, i.e.,

$$\frac{W^T}{W^N} = \left[\frac{1-\vartheta}{\vartheta} \frac{\theta^T}{\theta^N} \frac{1}{P} \frac{Y^T}{Y^N}\right]^{\frac{1}{\epsilon+1}}. \tag{479}$$

Additionally, since $\alpha_L = \frac{W^N L^N}{WL} = (1-\vartheta)\left(\frac{W^N}{W}\right)^{\epsilon+1}$, the share of hours worked in total hours worked is governed by the following optimal rule:

$$\begin{aligned}
\frac{L^N}{L} &= (1-\vartheta)\left(\frac{W^N}{W}\right)^{\epsilon}, \\
&= (1-\vartheta)\left(\frac{W}{W^N}\right)^{-\epsilon}.
\end{aligned} \tag{480}$$

Inserting (479) into (477) and plugging the resulting expression into (480) gives us a relationship between the non tradable content of labor and the ratio Y^T/Y^N (together with P):

$$\begin{aligned}\frac{L^N}{L} &= (1-\vartheta)\left[\vartheta\left(\frac{\theta^T}{\theta^N}\frac{1}{P}\frac{Y^T}{Y^N}\right)+(1-\vartheta)\right]^{-\frac{\epsilon}{\epsilon+1}}, \\ &= (1-\vartheta)^{\frac{1}{\epsilon+1}}\left[\frac{\theta^T}{\theta^N}\frac{1}{P}\frac{Y^T}{Y^N}+1\right]^{-\frac{\epsilon}{\epsilon+1}}. \end{aligned} \tag{481}$$

According to (481), given Y^T/Y^N and P, setting ϑ allows us to target the ratio L^N/L found in the data.

H.2 Calibration to a Representative OECD Economy

To calibrate our model, we estimated a set of parameters so that the initial steady state is consistent with the key empirical properties of a representative OECD economy. This section provides more details about how we calibrate the model to match the key empirical properties of a representative OECD economy. Because we consider an open economy setup with traded and non traded goods, we calculate the non tradable content of GDP, employment, consumption, gross fixed capital formation, government spending, labor compensation and the productivity in tradables in terms of non tradables, for all countries in our sample, as summarized in Table 4. To capture the key properties a typical OECD economy which is chosen as the baseline scenario, we take unweighted average values shown in the last line of Table 4. Columns 12-14 of Table 4 also report government spending and investment as a share of GDP along with the aggregate labor income share.

We first describe the parameters that are taken directly from the data; we start with the preference parameters shown in panel A of Table 13:

- One period in the model is a year.
- The world interest rate, $r^\star$, equal to the subjective time discount rate, β, is set to 4%.
- We assume that utility for consumption is logarithmic and thus set the intertemporal elasticity of substitution for consumption, σ_C, to 1.
- Next, we turn to the Frisch elasticity of labor supply. We set the intertemporal elasticity of substitution for labor supply σ_L to 0.4, in line with the evidence reported by Fiorito and Zanella [2012], but conduct a sensitivity analysis with respect to this parameter.
- The elasticity of labor supply across sectors, ϵ, which captures the degree of labor mobility is set to 0.75 in line with the average of our estimates shown in the last column of Table 4.[55] Our estimates display a wide dispersion across countries and we therefore conduct a sensitivity analysis with respect to this parameter. Excluding estimates of ϵ for Denmark and Norway which are not statistically significant at 10%, estimates of ϵ range from a low of 0.22 for the Netherlands to a high of 1.39 for the United States and 1.64 for Spain. Hence, we allow for ϵ to vary between 0.22 and 1.64 in the sensitivity analysis.
- Building on our panel data estimations (see section A.3), we set the elasticity of substitution (in consumption) between traded and non traded goods to 0.77 in the baseline calibration, in line with the unweighted average value shown in the last line of column 15 of Table 4.[56]

[55] Section A.4 presents the empirical strategy and contains the details of derivation of the relationship we explore empirically.

[56] We derive a testable equation by combining first-order conditions for relative demand and relative supply for tradables in terms of non tradables. Details of derivation of the equation we explore empirically can be found in section A.3. We explore empirically two variants of the testable equation, considering alternatively the ratio of sectoral value added or the ratio of sectoral labor compensation. Estimates of ϕ

- We set the elasticity of substitution, ϕ_J, in investment between traded and non traded inputs to 1, in line with the empirical findings documented by Bems [2008] for OECD countries.

We also consider a more general specification for preferences which are assumed to be non separable in consumption and labor. The functional form is taken from Shimer [2011]:

$$\frac{C^{1-\sigma}V(L)^{\sigma}-1}{1-\sigma}, \quad \text{if} \quad \sigma \neq 1, \quad V(L) \equiv \left(1+(\sigma-1)\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}\right). \tag{482}$$

Setting $\sigma = 1$, preferences are separable in consumption and labor, as in (312). When investigating the implications of non separability in preferences, we set $\sigma = 2$ while we keep other parameters unchanged.

We pursue with the non-tradable content of consumption, investment and government expenditure, employment, along with sectoral labor income shares and relative productivity of tradables shown in the last line of Table 4 that reports the average of our estimates while panel B of Table 13 displays the value of parameters we choose to calibrate the model:

- The weight of consumption in non tradables $1-\varphi$ is set to 0.51 to target a non-tradable content in total consumption expenditure (i.e. α_C) of 53%.
- In order to target a non tradable content of labor of 67% which corresponds to the 16 OECD countries' unweighted average shown in the last line of Table 4, we set the weight of labor supply to the traded sector in the labor index $L(.)$, $1-\vartheta$, to 0.68.
- We choose a value for the weight of non traded inputs in the investment aggregator function $J(.)$, $1-\varphi_J$, of 0.64 which allows us to obtain a non tradable content of investment expenditure of 64%.
- In accordance with our estimate shown in the last line of Table 4, we choose a non tradable content of government spending, $\omega_G^N = \frac{PG^N}{G}$, of 90%; by construction, we have a share of government consumption on tradables in total government spending, $\omega_{G^T} = 1 - \omega_{G^N}$, of 10%.
- Columns 9 and 10 of Table 4 give the labor income share of the traded and the non traded sector for the sixteen OECD countries in our sample. Labor income shares θ^T and θ^N average respectively to 0.60 and 0.67. Because average values suggest that the non traded sector is relatively more labor intensive than the traded sector, in the baseline calibration, we choose values for θ^T and θ^N so that $\theta^T < \theta^N$. The figures also show substantial dispersion across countries as the labor income share in the traded sector varies from a low of 0.38 in Norway to a high of 0.71 for Italy. Moreover, the labor income share in the traded sector, θ^T, is higher than that in the non traded sector, θ^N, for two countries, namely France and Italy. Thus, we also conduct a sensitivity analysis by considering a situation where the traded sector is more labor intensive than the non traded sector. When excluding France and Italy, the values of θ^T and θ^N average 0.58 and 0.67, respectively. In the baseline calibration, we set θ^T and θ^N to 0.58 and 0.68 which correspond roughly to the average for countries with $k^T > k^N$ and are consistent with an aggregate labor income share of 64%, as show in column 14 of Table 4. Formally, the aggregate labor income share, denoted by θ, is a value-weighted average of the sectoral labor income shares, i.e., $\theta = \frac{\theta^T Y^T}{Y} + \frac{\theta^N PY^N}{Y}$. When we consider a traded sector that is relatively more labor intensive than the non traded sector, i.e., $k^N > k^T$, we use reverse but symmetric values and thus set $\theta^T = 0.68$ and $\theta^N = 0.58$.
- We assume that traded firms are 28 percent more productive than non traded firms in line with our estimates; we thus normalize Z^N to 1 and set Z^T to 1.28.

for Italy are negative for both variants while for Belgium, only the estimate of the elasticity of substitution in consumption between tradables and non tradables when exploring empirically the second variant of the testable equation is statistically significant (see Table 3). Excluding estimates of ϕ for Italy which are negative and considering a value of 0.795 for Belgium, the elasticity of substitution ϕ averages to 0.77.

We describe below the choice of parameters displayed in panel C of Table 13 characterizing macroeconomic variables such as investment, government spending and the balance of trade of a typical OECD economy:

- As shown in the last line of column 13 of Table 4, government spending as a percentage of GDP averages 20% and thus we set $\omega_G = \frac{G}{Y}$ to 0.2.
- In order to target an investment-to-GDP ratio, $\omega_J = \frac{P_J I}{Y}$, of 21% as shown in the last line of column 12 of Table 4, we set the rate of physical capital depreciation, δ_K, to 6%.
- We choose the value of parameter κ so that the elasticity of I/K with respect to Tobin's q, i.e., Q/P_J, is equal to the value implied by estimates in Eberly, Rebelo, and Vincent [2008]. The resulting value of κ is equal to 17.[57]
- Finally, we choose initial values for B_0 and K_0 for the ratio of net exports to traded output to be nil at the initial steady-state, i.e., $\upsilon_{NX} \simeq 0$.

Investment- and government spending-to-GDP ratios along with balanced trade endogenously determine the consumption-to-GDP ratio. More precisely, since GDP is equal to the sum if its demand components, remembering that at the steady-state $I = J$, we thus have the following accounting identity, $Y = P_C C + P_J I + G + NX$. Dividing both sides by Y and remembering that net exports are nil, i.e., $NX = 0$, the consumption-to-GDP ratio denoted by $\omega_C = \frac{P_C C}{Y}$ is thus equal to 59%:

$$\omega_C = \frac{P_C C}{Y} = 1 - \left(\omega_J + \omega_G + \frac{NX}{Y}\right) = 59\%, \tag{483}$$

where $\omega_J = \frac{P_J I}{Y} = 21\%$, $\omega_G = \frac{G}{Y} = 20\%$, and $NX = 0$.

It is worthwhile mentioning that the non tradable content of GDP is endogenously determined by the non tradable content of consumption, α_C, of investment, α_J, and of government expenditure, ω_{G^N}, along with the consumption-to-GDP ratio, ω_C, and the investment-to-GDP ratio, ω_J. More precisely, dividing the non traded good market clearing condition (469p) by GDP, Y, leads to an expression that allows us to calculate the non tradable content of GDP:

$$\frac{Y^N}{Y} = \omega_C \alpha_C + \omega_J \alpha_J + \omega_{G^N} \omega_G = 63\%, \tag{484}$$

where $\omega_C = 59\%$, $\alpha_C = 53\%$, $\omega_J = 21\%$, $\alpha_J = 64\%$, $\omega_{G^N} = 90\%$, and $\omega_G = 20\%$. According to (484), the values we target for the non tradable content of consumption, investment and government spending along with the consumption-, investment-, and government spending-to-GDP ratios are consistent with a non tradable content of GDP of 63% found in the data, as reported in the last line of column 1 of Table 4.

In order to capture the dynamic adjustment of government consumption, we assume that the response of government consumption in percent of GDP is governed by the following dynamic equation:[58]

$$\frac{dG(t)}{\tilde{Y}} \equiv \frac{G(t) - \tilde{G}}{\tilde{Y}} = \left[e^{-\xi t} - (1-g)\, e^{-\chi t}\right], \tag{485}$$

where g parametrizes the exogenous fiscal shock while $\xi > 0$ and $\chi > 0$ parametrize the persistence of the response of government consumption along with the pattern of its dynamic adjustment. We present below the parameters related to the endogenous response of government spending to an exogenous fiscal shock which are summarized in panel D of Table 13:

[57] Eberly, Rebelo, and Vincent [2008] run the regression $I/K = \alpha + \beta \,.\, \ln(q)$ and obtain a point estimate for β of 0.06. In our model, the steady-state elasticity of I/K with respect to Tobin's q is $1/\kappa$. Equating $1/\kappa$ to 0.06 gives a value for κ of 17.

[58] More technical details can be found in section F.1.

- We investigate the effects of a rise in government consumption by 1 percentage point of GDP and thus set g to 0.01.

- We choose values of ξ and χ in order to account for the dynamic adjustment of government consumption. Data indicate that the endogenous response of government spending to an exogenous fiscal shock reaches a maximum at time $t = 1$:

$$\frac{dG(1)}{\tilde{Y}} \equiv \frac{G(1) - \tilde{G}}{\tilde{Y}} = g' = \left[e^{-\xi} - (1-g)\, e^{-\chi}\right]. \tag{486}$$

  Differentiating (485) w.r.t. time leads to:

$$\frac{\dot{G}(t)}{\tilde{Y}} = -\left[\xi e^{-\xi t} - \chi\,(1-g)\, e^{-\chi t}\right]. \tag{487}$$

  When government spending reaches its maximum value, we have $\dot{G}(t) = 0$. Setting $t = 1$ into (487) gives:

$$\frac{\dot{G}(1)}{\tilde{Y}} = -\left[\xi e^{-\xi} - \chi\,(1-g)\, e^{-\chi}\right] = 0 \tag{488}$$

  Using the fact that $g = 0.01$ and $g' = 0.01126548$, the system consisting of eq. (486) and eq. (488) jointly determine the values of ξ and χ which allow us to capture the endogenous response of government spending to an exogenous fiscal shock by $g \times 100$ percentage points of GDP; we set $\xi = 0.408675$ and $\chi = 0.415722$.

- While government purchases both non traded goods, G^N, and traded goods, G^T, our VAR evidence suggest that the rise in government consumption is strongly biased toward non traded goods as the relative size the non traded sector rises significantly. When we simulate the model, we thus consider a rise in government consumption by 1 percentage point of GDP which is split between non tradables and tradables in accordance with their respective share in government expenditure at 90% and 10%, respectively. Formally, we have:

$$\frac{dG(t)}{\tilde{Y}} = \omega_{G^N} \frac{dG^N(t)}{\tilde{Y}} + (1 - \omega_{G^N})\, \frac{dG^T(t)}{\tilde{Y}}, \tag{489}$$

  where $dG(t) = G(t) - \tilde{G}$ and $dG^j(t) = G^j(t) - \tilde{G}^j$.

I More Numerical Results

In this section, we provide more numerical results:

- First, while in the main text, we restrict attention to impact responses to a government spending shock when we conduct the sensitivity analysis for reasons of space, we provide below more numerical results. In particular, in subsection I.1, we report the cumulative responses over a two-year and a four-year horizon. Additionally, while in the main text, we assume that capital can move freely across sectors along with workers' costs of switching across sectors, in subsection I.1, we investigate the implications of imperfect mobility of capital across sectors. Since this feature merely affects quantitatively the responses, we relegate these results in the Technical Appendix as we believe they are secondary.

- Second, in the main text, we contrast the predictions of our baseline model allowing for imperfect mobility of labor across sectors along with adjustment costs to capital accumulation with those obtained in a model imposing perfect mobility of labor and abstracting from capital installation costs. Because both features play a pivotal role, we report in the main text the impact responses to a government spending shock in a model either imposing perfect mobility of labor across sectors or abstracting from

Table 13: Baseline Parameters (Representative OECD Economy)

Definition	Value		Reference
	OECD	Sensitivity	
Period of time	year	year	data frequency
A.Preferences			
Subjective time discount rate, β	4%	4%	equal to the world interest rate
Intertemporal elasticity of substitution for consumption, σ_C	1	1	logarithmic utility function for consumption
Elasticity of labor supply at the extensive margin, σ_L	0.4	0.2-1	Fiorito and Zanella [2012]
Separability vs. non separability in preferences, σ	1	2	Shimer [2011]
Elasticity of substitution between C^T and C^N, ϕ	0.77	0.77	our estimates (KLEMS [2011], OECD Economic Outlook)
Elasticity of substitution between J^T and J^N, ϕ_J	1	1	Bems [2008]
B.Non Tradable Share			
Weight of consumption in non traded goods, $1-\varphi$	0.51	0.51	set to target $\alpha_C = 53\%$ (United Nations [2011])
Weight of labor supply to the non traded sector, $1-\vartheta$	0.15	0.15	set to target $L^N/L = 67\%$ (KLEMS [2011])
Weight of non traded investment, $1-\vartheta$	0.64	0.64	set to target $\alpha_J = 64\%$ (OECD Input-Output database [2012a])
Non Tradable content of government expenditure, ω_{G^N}	0.90	0.90	our estimates (OECD [2012b], IMF [2011])
Labor income share in the non traded sector, θ^N	0.68	0.58	our estimates (EU KLEMS [2011] and OECD STAN databases)
Labor income share in the traded sector, θ^T	0.58	0.68	our estimates (EU KLEMS [2011] and OECD STAN databases)
Labor productivity index for the traded sector, Z^T	1.28	1.28	our estimates (KLEMS [2011])
C.GDP demand components			
Physical capital depreciation rate, δ_K	6%	6%	set to target $\omega_J = 21\%$ (Source: OECD Economic Outlook Database)
Parameter governing capital adjustment cost, κ	17	0	set to match the elasticity I/K to Tobin's q (Eberly et al. [2008])
Government spending as a ratio of GDP, ω_G	20%	20%	our estimates (Source: OECD Economic Outlook Database)
D.Government Spending Shock			
Exogenous fiscal shock, g	1%	2%	To generate $dG(0)/Y = 1\%$
Persistence and shape of endogenous response of G, ξ	0.408675	0.408675	set to target $dG(1) = g'$ and $\dot{G}(1) = 0$
Persistence and shape of endogenous response of G, χ	0.415722	0.415722	set to target $dG(1) = g'$ and $\dot{G}(1) = 0$

capital installation costs. We report below, in subsection I.2, the dynamic adjustment of a model either imposing perfect mobility of labor across sectors or abstracting from capital installation costs and contrast the predictions with those obtained in the baseline model. The model imposing perfect mobility of labor while assuming capital installation costs or the other way around both fail to account for the evidence at an aggregate and a sectoral level while the latter performs better than the former in reproducing the evidence, in particular for sectoral variables.

- Third, in section 5.3 of the main text, we plot the simulated responses of output shares of tradables and non tradables against the degree of labor mobility across sectors and contrast model's predictions with estimated cross-country relationships for both tradables and non tradables. To look at the cross-country differences in the sectoral impact of a government spending shock empirically, we estimate the same VAR model, i.e., $x_{it}^{S,j}$, as for the whole sample, but for a single a country at a time. To look at the cross-country differences in the sectoral impact of a government spending shock numerically, we calibrate the baseline model to each OECD country in our sample. While in the main text, we only show the scatter-plots, in subsection I.3, we report both estimated and simulated impact responses to a government spending shock of output shares of tradables and non tradables.

I.1 Numerical Results for a Representative OECD Economy

Table 14 reports impact effects while Table 15 shows cumulative responses over a two- and four-year horizon following a rise in government consumption by 1 percentage point of GDP. Column 1 of Tables 14 and 15 shows the effects of a government spending shock from our VAR model for comparison purposes while columns 2-14 report simulated responses. We conduct a sensitivity analysis with respect to a number of parameters, including the labor income share of sector j, θ^j, the elasticity of labor supply across sectors, ϵ, the parameter κ that governs the magnitude of adjustment costs to capital accumulation, the Frisch elasticity of labor supply, σ_L, and the parameter $\sigma > 0$ that determines the substitutability between consumption and leisure. We provide more details below:

- In columns 2 and 3, we impose perfect mobility of labor across sectors, i.e., $\epsilon \to \infty$. In column 2, we abstract from capital installation costs and thus set $\kappa = 0$ while in column 3, we consider adjustment costs to physical capital accumulation and thus sect $\kappa = 17$.

- Column 4 reports results from our baseline model with imperfect mobility of labor across sectors, setting ϵ to 0.75, while capital accumulation is assumed to be subject to adjustments costs with $\kappa = 17$.

- In columns 5 and 6, we keep unchanged κ and investigate the effects of a government spending shock when the degree of labor mobility across sectors is low, i.e., ϵ is set to 0.22, and when the elasticity of labor supply across sectors is high, i.e., ϵ is set to 1.64.

- In column 7, we investigate the sensitivity of our results to the Frisch elasticity of labor supply which is raised from 0.4 to 1.

- Column 8 shows results when we allow for imperfect mobility of labor across sectors, setting ϵ to 0.75, while we abstract from adjustment costs to capital accumulation, and thus set κ to 0.

- Column 9 reports results when we relax the assumption of separability in preferences between consumption and labor, setting σ to 2.

- In column 10 (IMK), we keep unchanged $\epsilon = 0.75$, $\sigma_L = 0.4$, $\sigma = 1$, $\kappa = 17$ and we allow for imperfect mobility of capital across sectors, setting the elasticity of capital supply across sectors, η, to 0.75, and the weight $1 - \zeta$ of capital supply to the non traded sector in the aggregate capital index $K(.)$ to 0.68 in order to target a non tradable content of capital income of 58%, in line with our estimates.

- While from column 2 to column 10, we assume that the non traded sector is relatively more labor intensive than the traded sector, and thus set θ^N to 0.68 and θ^T to 0.58, from column 11 to column 13, we explore the case where the non traded sector is relatively more capital intensive and thus choose reverse and symmetric values for the sectoral labor income shares, i.e., we set θ^N to 0.58 and θ^T to 0.68.
- While column 12 reports our baseline model's predictions when $\theta^T > \theta^N$, in column 11, we set $\kappa = 0$ and let ϵ tend toward infinity, and in column 13 (IMK), we allow for both imperfect mobility of labor and capital across sectors, and thus set η to 0.75.

In columns 10 and 13 of Table 14, we extend the baseline model with imperfect mobility of labor along with capital installation costs to imperfect mobility of capital. A shortcut to generate imperfect capital mobility is to assume limited substitutability in capital across sectors. Along the lines of Horvath [2000] who introduce limited substitutability of hours worked, we assume that capital in the traded and the non traded sectors are aggregated by means of a CES function:

$$K\left(K^T, K^N\right) = \left[\zeta^{-\frac{1}{\eta}} \left(K^T\right)^{\frac{\eta+1}{\eta}} + (1-\zeta)^{-\frac{1}{\eta}} \left(K^N\right)^{\frac{\eta+1}{\eta}}\right]^{\frac{\eta}{\eta+1}}, \tag{490}$$

where $0 < \zeta < 1$ is the weight of capital supply to the traded sector in the aggregate capital index $K(.)$ and η measures the ease with which capital in the traded and the non traded sector can be substituted for each other and thereby captures the degree of capital mobility across sectors. The case of perfect capital mobility is nested under the assumption that η tends towards infinity; in this case, (490) reduces to $K = K^T + K^N$ which implies that capital is perfectly substitutable across sectors. When $\eta < \infty$, sectoral capital goods are no longer perfect substitutes. More specifically, as η becomes smaller, capital mobility across sectors becomes lower as investors perceive a higher cost of shifting capital and therefore become more reluctant to reallocate capital across sectors.

Panels A and B of Table 14 show impact effects of a government spending shock for GDP, investment and the current account along with labor market variables such as total hours worked and the real consumption wage. Panels C and D of Table 14 summarize the theoretical responses of sectoral variables for the labor and product markets. Because the results shown in column 10 when we allow for imperfect mobility of capital across sectors do not neither improve the performance of the model with imperfect mobility of labor in replicating the evidence, nor provide major additional information on the fiscal transmission as the conclusions are similar whether we allow or not for imperfect mobility of capital across sectors, to save space we do not present them in the main text and relegate these results in the Technical Appendix. Panels E and F of Table 15 report cumulative responses over a two- and a fourth-year horizon for aggregate and selected sectoral variables.

I.2 Numerical Results for a Representative OECD Economy

In the main text, see section 5.2, we show that the model is successful in replicating both aggregate and sectoral effects of a government spending shock as long as we allow for both imperfect mobility of labor across sectors, captured by ϵ, along with adjustment costs to capital accumulation, captured by the parameter κ. Table 2 contrasts impact effects in the baseline scenario with a number of alternative scenarios where we impose perfect mobility of labor across sectors and abstract from capital installation costs (column 2), we consider capital installation costs along with perfect mobility of labor across sectors (column 3), and we allow for imperfect mobility of labor across sectors but abstract from capital installation costs (column 8). Figures 6 and 7 in the main text display the model predictions for the aggregate and sectoral effects, respectively, of a government spending shock under imperfect (solid black line) and perfect mobility of labor across sectors (dotted black line) together with the respective VAR evidence (solid blue line). For reason of space, we do not contrast the dynamic adjustment of the baseline model with that obtained from a model with perfect mobility of labor while assuming capital installation costs or alternatively from a model assuming imperfect mobility of labor but abstracting from adjustment costs to

Table 14: Impact Responses of Aggregate and Sectoral Variables to of a Rise in Government Consumption (in %)

	Data	$1-\theta^T > 1-\theta^N$									$1-\theta^T < 1-\theta^N$		
		Perf. Mob.		Bench	Mobility		Lab. supply	No Adj. Cost.	Non sep.	IMK	Perf. Mob.	IML	IMK
		$(\kappa=0)$	$(\kappa=17)$	$(\epsilon=0.75)$	$(\epsilon=0.22)$	$(\epsilon=1.64)$	$(\sigma_L=1)$	$(\kappa=0)$	$(\sigma=2)$	$(\eta=0.75)$	$(\epsilon=\infty)$	$(\epsilon=0.75)$	$(\eta=0.75)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A.Impact:GDP & Components													
Real GDP, $dY(0)$	0.51	0.07	0.09	0.19	0.22	0.16	0.34	0.15	0.17	0.23	0.00	0.16	0.20
Investment, $dI(0)$	-0.01	-0.84	0.04	-0.13	-0.17	-0.08	-0.14	-0.41	-0.14	-0.19	1.49	-0.22	-0.28
Current Account, $dCA(0)$	-0.30	0.06	-0.75	-0.34	-0.22	-0.46	-0.29	-0.12	-0.50	-0.18	-2.49	-0.35	-0.19
B.Impact: Labor & Real Wage													
Labor, $dL(0)$	0.53	0.11	0.15	0.30	0.34	0.25	0.53	0.24	0.27	0.36	0.00	0.25	0.32
Real wage, $d\left(W/P_C\right)(0)$	0.48	0.00	0.07	0.07	0.08	0.06	-0.04	0.05	0.12	0.10	-0.30	-0.05	-0.01
C.Impact: Sectoral Labor													
Traded labor, $dL^T(0)$	0.01	-0.20	-0.68	-0.14	0.02	-0.29	-0.04	-0.09	-0.19	-0.09	-1.94	-0.17	-0.11
Non traded labor, $dL^N(0)$	0.54	0.30	0.83	0.44	0.32	0.55	0.57	0.33	0.45	0.45	1.95	0.42	0.43
Traded wage, $d\left(W^T/P_C\right)(0)$	0.22	0.00	0.07	-0.89	-1.18	-0.61	-0.91	-0.65	-1.00	-0.76	-0.30	-0.96	-0.81
Non traded wage, $d\left(W^N/P_C\right)(0)$	0.83	0.00	0.07	0.55	0.69	0.42	0.43	0.38	0.66	0.50	-0.30	0.54	0.50
Relative labor, $d\left(L^T/L^N\right)(0)$	-0.71	-0.53	-1.86	-0.52	-0.19	-0.86	-0.50	-0.36	-0.59	-0.44	-5.83	-0.60	-0.53
Relative wage, $d\left(W^N/W^T\right)(0)$	0.93	-0.00	0.00	1.44	1.87	1.03	1.33	1.02	1.66	1.25	-0.00	1.49	1.31
Labor share of T, $d(L^T/L)(0)$	-0.27	-0.23	-0.74	-0.24	-0.09	-0.38	-0.23	-0.17	-0.27	-0.20	-1.94	-0.27	-0.23
Labor share of N, $d(L^N/L)(0)$	0.27	0.23	0.74	0.24	0.09	0.38	0.23	0.17	0.27	0.20	1.94	0.27	0.23
D.Impact: Sectoral Output													
Traded output, $dY^T(0)$	-0.03	-0.22	-0.72	-0.31	-0.19	-0.43	-0.24	-0.21	-0.37	-0.14	-1.87	-0.31	-0.15
Non traded output, $dY^N(0)$	0.70	0.28	0.82	0.50	0.41	0.59	0.58	0.37	0.55	0.37	1.87	0.47	0.34
Relative output, $d\left(Y^T/Y^N\right)(0)$	-1.03	-0.62	-3.16	-0.97	-0.64	-1.30	-0.97	-0.64	-1.07	-0.52	-4.93	-0.88	-0.51
Relative price, $dP(0)$	1.06	-0.00	0.02	0.88	1.13	0.64	0.79	0.62	1.02	1.22	0.08	1.01	1.36
Output share of T, $d(Y^T/Y_R)(0)$	-0.45	-0.24	-0.76	-0.38	-0.26	-0.49	-0.37	-0.27	-0.44	-0.22	-1.87	-0.37	-0.21
Output share of N, $d(Y^N/Y_R)(0)$	0.35	0.24	0.76	0.38	0.26	0.49	0.37	0.27	0.44	0.22	1.87	0.37	0.21

Notes: Effects of an unanticipated and temporary exogenous rise in government consumption by 1% of GDP. Panels A,B,C,D show the initial deviation in percentage relative to steady-state for aggregate and sectoral variables. Market product (aggregate and sectoral) quantities are expressed in percent of initial GDP while labor market (aggregate and sectoral) quantities are expressed in percent of initial total hours worked; θ^T and θ^N are the labor income share in the traded sector and non traded sector, respectively; ϵ measures the degree of substitutability in hours worked across sectors and captures the degree of labor mobility; σ_L is the Frisch elasticity of labor supply; κ governs the magnitude of adjustment costs to capital accumulation; σ determines the substitutability between consumption and leisure when preferences are non separable, η measures the degree of substitutability in capital across sectors and captures the degree of capital mobility. In our baseline calibration we set $\theta^T = 0.58$, $\theta^N = 0.68$, $\epsilon = 0.75$, $\eta \to \infty$, $\phi = 0.77$, $\sigma_L = 0.4$, $\kappa = 17$, $\sigma = 1$.

Table 15: Cumulative Responses of Aggregate and Sectoral Variables to of a Rise in Government Consumption (in %)

	Data	$1-\theta^T > 1-\theta^N$									$1-\theta^T < 1-\theta^N$		
		Perf. Mob.		Bench	Mobility		Lab. supply	No Adj. Cost.	Non sep.	IMK	Perf. Mob.	IML	IMK
		$(\kappa = 0)$	$(\kappa = 17)$	$(\epsilon = 0.75)$	$(\epsilon = 0.22)$	$(\epsilon = 1.64)$	$(\sigma_L = 1)$	$(\kappa = 0)$	$(\sigma = 2)$	$(\eta = 0.75)$	$(\epsilon = \infty)$	$(\epsilon = 0.75)$	$(\eta = 0.75)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
E.Cumulative: 2 year													
Real GDP, dY_R	1.03	0.07	0.19	0.39	0.45	0.33	0.70	0.24	0.34	0.47	0.14	0.32	0.40
Investment, dI	-0.33	-1.23	0.10	-0.28	-0.39	-0.18	-0.31	-1.03	-0.31	-0.43	1.89	-0.50	-0.63
Current account, dCA	-1.45	-0.47	-1.65	-0.75	-0.48	-1.00	-0.64	-0.20	-1.08	-0.39	-3.90	-0.75	-0.42
Labor, dL	1.26	0.21	0.30	0.62	0.71	0.53	1.11	0.45	0.55	0.74	0.07	0.53	0.67
Real wage, dW/P_C	0.59	0.00	0.15	0.15	0.17	0.13	-0.08	0.05	0.25	0.20	-0.41	-0.11	-0.02
Relative price, dP	3.42	0.00	0.04	1.85	2.39	1.35	1.67	1.22	2.16	2.58	0.11	2.12	2.85
Relative wage, $d\Omega$	2.50	0.00	0.00	3.04	3.94	2.18	2.82	2.04	3.51	2.64	0.00	3.13	2.76
Traded output, dY^T	-0.10	-0.85	-1.54	-0.67	-0.40	-0.92	-0.50	-0.45	-0.80	-0.30	-2.97	-0.66	-0.31
Non traded output, dY^N	1.27	0.92	1.73	1.06	0.85	1.25	1.21	0.69	1.15	0.77	3.12	0.98	0.71
Output share of T, $d(Y^T/Y_R)$	-0.99	-0.87	-1.61	-0.81	-0.56	-1.04	-0.77	-0.54	-0.92	-0.46	-3.03	-0.77	-0.45
Output share of N, $d(Y^N/Y_R)$	0.76	0.87	1.61	0.81	0.56	1.04	0.77	0.54	0.92	0.46	3.03	0.77	0.45
F.Cumulative: 4 year													
Real GDP, dY	1.10	0.05	0.38	0.71	0.81	0.61	1.31	0.21	0.62	0.84	0.50	0.57	0.71
Investment, dI	-1.29	-1.19	0.20	-0.57	-0.79	-0.35	-0.63	-2.11	-0.62	-0.87	1.74	-1.01	-1.27
Current account, dCA	-3.35	-2.15	-3.24	-1.48	-0.95	-1.98	-1.25	-0.46	-2.14	-0.76	-5.44	-1.47	-0.81
Labor, dL	1.99	0.42	0.58	1.17	1.35	1.01	2.10	0.81	1.04	1.40	0.27	1.00	1.26
Real wage, $d(W/P_C)$	-0.70	0.00	0.28	0.24	0.29	0.23	-0.17	-0.09	0.43	0.34	-0.47	-0.23	-0.09
Relative price, dP	7.98	-0.00	0.08	3.51	4.53	2.55	3.16	2.34	4.08	4.89	0.13	4.01	5.40
Relative Wage, $d\Omega$	5.17	-0.00	0.00	5.76	7.49	4.14	5.34	3.99	6.66	5.01	-0.00	5.92	5.22
Traded output, dY^T	-0.79	-2.39	-2.91	-1.28	-0.77	-1.75	-0.96	-0.99	-1.53	-0.59	-4.19	-1.26	-0.60
Non traded output, dY^N	1.88	2.44	3.28	1.98	1.58	2.36	2.28	1.20	2.15	1.43	4.69	1.83	1.31
Output share of T, $d(Y^T/Y_R)$	-2.02	-2.40	-3.05	-1.54	-1.06	-1.98	-1.47	-1.06	-1.75	-0.89	-4.38	-1.46	-0.85
Output share of N, $d(Y^N/Y_R)$	1.77	2.40	3.05	1.54	1.06	1.98	1.47	1.06	1.75	0.89	4.38	1.46	0.85

Notes: Effects of an unanticipated and temporary exogenous rise in government consumption by 1% of GDP. Panels E and F show the cumulative responses over a two- and four-year horizon, respectively. Market product (aggregate and sectoral) quantities are expressed in percent of initial GDP while labor market (aggregate and sectoral) quantities are expressed in percent of initial total hours worked; θ^T and θ^N are the labor income share in the traded sector and non traded sector, respectively; ϵ measures the degree of substitutability in hours worked across sectors and captures the degree of labor mobility; σ_L is the Frisch elasticity of labor supply; κ governs the magnitude of adjustment costs to capital accumulation; σ determines the substitutability between consumption and leisure when preferences are non separable, η measures the degree of substitutability in capital across sectors and captures the degree of capital mobility. In our baseline calibration we set $\theta^T = 0.58$, $\theta^N = 0.68$, $\epsilon = 0.75$, $\eta \to \infty$, $\phi = 0.77$, $\sigma_L = 0.4$, $\kappa = 17$, $\sigma = 1$.

physical capital accumulation. The results are relegated in this subsection. We emphasize very briefly in what a model either abstracting from capital installation costs or imposing perfect mobility of labor across sectors fails to account for our panel VAR evidence.

The solid black line in Figures 20 and 21 show the predictions of the baseline model while the dotted black line displays the predictions of a model with a difficulty in reallocating labor across sectors but abstracting from capital installation costs. As emphasized in the main text, the conclusion that emerges is that the model without capital adjustment costs tend to overstate the crowding out of investment in the short-run and to understate substantially the current account deficit. Because investment declines more, excess demand in the non traded goods market and thus the appreciation in the relative price of non tradables is much smaller than that found in the data. Because the model without capital installation costs underpredicts the short-run rise in P, it tends to understate the responses of sectoral output shares. The solid black line in Figures 22 and 23 show the predictions of the baseline model while the dotted black line displays the predictions of a model imposing perfect mobility of labor across sectors while assuming that capital accumulation is subject to installation costs. First, the model predicts a rise in investment instead of decline, in contradiction with the evidence, and tends to overstate the current account deficit. Turning to the sectoral effects, while assuming capital installation costs restore transitional dynamics for the relative price of non tradables, the model imposing perfect mobility considerably understates the appreciation in the relative price and cannot account for the rise in non traded wages relative to traded wages as sectoral wages equalize. Moreover, while the relative price of non tradables merely appreciates, because labor is extremely sensitive to relative price changes, the consecutive changes in sectoral output shares conflict with the evidence since their magnitude are about twice what is estimated empirically,

I.3 Simulated Responses of Sectoral Output Shares across Countries

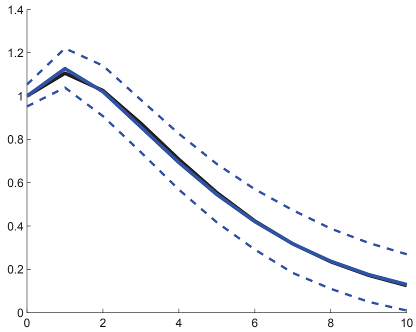
We denote by $\nu_i^{Y,j}(t)$ the output (Y) share of sector j, in country i at year t. In terms of our model's notation, the response of the output share of sector j to a government spending shock is measured in total output units and thus is calculated as the product between the growth differential between sectoral output and GDP (both at constant prices) and the content of production of good j in total output. Formally, the response at year t of the sectoral output share to a government spending shock reads as:

$$\hat{\nu}_i^{Y,j}(t) = \frac{P_i^j Y_i^j}{P_i Y_i}\left(\hat{Y}_{it}^j - \hat{Y}_{R,it}\right).$$

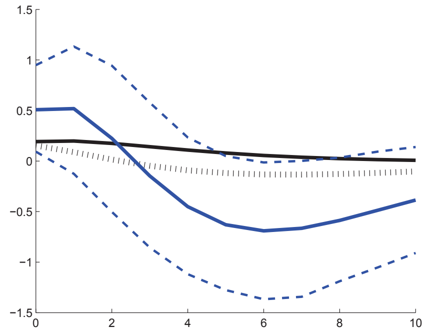
To assess the ability of our model to account for our evidence, we calibrate the model to the data of each country in our sample, except for the world interest rate, elasticity of labor supply, and κ that governs the magnitude of capital adjustment costs which are kept unchanged, i.e., $r^\star = 4\%$, $\sigma_L = 0.4$, and $\kappa = 17$. When numerically computing $\hat{\nu}_i^{Y,j}(0)$ for each country i, we set ϕ_i ϵ_i in accordance with their empirical estimates shown the two last columns of Table 4. When we calibrate the model to the whole sample (i.e., a representative OECD economy), we set ϵ to 0.75 and ϕ to 0.77 which correspond to their unweighted average values.

Columns 2 and 4 of Table 16 report the simulated impact responses of the output share of tradables, $\hat{\nu}_i^{Y,T}(0)$, and non tradables, $\hat{\nu}_i^{Y,N}(0)$, respectively, to an exogenous rise in government consumption by 1 percentage point of GDP. Columns 3 and 5 report point estimates from the VAR model for $\hat{\nu}_i^{Y,j}(0)$ for each country and the whole sample as well. In line with our model's predictions, an increase in government consumption gives rise to a contraction in the traded sector and has an expansionary effect on the non traded sector, except for Australia and Ireland. Because in these two economies, the traded sector expands while the non traded sector shrinks, we consider a rise in government consumption by 1 percentage point of GDP triggered by an increase in public purchases on tradables while keeping G^N fixed.

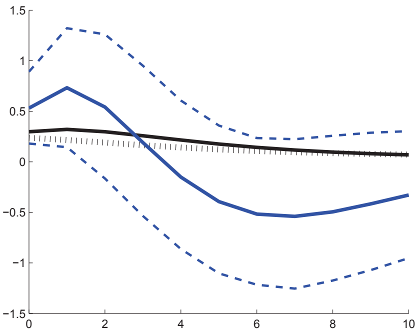
Because the time horizon of the sample is small for each country due to the annual frequency of data, the VAR estimates have to be taken with a grain of salt. More precisely, VAR estimates for $\hat{\nu}_i^{Y,j}(0)$ are significant at 10% for only five countries in our sample. As



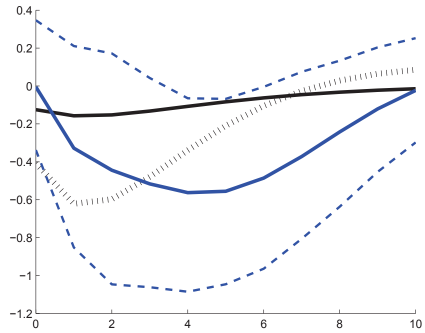
(a) Government Spending



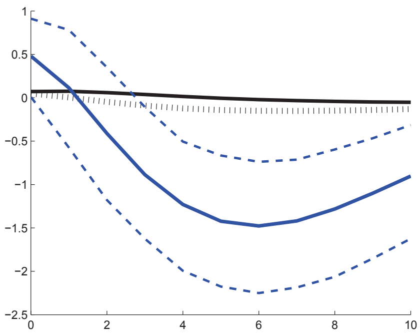
(b) GDP



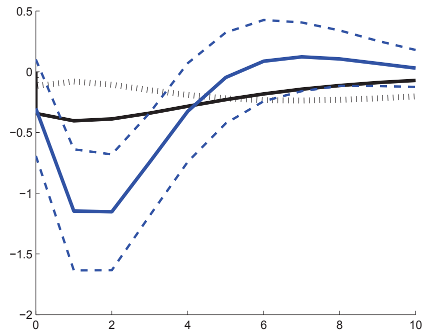
(c) Hours Worked



(d) Investment

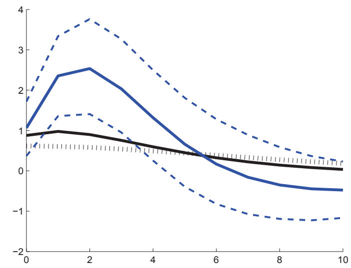


(e) Aggregate Real Wage

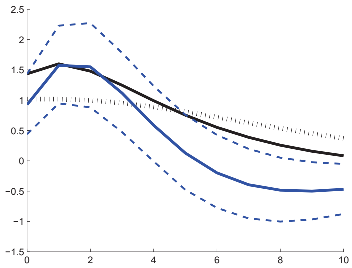


(f) Current Account

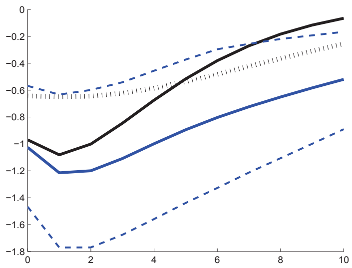
Figure 20: Dynamic Adjustment of Aggregate Variables to Unanticipated Government Spending Shock: The Role of Capital Adjustment Costs. <u>Notes:</u> solid blue line display point estimate of VAR with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows results when abstracting from capital adjustment costs ($\kappa = 0$).



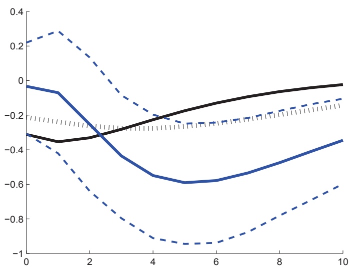
(a) Relative Price, P



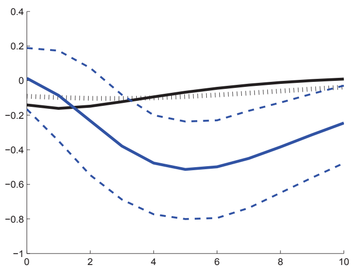
(b) Relative Wage, W^N/W^T



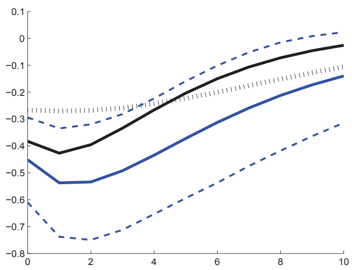
(c) Relative Output, Y^T/Y^N



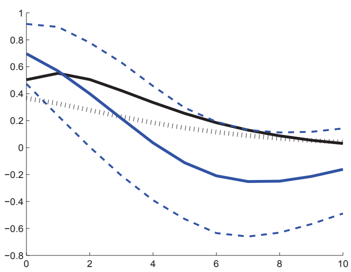
(d) Traded Output, Y^T



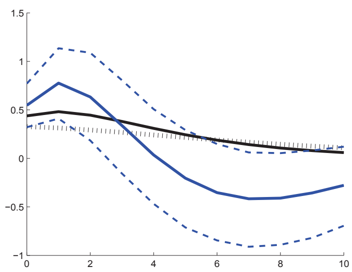
(e) Traded Labor, L^T



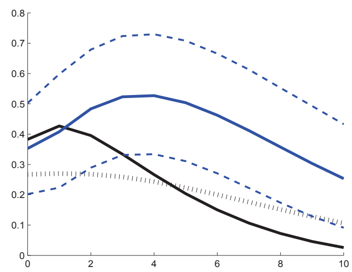
(f) Tradable share, Y^T/Y



(g) Non Traded Output, Y^N

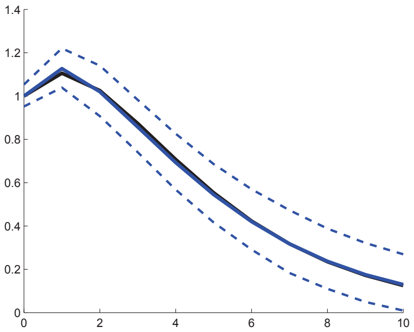


(h) Non Traded Labor, L^N

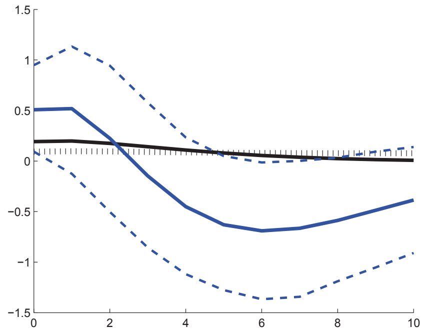


(i) Non Tradable share, Y^N/Y

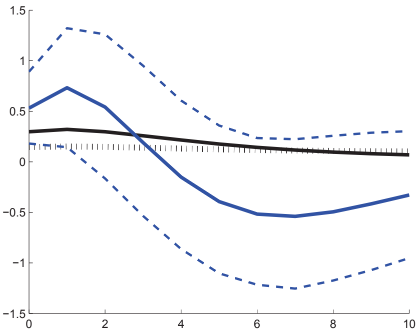
Figure 21: Dynamic Adjustment of Sectoral Variables to Unanticipated Government Spending Shock: The Role of Capital Adjustment Costs. Notes: Solid blue line display point estimate of VAR with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows results when abstracting from capital adjustment costs ($\kappa = 0$).



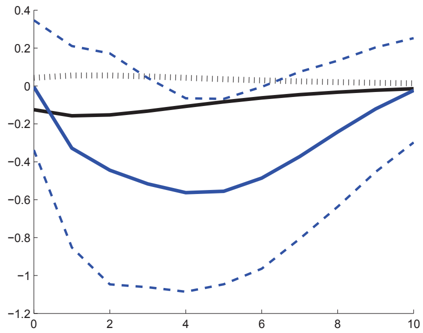
(a) Government Spending



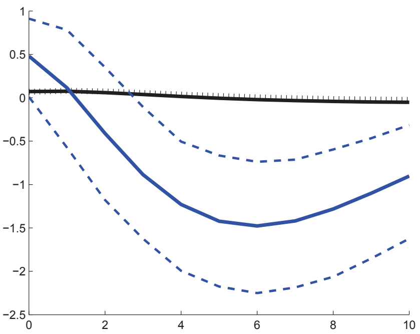
(b) GDP



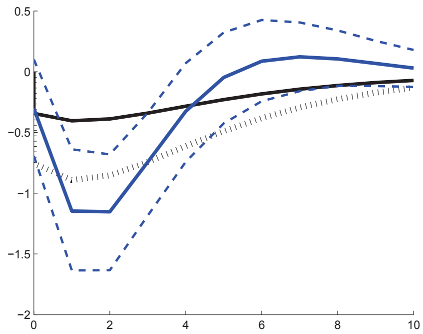
(c) Hours Worked



(d) Investment

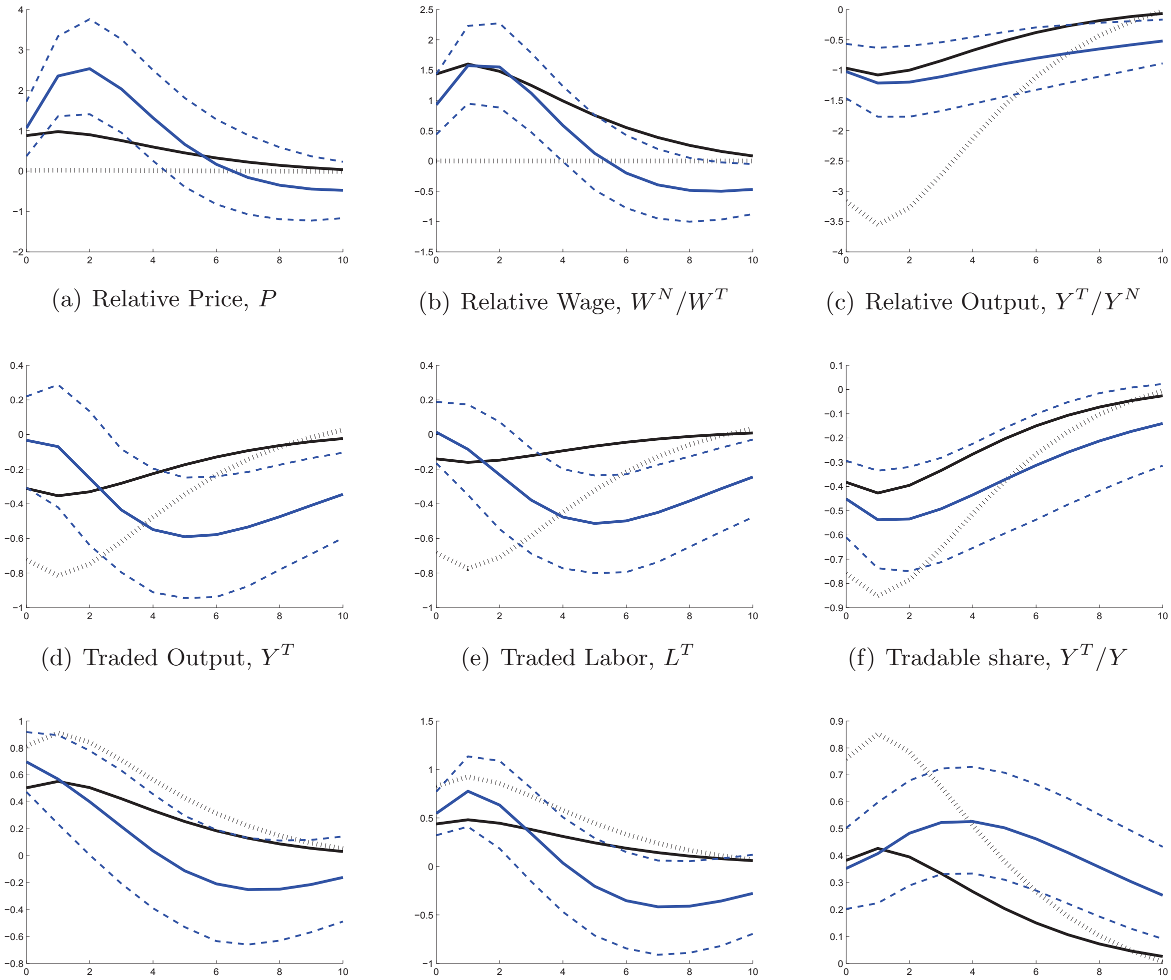


(e) Aggregate Real Wage



(f) Current Account

Figure 22: Dynamic Adjustment of Aggregate Variables to Unanticipated Government Spending Shock: The Role of Limited Mobility across Sectors. Notes: solid blue line display point estimate of VAR with dotted blue lines indicating 90% confidence bounds; the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows results when imposing perfect mobility of labor across sectors ($\epsilon \rightarrow \infty$).



(a) Relative Price, P (b) Relative Wage, W^N/W^T (c) Relative Output, Y^T/Y^N

(d) Traded Output, Y^T (e) Traded Labor, L^T (f) Tradable share, Y^T/Y

(g) Non Traded Output, Y^N (h) Non Traded Labor, L^N (i) Non Tradable share, Y^N/Y

Figure 23: Dynamic Adjustment of Sectoral Variables to Unanticipated Government Spending Shock: The Role of Limited Labor Mobility across Sectors. Notes: Solid blue line display point estimate of VAR with dotted blue lines indicating 90% confidence bounds;the solid black line displays model predictions in the baseline scenario with imperfect mobility of labor across sectors ($\epsilon = 0.75$) and capital installation costs ($\kappa = 17$) while the dotted black line shows results when imposing perfect mobility of labor across sectors ($\epsilon \to \infty$).

shown in the last line of Table 16, our model predicts remarkably well the contraction in the traded sector and the expansionary effect in the non traded sector. While our results tends to understate the changes in output shares of both sectors, the predicted values lie within the 90% confidence interval for most of the economies of our sample. More precisely, when we restrict our attention to statistically significant estimates, the model's predictions fall in the range of empirical estimates except for Canada. While we find that the model tends to understate the responses of sectoral output shares for most of the countries, in particular for Japan, Sweden, and the USA, the correlation between predicted and observed series is 0.64 for tradables and 0.67 for non tradables, as shown in the last line of Table 16, which suggest that the model can account reasonably well for cross-country differences in impact responses of sectoral output shares to a government spending shock.

To investigate the relationship between the magnitude of the sectoral impact of a fiscal shock and the degree of labor mobility across sectors, we regress the estimated sectoral output responses, $\hat{\nu}_i^{Y,j}(0)$, on the elasticity of labor supply across sectors, ϵ_i:

$$\hat{\nu}_i^{Y,j}(0) = \beta_0 + \beta_1 \,.\epsilon_i + \varepsilon_i. \tag{491}$$

According to our estimates reported in Table 17, the regression coefficient, β_1, is negative for tradables and positive for non tradables which suggests that following a rise in government consumption, the output share of tradables falls more while the output share of non tradables rises by a larger amount in countries with a higher labor mobility across sectors. Importantly, the regression coefficients from simulated and estimated values are roughly similar.

Table 16: Comparison of Simulated with Estimated Values for Changes in Sectoral Output Shares

Country	Parameter	Impact responses: sectoral output shares			
	(1)	(2)	(3)	(4)	(5)
	Mobility ϵ	$\left(\hat{\nu}_i^{Y,T}(0)\right)^{simul}$	$\left(\hat{\nu}_i^{Y,T}(0)\right)^{estim}$	$\left(\hat{\nu}_i^{Y,N}(0)\right)^{simul}$	$\left(\hat{\nu}_i^{Y,N}(0)\right)^{estim}$
AUS	0.635	$0.09^{\dagger}$	0.49	$-0.09^{\dagger}$	-0.15
AUT	0.548	$-0.33^{\dagger}$	-0.35	$0.33^{\dagger}$	0.22
BEL	0.326	$-0.28^{\dagger}$	-0.12	$0.28^{\dagger}$	0.12
CAN	0.454	-0.37	-1.03	0.37	0.94
DNK	-	-0.30	-0.77	0.30^{*}	0.68
ESP	1.642	$-0.49^{\dagger}$	-0.19	$0.49^{\dagger}$	0.39
FIN	0.544	-0.35^{*}	-0.81	0.35^{*}	0.90
FRA	1.287	$-0.38^{\dagger}$	-0.36	$0.38^{\dagger}$	0.41
GBR	1.008	$-0.40^{\dagger}$	-0.46	$0.40^{\dagger}$	0.55
IRL	0.264	$0.05^{\dagger}$	0.05	$-0.05^{\dagger}$	-0.07
ITA	0.686	$-0.37^{\dagger}$	-0.60	$0.37^{\dagger}$	0.50
JPN	0.993	$-0.43^{\dagger}$	-0.96	$0.43^{\dagger}$	0.89
NLD	0.224	$-0.26^{\dagger}$	-0.18	$0.26^{\dagger}$	0.22
NOR	-	$-0.35^{\dagger}$	0.03	$0.35^{\dagger}$	0.09
SWE	0.443	-0.34^{*}	-0.69	0.34^{*}	0.59
USA	1.387	-0.41^{*}	-1.21	0.41^{*}	0.77
Whole	0.746	-0.38^{*}	-0.43	0.38^{*}	0.33
Corr.			0.64		0.67

Notes: Table provides simulated (*simul*) and estimated (*estim*) responses on impact for $\hat{\nu}_i^{Y,j}(0)$ (with $j = T, N$); responses correspond to the change in sectoral value added at constant prices relative to real GDP measured in total output units; when computing the change in the share of valued added of sector j, we keep relative prices constant so that its change is only triggered by variations in quantities; ϵ is the elasticity of labor supply across sectors; because estimates of ϵ for Denmark and Norway are not statistically significant, their values are left blank. Predicted values for Denmark are obtained when setting ϵ to its value for the whole sample. We denote by superscripts 'simul' and 'estim' the numerically computed values and VAR estimates, respectively; † and * indicate that the predicted value lies within the estimated confidence interval while * indicates that the estimated value is significant at 10%; we calculate 90% confidence intervals based on estimated standard deviations of $\hat{\nu}_i^{Y,j}(0)$ obtained when the VAR model is estimated, for each country and the whole sample as well; 'Corr.' refers to the correlation coefficient between simulated and estimated values.

Table 17: Relationship between Impact Responses of Sectoral Output Shares to a Rise in Government Consumption and the Degree of Labor Mobility across Sectors (OLS estimates)

Variable	β_0	β_1	R^2	N
Y^T/Y				
Data	-0.272	-0.249	0.058	14
	(-1.090)	(-0.860)		
Model	-0.151^c	-0.206^b	0.295	14
	(-1.903)	(-2.238)		
Y^N/Y				
Data	0.274	0.234	0.087	14
	(1.452)	(1.072)		
Model	0.151^c	0.206^b	0.295	14
	(1.903)	(2.238)		

Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels; t-statistics are reported in parentheses.

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