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IMPERFECT MOBILITY OF LABOR ACROSS SECTORS: A REAPPRAISAL OF THE BALASSA-SAMUELSON EFFECT*

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Abstract

This paper investigates the relative price and relative wage effects of a higher productivity in the traded sector compared with the non traded sector in a two-sector open economy model with imperfect substitutability in hours worked across sectors. The Balassa-Samuelson model predicts that a rise in the sectoral productivity ratio by 1% raises the relative price of non tradables by 1% while leaving unchanged the non traded wage-traded wage ratio. Applying cointegration methods to a panel of fourteen OECD countries over the period 1970-2007, our estimates show that the relative price rises by only 0.78% while the relative wage falls by 0.27%. Hence, our first set of empirical findings cast doubt on the quantitative predictions of the Balassa-Samuelson model. A second set of empirical findings highlights the role of imperfect labor mobility: interacting the ratio of sectoral labor share-adjusted total factor productivities with an index of labor mobility across sectors, we find that the relative price responds more to a productivity differential between tradables and non tradables while the reaction of the relative wage is more muted as the degree of labor mobility increases. We show that the ability of the two-sector model to account for our evidence quantitatively relies upon two ingredients: i) imperfect mobility of labor across sectors, and ii) physical capital accumulation. Finally, our numerical results are robust to the introduction of i) non-separability in preferences between consumption and labor, and ii) traded investment.

Keywords: Relative price of non tradables; Sectoral wages; Productivity growth; Sectoral labor reallocation; Investment;
JEL Classification: E22; F11; F41; F43;

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1 Introduction

One major empirical finding in the macroeconomic literature is that the price of non traded goods in terms of traded goods exhibits a strong positive relationship with relative productivity in the traded and non traded sectors (see e.g., Canzoneri et al. [1999], Kakkar [2003]). Balassa [1964] and Samuelson [1964] have provided the benchmark setup to explain the movements in the long run of the relative price of non tradables in terms of the productivity differential between tradables and non tradables. Quantitatively, the Balassa-Samuelson (BS hereafter) model predicts that a rise by 1% of productivity in the traded sector relative to productivity in the non traded sector raises the relative price of non tradables by the same amount while leaving unchanged the ratio of the non traded wage to the traded wage due to the assumption of perfect mobility of labor across sectors. However, using a panel of 14 OECD countries over the period 1970-2007, our empirical estimates cast doubt on these predictions as the relative price increases by less than 1% while the ratio of non traded wage to traded wage falls. We find that theory can be reconciled with evidence once we consider imperfect mobility of labor across sectors and allow for physical capital accumulation.

To set the stage for our theoretical analysis, we briefly revisit the evidence related to the effects of higher productivity in tradables relative to non tradables on the relative price of non tradables. Our sample includes 14 OECD countries over the period 1970-2007. Following Canzoneri et al. [1999] and Kakkar [2003], we use unit root tests and cointegration methods to test the predictions of the BS model. Two major results emerge. First, our panel unit root tests reject the strict proportional relationship between the relative price and the labor share-adjusted sectoral total factor productivities (TFPs hereafter) differential. Second, when estimating the relative price effect of a productivity differential between tradables and non tradables, we find that the slope of the cointegrating vector is 0.78 for the whole sample and varies between 0.47 and 0.92 across countries.[1]

In our empirical analysis, we also analyze the effect of higher productivity of tradables relative to non tradables on the ratio of the non traded wage to the traded wage which has so far been mostly ignored by the empirical literature. Applying panel unit root tests, we find that the relative wage is integrated of order one and thereby reveals that the ratio of the non traded wage to the traded wage is non stationary. Hence, sectoral wages do not rise at the same speed, invalidating the wage equalization across sectors hypothesis imposed in the BS model.[2] When estimating the relationship between the relative wage and relative

[1]We adopt the same methodology as Canzoneri et al. [1999] and Kakkar [2003]. While we use a different sample, by and large our results are in line with the findings of Canzoneri et al. [1999] and Kakkar [2003].

[2]This conclusion is in accordance with the findings documented by Lee [2005], Schmillen [2011], Strauss

sectoral TFPs, we find a negative cointegrating slope of -0.27 for the whole sample. Further, our estimates for each economy reveal that countries where the relative wage declines more following a productivity differential also experience a smaller increase in the relative price. We conjecture that imperfect mobility of labor could rationalize the evidence because firms in the traded sector have to compensate for the mobility cost by increasing wages to hire more workers. Hence, the ratio of non traded wage to traded wage should fall when traded firms experience higher productivity gains than non traded producers. Because the non tradable unit labor cost increases less than if labor were perfectly mobile, the relative price must be increased by a smaller amount. To test our conjecture, we interact the relative sectoral TFPs with an index measuring the degree of labor mobility between tradables and non tradables. Our estimates corroborate our conjecture and reveal that as labor mobility increases, the relative price rises more while the response of the relative wage becomes more muted.

To accommodate our empirical findings, we put forward a variant of the two-sector small open model with tradables and non tradables.[3] More precisely, we assess its ability to account for the following set of evidence: a productivity differential between tradables and non tradables of 1% i) raises the relative price of non tradables by less than one 1%, ii) lowers the relative wage, iii) raises the relative price more and lowers the relative wage less as labor mobility increases. One major feature of our model with tradables and non tradables is that we consider imperfect mobility of labor across sectors by assuming that workers experience a (utility) loss when shifting from one sector to another, along the lines of Horvath [2000] (see also Benigno et al. [2011], Bouakez et al. [2009], [2011], Kim and Kim [2006]). This shortcut to produce a difficulty in reallocating hours worked across sectors allows us to preserve analytical tractability and to estimate a deep parameter of the model capturing the degree of labor mobility across sectors, for each country in our sample.

To shed light on the transmission mechanism of a productivity differential between tradables and non tradables, we abstract first from physical capital accumulation. We find that the model with imperfect mobility of labor can account for the evidence but only when the elasticity of substitution in consumption between tradables and non tradables is larger than one. Only in this case does the relative price of non tradables increase less than proportionately

and Ferris [1996], Strauss [1998] who empirically examine the wage equalization assumption. Another related work is Jensen et al. [2005]. Using sectoral data for the US over the period 1992-2002, they find that workers in traded industries are more highly skilled and are paid more than in nontraded industries: the earnings differential, unadjusted for worker differences in educational attainment is about 35%. When education is controlled for, a wage premium persists and amounts to between 10% and 17%.

[3] A number of variants of the two-sector model with tradables and non tradables have been used to investigate the real exchange rate and trade balance effects of financial liberalization (see Cordoba (de) and Kehoe [2000], Bems and Hartelius [2006]), or to analyze disinflation policy transmission (see Mendoza and Uribe [2000], Rebelo and Vegh [1995]). See also Turnovsky [1997] who presents variants of the two-sector model.

to clear the goods market. The relative wage falls because the consecutive increased share of tradables in total expenditure has an expansionary effect on labor demand in the traded sector which pays higher wages to attract workers. Conversely, an elasticity of substitution smaller than one implies that the relative price growth exceeds the productivity differential while the relative wage increases, in contradiction to our evidence.

Since the elasticity of substitution plays a major role in the determination of the relative price and relative wage responses, we estimate its value for the fourteen OECD countries in our sample. Our estimates display a sizeable dispersion across countries, ranging from a low of 0.05 to a high of 2.1. Importantly, our findings reveal that more than half of the countries in our sample have an elasticity of substitution smaller than one. Because in this case our model cannot account for the evidence, we therefore investigate if capital accumulation may improve the predictive power of the model.

To emphasize the role of physical capital, we analytically break down the relative price and relative wage effects into three components: i) a baseline channel when keeping unchanged sectoral capital-labor ratios and the capital stock, ii) a capital reallocation channel stemming from the shift of capital across sectors, iii) a capital accumulation channel caused by the investment boom along the transitional path. When the elasticity of substitution between traded and non traded goods is smaller than one, we find analytically that both the reallocation of capital across sectors and physical capital accumulation counteract the baseline channel. First, a productivity differential between tradables and non tradables produces a shift of capital towards the non traded sector, therefore raising non traded output and exerting a negative impact on the relative price and the relative wage. Second, the current account deficit along the transitional path caused by the investment boom must be matched in the long run by a trade balance surplus for the intertemporal solvency condition to hold. The consecutive increased demand for tradable goods produces a fall in the relative price of non tradables and the relative wage.

To calibrate the model, we estimated the parameter capturing the degree of labor mobility for each country. Our findings reveal a high level of difficulty reallocating labor between the traded and the non traded sector in all countries. By paying particular attention to the adequacy of the non-tradable content of the model to the data, we assess numerically the ability of the model with imperfect mobility of labor and physical capital to accommodate our evidence by calibrating the model for a representative OECD economy. Numerical results indicate that regardless of the value of the elasticity of substitution between traded and non traded goods, the model can produce the less than proportional increase in the relative price of non tradables and the decline in the relative wage. Further, reducing the utility loss experienced by a worker when shifting, we find that the relative wage falls less while the relative price responds more, in line with our evidence. The final exercise we perform is to compare the responses of the relative price and relative wage for each OECD economy in our sample to our fully modified OLS estimates. To do so, we allow the two pivotal parameters, namely the degree of labor mobility and the elasticity of substitution between traded and non traded goods which have been estimated for each economy, to vary across countries. It is found that the model predicts the relative price growth pretty well but tends to overstate the decline in the relative wage.

While the analysis of the consequences of a productivity differential between tradables and non tradables has recently received growing attention in the theoretical literature, most studies focus on the real exchange rate rather than the relative price of non tradables. Further, most studies analyze the implications of entry and exit of firms. In particular, a number of papers consider heterogenous firms with different productivity, see e.g., Ghironi and Melitz [2005].[4] Other papers abstract from firm heterogeneity and introduce spatial decisions, see e.g., Mejean [2008].[5] Corsetti et al. [2007] abstract from non traded goods and focus on the response of terms of trade to technological change.[6] Allowing for differentiated traded and non traded goods, Choudhri and Schembri [2001] find that the relative price of non tradables is affected by the productivity differential between tradables and non tradables and entry of firms in both sectors. Bergin et al. [2006] develop a model with heterogenous firms and endogenous tradability to generate a time-varying BS effect. In our paper, we revisit the BS effect by relaxing the assumption of perfect mobility of labor across sectors. In this regard, our analysis is closely related to that of Benigno et al. [2011] who address the determinants of inflation differentials in the EMU by assuming imperfect mobility of labor. Our analysis differs in two respects. First, we allow for capital accumulation which plays a crucial role in accommodating our empirical findings. Second, we concentrate both empirically and theoretically on the effects on a productivity differential while Benigno et al. [2011] consider other determinants of inflation differentials such as markup changes and government spending shocks.

The remainder of the paper is organized as follows. In section 2, we provide evidence on

[4]In Ghironi and Melitz [2005], persistent deviations from Purchasing Power Parity stem from firms' entry; by stimulating entry and thereby demand for labor, higher productivity gains drive up wages which increase the relative price of both traded and non traded goods.

[5]Mejean [2008] reaches similar conclusions to Ghironi and Melitz [2005] while firms' entry is induced by increased attractiveness of the country.

[6]In Corsetti et al. [2007], if productivity improvements raise the firms' ability to develop new products, more goods are produced, raising the relative demand for labor and therefore the relative labor costs. As a result, terms of trade improve.

the relative price and relative wage effects of relative productivities in the long run. In section 3, we develop an open economy version of the two-sector model with imperfect mobility of labor across sectors. In section 4, we abstract from physical capital accumulation which allows us to derive a number of analytical results and to build intuition about the effects of higher productivity in tradables relative to non tradables. Section 5 analytically investigates the role of physical capital accumulation in the determination of the relative price and relative wage responses. In section 6, we report results from numerical simulations. In section 7, we discuss the implications of non-separability in preferences between consumption and labor and of introducing traded investment. Finally, we calibrate and simulate the model for each OECD economy in our sample in section 8. Section 9 summarizes our main results and concludes.

2 Empirical evidence

The Balassa-Samuelson (BS hereafter) model has two important predictions for the behavior of the relative wage and relative price: a productivity differential between tradables and non tradables raises the relative price of non tradables by 1% and leaves unchanged the non traded wage-traded wage ratio (i.e., the relative wage). In this section, we confront the predictions of the BS model with data and thereby revisit the evidence regarding the relationships between the relative price, the relative wage and the relative productivity.[7]

The key findings are as follows. Differences in productivity growth between the traded and non traded sectors i) exert a positive but smaller impact on the relative price than that predicted by the BS model, ii) produce a negative impact on the relative wage, iii) raise the relative price more and lower the relative wage less as labor mobility across sectors increases.

Throughout the paper, we denote the level of the variable in upper case, the logarithm in lower case, and the percentage deviation from its initial steady-state by a hat.

2.1 Data Construction

Before empirically exploring the relative price and relative wage effects of a productivity differential, we briefly describe the dataset we use and provide details about data construction. Our sample consists of a panel of fourteen OECD countries: Belgium, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Sweden, the UK and the US. Our sample covers the period 1970-2007, for eleven 1-digit ISIC-rev.3 industries.

To split these eleven industries into traded and non traded sectors, we follow the classi-

[7]Additional empirical results, and more details on the model as well as the derivations of the results which are stated below are provided in a Technical Appendix which is available at `http://www.beta-umr7522.fr/productions/WP/mainwp.php?y=2013`.

fication suggested by De Gregorio et al. [1994].[8] Agriculture, hunting, forestry and fishing; Mining and quarrying; Total manufacturing; Transport, storage and communication are classified as traded industries. Following Schmillen [2011], we updated the classification of 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.

We use the EU KLEMS database which provides data on value added in current and constant prices, labor compensation and employment for each sector j (with $j = T, N$), permitting the construction of sectoral value added deflators p^j (in log), sectoral wage rates w^j (in log), and sectoral measures of productivities z^j (in log). The (logged) relative price of non tradables p is the ratio of the non traded value added deflator p^N to the traded value added deflator p^T. The (logged) relative wage ω is the ratio of the non traded wage w^N to the traded wage w^T. We use sectoral total factor productivities (TFPs) to approximate technical change.[9] The relative productivity is the ratio of traded TFP to non traded TFP. Sectoral TFPs z_t^j at time t are constructed as Solow residuals from constant-price series of output y_t^j and capital stock k_t^j, and employment l_t^j (number of employees):

$$z_t^j = y_t^j - \theta^j l_t^j - \left(1 - \theta^j\right) k_t^j, \tag{1}$$

where θ^j is labor's share in output in sector $j = T, N$ defined as the ratio of the compensation of employees to value added in the jth sector, averaged over the period 1970-2007. To obtain series for sectoral capital stock, we first compute the overall capital stock by adopting the perpetual inventory approach, using constant-price investment series taken from the OECD's Annual National Accounts.[10] Following Garofalo and Yamarik [2002], we split the gross capital stock into traded and non traded industries by using sectoral output shares. Assuming that investment expenditures are non traded, we compute the labor share-adjusted TFP differential as follows $z^T - \left(\theta^T/\theta^N\right) z^N$.[11]

[8]According to this classification, an industry is treated as being traded when this industry exports more than 10% of its production.

[9]An alternative way to measure sectoral productivity is to use the ratio of sectoral output to labor in that sector. We find that our results are insensitive to the measure of sectoral productivity. We use sectoral TFPs since they take account of changes in the capital stock, and thus TFP is arguably a better measure of technological change than labor productivity.

[10]More details to compute series for constant-price capital stock can be found in Appendix B.2.

[11]As a robustness check, we run the same regressions by using an alternative measure of the productivity differential when investment expenditures are assumed to be traded, implying $\left(\theta^N/\theta^T\right) z^T - z^N$ or both traded and non traded (see (50)). Because results are very similar, to economize space we do not present them and they are available upon request.

2.2 A Quick Overview of the Data

Because the tests that we consider focus on the long-run behavior of the relative prices, relative wages and relative productivities in the traded and non traded goods sectors, we begin by examining the trend behavior of the series for 14 OECD economies over the period 1970-2007.

Figures 1(a) and 1(b) plot the unweighted average of the relative price of non tradables and the relative wage against the ratio of sectoral TFPs, respectively, over the period 1970-2007. Figure 1(a) reveals that there exists a clear upward trend in both the relative price of non tradables and the ratio of sectoral TFPs. Hence, this graphic lends credence to the Balassa-Samuelson effect which states that the appreciation in the relative price of non tradables originates from higher productivity in tradables relative to non tradables. Quantitatively, over 1970-2007, the relative price of non tradables doubled while the ratio of traded TFP to non traded TFP increased by 150%. As shown in Figure 1(b), the relative wage displays a clear downward trend. More precisely, the ratio of the non traded wage to the traded wage has declined by 25% over the last four decades. This pattern does not accord with the standard BS model predicting an unchanged relative wage.

We now investigate the BS effect across countries. Figures 2(a) and 2(b) plot the average relative price growth and average relative wage growth against the average productivity differential between tradables and non tradables, respectively. Quantitatively, the BS model predicts that a productivity differential by 1% i) raises the relative price of non tradables by 1%, ii) while leaving the relative wage unchanged. The first prediction implies that graphically, all countries should be positioned on the 45° line in Figure 2(a). However, we find that all countries are positioned below the 45° line which suggests that higher productivity in tradables relative to non tradables is not fully reflected in the relative price. According to the second prediction, all countries should be positioned on the X-axis in the right bottom panel. However, as shown in Figure 2(b), all countries are below the X-axis which suggests that a productivity differential between tradables and non tradables lowers the relative wage.

While the data seem to challenge the conclusions of the standard BS model, in the following we use unit root tests and cointegration methods to confirm these findings and to estimate precisely the effects of the higher productivity in tradables relative to non tradables on both the relative price of non tradables and the relative wage.

< Please insert Figures 1 and 2 about here >

2.3 Tests of BS predictions: Unit Root Tests

We test for the presence of unit roots in the logged relative wage ω (i.e., $w^N - w^T$) and in the difference between the (log) relative price p (i.e., $p^N - p^T$) and the (log) relative TFPs (i.e., $z^T - \left(\theta^T/\theta^N\right) z^N$). If the predictions of the BS model were right, the relative wage should be stationary due to the assumption of perfect labor mobility which implies wage equalization across sectors. Moreover, the difference between the logged relative price and the logged relative sectoral productivity should also be integrated of order zero since a change in the relative sectoral productivity should be fully reflected in the relative price as the relative wage remains unchanged.

To begin with, we examine the stochastic properties of the variables p, ω, and $z^T - \left(\theta^T/\theta^N\right) z^N$. We consider five panel unit root tests among the most commonly used in the literature: i) Levin, Lin and Chu's [2002] test based on a homogenous alternative assumption, ii) a t-ratio type test statistic by Breitung [2000] for testing a panel unit root based on alternative detrenting methods , iii) Im, Pesaran and Shin's [2003] test that allows for a heterogeneous alternative, iv) Fisher type test by Maddala and Wu [1999] and v) Hadri [2000] who proposes a test of the null of stationarity against the alternative of a unit root in the panel data. Results are summarized in Table 1.[12]

< Please insert Table 1 about here >

As shown in the first line of Table 1, all unit root tests applied to the relative price (p) and the relative sectoral productivity ($z^T - \left(\theta^T/\theta^N\right) z^N$) confirm that these two variables are non-stationary. On the basis of all tests, except for Levin et al.'s [2002] unit root test, the relative wage variable (ω) is found to be non-stationary. Hence, the data reject the wage equalization hypothesis. On the contrary, the sectoral wage differential persists in the long run, casting doubt on the assumption of perfect mobility of labor. The p-values shown in the last line of Table 1 reveal that the relative price of non tradables and the ratio of sectoral labor share-adjusted TFPs are not cointegrated with a unit cointegrating vector. Put differently, the change in the ratio of sectoral TFPs is not fully reflected in p.[13]

[12] In Table 1, LLC and Breitung are the t-statistics developed by Levin et al. [2002] and Breitung [2000] respectively. IPS denotes the Im, Pesaran and Shin's [2003] W_{tbar} test. MW (ADF) and MW (PP) are the Maddala and Wu's [1999] P test based on Augmented Dickey-Fuller and Phillips-Perron p-values respectively. Hadri corresponds to Hadri's [2000] Z_μ test.

[13] We present the first generation tests which assume that all cross-sections are independent. In the Technical Appendix, as a robustness check, we also consider some second generation tests that allow for cross-unit dependencies, in particular Bai and Ng [2002], Choi [2001], Pesaran [2007] and Chang [2002]. Second generation tests yield similar conclusions.

2.4 Estimating Long-Run Relationships

To get some sense of the magnitude of the long-run effects that a productivity differential might generate, we now estimate the cointegrating vectors. To do so, we regress the (log) relative wage ω and the (log) relative price p on the (log) relative productivity, respectively:

$$\left(w_{i,t}^N - w_{i,t}^T\right) = \delta_i + \beta\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] + v_{i,t}, \tag{2a}$$

$$\left(p_{i,t}^N - p_{i,t}^T\right) = \alpha_i + \gamma\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] + u_{i,t}, \tag{2b}$$

where i and t index country and time and $v_{i,t}$ and $u_{i,t}$ are i.i.d. error terms. Country fixed effects are captured by country dummies δ_i and α_i. According to the BS model's predictions, the slope of the cointegrating relationship (2a) should be zero (i.e., $\hat{\beta} = 0$), while the slope of the cointegrating relationship (2b) should be equal to one (i.e., $\hat{\gamma} = 1$). However, building on our empirical findings above, we expect $\hat{\beta} < 0$ and $0 < \hat{\gamma} < 1$.

To begin with, we test whether p and ω are cointegrated with $z^T - \left(\theta^T/\theta^N\right) z^N$ by applying parametric and non-parametric tests developed by Pedroni [1999], [2004]. Pedroni considers seven tests based on the estimated residuals of (2a) and (2b). Four (three) come from pooling data along the within (between) dimension. Results for cointegration tests are reported in Table 8. We find strong evidence in favor of cointegration between the relative wage and relative productivity, and to a greater extent between the relative price and relative productivity.

Having verified that the assumption of cointegration is empirically supported, we estimate the cointegrating relationships by using fully modified OLS (FMOLS) and dynamic OLS (DOLS) procedures for the cointegrated panel proposed by Pedroni [2000], [2001].[14] Both estimators give the same results. Coefficients $\hat{\beta}$ and $\hat{\gamma}$ of the cointegrating relationships are significant at 1%. Two major results emerge.

First, estimates reported in the first line of Table 2 reveal that a productivity differential between tradables and non tradables of 1% lowers the relative wage by 0.27%. In the second line of Table 2, we impose the restriction that the slope of the cointegrating vector $\hat{\beta}$ is equal to zero. This assumption is strongly rejected at a 1% significance level. Hence, our results invalidate the wage equalization between the traded and the non traded sectors.

Second, our estimates cast doubt on the long-run proportionality of the relative price and relative productivity. More precisely, estimates in the first line of Table 2 reveal that a productivity differential between tradables and non tradables of 1% raises the relative price

[14] The panel FMOLS and DOLS of Pedroni ([2000], [2001]) are used to estimate the cointegrating vector. The DOLS estimator adds q leads and lags of $\triangle(z^T - \left(\theta^T/\theta^N\right) z^N)$ as additional regressors in (2). We set $q = 1$; our results were identical for $q = 2$ and $q = 3$. We also used alternative estimators: dynamic fixed effects estimator, mean group estimator (Pesaran and Smith [1995]), pooled mean group estimator (Pesaran et al. [1999]) and the panel DOLS (Mark and Sul [2003]). The results were almost identical and are relegated in the Technical Appendix.

increases by 0.78%. As shown in the last row of Table 2, imposing the restriction that the slope of the cointegrating vector $\hat{\gamma}$ is equal to one is strongly rejected at a 1% significance level. Hence, our results indicate that a productivity differential between tradables and non tradables is not fully reflected in the relative price of non tradables.

< Please insert Table 2 about here >

< Please insert Table 3 about here >

To get a sense of the interval of estimates across countries, we again run regressions of (2a)-(2b) by letting β and γ vary across countries. Table 3 shows results for the fourteen countries in our sample, using both DOLS and FMOLS cointegration procedures. Two conclusions emerge. First, the slopes are fairly precisely estimated.[15] Further, both DOLS and FMOLS estimators yield very similar results. Second, while estimates display a wide dispersion, our conclusion for the whole sample is confirmed. More precisely, when considering the fully modified OLS estimates and excluding Sweden, the response of the relative wage to a productivity differential of 1% ranges from a low of -0.581 for Germany to a high of -0.092 for the US while the reaction of the relative price of non tradables varies between 0.471 for Denmark to 0.922 for the United Kingdom. Hence, despite these large cross-country variations, higher productivity in tradables relative to non tradables significantly lowers the relative wage in all countries while the estimated coefficient for the relative price is always significantly smaller than one.

2.5 Related Empirical Literature

Two notable articles have estimated the effects of higher productivity in tradables relative to non tradables by adopting cointegration procedures. In order to test the predictions of the standard BS model, Canzoneri et al. [1999] apply unit root tests and cointegration procedures to a panel of thirteen OECD countries over the period 1970-1992.[16] When estimating the slope of the cointegrating relationship between the relative price and relative productivity,

[15] Columns 2 and 3 of Table 3 give the slopes of the cointegrating relationship between the relative wage and relative productivity. For 11 of the 14 countries in the sample, coefficients are statistically significant at the 5% significance level when using the DOLS cointegration procedure while all coefficients except Sweden are statistically significant at the 5% significance level when using the FMOLS cointegration procedure. Columns 4 and 5 of Table 3 give the slopes of the cointegrating relationship between the relative price and relative productivity. For the relative price equation, all coefficients are statistically significant at the 1% significance level for both DOLS and FMOLS estimators.

[16] Note that in contrast to us, Canzoneri et al. [1999] measure technological change by using labor productivity.

the average fully modified OLS slope estimate is roughly 0.8. The coefficient estimate is very close to our own estimate whereas we use sectoral TFP's to measure productivity and we consider a sample running from 1970 to 2007 for each country. Our empirical findings accord with estimates by Kakkar [2003] as well. Using a sample of fourteen OECD countries with an average of 25 years for each country, Kakkar [2003] examines the relationship between the relative price of non traded goods and the labor-share adjusted TFPs differential. Using the panel dynamic OLS estimator developed by Mark and Sul [2003], Kakkar [2003] finds that a productivity differential between tradables and non tradables of 1% raises the relative price of non tradables by 0.752% and 0.927% with two lags and three lags, respectively. As a robustness check, we estimate cointegration relationships (2a) and (2b) using Mark and Sul's [2003] panel DOLS estimator. The panel OLS point estimates are 0.764 with two lags and 0.763 with three lags.[17] Hence, while evidence provided by Kakkar [2003] suggests a cointegrating vector close to one when considering three lags, our estimates are smaller. This discrepancy can be explained by the span of the data series used by Kakkar which vary between 20 and 37 years across countries and stop in 1995, while for all countries our sample runs from 1970 to 2007. Moreover, our sample includes Ireland and Spain but excludes Canada and Norway.

In contrast to our study, Kakkar [2003] and Canzoneri et al. [1999] restrict their analysis to the relative price effects of a productivity differential. Our paper focuses on a second dimension of the effects of sectoral productivity shocks which has so far been mostly ignored by the existing empirical literature, namely the behavior of the ratio of sectoral wages. To our knowledge, we are the first to use unit root tests and the cointegration procedure to examine the relationship between the relative wage and relative productivity. However, an earlier study by Strauss and Ferris [1996] emphasizes the key role of wage differentials in the determination of the relative price of non tradables. More precisely, using a sample of 14 OECD countries over 1970-1990, and employing tests of mean, Strauss and Ferris [1996] find that the assumption of sectoral wage equalization is not supported by the data, in line with our findings. This conclusion has been confirmed by Strauss [1998] who tests the assumption of wage equalization across industries for France, Germany, Japan, the UK, and the US in the short and medium run.[18] Using a sample of 10 OECD countries, Lee [2005] reaches similar conclusions by employing permutation tests to investigate the wage equalization assumption

[17]These estimates can be found in the Technical Appendix which provides robustness checks for our cointegration tests.

[18]Strauss [1998] investigates wage equalization by testing whether the difference between wage growth in one sector and aggregate wages is significantly different from zero. Wald restriction tests show that significant real wage differentials exist across industries and sectors in the short and medium run, which suggests incomplete labor mobility.

between traded and non traded sectors. Closest to our work is the empirical study by Schmillen [2011]. In the same spirit as Strauss and Ferris [1996], Schmillen [2011] regresses wages in the non-tradable sector and productivity in the tradable sector by using the pooled mean group estimator developed by Pesaran et al. [1999]. Schmillen finds a weak relationship between the two variables, thereby rejecting the wage equalization hypothesis.

< Please insert Figure 3 about here >

If wage equalization across sectors does not hold, the relative price of tradables is affected by both the productivity differential and changes in the relative wage. When running the regression of the relative price of non tradables on the productivity differential and the wage differential, Strauss and Ferris [1996] find that the latter plays a significant role in the determination of the relative price behavior. Using FMOLS estimates, Figure 3 depicts the relationship between the relative price response and the relative wage reaction (in absolute value) to a productivity differential across countries. The trend line in Figure 3 shows that the growth rates of these two variables are inversely related across countries. Hence, the data suggest that smaller responses of the relative price to a productivity differential are associated with larger declines in the relative wage. In our paper, the negative relationship between the size of the relative price response and the magnitude of the decline of the relative wage stems from imperfect mobility of labor across sectors: the larger the loss experienced by a worker when shifting hours worked across sectors, the more the traded sector must raise wages, and therefore the smaller the growth in the relative price of non tradables.

2.6 Interpreting the Puzzle: Imperfect Mobility of Labor across Sectors

To conclude, our evidence invalidates two strong predictions of the BS model: i) the unchanged relative wage following a productivity differential between tradables and non tradables and ii) the strict proportional relationship between the relative price and the relative productivity. Further, our empirical findings suggest that in countries where the negative response of the relative wage to a productivity differential is larger, the rise in the relative price of non tradables tends to be smaller.

To interpret these results, let us assume that both traded and non traded goods are produced with labor only and constant returns-to-scale technology. In perfect competition, prices equalize with the unit labor costs within each sector:

$$p^T = w^T - a^T, \quad p^N = w^N - a^N, \tag{3}$$

where variables are expressed in logarithm terms and a^j is the (log) labor productivity in sector j. Denoting by a hat the deviation from steady-state in percentage, we find that both the relative wage growth $\hat{\omega}$ and the productivity differential $a^T - a^N$ exert a positive effect on the relative price p:

$$\hat{p} \equiv \hat{p}^N - \hat{p}^T = \hat{\omega} + \left(\hat{a}^T - \hat{a}^N\right). \tag{4}$$

Imposing perfect labor mobility across sectors, as in the standard BS model, both sectors pay the same wage so that the wage differential across sectors vanishes. As a result, when $a^T - a^N$ increases by 1%, the relative price of non tradables must rise by 1%. More precisely, the wage in the non traded sector rises at the same speed as in the traded sector while productivity gains are smaller. To compensate for the rise in the non-tradable unit labor cost, prices must increase in that sector.

Conversely, if labor is not perfectly mobile, there is no longer wage equalization across sectors and therefore ω may change. A shortcut for introducing some form of the difficulty in reallocating labor across sectors is to assume that workers experience a cost in shifting hours worked across sectors. According to estimates by Lee and Wolpin [2006] who use a structural econometric approach, the cost of moving between the goods and the services sectors within the same occupation is estimated to be significantly larger than moving between occupations within the same sector.[19] There exist several reasons why it is costly for workers to reallocate labor between sectors: i) human capital may be sector-specific, ii) agents may have geographic preferences or own immobile assets like housing, iii) shifting across sectors may induce a human capital loss as experience gained in a given occupation may be not entirely transferable between sectors.

Because shifting induces a loss, workers are willing to move from one sector to another if firms pay higher wages to compensate for the cost of reallocating. Hence, when labor demand expands in the traded sector due to higher productivity in tradables relative to non tradables, the traded wage growth must exceed non traded wage growth. As a result, the relative wage ω falls. Since $\hat{\omega} < 0$, eq. (4) implies that following a productivity differential between tradables and non tradables of 1%, $\hat{p}$ is less than 1%. As the cost of shifting is smaller, labor mobility across sectors increases. Hence, ω falls less while the relative price responds more to a productivity differential between tradables and non tradables. Only when the cost of moving from one sector to another vanishes, as in the standard BS model, does the strict proportional relationship between the productivity differential and non tradables inflation hold.

[19] More precisely, according to Lee and Wolpin's [2006] estimates, the mobility cost between sectors ranges from 50 to 75% of average annual earnings.

2.7 The Role of Imperfect Labor Mobility

To test the role of imperfect mobility of labor across sectors in explaining the relationship between $\hat{p}$ and $\hat{\omega}$ and the productivity differential, we test our conjecture according to which the relative price of non tradables is more responsive to the productivity differential while the reaction of the relative wage becomes more muted, as labor becomes more mobile across sectors. Our empirical strategy is as follows. First, we construct an index capturing the extent of labor mobility across sectors. Then we empirically explore our conjecture by interacting the measure of labor mobility across sectors and the productivity differential.

2.7.1 Measures of sectoral labor movements

For our empirical analysis, we construct an indicator capturing the extent of labor mobility across sectors. Following Wacziarg and Wallack [2004], we compute the labor reallocation index in year t for country i denoted by $LR_{i,t}$ by calculating the ratio of the absolute change in sectoral employment resulting from labor reallocation to average employment over 2 years:[20]

$$LR_{i,t} = \frac{\sum_{j=T}^{N} |L_{i,t}^{j} - L_{i,t-2}^{j}| - \left|\sum_{j=T}^{N} L_{i,t}^{j} - \sum_{j=T}^{N} L_{i,t-2}^{j}\right|}{0.5\sum_{j=T}^{N}(L_{i,t-2}^{j} + L_{i,t}^{j})}, \tag{5}$$

where $L_{i,t}^{j}$ denotes employment in sector $j = T, N$ at time t in country i.[21] The first term in the numerator of (5) captures the change in employment over two years in sector j while the second term "filters" the change in labor arising from total employment growth. The term in the denominator of (5) is a measure of total employment in the economy (i.e., the average employment computed over t and $t-2$). Dividing one by the other gives the rate of workers that have shifted from one sector to another over two years.

Table 9 in the Appendix summarizes the intersectoral reallocation index for the countries in our sample. First, on average, 0.87% of workers have shifted from one sector to another over any given 2-year period.[22] There is considerable heterogeneity in this indicator, which varies from a low of 0.34 for the Netherlands to a high of 1.69 for Korea.

[20] Note that the data are taken from EU KLEMS.

[21] We restrict our attention to differences over 2 years. Following Wacziarg and Wallack [2004], we eschew year-to-year changes because of the low frequency changes in labor at that horizon. Data limitation also prevents the use of differences over longer horizons.

[22] This result is in line with the evidence documented by Davis and Haltiwanger [1999] who find that most job reallocations are within sectors.

2.7.2 Empirical results

We test our conjecture by adding interaction terms and explore the following relationships empirically:

$$\left(w_{i,t}^N - w_{i,t}^T\right) = \delta_i + \beta\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] + \beta_L\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] * LR_{i,t} + v_{i,t}, \quad \text{(6a)}$$

$$\left(p_{i,t}^N - p_{i,t}^T\right) = \alpha_i + \gamma\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] + \gamma_L\left[z_{i,t}^T - \left(\theta_i^T/\theta_i^N\right) z_{i,t}^N\right] * LR_{i,t} + u_{i,t}, \quad \text{(6b)}$$

where i and t are index country and time, δ_i and α_i are fixed effects and $v_{i,t}$ and $u_{i,t}$ are i.i.d. error terms. In light of our conjecture, we expect coefficients of interaction terms to be positive in both regressions (6a) and (6b). Such a result would imply that higher productivity in tradables relative to non tradables lowers less the relative wage and raises the relative price more in countries where workers are more mobile across sectors.

< Please insert Table 4 about here >

We estimate cointegrating vectors by using DOLS and FMOLS estimators. The estimates are reported in Table 4. Both DOLS and FMOLS cointegration procedures yield similar results. The first line of Table 4 confirms that a productivity differential lowers the relative wage and raises the relative price less than proportionately. Importantly, as shown in the second line of Table 4, the coefficients β_L and γ_L of interaction terms are positive (and statistically significant at conventional level) for DOLS and FMOLS estimates. Hence, in line with our conjecture, as labor mobility across sectors increases, the relative price becomes more responsive to a productivity differential while the reaction of the relative wage is more muted.

To conclude, this empirical evidence suggests that labor mobility plays a key role in driving the relative price and relative wage responses to a productivity differential between tradables and non tradables. In the following section, we construct a dynamic general equilibrium model with a traded and a non traded sector by allowing for imperfect mobility of labor across sectors. In particular, our aim is to assess its ability to account for the following set of empirical findings. A productivity differential of 1% between tradables and non tradables: i) raises the relative price of non tradables p by 0.78%, ii) lowers the relative wage ω by 0.27%, iii) as labor becomes more mobile across sectors, p increases more while ω falls less.

3 Two-Sector Model with Limited Substitutability of Labor

We consider a small open economy that is 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 that can be exported and consumed domestically. A second sector produces a non traded good denoted by the superscript N which can be consumed domestically or invested.[23] The traded good is chosen as the numeraire.[24] We denote by P the price of non traded goods in terms of traded goods.

In the light of our empirical evidence discussed in section 2, real wage equalization across sectors is strongly rejected, suggesting the presence of imperfect mobility of labor across sectors. To produce some form of difficulty in reallocating labor across sectors, we assume that hours worked are not perfect substitutes for the worker. More precisely, following Horvath [2000], we introduce imperfect labor mobility across sectors by assuming that workers experience a utility loss when shifting hours from one sector to another.

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:

$$C = \left[\varphi^{\frac{1}{\phi}} \left(C^T\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(C^N\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{7}$$

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. The standard BS model assumes that workers do not experience a cost when shifting hours worked across sectors so that hours worked are perfect substitutes. Because workers are willing to devote their whole time to the sector that pays the highest wages, sectors pay the same wage. However, our unit root tests applied to the ratio of sectoral wages reject the wage equalization between sectors. A shortcut to produce a persistent wage differential across sectors is to assume that workers experience a utility loss when shifting hours worked from one sector to another. To introduce limited substitutability in hours worked across sectors, we follow Horvath [2000] who proposes a form for the aggregate labor

[23] For the purpose of clarity, we assume that investment expenditures are non traded. In section 6, we relax this assumption and instead assume that investment expenditures are both traded and non traded. As will become clear later, when discussing numerical results, our main conclusions are insensitive to this feature.

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

index allowing for a low elasticity of substitution of labor supply across sectors. Formally, we assume that hours worked in the traded and the non traded sectors are aggregated by means of a CES function:

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

and $0 < \vartheta < 1$ is the fraction of aggregate labor supplied in the traded sector and ϵ measures the ease with which worked hours can be substituted for each other and thereby captures the degree of labor mobility. The case of perfect labor mobility is nested under the assumption that ϵ tends towards infinity; in this case, (8) reduces to $L = L^T + L^N$ which implies that hours worked are perfectly substitutable across sectors. When $\epsilon < \infty$, hours worked are no longer perfect substitutes. More specifically, as ϵ becomes smaller, the labor mobility across sectors becomes lower as workers perceive a higher cost (in utility terms) of shifting and therefore become more reluctant to reallocate labor across sectors.[25]

The advantage of producing imperfect labor mobility across sectors by means of (8) over alternatives is fourfold. First, the CES form (8) for aggregate labor index allows us to consider the range of all degrees of labor mobility across sectors. Specifically, if we let ϵ be zero or tend towards infinity, the situations of total immobility ($\epsilon = 0$) and perfect mobility ($\epsilon \to \infty$) of labor emerge as special cases. The modeling of an intermediate degree of sectoral labor mobility is relevant as it is more factual than the extreme cases. Second, by combining first-order conditions for labor supply and labor demand, the formulation (8) allows us to estimate precisely the parameter ϵ for each country in our sample. Hence, the formulation (8) serves our purpose which is to assess quantitatively the ability of the two-sector model to account for our evidence. Third, as emphasized by Horvath [2000], this formulation introduces partial labor mobility across sectors without deviating from the tractable representative agent framework. Fourth, several papers introduce intersectoral adjustment costs to produce imperfect mobility of labor across sectors (see e.g., Bems and Hartelius [2006]). Such formulation implies that labor frictions are absent in steady state while our evidence reveals that sectoral wages do not equalize in the long run. Since we focus on long-run relative price and relative wage effects of a productivity differential, we need to set up a model that can produce a sectoral wage differential. The aggregator function (8) is consistent with our objective.

The representative agent is endowed with one unit of time, 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

[25] See e.g., Bouakez et al. [2009], [2011], Kim and Kim [2006] who consider the aggregator function (8) to account for the evidence related to the co-movement of sectoral aggregates or Benigno et al. [2011] who address inflation dispersion across EMU members.

that the felicity function is additively separable in consumption and labor, the representative household maximizes the following objective function:[26]

$$U = \int_0^\infty \left\{ \frac{1}{1-\frac{1}{\sigma_C}} C(t)^{1-\frac{1}{\sigma_C}} - \frac{1}{1+\frac{1}{\sigma_L}} L(t)^{1+\frac{1}{\sigma_L}} \right\} e^{-\beta t} \mathrm{d}t, \tag{9}$$

where β is the discount rate, $\sigma_C > 0$ corresponds to 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 at a wage rate W, and capital K at a rental rate R. In addition, households accumulate internationally traded bonds, B, that yield net interest rate earnings of $r^\star B$. The households' flow budget constraint can be written as:

$$\dot{B}(t) = r^\star B(t) + R(t)K(t) + W\left(W^T(t), W^N(t)\right) L(t) - P_C\left(P(t)\right) C(t) - P(t)I(t), \tag{10}$$

where PI corresponds to investment expenditure and the consumption-based price index $P_C(.)$ is increasing with the relative price of non tradables P; the aggregate wage index $W(.)$ associated with the above defined labor index (8) is:

$$W = \left[\vartheta \left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}, \tag{11}$$

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

Aggregate investment gives rise to overall capital accumulation according to the dynamic equation:

$$\dot{K}(t) = I(t) - \delta_K K(t), \tag{12}$$

where $0 \leq \delta_K < 1$ is a fixed depreciation rate.

Households choose consumption, worked hours and investment in physical capital by maximizing lifetime utility (9) subject to (10) and (12). Denoting by λ and ψ the co-state variables associated with (10) and (12), the first-order conditions characterizing the representative household's optimal plans are:

$$C = \left(P_C \lambda\right)^{-\sigma_C}, \tag{13a}$$

$$L = \left(W\lambda\right)^{\sigma_L}, \tag{13b}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right), \tag{13c}$$

$$\frac{R}{P} - \delta_K + \frac{\dot{P}}{P} = r^\star, \tag{13d}$$

and the transversality conditions $\lim_{t\to\infty} \lambda B(t) e^{-\beta t} = 0$ and $\lim_{t\to\infty} \psi(t)K(t)e^{-\beta t} = 0$;.[27]

[26] In section 6, we relax the assumption of separability in preferences between consumption and labor.

[27] To derive (13d), we used the fact that $\psi(t) = \lambda P(t)$.

Applying Shephard's lemma (or the envelope theorem) yields expenditure in tradables and non tradables, i.e., $PC^N = \alpha_C P_C C$, $(1-\alpha_C) P_C C$, with α_C being the share of non traded goods in consumption expenditure.[28] Intra-temporal allocation of consumption follows from the following optimal rule:

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

An appreciation in the relative price of non tradables P increases expenditure on tradables relative to expenditure on non tradables (i.e. C^T/PC^N), only when $\phi > 1$.

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. $W^N L^N = \alpha_L W L$ and $W^T L^T = (1-\alpha_L) W L$, with α_L being the share of non-tradable labor revenue in the labor income.[29] Denoting by $\Omega \equiv W^N/W^T$ the relative wage, workers allocate hours worked in the traded and the non traded sectors according to the following optimal rule:

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

If the traded sector pays higher wages (i.e., if Ω falls) workers are induced to shift hours worked towards the traded sector, but less so as ϵ is lower. Put differently, the worker is reluctant to shift hours worked from the non traded to the traded sector, unless the wage differential across sectors is large enough to compensate for the disutility of moving hours worked across sectors.

3.2 Firms

Both the traded and non traded sectors produce Y^T and Y^N, respectively, by using physical capital, K^T and K^N, and labor, L^T and L^N, according to Cobb-Douglas production functions:

$$Y^T = Z^T \left(L^T\right)^{\theta^T} \left(K^T\right)^{1-\theta^T}, \quad \text{and} \quad Y^N = Z^N \left(L^N\right)^{\theta^N} \left(K^N\right)^{1-\theta^N}, \tag{16}$$

where Z^j represents the TFP index and θ^j the labor income share in the output of sector j.

Both sectors are assumed to be perfectly competitive and face two cost components: a capital rental cost equal to R, and the wage rates in the traded and non traded sector equal to W^T and W^N, respectively. Since capital can move freely between the two sectors, marginal products in the traded and the non traded sector equalize while costly labor mobility implies

[28] Specifically, we have $\alpha_C = \frac{(1-\varphi)P^{1-\phi}}{\varphi+(1-\varphi)P^{1-\phi}}$. Note that α_C depends negatively on the relative price P as long as $\phi > 1$.

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

a persistent real wage differential across sectors:

$$Z^T \left(1-\theta^T\right) \left(k^T\right)^{-\theta^T} = PZ^N \left(1-\theta^N\right) \left(k^N\right)^{-\theta^N} \equiv R, \tag{17a}$$

$$Z^T\theta^T \left(k^T\right)^{1-\theta^T} \equiv W^T, \quad PZ^N\theta^N \left(k^N\right)^{1-\theta^N} \equiv W^N, \tag{17b}$$

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

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

$$k^T L^T + k^N L^N = K. \tag{18}$$

3.3 The Equilibrium

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. Setting $\beta = r^\star$ into (13c) yields $\lambda = \bar{\lambda}$.[30]

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 P and K. First, the dynamic equation (13d) for the relative price of non traded goods equalizes the rates of return on domestic capital and foreign bonds $r^\star$. Second, the accumulation equation for physical capital clears the non traded goods market along the transitional path:[31]

$$\dot{K} = Y^N (K, P) - C^N (P) - \delta_K K, \tag{19}$$

where for the purposes of clarity, we abstract from time-constant arguments of short-run static solutions, i.e., $\bar{\lambda}$, Z^T, and Z^N.[32]

Inserting (19) into (10), using first-order conditions (17), and substituting appropriate short-run static solutions lead to the market-clearing condition for the traded good:

$$\dot{B} = r^\star B + Y^T (K, P) - C^T (P). \tag{20}$$

[30]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 then on.

[31]In the Technical Appendix, we detail the derivation of short-run static solutions. Eqs. (13a)-(13b) can be solved for consumption $C = C\left(\bar{\lambda}, P\right)$ and labor $L = L\left(\bar{\lambda}, W^T, W^N\right)$. Using the fact that $C^N = \frac{\partial P_C(P)}{\partial P} C$ and $C^T = \left(P_C - PP_C'\right) C$ and inserting the short-run static 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 $L^T = \frac{\partial W\left(W^T, W^N\right)}{\partial W^T} L$ and $L^N = \frac{\partial W\left(W^T, W^N\right)}{\partial W^N} L$, respectively, and inserting the short-run static 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 the short-run static solutions for L^T and L^N, into the resource constraint for capital, (17a)-(17b) and (18) can be solved for the sectoral capital-labor ratio $k^j = k^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$ and the sectoral wage $W^j = W^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$ (with $j = T, N$). Inserting short-run static solutions for sectoral capital-labor ratios and sectoral labor into production functions (16) allows us to solve for sectoral output: $Y^j = Y^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$.

[32]Linearizing (19) and (13d), it can be shown that the trace of the Jacobian matrix is equal to $r^\star$. We find numerically that the determinant of the Jacobian matrix is negative for all parametrization. Since the number of predetermined variables (K) equals the number of negative eigenvalues denoted by ν_1, and the number of jump variables (P) equals the number of positive eigenvalues denoted by ν_2, there is a unique one-dimensional convergent path towards the steady state. Eigenvalues satisfy $\nu_1 < 0 < r^\star < \nu_2$ with $\nu_1 + \nu_2 = r^\star$. More details can be found in the Technical Appendix.

Linearizing (20) around the steady state, substituting the solutions for $K(t)$ and $P(t)$, and invoking the transversality condition, yields the stable solution for traded bonds $B(t) = \tilde{B} + \Phi\left(K(t) - \tilde{K}\right)$ consistent with the intertemporal solvency condition:

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right), \tag{21}$$

where $\Phi \equiv \left[Y_K^T + \left(Y_P^T - C_P^T\right)\omega_2^1\right] / \left(\nu_1 - r^\star\right) < 0$ with ω_2^1 the element of the eigenvector associated with the eigenvalue ν_1, and K_0 is the initial stock of physical capital.

4 Relative Price and Relative Wage Effects without Capital

Our model has two distinctive features: imperfect mobility of labor and physical capital accumulation. In assessing the implications of higher productivity in tradables relative to non tradables, we first abstract from physical capital. This allows us to derive a number of analytical results and therefore to build intuition about the transmission mechanism.[33]

4.1 Model Closure and Equilibrium

We assume that the technology of production within each sector is described by a linearly homogenous production function in labor:

$$Y^T = A^T L^T, \quad Y^N = A^N L^N, \tag{22}$$

where A^j is the labor productivity index in sector j. First-order conditions from firms' profit maximization problem yields:

$$P = \Omega \frac{A^T}{A^N}. \tag{23}$$

where $\Omega \equiv W^N/W^T$ is the relative wage.

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

$$Y^N = C^N. \tag{24}$$

Inserting $A^T = W^T$ and $PA^N = W^N$ into the flow budget constraint $\dot{B}(t) = r^\star B(t) + W\left(W^T(t), W^N(t)\right)L(t) - P_C\left(P(t)\right)C(t)$ and substituting (24) yields the market clearing condition for tradables or the current account dynamic equation $\dot{B} = r^\star B + Y^T - C^T$. As the shadow value of wealth must remain constant over time, the solution for the stock of foreign bonds consistent with the intertemporal solvency condition is $B(t) = B_0$, with B_0 the initial stock of traded bonds.[34] Hence, the dynamics degenerate, so that the economy

[33] In section 5, we introduce physical capital accumulation.

[34] More precisely, for the transversality condition to hold, we have to set $\tilde{B} = B_0$.

adjusts instantaneously to its steady-state and the market clearing condition for the traded good reduces to:

$$r^{\star} B_0 + Y^T = C^T. \tag{25}$$

Because the stock of foreign bonds must stick to its initial value, for the sake of simplicity and without loss of generality, we set $B_0 = 0$.

The equilibrium which comprises (14)-(15), (23), (24) and (25), can be reduced to two equations. Combining (14) with market clearing conditions for the non traded and the traded good, i.e., (24) and (25), yields the goods market equilibrium (GME henceforth) schedule:

$$\frac{Y^T}{Y^N} = \frac{\varphi}{1-\varphi} P^{\phi}. \tag{26}$$

Inserting (23) into (15) to eliminate Ω, and using the production functions (22), yields the labor market equilibrium (LME henceforth) schedule:

$$\frac{Y^T}{Y^N} = \left(\frac{\vartheta}{1-\vartheta}\right) \left(\frac{A^T}{A^N}\right)^{\epsilon+1} P^{-\epsilon}. \tag{27}$$

4.2 Graphical Apparatus

Before turning to the derivation of steady-state effects of a productivity differential, 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 labor market or the goods market. The initial long-run equilibrium is represented by E_0 in Figure 4.

When focusing on the labor market, the model can be summarized graphically by two schedules in the $(l^T/l^N, \omega)$-space, as shown in Figure 4(a). Taking logarithm to (15) yields the labor supply-schedule (LS henceforth):

$$\left(l^T/l^N\right)|^{LS} = -\epsilon\omega + d, \tag{28}$$

where $d = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. When the traded sector pays higher wages, the consecutive decline in ω provides an incentive to shift labor supply from the non traded sector towards the traded sector. Hence the LS-schedule is downward-sloping in the $(l^T/l^N, \omega)$-space where the slope is equal to $-1/\epsilon$. In the polar case of perfect labor mobility, ϵ tends towards infinity so that the LS-schedule becomes horizontal. Inserting the first-order conditions for the firm's maximization problem given by (23) into (27), using production functions (22) to eliminate sectoral outputs, yields the labor demand-schedule (LD henceforth). Taking logarithm, the LD-schedule is given by:

$$\left(l^T/l^N\right)|^{LD} = \phi\omega + (\phi - 1)\left(a^T/a^N\right) + x, \tag{29}$$

where $x = \ln\left(\frac{\varphi}{1-\varphi}\right)$. The LD-schedule is upward-sloping in the $(l^T/l^N, \omega)$-space where the slope is equal to $1/\phi$. If the non traded sector pays higher wages, that sector raises its prices to compensate for the increased unit labor cost. As a result, consumers substitute traded for non traded goods and this in turn produces an expansionary effect on labor demand in the traded sector relative to the non traded sector, and all the more so the larger the elasticity of substitution ϕ between traded and non traded goods.

We turn now to the goods market which can be summarized graphically by two schedules in the $(y^T/y^N, p)$-space, as shown in Figure 4(b). The GME-equilibrium (see (26)) is upward-sloping in the $(y^T/y^N, p)$-space with a slope equal to $1/\phi$.[35] A rise in the relative price p induces agents to substitute the traded good for the non traded good. For the market-clearing conditions to hold, the ratio of traded output to non traded output (i.e., y^T/y^N) must rise, and all the more so as the elasticity of substitution ϕ is larger. The LME-schedule (see (27)) is downward-sloping in the $(y^T/y^N, p)$-space with a slope equal to $-1/\epsilon$. 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 induced to shift hours worked from the traded sector to the non traded sector. As a consequence, the ratio of sectoral outputs y^T/y^N declines. Assuming that the shift of labor across sectors is utility costless (i.e., $\epsilon \to \infty$), sectors pay the same wage. Hence, as shown by (23), the relative price of non tradables is only affected by the productivity differential between tradables and non tradables. Graphically, the LME-schedule becomes a horizontal line.

< Please insert Figure 4 about here >

4.3 Relative Price and Relative Wage Effects

This section graphically and analytically analyzes the consequences on the relative price and the relative wage of an increase in the relative productivity a^T/a^N. Because our estimates capture the long-term effects of an increase in a^T/a^N, we compare the steady state of the model before and after the productivity shock biased towards the traded sector.

To begin with, an inspection of (29) shows that higher productivity in tradables relative to non tradables has an expansionary effect on labor demand in the traded sector relative to the non traded sector, if and only if the elasticity of substitution ϕ between traded and non traded goods is larger than one. The reason is as follows. Higher productivity in tradables increases

[35] Note that we take the logarithm of (26).

output of tradables relative to non tradables. For the market clearing condition to hold (see (26)), the relative price of non tradables must rise. With an elasticity of substitution ϕ greater than one, the demand for tradables rises more than proportionately. The increased share of tradables in total expenditure has an expansionary effect on labor demand in tradables relative to non tradables and therefore lowers the relative wage ω (see (23)). Graphically, as shown in Figure 4(a), the LD-schedule shifts to the right along the LS-schedule, producing a fall in the relative wage from ω_0 to ω_1. Because the traded sector pays higher wages, workers shift hours worked towards that sector (see (15)). The new steady state is E_1 and the ratio l^T/l^N is higher.

Equating labor demand given by (29) and labor supply described by (28), differentiating and denoting by a hat the deviation from initial steady state in percentage terms, we find that the relative wage w^N/w^T declines in the long run as a result of a productivity differential between tradables and non tradables only if $\phi > 1$:

$$\hat{\omega} = -\left(\phi - 1\right)\Theta^L\left(\hat{a}^T - \hat{a}^N\right), \quad \Theta^L = \left(\frac{1}{\epsilon + \phi}\right). \tag{30}$$

As workers are more reluctant to shift hours worked from the non traded to the traded sector, as reflected by a lower ϵ, the response of the relative wage to a productivity differential is amplified because the traded sector must pay higher wages to attract workers. Graphically, the LD-schedule shifts along a steeper LS-schedule. When $\epsilon \to \infty$, the new steady state is BS_1 and $\hat{\omega} = 0$.

Having explored the change in the relative wage, let us now examine the response of the relative price of non tradables to a productivity differential between tradables and non tradables. Graphically, irrespective of whether $\phi \gtrless 1$, an increase in a^T/a^N shifts the LME-schedule to the right, as shown in Figure 4(b). As long as $\phi > 1$, the LME-schedule shifts along a flatter GME-schedule than the 45° line which implies that p increases less than a^T/a^N, in line with our evidence. To show it formally, we equate (26) to (27) and differentiate, which leads to:

$$\hat{p} = \left(\epsilon + 1\right)\Theta^L\left(\hat{a}^T - \hat{a}^N\right), \tag{31}$$

where Θ^L is given by (30). According to (31), following a productivity differential of 1%, p must increase by less than 1% only if $\phi > 1$. In this case, the lower ϵ, the smaller $\hat{p}$. Intuitively, because workers are more reluctant to shift hours worked across sectors, the ratio l^T/l^N increases less, requiring a lower $\hat{p}$ to clear the market. Graphically, the LME-schedule shifts to the right by a smaller amount. When $\epsilon \to \infty$, we have $\hat{p} = \hat{a}^T - \hat{a}^N$, i.e., a strict proportional relationship between p and a^T/a^N.

In conclusion, when assuming imperfect labor mobility, the two-sector model can account for our set of empirical findings but only if the elasticity of substitution is larger than one.

4.4 Estimating the Intratemporal Elasticity of Substitution ϕ

While the ability of the two-sector model with imperfect mobility of labor across sectors to accommodate the data related to sectoral productivity shocks relies heavily upon the size of the elasticity of substitution between traded and non traded goods, 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.[36] 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 existing empirical studies do not unanimously report an elasticity of substitution larger than one, we explore this assumption empirically for the whole sample and each economy.

As in Stockman and Tesar [1995], we estimate ϕ by running the regression of logged relative expenditures on logged relative prices:

$$e^T_{i,t}/e^N_{i,t} = f_i + +\kappa_i p_{i,t} + \xi_i y_{i,t} + \eta_{i,t}, \tag{32}$$

where e^T and e^N are (log) expenditure on tradables and non tradables, respectively, and p is the (log) relative price of non tradables; y corresponds to the volume index of GDP per capita taken from the Country statistical profiles 2010 provided by the OECD; f_i captures the country fixed effects and $\eta_{i,t}$ are the i.i.d. error terms. Once κ_i is estimated, we compute ϕ_i as $1 + \kappa_i$. 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 alternatively capture the wealth effect by time trend, thus replacing $y_{i,t}$ by "trend" in (32).

To split aggregate consumption expenditure into tradables and non tradables, we use the methodology described in Appendix E when computing the non-tradable share of consumption expenditure. Our dataset covers the fourteen OECD countries in our sample while the period varies across countries (see Table 5).

Since relative expenditures e^T/e^N and relative prices display trends, we ran unit root

[36] 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.

and then cointegration tests.[37] Having verified that these two assumptions are empirically supported, we estimate the cointegrating relationships by using fully modified OLS (FMOLS) and dynamic OLS (DOLS) procedures for cointegrated panel proposed by Pedroni ([2000]), ([2001]). Results are given in Table 5.

For the whole sample, as shown in the last line of Table 5, our estimates of ϕ lie in the range 0.496-0.861. When estimating ϕ for each country, replacing (log) GDP per capita with a time trend seems to give more robust results.[38] Hence, in the following, when calibrating the model, we build on estimates obtained with a time trend rather than GDP per capita to capture the wealth effect. Focusing on estimates with a time trend, four conclusions emerge. First, ϕ is estimated precisely for 11 of the 14 countries of the sample, at 1% significance level. Only estimates for Korea and the United States are not statistically significant. Second, estimates display sizeable dispersion, ranging from a low of 0.069 for Korea to a high of 2.123 for Japan. Third, considering estimates that are statistically significant, we find that ϕ is larger than one in 5 of the 11 remaining countries. Hence, more than half of the countries in our sample display an elasticity of substitution ϕ smaller than one. Fourth, for the whole sample, the DOLS and FMOLS estimates give a value of ϕ of about 0.86.

By and large, our estimates invalidate the assumption of an elasticity of substitution larger than one. As a result, our two-sector model with imperfect mobility of labor across sectors would fail to produce the three empirical facts established in section 2 for countries having a ϕ smaller than one. In the following section, we add a new ingredient to improve the predictive power of our model.

5 Relative Price and Relative Wage Effects with Physical Capital

We now introduce physical capital into the framework which is assumed to be mobile across sectors. As will become clear later, this ingredient makes the model with imperfect mobility of labor able to account for our set of empirical findings. Since the main ingredients of the setup have been presented in section 3, we turn to the steady state and break down the long-run relative and relative wage responses to a productivity differential between tradables and non tradables.

[37] Unit root tests for the relative price of non tradables are shown in Table 1. Unit root tests for the (log) relative expenditures and cointegration tests can be found in the Technical Appendix.

[38] For the former specification, we observe a substantial discrepancy between DOLS and FMOLS estimates of ϕ, as shown in columns 3 and 4 of Table 5, while they are more consistent when considering a time trend, as shown in columns 5 and 6 of Table 5. Moreover, when adding a time trend, all values of ϕ are positive, except for the Netherlands but the estimate is not statistically significant. By contrast, when adding GDP per capita to capture the wealth effect, we find that ϕ is negative for Finland and Japan, the latter being statistically significant at 1%.

5.1 The Steady State

In the following, we denote the long-term values with a tilde. Setting $\dot{P} = 0$ into (13d), we obtain the equality between the return on domestic capital and the world interest rate:

$$\tilde{R}/\tilde{P} - \delta_K = r^\star, \tag{33}$$

where R is the marginal product of capital measured in terms of the traded good given by (17a).

Setting $\dot{K} = 0$ and $\dot{B} = 0$ into (19) and (20), using the fact that $\tilde{I} = \delta_K \tilde{K}$, denoting by $\upsilon_I \equiv \frac{\delta_K \tilde{K}}{\tilde{Y}^N}$ and $\upsilon_B \equiv \frac{r^\star \tilde{B}}{\tilde{Y}^T}$ the ratio of investment to non traded output and the ratio of interest receipts to traded output, respectively, yields the market-clearing condition:

$$\frac{\tilde{Y}^T (1 + \upsilon_B)}{\tilde{Y}^N (1 - \upsilon_I)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{34}$$

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

Using production functions, the system consisting of (33)-(34), (14)-(15), and (17a)-(17b) can be solved for $\tilde{C}^T/\tilde{C}^N$, $\tilde{L}^T/\tilde{L}^N$, $\tilde{k}^T$, $\tilde{k}^N$, $\tilde{W}^T$, $\tilde{W}^N$ and $\tilde{P}$ as functions of $Z^T, Z^N, \left(\frac{1-\upsilon_I}{1+\upsilon_B}\right)$ which is taken as exogenous for pedagogical purposes.[39] Hence, when solving the steady state in this way, we thus assume that the capital stock and traded bonds holding are exogenous. This procedure to solve for the steady state enables us to break down analytically the relative price and relative wage effects of a productivity differential between tradables and non tradables in three components as detailed below.[40]

First, households hold financial wealth which consists of physical capital and foreign bonds. A productivity shock increases the marginal product of capital above the rate of return on traded bonds which triggers capital accumulation. Because the economy has perfect access to external borrowing, capital accumulation can be financed by running a current account deficit along the transitional path. For the intertemporal solvency condition to hold, the country must run a trade balance surplus in the long run. Increased net exports raise the demand for tradables which in turn impinges on the relative price and the relative wage. Hence, compared with a model abstracting from physical capital, a productivity differential affects p and ω through a **capital accumulation channel** stemming from changes in K and B.

[39] While we solve the steady state keeping unchanged the capital stock and the stock of foreign bonds, these two aggregates can be determined as follows. The system consisting of (33)-(34), (14)-(15), and (17a)-(17b) together with $\tilde{Y}^N = \tilde{C}^N + \tilde{I}$, $\tilde{K} = \tilde{k}^T \tilde{L}^T + \tilde{k}^N \tilde{L}^N$ (inserting short-run static solutions for L^T and L^N) and (21), can be solved for $\tilde{K}$, $\tilde{B}$ and $\bar{\lambda}$ as functions of Z^T and Z^N. Note that in Appendix A, we characterize the whole steady state in a compact form. However, totally differentiating the steady state (51) is useless since formal expressions cannot be interpreted.

[40] Hence, when solving the steady state, changes in capital stock and foreign assets as reflected by changes in υ_I and υ_B are assumed to be exogenous. Such a procedure allows us to isolate the relative price and relative wage effects stemming from capital accumulation and changes in traded bonds holding.

Second, combining (33) and (17a) yields an equation which shows that changes in sectoral TFPs shift capital across sectors (i.e., modify k^j), therefore affecting sectoral outputs. As a result, changes in sectoral capital-labor ratios influence the relative price by modifying sectoral outputs. Further, as shown by (17b), a change in the relative price influences labor demand in the non traded sector and thereby the relative wage. Therefore, keeping unchanged the overall capital stock (and the stock of foreign bonds), the **capital reallocation channel** impinges on the relative price and the relative wage by shifting capital across sectors.

In conclusion, introducing physical capital produces two channels in addition to the **baseline channel**. The latter corresponds to the channel through which a productivity differential impinges on the relative price and the relative wage keeping unchanged k^j, K and B. Hence, long-run adjustments in p and ω through the baseline channel are given by (30) and (31) which have been obtained in a model abstracting from physical capital accumulation.

5.2 Graphical Apparatus

Before breaking down the three channels analytically, we characterize the steady state graphically, as in section 4, which allows us to emphasize how introducing physical capital modifies the results. Because we restrict ourselves to the analysis of the long-run effects, the tilde is suppressed for the purposes of clarity.

The Labor Market

When focusing on the labor market, the model can be summarized graphically by two schedules in the $(l^T/l^N, \omega)$-space, as shown in Figure 5(a) if $\phi > 1$ and Figure 6(a) if $\phi < 1$. The LS-schedule is identical to (28); the slope is given by $-1/\epsilon$ and therefore the LS-schedule is downward sloping. We turn now to the LD-schedule given by:[41]

$$\left.\frac{l^T}{l^N}\right|^{LD} = \left[1 + \theta^T(\phi - 1)\right] \ln \tilde{\omega} + (\phi - 1)\left(z^T - \frac{\theta^T}{\theta^N} z^N\right) - \ln\left(\frac{1 + \upsilon_B}{1 - \upsilon_I}\right) - \ln \Theta. \qquad (35)$$

Eq. (35) states that, as in a model abstracting from physical capital, the LD-schedule is upward-sloping in the $(l^T/l^N, \omega)$-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.

[41]Dividing the second equality of (17b) by the first equality, using (33) and (17a) to eliminate the sectoral capital-labor ratios, combining the market-clearing condition (34) with the optimal rule allocating consumption into tradables and non tradables (14) and production functions (16), and taking logarithm allow us to derive the LD-schedule (35). The term Θ is given by:

$$\Theta = (r^\star + \delta)^{\frac{\left(\theta^N - \theta^T\right)(\phi-1)}{\theta^N}} \left(\frac{1-\varphi}{\varphi}\right)\left(\frac{\theta^N}{\theta^T}\right)^{\left[1+\theta^T(\phi-1)\right]} \left[\frac{\left(1-\theta^N\right)^{\left(1-\theta^N\right)\frac{\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{(\phi-1)} > 0.$$

When $\theta^T < 1$, the LD-schedule (labelled LD^K in Figures 5(a) and 6(a)) 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.

The Goods Market

We now characterize the goods market equilibrium. The steady state can be summarized graphically in Figure 5(b) if $\phi > 1$ and Figure 6(b) if $\phi < 1$. Each figure traces out two schedules in the $(y^T/y^N, p)$-space which are derived below.

Combining the market clearing condition given by (34) with (14), and taking logarithm yields the GME-schedule:

$$\left.\frac{y^T}{y^N}\right|^{GME} = x + \phi\tilde{p} + \ln\left(\frac{1-\upsilon_I}{1+\upsilon_B}\right), \tag{36}$$

where $x = \ln\left(\frac{\varphi}{1-\varphi}\right)$. As in a model abstracting from physical capital, the GME-schedule is upward-sloping in the $(y^T/y^N, p)$-space; the slope is equal to $1/\phi$. The 45° dotted line allows us to consider two cases. In Figure 5(b) (Figure 6(b)), we assume that ϕ is larger (smaller) than one, which results in a GME-schedule flatter (steeper) than the 45° line.

As in a model abstracting from physical capital, the LME-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 induces 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:[42]

$$\left.\frac{\tilde{y}^T}{\tilde{y}^N}\right|^{LME} = -\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]\tilde{p} + \left(\frac{1+\epsilon}{\theta^T}\right)\left(z_T - \frac{\theta^T}{\theta^N}z_N\right) + \ln\Pi. \tag{37}$$

When $\theta^T < 1$, the LME-schedule (labelled LME^K in Figures 5(b) and 6(b)) becomes flatter in the $(y^T/y^N, p)$-space due to the shift of capital across sectors triggered by a change in

[42] Using (17b) to determine the relative wage $\tilde{\omega}$, inserting the optimal allocation of aggregate labor supply across sectors (15) and production functions (16), using (33)-(17a) to eliminate the sectoral capital-labor ratios, yields the LME-schedule (37). The term Π is given by:

$$\Pi = \frac{\vartheta}{1-\vartheta}(r^\star + \delta)^{\left(\frac{\theta^T-\theta^N}{\theta^T\theta^N}\right)(1+\epsilon)} \frac{\left[\left(\theta^T\right)^{\epsilon\theta^T}\left(1-\theta^T\right)^{\left(1-\theta^T\right)(1+\epsilon)}\right]^{1/\theta^T}}{\left[\left(\theta^N\right)^{\epsilon\theta^N}\left(1-\theta^N\right)^{\left(1-\theta^N\right)(1+\epsilon)}\right]^{1/\theta^N}} > 0.$$

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 than in a model abstracting from physical capital.

< Please insert Figure 5 about here >

5.3 Relative Price and Relative Wage Effects

Before turning to the numerical analysis, we analytically break down the relative price and relative wage effects of a productivity differential between tradables and non tradables in three components. To build intuition, we will show graphically how previous results change when we allow for physical capital.

We first explore the relative wage effect of a productivity differential. Equating labor supply (28) and labor demand (35) to eliminate l^T/l^N, and differentiating yields the deviation in percentage of the relative wage from its initial steady state:[43]

$$\hat{\omega} = -\left(\phi - 1\right)\Theta^K \left(\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right) + \Theta^K \left(\mathrm{d}\upsilon_B + \mathrm{d}\upsilon_I\right), \quad \Theta^K \equiv \frac{1}{\left[\left(\epsilon + 1\right) + \theta^T \left(\phi - 1\right)\right]} > 0. \tag{38}$$

Adding and subtracting $\Theta^L = \left(\frac{1}{\epsilon+\phi}\right)$ (see (30)) in the RHS of (38), and noting that $\upsilon_B = -\upsilon_{NX}$ where we denote by $\upsilon_{NX} \equiv \left(\tilde{Y}^T - \tilde{C}^T\right)/\tilde{Y}^T$ the ratio of net exports to traded output, allows us to break down the relative wage growth into three components:[44]

$$\hat{\omega} = -\left(\phi - 1\right)\left[\Theta^L + \left(\Theta^K - \Theta^L\right)\right]\left[\hat{z}^T - \left(\theta^T/\theta^N\right)\hat{z}^N\right] - \Theta^K \left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right), \tag{39}$$

where $\hat{z}^T - \left(\theta^T/\theta^N\right)\hat{z}^N$ is the labor share-adjusted TFP differential. Setting $\theta^T = 1$ in (39) implies $\Theta^K = \Theta^L$ and $\mathrm{d}\upsilon_{NX} = \mathrm{d}\upsilon_I = 0$. Hence, when abstracting from physical capital accumulation, (39) reduces to (30). In this case, the relative wage is only affected through the **baseline channel**, as captured by $-\left(\phi - 1\right)\Theta^L \lesseqgtr 0$. As mentioned in section 4.3, in a model abstracting from physical capital, the relative wage falls only when the elasticity of substitution between traded and non traded goods is larger than one since only in this case does the share of tradables rise. As depicted in Figure 5(a) (Figure 6(a)) assuming $\phi > 1$ ($\phi < 1$) the productivity differential shifts to the right (to the left) the LD-schedule from LD_0 to LD_1, therefore resulting in a decline (rise) in the relative wage from ω_0 to ω_1.

[43] Note that to derive the RHS of (38), we use a first-order Taylor approximation to rewrite $\mathrm{d}\ln\left(\frac{1+\upsilon_B}{1-\upsilon_I}\right)$ as $\mathrm{d}\upsilon_B + \mathrm{d}\upsilon_I$ which eases the discussion.

[44] Remembering that at the steady state the traded good market clearing condition is $r^\star \tilde{B} + \tilde{Y}^T - \tilde{C}^T = 0$, and rearranging terms yields $-\tilde{NX} = r^\star \tilde{B}$. Dividing the LHS and the RHS by $\tilde{Y}^T$, we get $\upsilon_B = -\upsilon_{NX}$.

Eq. (39) reveals that introducing physical capital (i.e., $\theta^T < 1$) produces two additional effects on the relative wage. First, the effect of a productivity differential on ω stemming from the shift of capital across sectors is captured by the term $-(\phi - 1)\left(\Theta^K - \Theta^L\right) < 0$, as shown in the RHS of (39).[45] While the **capital reallocation channel** exerts a negative impact on ω irrespective of whether $\phi > 1$ or $\phi < 1$, the interpretation requires us to differentiate between the two cases. When $\phi > 1$, the productivity differential shifts capital towards the traded sector which raises the marginal product of labor and thus lowers the relative wage further. Graphically, as shown in Figure 5(a), the LD^K schedule shifts to the right from LD_0^K to $LD^{K,\prime}$ which is steeper than LD_1. Hence, the shift of capital lowers the relative wage from ω_1 to ω'. If $\phi < 1$, capital moves towards the non traded sector and thus raises output in that sector. This exerts a negative impact on p which lowers the marginal product of labor in the non traded sector and therefore the relative wage. Graphically, as shown in Figure 6(a), because LD^K is flatter than LD, the $LD^{K,\prime}$-schedule intercepts the LS-schedule for a relative wage ω_1 below ω'.

Second, when introducing physical capital, the productivity differential impinges on $\hat{\omega}$ through a **capital accumulation channel**, as captured by $-\Theta^K\left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right) < 0$. Because higher productivity raises the rate of return on domestic capital, it is optimal for the economy to accumulate physical capital by running a current account deficit which must be matched in the long run by a trade balance surplus. Further, the improvement in the trade balance must exceed the investment boom because along the transitional path, the current account deficit is induced by the combined effect of capital accumulation and reduced savings.[46] Formally, we have $\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I > 0$. Higher steady-state net exports raise demand for tradables, with an expansionary effect on labor demand in the traded sector and thereby lowering ω. Graphically, the capital accumulation channel produces a shift to the right of the LD-schedule from $LD^{K,\prime}$ to LD_1^K which lowers the relative wage from ω' to ω_1^K, as shown alternatively in Figure 5(a) or 6(a). The new steady state is F_1. Note that assuming perfect mobility of labor across sectors (i.e., setting $\epsilon \to \infty$) implies $\hat{\omega} = 0$; graphically, the LS-schedule becomes a horizontal line and the new steady state is BS_1.

We now explore the long-run response of the relative price of non tradables to a productivity differential. Equating (36) and (37) to eliminate y^T/y^N, differentiating, adding and

[45] The *capital reallocation channel* captured by $-(\phi-1)\left(\Theta^K - \Theta^L\right)$ always exerts a negative effect on the relative wage ω irrespective of whether ϕ is larger or smaller than one. Formally, we have:

$$-(\phi - 1)\left(\Theta^K - \Theta^L\right) = \frac{-(\phi-1)^2\left(1-\theta^T\right)}{(\epsilon+\phi)\left[(\epsilon+1)+\theta^T(\phi-1)\right]} \leq 0.$$

[46] The worker/consumer reduces private savings to avoid a reduction in consumption while she/he lowers labor supply.

subtracting Θ^L, yields the deviation in percentage of the relative price from its initial steady state:

$$\hat{p} = (1+\epsilon)\left[\Theta^L + \left(\Theta^K - \Theta^L\right)\right]\left(\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right) - \theta^T\Theta^K\left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right), \tag{40}$$

where $\Theta^K \equiv \frac{1}{[(\epsilon+1)+\theta^T(\phi-1)]} > 0$ and $\Theta^L = \frac{1}{\epsilon+\phi} > 0$. When assuming perfect mobility of labor across sectors, (40) reduces to $\hat{p} = \hat{z}^T - \left(\theta^T/\theta^N\right)\hat{z}^N$. Graphically, as shown in Figure 5(b), the LME-schedule is horizontal and shifts higher; p increases from p_0 to p^{BS}, i.e., by the same amount as the productivity differential.

Conversely, assuming imperfect mobility of labor across sectors while abstracting from physical capital accumulation, (40) reduces to (31). In this case, only the **baseline channel**, reflected by $(1+\epsilon)\Theta^L > 0$, is in effect. According to the baseline channel, a productivity differential of 1% raises the relative price of non tradables less than proportionately if the elasticity of substitution ϕ is larger than one. This configuration is depicted in Figure 5(b). Higher productivity in tradables relative to non tradables shifts the LME-schedule along the GME-schedule which is flatter than the 45° degree line. Hence, the relative price increases from p_0 to p_1 which is below p^{BS}. However, as shown in Figure 6(b), because the the GME-schedule is steeper than the 45° degree line, the intersect of the two schedules (i.e., p_1) is above p^{BS}.

Introducing physical capital produces two additional channels through which a productivity differential may impinge on the relative price of non tradables. First, the effect of a productivity differential on p stemming from the shift of capital across sectors is captured by the term $(1+\epsilon)\left(\Theta^K - \Theta^L\right) \gtrless 0$, as shown in the RHS of (40), depending on whether $\phi \gtrless 1$.[47] Hence, the **capital reallocation channel** may reinforce the increase in p triggered by the baseline channel if $\phi > 1$ or may moderate it if $\phi < 1$. When $\phi > 1$, the capital inflow in the traded sector raises the marginal product of labor and thereby wages in that sector. The consecutive labor inflow raises traded output. Hence p must rise more than in a model abstracting from physical capital to clear the goods market. If $\phi < 1$, capital shifts towards the non traded sector, thereby raising output in that sector, which lowers p. As shown alternatively in Figure 5(b) or Figure 6(b), introducing physical capital rotates counterclockwise the LME-schedule (labelled LME^K), which becomes flatter. The productivity differential shifts to the right the LME^K-schedule from LME_0^K to $LME^{K,\prime}$ and raises the relative price

[47] The capital reallocation channel captured by $(1+\epsilon)\left(\Theta^K - \Theta^L\right)$ exerts a positive or a negative impact on the relative price p depending on whether ϕ is larger or smaller than one. Formally, we have:

$$(1+\epsilon)\left(\Theta^K - \Theta^L\right) = \frac{(\phi-1)\left(1-\theta^T\right)(1+\epsilon)}{(\epsilon+\phi)\left[(\epsilon+1)+\theta^T(\phi-1)\right]}.$$

Note that the sign of the numerator depends on $\phi - 1$ while the denominator is always positive.

of non tradables to p'. If $\phi > 1$, p' is above p_1. Conversely, when $\phi < 1$, the $LME^{K,\prime}$-schedule intercepts the GME-schedule for a relative price p' below p_1.

When introducing physical capital, a productivity differential impinges on p through a **capital accumulation channel** captured by $-\theta^T \Theta^K \left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right) < 0$ (see the second term on the RHS of (40)). As mentioned above, the long-run improvement in the trade balance raises the demand for tradables which produces a fall in the relative price of non tradables. Graphically, as shown alternatively in Figure 5(b) or Figure 6(b), the GME-schedule shifts to the right from GME to GME' along the $LME^{K,\prime}$-schedule. Irrespective of whether ϕ is larger or smaller than one, the capital accumulation channel always exerts a negative impact on the relative price of non tradables. As shown in Figure 5(b) and Figure 6(b)), p falls from p' to p_1^K. the new steady state is F_1.

To conclude, we have to consider two cases depending on whether the elasticity of substitution between traded and non traded goods is larger or smaller than one:

- If $\phi > 1$, when abstracting from physical capital, a productivity differential lowers the relative wage and increases less than proportionately the relative price of non tradables, in line with our evidence. Introducing physical capital exerts two opposite effects on the relative price while both channels reduce the relative wage. First, a productivity differential induces a shift of capital towards the traded sector which pushes up the relative price and lowers the relative wage. Second, increased demand for tradables due to the long-run trade balance surplus drives down both the relative price of non tradables and the relative wage.

- When $\phi < 1$, a model without physical capital predicts that a productivity differential raises the relative wage and more than proportionately increases the relative price, in contradiction to our evidence. Introducing physical capital produces two novel channels which lower the relative price and the relative wage. First, by shifting capital towards the non traded sector, a productivity differential exerts a negative impact on p and ω. Second, the trade balance surplus further reduces p and ω.

While in the latter case (i.e., $\phi < 1$), the capital reallocation and accumulation channels counteract the baseline channel, we have to determine numerically if they are large enough to produce a decline in the relative wage and a less than proportional increase in the relative price following a productivity differential between tradables and non tradables.

6 Quantitative Analysis

In this section, we analyze the effects of a labor share-adjusted TFP differential quantitatively. For this purpose we solve the model numerically.[48] Therefore, first we discuss parameter values before turning to the long-term consequences of higher productivity in tradables relative to non tradables.

6.1 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. While in the next section we move a step further and calibrate the model for each economy, we first have to evaluate the ability of the two-sector open economy model with physical capital to accommodate our findings. Our sample covers the fourteen OECD economies in our dataset. Our reference period for the calibration corresponds to the period 1990-2007.[49] Since we calibrate a two-sector model with tradables and non tradables, we pay particular attention to the adequacy of the non-tradable content of the model to the data. Table 11 summarizes our estimates of the non-tradable content of GDP, employment, consumption, gross fixed capital formation and government spending, and gives the share of government spending on the traded and non traded good in the sectoral output, the shares of capital income in output in both sectors, for all countries in our sample.[50] Targeted ratios when calibrating to the representative OECD economy are the fourteen OECD countries' unweighed average. The averages of non-tradable shares and of estimates of various parameters are shown in the last line of Table 11.

We start by describing the calibration of consumption-side parameters that we use as a baseline. The world interest rate which is equal to the subjective time discount rate β is set to 4%. One period of time corresponds to a year. In light of our discussion above, both ϵ and ϕ play a key role in the determination of the relative price and the relative wage responses to a productivity differential. Building on our panel data estimations discussed in section 3, the elasticity of substitution ϕ between traded and non traded goods is set to one in the baseline calibration. The reason is twofold. First, this value corresponds roughly to the average of estimates.[51] Second, we conduct a sensitivity analysis by considering alternatively a value of

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

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

[50] Government spending on traded G^T and non traded goods PG^N are considered for calibration purposes. Hence, the market clearing condition for the traded good and the non traded good at the steady-state are $r^{\star}\tilde{B} + \tilde{Y}^T = \tilde{C}^T + G^T$ and $\tilde{Y}^N = \tilde{C}^N + \tilde{I} + G^N$.

[51] As mentioned in Appendix E, excluding the estimate for the Netherlands which is negative and therefore is not consistent, the elasticity of substitution averages to 0.93, as shown in the last line of Table 11. When

ϕ smaller or larger than one (i.e., ϕ is set to 0.5 and 1.5, respectively). In this regard, a value of one is halfway between these two scenarios.

The degree of labor mobility captured by ϵ is set to 0.8 in line with the average of our estimates shown in the last line of Table 11. 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.[52] Then we 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. Our estimates display a wide dispersion across countries and we therefore conduct a sensitivity analysis with respect to this parameter. Excluding the estimate of ϵ for Netherlands which is not statistically significant at 10%, estimates of ϵ range from a low of 0.242 for Ireland to a high of 1.791 for the United States and 1.795 for Korea.[53] Hence, we allow for ϵ to vary between 0.2 and 1.8 in the sensitivity analysis.

The weight of consumption in non tradables $1 - \varphi$ is set to 0.43 to target a non-tradable content in total consumption expenditure (i.e. α_C) of 43%, in line with the average of our estimates shown in the last line of Table 11. The intertemporal elasticity of substitution for consumption σ_C is set to 1.[54] One critical parameter is the intertemporal elasticity of substitution for labor supply σ_L. In our baseline parametrization, we set $\sigma_L = 0.5$, in line with evidence reported by Domeij and Flodén [2006], 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 0.6 to target a non-tradable content of labor compensation of 65%, in line with the average of our estimates shown in the last line of Table 11.

We now describe the calibration of production-side parameters. We assume that physical capital depreciates at a rate $\delta_K = 5\%$ to target an investment-GDP ratio of 20%. The shares of sectoral capital 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 shares in the traded (θ^T) and the non traded sector (θ^N) are set to 0.6 and 0.7, respectively, which correspond roughly to the averages for countries with $k^T > k^N$. For these values, the non-tradable content of GDP and labor are 63%.[55] When $k^N > k^T$, we use reverse but symmetric values, i.e., $\theta^T = 0.7$ and $\theta^N = 0.6$; in this case, the non tradable content of GDP and labor are 63% and 60%, respectively, for our baseline calibration. As in Ghironi and Melitz [2005], we

excluding estimates which are not statistically significant at 10% (i.e., Korea and the U.S.), the elasticity of substitution averages to 1.08. Hence a value of one for ϕ is halfway between these two values.

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

[53] Horvath [2000] finds a value of one for the United States by considering 36 sectors over the period 1948-1985.

[54] Numerical results are almost insensitive to this parameter.

[55] Table 11 gives the labor share of sector j θ^j (with $j = T, N$) for the fourteen OECD countries in our sample. The values of θ^T and θ^N we have chosen correspond roughly to the averages for countries with $k^T > k^N$.

assume that traded firms are 50 percent more productive than non traded firms; hence we set Z^T and Z^N to 1.5 and 1, respectively. In section 7.2, we assume that investment expenditures are both traded and non traded. In this case, we set the elasticity of substitution ϕ_I between I^T and I^N to 1, in line with the empirical findings documented by Bems [2008] for OECD countries. Further, the weight of non traded investment $(1-\varphi_I)$ is set to 0.58 to target a non-tradable content of investment expenditure of 58%, in line with our estimates shown in the last line of Table 11.

For calibration purposes, we introduce government spending on traded and non traded goods in the setup. We set G^N and G^T so as to yield a non-tradable share of government spending of 90%, and government spending as a share of GDP of 20%. In line with the averages of the values reported in the last line of Table 11, the ratios G^T/Y^T and G^N/Y^N are 5% and 28% in the baseline calibration.

We consider a permanent increase in the TFP index Z^j of both sectors biased towards the traded sector so that the labor share-adjusted productivity differential between tradables and non tradables, i.e., $\hat{z}^T - \left(\theta^T/\theta^N\right)\hat{z}^N$, is 1%. While in our baseline calibration we set $\phi = 1$, $\epsilon = 0.8$, $\sigma_L = 0.5$, $\theta^T = 0.6$, we conduct a sensitivity analysis with respect to these four parameters. Regarding the elasticity of substitution between traded and non traded goods, we consider two alternative scenarios, setting ϕ to 0.5 and 1.5.[56] Because our estimates of the parameter capturing the degree of labor mobility display a wide dispersion, we consider two alternative scenarios, setting ϵ to 0.2 and 1.8. We also conduct a sensitivity analysis with respect to the elasticity of labor supply (we set σ_L to 0.2 and 1) and the sectoral labor share (we set $\theta^T = 0.7$).

The relative price and relative wage responses are summarized in Table 6. We also consider two variants of the model for robustness purposes: we consider preferences which are non-separable in consumption and labor, and introduce traded investment. Numerical results obtained in these two cases will be discussed in section 6. Before analyzing in detail the responses of the relative price and the relative wage to a productivity differential, we should mention the set of empirical evidence established in section 2. It is found that for the whole sample, a labor share-adjusted TFP differential between tradables and non tradables of 1% induces a rise in the relative price of non tradables by 0.78% and a decline in the relative wage by 0.27%; further, as the degree of labor mobility increases, the relative price rises more while the relative wage falls less. We discuss below the predictions of our model when ϕ is alternatively smaller, higher or equal to one.

[56]These values for ϕ of 0.5 and 1.5 correspond roughly to the averages of estimates of ϕ for countries with $\phi < 1$ and $\phi > 1$, respectively.

6.2 Discussion: $\phi < 1$

Since a two-sector model (with imperfect mobility of labor) abstracting from physical capital accumulation fails to account for the evidence when the elasticity of substitution between traded and non traded goods is smaller than one, we first discuss the numerical results in this configuration. Panels C and D of Table 6 report the long-run changes for the relative price of non traded goods p and the relative wage $\omega \equiv w^N/w^T$ expressed as a percentage. The numbers reported in the first line of each panel give the (overall) responses of these variables to a productivity differential between tradables and non tradables of 1%.

Column 2 of Table 6 shows that the standard two-sector model assuming perfect mobility of labor across sectors predicts an unchanged relative wage and an increase in the relative price of 1%. While the standard BS model fails to account for the evidence, the predictive power of the two- sector model improves when we introduce two ingredients: imperfect mobility of labor across sectors and physical capital. More precisely, the results summarized in column 3 for the benchmark scenario reveal that the relative wage falls by 0.24% while the relative price increases by 0.85%.

To emphasize the key role of physical capital in improving the predictive power of the model, it is useful to break down the responses of the relative wage and relative price into three components: a baseline effect keeping fixed k^j (with $j = T, N$) and K, a capital reallocation effect arising from changes in sectoral capital-labor ratios, and a capital accumulation effect stemming from changes in the overall capital stock and therefore in net exports. When breaking down the effects, the second line of panel D shows that a model abstracting from physical capital predicts an increase in p by 1.38%. The reason is when the elasticity of substitution ϕ is smaller than one, the relative price must increase more than proportionately to clear the goods market. Moreover, as shown in the second line of panel C, the relative wage increases instead of decreasing as expenditure on non tradables rises relative to expenditure on tradables, therefore producing an expansionary effect on labor demand in the non traded sector.

The third line and the fourth line of panel C and panel D show that both the capital reallocation and capital accumulation channels counteract the baseline channel. More precisely, the third line of panel D reveals that the capital reallocation channel produces a fall in the relative price of non tradables by shifting capital towards the non traded sector, raising non traded output. The decline in p lowers the marginal product of labor in the non traded sector, which lowers the relative wage, as shown in the third line of panel C. The productivity differential also lowers the relative price and the relative wage through the capital accumulation channel. More precisely, the long-run improvement in the trade balance raises the demand for tradables, which substantially lowers the relative price by 0.34%, as shown in the fourth line of panel D. Additionally, the traded sector is induced to hire more workers, significantly driving down the relative wage by 0.57%. Importantly, numerical results show that both the capital reallocation and accumulation channels are large enough to produce a less than proportional increase in the relative price and a decline in the relative wage, in line with the evidence established in section 2.

As shown in columns 4 and 5, the elasticity of labor supply merely affects the results by modifying the capital accumulation channel. The reason is as follows. Following the productivity differential, the worker/consumer lowers labor supply on impact and thus reduces private savings to avoid a decline in consumption, all else being equal. The more responsive the labor supply (i.e., σ_L is higher), the more private savings decline, and therefore the more likely it is that the open economy experiences a larger current account deficit. As a result, net exports and therefore demand for tradables rise further, exerting a larger negative impact on ω and p, as shown in the fourth line of panel C and D, respectively.

Columns 6 and 7 of Table 6 reveal that the degree of labor mobility substantially modifies the results. As the utility loss that workers experience when shifting is lowered (i.e., ϵ is raised from 0.2 to 1.8), the first line of panel C and panel D indicates that the relative price increases more while the relative wage falls less, in line with the evidence. Introducing physical capital plays a key role in accommodating the data. As shown in the fourth line of panel C and D, raising labor mobility across sectors significantly moderates the capital accumulation channel. As workers are more willing to shift hours worked across sectors, traded wages increase by a smaller amount, dampening the decline in ω from -0.87% to -0.35%. In terms of Figure 6(b) which summarizes the steady state by focusing on the labor market equilibrium, raising ϵ rotates the LS-schedule counterclockwise. Because the LD^K-schedule shifts along a flatter LS-schedule, the decline in ω is less pronounced. Because traded output increases by a larger amount as ϵ is raised from 0.2 to 1.8, the relative price must fall less to clear the goods market. In terms of Figure 6(b) which summarizes the steady state by focusing on the goods market equilibrium, the GME-schedule shifts to the right along a flatter LME^K-schedule as labor becomes more mobile across sectors, resulting in a smaller decline in p.

Finally, columns 8 and 9 of Table 5 show results when it is assumed that the non traded sector is more capital intensive than the traded sector. If the assumption of perfect mobility across sectors is imposed, the responses of ω and p shown in column 8 are unchanged compared with those displayed in column 2 where we assume $k^T > k^N$. When assuming imperfect labor mobility, a comparison of the responses of ω and p in column 9 with those shown in column 3 indicates that our results are robust to sectoral capital intensities.[57]

6.3 Discussion: $\phi > 1$

Let us briefly discuss the scenario of an elasticity larger than one. Panels E and F of Table 6 report the long-run responses of the relative price of non traded goods p and the relative wage $\omega \equiv w^N/w^T$ to a productivity differential between tradables and non tradables of 1%.

As shown in column 3, the model with imperfect labor mobility produces a decline in the relative wage and a less than proportional increase in the relative price, in line with the evidence. However, the model tends to overstate the decline in the relative wage and to understate the relative price growth following a productivity differential. The second line of panel E and panel F of Table 6 reveals that a model abstracting from physical capital predicts the responses of ω and p estimated empirically pretty well. More precisely, a two-sector model with labor only and imperfect mobility produces an increase in the relative price of 0.78% and a decline in the relative wage of 0.22%. The third and fourth lines of panel E reveal that both the capital reallocation and the capital accumulation channels drive down the relative wage by a larger amount: the former shifts capital towards the traded sector, increasing the marginal product of labor in that sector, while the latter further raises labor demand in the traded sector by raising the demand for tradables.

When raising the degree of labor mobility, as shown in columns 6 and 7, we find that the response of the relative price is amplified while the reaction of the relative wage becomes more muted, in line with our evidence. Moreover, column 7 reveals that the predictive power of the two-sector model with imperfect mobility of labor across sectors and physical capital improves when ϵ is set to 1.8 since in this case, we find that the relative price increases by 0.77% while the relative wage declines by 0.37%.

6.4 Discussion: $\phi = 1$

We now explore the relative wage and relative price effects when the elasticity of substitution between tradables and non tradables is set to one. This case is shown in panel A and panel B of Table 6. The second line reveals that a model with imperfect labor mobility across sectors abstracting from physical capital, yields identical results to those obtained in the standard BS framework assuming $\epsilon \to \infty$. The reason is that the share of tradables in total expenditure

[57] Numerical results indicate that raising θ^T from 0.6 to 0.7 while reducing θ^N from 0.7 to 0.6 moderates the capital reallocation channel. When the non traded sector becomes more capital intensive, the capital inflow in the non traded sector is less pronounced as the traded sector is more labor intensive. Hence, decreases in p and ω due to the shift of capital are moderated.

remains unchanged. While this case is not depicted in order to economize space, we can refer to Figures 5(a) and 5(b) to build intuition. Graphically, in terms of Figure 5(a) which focuses on the labor market, the LD-schedule remains unaffected, as does the relative wage. In terms of Figure 5(b) which depicts the goods market, the productivity shock biased towards the traded sector shifts to the right the LME-schedule. Since the GME-schedule now coincides with the 45° line because $\phi = 1$, a productivity differential of 1% raises the relative price by the same proportion. However, by producing a trade balance surplus in the long run, introducing physical capital in a model with imperfect mobility of labor improves the predictive power of the model. More precisely, as shown in the fourth line of panel A and panel B of Table 6, the capital accumulation channel lowers the relative wage and exerts a negative impact on the relative price by raising the demand for tradables. Graphically, the capital accumulation channel shifts to the right the LD^K-schedule in the labor market and the GME-schedule in the goods market, which reduces ω by 0.45% and moderates the increase in p, respectively. The latter rises by 0.72% instead of 1% when perfect labor mobility is assumed. Alternative scenarios yield similar results to those discussed above and therefore do not merit further comment.

< Please insert Table 5 about here >

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7 Two Variants of the Two-Sector Model

We now briefly assess to what extent our results depend on the assumptions regarding the form of preferences and the absence of traded investment.

7.1 Non-Separability in Preferences between Consumption and Labor

In this subsection, we consider a more general specification for preferences which are assumed to be non-separable in consumption and leisure. The household's period utility function is:[58]

$$\frac{C^{1-\sigma}V(L)^{\sigma}-1}{1-\sigma}, \quad \text{if} \quad \sigma \neq 1, \quad V(L) \equiv \left(1+(\sigma-1)\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}\right). \tag{41}$$

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; it is worthwhile noting that if $\sigma > 1$, the marginal utility of consumption is increasing in hours worked. Importantly, such preferences imply that the Frisch elasticity of labor supply

[58]The functional form (41) is taken from Shimer [2011].

is constant. When $\sigma = 1$, preferences are separable in consumption and labor:

$$\log C - \frac{\sigma_L}{1+\sigma_L} L^{1+\frac{1}{\sigma_L}}, \quad \text{if} \quad \sigma = 1. \tag{42}$$

The representative agent maximizes lifetime utility subject to the flow budget constraint (10) and physical capital accumulation (12). The first-order conditions characterizing the representative household's optimal plans are now given by:

$$C^{-\sigma} V(L)^{\sigma} = P_C \lambda, \tag{43a}$$

$$C^{1-\sigma} \sigma L^{1/\sigma_L} V(L)^{\sigma-1} = W\lambda, \tag{43b}$$

together with (13c) and (13d) which remain unchanged.

First-order conditions (43a) and (43b) can be solved for consumption and labor as follows:

$$C = C\left(\bar{\lambda}, P, W\right), \quad L = L\left(\bar{\lambda}, P, W\right), \tag{44}$$

where $C_{\bar{\lambda}} < 0$, $L_{\bar{\lambda}} > 0$, $C_P < 0$ and $L_P < 0$ (as long as $\sigma > 1$), $C_W > 0$ and $L_W > 0$. When preferences are non-separable in consumption and labor, consumption responds positively to a rise in the aggregate wage index W while agents supply less labor following an appreciation in the relative price of non tradables P (if $\sigma > 1$).

Let us emphasize the main changes. The positive relationship between consumption and the aggregate wage index modifies only the capital accumulation channel by affecting private savings along the transitional path. The reason is as follows. A higher aggregate wage index triggered by the productivity differential now induces agents to consume more. As a result, private savings decline further which results in a larger current account deficit. In the long run, the economy must therefore run a larger surplus in the balance of trade for the intertemporal solvency condition to hold. Because the demand for tradables rises more, the relative price of non tradables must decline by a greater amount to clear the goods market. Additionally, because it induces a greater expansionary effect on labor demand in the traded sector, the relative wage declines further. Graphically, in terms of Figure 5(a) or 6(a), the LD^K-schedule shifts to the right by a larger amount when moving from $LD^{K,\prime}$ to LD_1^K. As a result, ω falls more. When focusing on the goods market, the GME-equilibrium also shifts to the right by a larger amount. Therefore, the capital accumulation channel drives the relative price down further.

When exploring the implications of non-separability in preferences between consumption and leisure numerically, we set the substitutability between consumption and leisure captured by σ to 2, as in Shimer [2011], keeping unchanged the baseline calibration discussed in section 6.1. the results for the case of non-separability in preferences are shown in column 10 of Table

6, for our three alternative scenarios, i.e., $\phi = 1$, $\phi < 1$ and $\phi > 1$. Neither the baseline channel nor the capital reallocation channel is modified when considering non-separability in preferences. As shown in the fourth line of panel A and B of Table 6, non-separability in preferences substantially amplifies the capital accumulation channel, in line with the theoretical predictions. For example, when setting ϕ to 1, the relative wage falls by 0.54% when assuming non separability in preferences between consumption and labor instead of 0.45% for the benchmark scenario. Non separability in preferences also significantly moderates the increase in the relative price of non tradables, which rises by 0.66% instead of 0.72%.

7.2 Introducing Traded Investment

Along the lines of de Cordoba and Kehoe [2000], we assume that investment expenditures are both traded and non traded and explore the implications for the relative price and the relative wage effects of higher productivity in tradables relative to non tradables. We first emphasize the main changes for the modeling of introducing traded investment and then discuss its consequences.

Output in each sector can be used either for consumption, C^j $(j = T, N)$, or investment, I^j $(j = T, N)$ purposes. 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:

$$I \equiv I\left(I^T, I^N\right) = \left[\varphi_I^{\frac{1}{\phi_I}} \left(I^T\right)^{\frac{\phi_I - 1}{\phi_I}} + \left(1-\varphi_I\right)^{\frac{1}{\phi_I}} \left(I^N\right)^{\frac{\phi_I - 1}{\phi_I}}\right]^{\frac{\phi_I}{\phi_I - 1}}, \tag{45}$$

where $0 < \varphi_I < 1$ is the weight of the investment traded input and ϕ_I corresponds to the intratemporal elasticity of substitution between investment traded goods and investment non traded goods.

The representative household chooses consumption C, hours worked L, and investment that maximizes his/her lifetime utility (9) subject to the budget constraint:

$$\dot{B}(t) = r^\star B(t) + R(t)K(t) + W\left(W^T(t), W^N(t)\right) L(t) - P_C\left(P(t)\right) C(t) - P_I\left(P(t)\right) I(t), \tag{46}$$

and capital accumulation given by (12). We denote by P_I the investment price index.

First-order conditions (13a)-(13c) are identical while the dynamic equation for the relative price of non tradables now reads:[59]

$$R/P_I - \delta_K + \alpha_I \dot{P}/P = r^\star, \tag{47}$$

where α_I is the non-tradable content of investment expenditure.

[59] Specifically, we have $\alpha_I = \frac{(1-\varphi_I)P^{1-\phi_I}}{\varphi_I + (1-\varphi_I)P^{1-\phi_I}}$.

We now characterize the steady state, denoting the long-run values with a tilde, and restricting ourselves to the main changes. Setting $\dot{P} = 0$ into (47), we obtain the equality between the return on domestic capital and the exogenous world interest rate:

$$\tilde{R}/P_I - \delta_K = r^\star, \tag{48}$$

where $\tilde{R}$ corresponds to the marginal product of capital given by (17a). When investments are both traded and non traded, the user cost of capital is now given by $P_I \left(r^\star + \delta_K\right)$. Hence, following an appreciation in the relative price of non tradables, the user cost of capital increases less than if investment expenditure were exclusively non traded.

Since both traded and non traded outputs can be devoted to capital accumulation, the market clearing condition for the goods market (34) is rewritten as follows:

$$\frac{\tilde{Y}^T \left(1 + \upsilon_B - \upsilon_{I^T}\right)}{\tilde{Y}^N \left(1 - \upsilon_{I^N}\right)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{49}$$

where $\upsilon_{I^T} \equiv \tilde{I}^T/\tilde{Y}^T$ and $\upsilon_{I^N} \equiv \tilde{I}^N/\tilde{Y}^N$ are the ratio of traded and non traded investment expenditure, respectively, to sectoral output and $\upsilon_B \equiv r^\star \tilde{B}/\tilde{Y}^T$ is the ratio of interest receipts from traded bonds holding to traded output.

To begin with, in a model assuming perfect mobility of labor across sectors and considering both tradable and non-tradable investments, the long-run response of the relative price becomes:

$$\hat{p} = \left[\frac{\theta^N}{\theta^T}\hat{z}^T - \hat{z}^N\right] / \left[\vartheta_I + \frac{\theta^N}{\theta^T}\left(1 - \vartheta_I\right)\right]. \tag{50}$$

Since introducing traded investment modifies the labor share-adjusted TFPs differential, when running the simulations we now consider that (50) increases by 1%. Because the numerical results are almost identical to those obtained when assuming that investment expenditures are non traded only, we move directly onto the discussion of numerical results in order to economize space.[60]

Relative wage and relative price growth following a productivity differential between tradables and non tradables by 1% are shown in the last column of Table 6 when introducing traded investment (i.e., φ_I is set to 0.42) for three alternative scenarios. Note that in any of the three scenarios we consider that the traded sector is more capital intensive than the non traded sector, i.e., $\theta^N > \theta^T$. We expect the reallocation channel to exert a smaller impact on the relative wage and the relative price, irrespective of whether ϕ is larger or smaller than one. Intuitively, following an appreciation in the relative price, the user cost of capital

[60] In a Technical Appendix we provide an analytical breakdown of the relative price and relative wage effects into a baseline channel, a capital reallocation channel and a capital accumulation channel and emphasize the implications of introducing traded investment compared with a model abstracting from traded investment.

$P_I(r^\star + \delta_K)$ increases by a smaller amount when $0 < \varphi_I < 1$ since P_I rises in proportion of the non-tradable content of investment expenditure. Thus, an appreciation in the relative price of non tradables raises the ratio k^N/k^T but less than if $\varphi_I = 0$ as long as $\theta^N > \theta^T$. Hence, the downward-sloping LME^K-schedule shown alternatively in Figure 5(b) or Figure 6(b) becomes steeper when introducing traded investment. For example, if $\phi < 1$, the non traded sector experiences a smaller capital inflow which moderates the decline in the relative price of non tradables driven by the capital reallocation channel. As shown in the third line of panel D of Table 6, the relative price falls by only 0.17% instead of 0.18%. When considering alternative scenarios, i.e. $\phi > 1$ or $\phi = 1$, relative price and relative wage responses are almost unchanged if not identical and therefore do not merit further comment.

To conclude, our previous conclusions hold and are robust to the introduction of non-separability in preferences between consumption and labor or traded investment. For these two variants of the two-sector model, we find that a productivity differential between tradables and non tradables lowers the relative wage and increases less than proportionately the relative price, in line with our evidence.

8 Taking the Model to the Data

We now compare the predicted values for $\hat{p}$ and $\hat{\omega}$ with estimates for each country and the whole sample. To do so, we keep unchanged the baseline calibration, except for the parameter capturing the degree of labor mobility across sectors (i.e., ϵ) and the elasticity of substitution between traded and non traded goods (i.e., ϕ) which play a major role in the determination of responses of p and ω. When numerically computing $\hat{\omega}_i$ and $\hat{p}_i$ for each country i, we set ϵ_i and ϕ_i in accordance with their empirical estimates shown in the two last columns of Table 11.[61] When contrasting predicted with empirically estimated values for $\hat{p}$ and $\hat{\omega}$ for the whole sample, we set ϵ to 0.587 and ϕ to 0.856 which correspond to their estimates for the whole sample (see Table 10 and Table 5, respectively).[62] We simulate the two-sector model with both traded and non traded investments since the data reported in Table 11 indicate that the tradable content of investment expenditure is significant.[63]

Results are shown in Table 7. Columns 2 and 5 of Table 7 give the predicted responses of $\hat{p}$ and $\hat{\omega}$ to a productivity differential between tradables and non tradables by 1%. Columns 3

[61]Since our estimate of ϕ for the Netherlands is negative, we replace its inconsistent value with the fully modified OLS estimate of 1.13 (see Table 5) obtained when running the regression (32) with the (log) GDP per capita instead of the time trend.

[62]To be consistent with our calibration of parameter ϕ, we take the fully modified OLS estimate; the dynamic OLS estimate gives very similar values for ϕ when a time trend is included instead of GDP per capita. To target a non tradable content of consumption expenditure of 43%, we set φ to 0.59.

[63]Note that we assume that preferences are separable in consumption and labor.

and 6 report fully modified OLS estimates of $\hat{p}$ and $\hat{\omega}$ for each country and the whole sample.[64] Columns 4 and 7 give the ratio between the actual and the predicted value; when the ratio is smaller (larger) than one, the model tends to overstate (understate) the actual values. As shown in the last line of Table 7, for the whole sample, our two-sector model with imperfect mobility of labor across sectors predicts the actual response of the relative price pretty well. More precisely, we find numerically that a productivity differential increases the relative price by 0.785%, while we find empirically that p rises by 0.775% following a productivity differential between tradables and non tradables of 1%. Column 4 reveals that our model's predictions for $\hat{p}$ are close to the evidence for more than half of the countries in our sample, in particular Belgium, Finland, France, Ireland, Italy, Spain and to a lesser extent Germany and the United States.

< Please insert Table 6 about here >

When we turn to the relative wage response, we find that the model tends to substantially overstate the response of the relative wage. For the whole sample, the model predicts a decline in ω by 0.434% while the relative wage is found to fall by 0.271% in the data. Ratios of actual to predicted values reported in the last column reveal that the two-sector model is able to predict relatively well the relative wage growth for four countries, including Denmark, Germany, Italy and Spain. By and large, the numbers shown in the last column of Table 7 indicate that the model tends to overstate the decline in the relative wage, except for France, Korea and the United States.

9 Conclusion

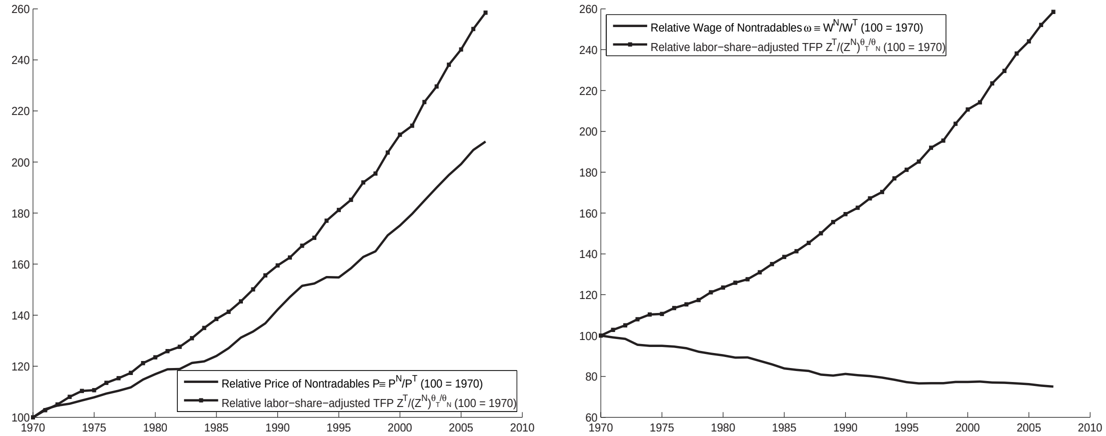
In this paper we have analyzed the relative price and the relative wage effects of higher productivity in tradables relative to non tradables in a two-sector small open economy model with imperfect mobility of labor across sectors. To guide our theoretical analysis, we have estimated the responses of the relative price of non tradables and the ratio of the non traded wage to the traded wage to a productivity differential. For a sample covering fourteen OECD countries over the period 1970-2007, three major results emerge. Following a productivity differential between tradables and non tradables of 1%, i) the relative price increases by 0.78%, ii) the relative wage declines by 0.27%, and iii) the relative price rises more while the

[64]FMOLS and DOLS cointegration procedures give very similar estimates. Since the model has been calibrated by using FMOLS estimates of ϕ, we compare predicted values with FMOLS estimates. We reach similar conclusions when using DOLS estimates.

relative wage falls less as the degree of labor mobility across sectors increases.

We find analytically that two parameters play a major role in the determination of the relative price and relative wage responses to a productivity differential: the elasticity of substitution between traded and non traded goods and the size of the utility loss that workers experience when shifting hours worked across sectors. After estimating these two parameters for each country in our sample and calibrating the two-sector model, the numerical results reveal that two ingredients are necessary to account for the set of evidence: imperfect mobility of labor across sectors and physical capital accumulation. Our sensitivity analysis reveals that our conclusions hold when considering non-separability in preferences between consumption and labor or introducing traded investment.

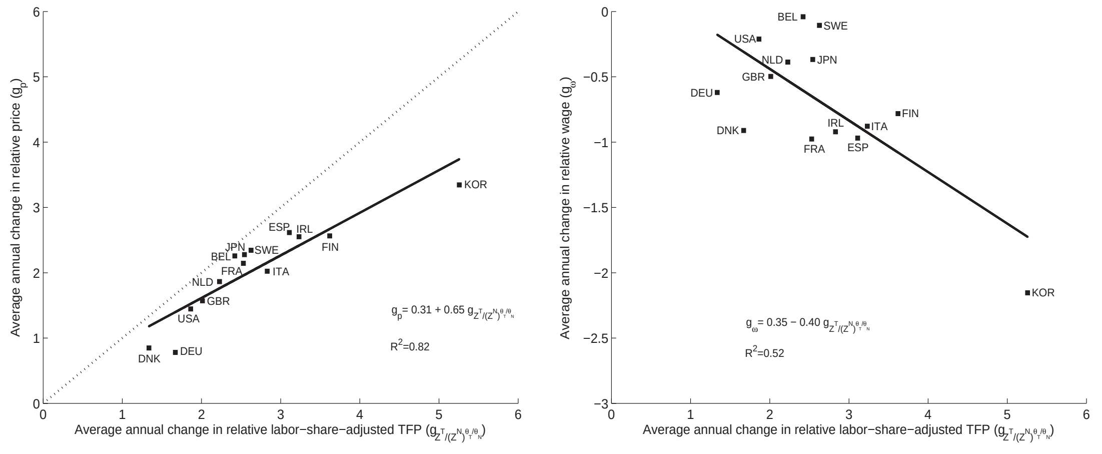
Quantitatively, we find that our calibrated and simulated two-sector model predicts the response of the relative price pretty well but tends to overstate the decline in the response in the relative wage. More precisely, for the whole sample, our model produces an increase in the relative price of non tradables of 0.785% and a drop in the relative wage of 0.434%. Our quantitative exercise suggests that further work has to be done to improve the predictive power of the two-sector model regarding the response of the relative wage. We believe that our assumption of perfectly competitive labor markets is too strong; in this regard, extending the setup to labor market frictions in the tradition of Diamond-Mortensen-Pissarides should improve the model's performance.



(a) Relative Price of non tradables and Relative Productivities

(b) Relative Wage and Relative Productivities

Figure 1: Trends in the Relative Price, Relative TFPs and Relative Wage. Notes: Figure 1(a) plots the relative price of non-tradables P^N/P^T and relative labor share-adjusted TFPs $Z^T/\left(Z^N\right)^{\theta^T/\theta^N}$; Figure 1(b) plots the relative wage W^N/W^T and relative labor share-adjusted TFPs $Z^T/\left(Z^N\right)^{\theta^T/\theta^N}$; relative price, relative wage and sectoral productivity ratio are the fourteen OECD countries' unweighed average.



(a) Relative Price Growth against Productivity Differential

(b) Relative Wage Growth against Productivity Differential

Figure 2: Relative Price and Relative Wage Growth against Productivity Differential. Notes: Figure 2(a) plots the average relative price growth (Y-axis) against the average productivity differential between tradables and non tradables (X-axis) while Figure 2(b) plots the average relative wage growth (Y-axis) against the average productivity differential (X-axis) over the period 1970-2007.

Table 1: Panel Unit Root Tests (p-values)

Variables	LLC (t-stat)	Breitung (t-stat)	IPS (W-stat)	MW (ADF)	MW (PP)	Hadri (Z_μ-stat)
p	0.78	0.73	1.00	1.00	0.90	0.00
ω	0.00	0.63	0.34	0.16	0.12	0.00
$(z^T - (\theta^T/\theta^N)z^N)$	0.99	0.51	1.00	0.98	0.97	0.00
$[p - (z^T - (\theta^T/\theta^N)z^N)]$	0.24	0.14	0.94	0.88	0.93	0.00

Notes: For all tests, except for Hadri, the null of a unit root is not rejected if p-value ≥ 0.05. For Hadri, the null of stationarity is rejected if p-value ≤ 0.05.

Table 2: Panel Cointegration Estimates of β and γ for the Whole Sample (eq. (2))

	Relative wage eq. (2a)		Relative price eq. (2b)	
	DOLS	FMOLS	DOLS	FMOLS
$z^T - (\theta^T/\theta^N)z^N$	-0.270^a (−21.30)	-0.271^a (−26.15)	0.779^a (95.22)	0.775^a (107.28)
$t(\hat{\beta}) = 0$	0.000	0.000		
$t(\hat{\gamma}) = 1$			0.000	0.000

Notes: ^{a} denotes significance at 1% level. The last two rows report the p-value of the test of $H_0 : \hat{\beta} = 0$ and $H_0 : \hat{\gamma} = 1$.

Table 3: Panel Cointegration Estimates of β_i and γ_i for Each Country (eq. (2))

	Relative wage equation		Relative price equation	
Country	$\hat{\beta}_i^{DOLS}$	$\hat{\beta}_i^{FMOLS}$	$\hat{\gamma}_i^{DOLS}$	$\hat{\gamma}_i^{FMOLS}$
BEL	-0.147^a (−5.00)	-0.131^a (−4.54)	0.820^a (24.51)	0.830^a (23.23)
DEU	-0.590^a (−14.49)	-0.581^a (−17.99)	0.624^a (10.42)	0.607^a (11.27)
DNK	-0.450^a (−4.00)	-0.452^a (−5.44)	0.471^a (10.42)	0.471^a (14.68)
ESP	-0.277^a (−7.16)	-0.281^a (−10.68)	0.821^a (22.57)	0.836^a (27.69)
FIN	-0.223^a (−9.33)	-0.221^a (−11.60)	0.762^a (25.97)	0.733^a (28.21)
FRA	-0.413^a (−5.30)	-0.412^a (−6.44)	0.840^a (34.63)	0.841^a (37.61)
GBR	-0.121 (−1.57)	-0.140^b (−2.26)	0.941^a (9.06)	0.922^a (10.60)
IRL	-0.171^b (−2.11)	-0.211^a (−3.10)	0.733^a (16.78)	0.737^a (20.95)
ITA	-0.274^a (−9.91)	-0.290^a (−10.50)	0.786^a (35.69)	0.767^a (32.01)
JPN	-0.146^a (−3.59)	-0.148^a (−4.55)	0.916^a (63.59)	0.915^a (64.83)
KOR	-0.499^a (−9.54)	-0.482^a (−12.17)	0.648^a (41.48)	0.651^a (52.14)
NLD	-0.375^a (−5.75)	-0.345^a (−6.02)	0.795^a (21.01)	0.800^a (23.75)
SWE	-0.012 (−0.36)	-0.004 (−0.23)	0.925^a (11.65)	0.918^a (23.73)
USA	-0.083 (−1.59)	-0.092^b (−2.32)	0.819^a (28.49)	0.820^a (30.69)
All sample	-0.270^a (−21.30)	-0.271^a (−26.15)	0.779^a (95.22)	0.775^a (107.28)

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

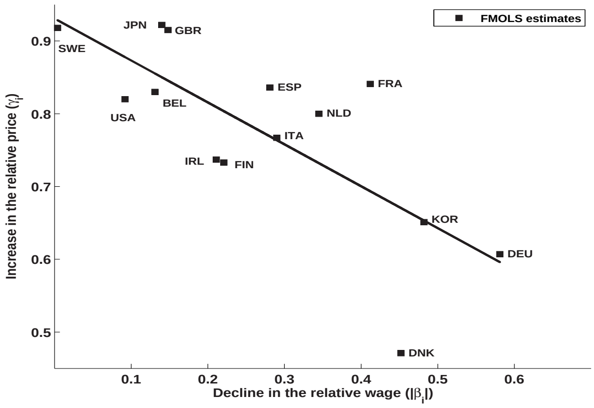


Figure 3: Relative Price against Relative Wage Growth. Notes: Figure plots fully modified OLS estimates of relative price responses to a labor-share adjusted TFPs differential against relative wage responses. FMOLS estimates for each country are taken from Table 3.

Table 4: Panel Cointegration Estimates with Labor Reallocation (LR) index (eq. (6))

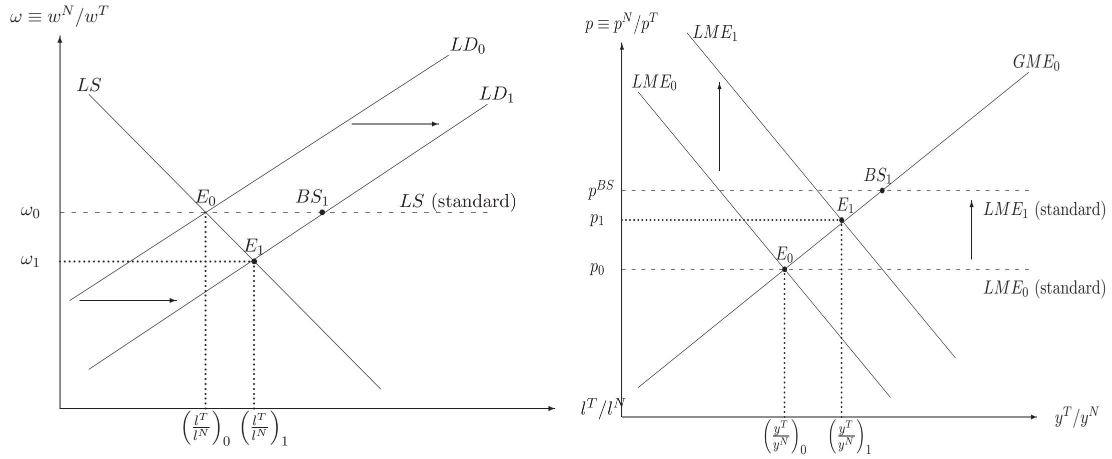
	wage equation		price equation	
	DOLS	FMOLS	DOLS	FMOLS
$z^T - (\theta^T/\theta^N)z^N$	-0.262^a	-0.261^a	0.792^a	0.782^a
	(-27.73)	(-25.49)	(111.54)	(107.60)
$(z^T - (\theta^T/\theta^N)z^N) * LR$	0.230^b	0.166^c	0.150^a	0.116^b
	(2.40)	(1.80)	(3.20)	(2.22)

Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels. Heteroskedasticity and autocorrelation consistent t-statistics are reported in parentheses. LR is the workers' mobility index developed by Wacziarg and Wallack [2004].

Table 5: Panel Cointegration Estimates of ϕ (eq. (32))

	Data coverage	With GDP per capita		With time trend	
		$\hat{\phi}_i^{DOLS}$	$\hat{\phi}_i^{FMOLS}$	$\hat{\phi}_i^{DOLS}$	$\hat{\phi}_i^{FMOLS}$
BEL	1995-2007	2.406^a (2.85)	0.469 (0.90)	0.636^a (21.38)	0.571^a (5.21)
DEU	1991-2007	1.140^a (5.57)	0.049 (0.09)	1.081^a (26.50)	1.108^a (13.10)
DNK	1970-2007	2.055^a (3.81)	1.758^a (3.31)	0.709^a (6.26)	0.729^a (6.20)
ESP	1995-2007	1.424^a (46.56)	0.785^a (5.29)	1.119^a (11.99)	1.155^a (6.13)
FIN	1975-2007	-0.223 (-0.42)	-0.120 (-0.39)	0.649^b (2.56)	0.690^a (3.10)
FRA	1970-2007	0.759^a (4.47)	0.712^a (4.14)	0.643^a (3.40)	0.735^a (3.88)
GBR	1980-2007	1.566^a (26.37)	1.226^a (9.20)	1.939^a (9.00)	1.665^a (4.75)
IRL	1995-2007	0.302^a (5.83)	0.639^a (6.41)	0.614^a (44.93)	0.585^a (11.95)
ITA	1970-2007	0.206 (1.04)	0.147 (0.93)	0.640^a (4.48)	0.688^a (3.89)
JPN	1980-2007	-1.897^a (-4.57)	-1.973^a (-3.96)	2.122^a (6.00)	2.123^a (6.93)
KOR	1970-2007	0.355 (1.17)	0.456 (1.41)	0.052 (0.65)	0.069 (0.73)
NLD	1980-2007	1.843^a (3.65)	1.127^a (2.86)	-0.138 (-0.64)	-0.120 (-0.44)
SWE	1993-2007	0.526^a (7.51)	0.862^a (3.34)	1.878^a (54.13)	1.803^a (35.02)
USA	1970-2007	0.634 (1.45)	0.815^b (2.24)	0.105 (0.57)	0.188 (1.00)
All sample		0.793 (8.71)	0.496^a (6.29)	0.861^a (57.12)	0.856^a (22.76)

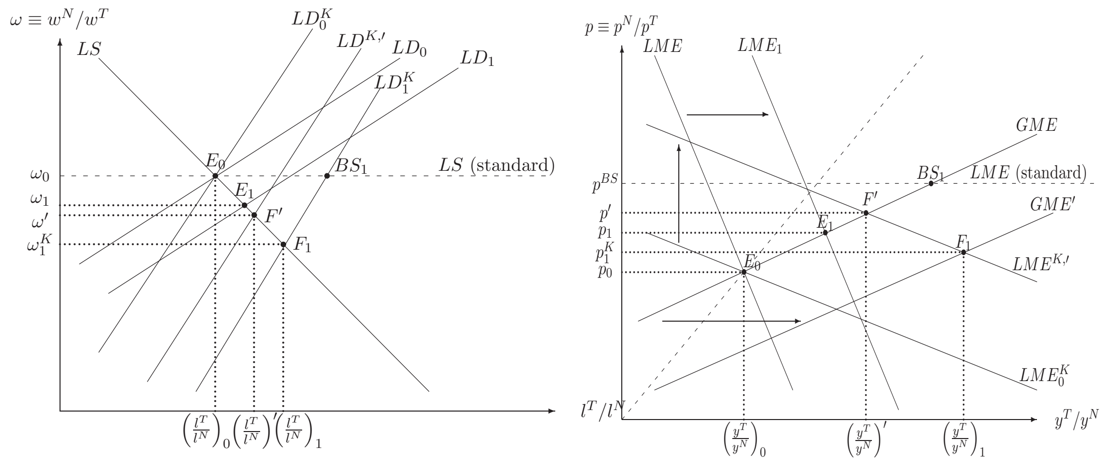
Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels. Heteroskedasticity and autocorrelation consistent t-statistics are reported in parentheses.



(a) $(l^T/l^N, \omega)$-space

(b) $(y^T/y^N, p)$-space

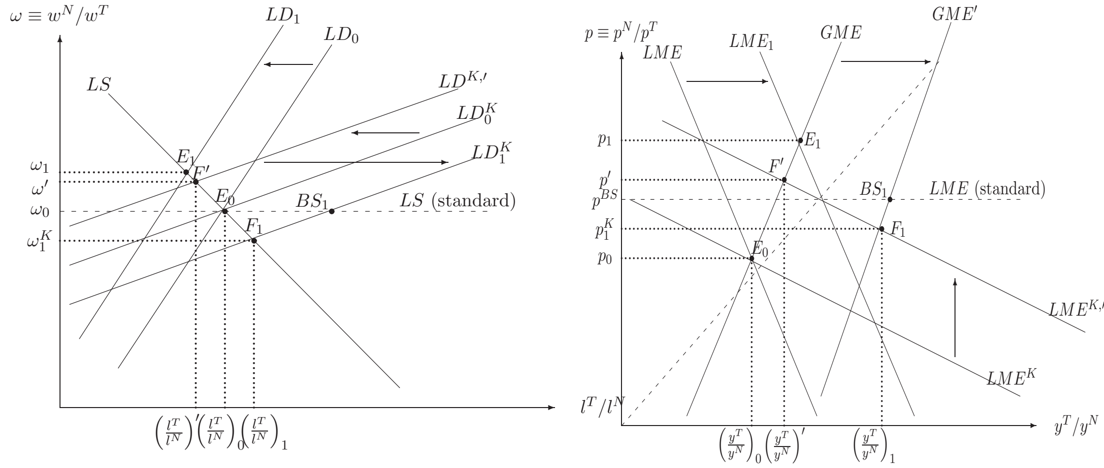
Figure 4: Relative Price and Relative Wage Effects of an Increase in A^T/A^N



(a) $(l^T/l^N, \omega)$-space

(b) $(y^T/y^N, p)$-space

Figure 5: Effects of an Increase in $Z^T/\left(Z^N\right)^{\theta^T/\theta^N}$ when $\phi > 1$



(a) $(l^T/l^N, \omega)$-space

(b) $(y^T/y^N, p)$-space

Figure 6: Effects of an Increase in $Z^T/\left(Z^N\right)^{\theta^T/\theta^N}$ when $\phi < 1$

Table 6: Long-Term Relative Price and Relative Wage Responses to a Productivity Differential between Tradables and Non Tradables (in %)

	BS	Bench	Labor supply		Mobility		$k^N > k^T$		Non sep.	Traded inv.
	$(\epsilon = \infty)$	$(\epsilon = 0.8)$	$(\sigma_L = 0.2)$	$(\sigma_L = 1)$	$(\epsilon = 0.2)$	$(\epsilon = 1.8)$	$(\epsilon = \infty)$	$(\epsilon = 0.8)$	$(\sigma = 2)$	$(\varphi_I = 0.42)$
$\underline{\phi = 1}$										
A.Relative Wage										
Relative wage, $\hat{\omega}$	0.00	-0.45	-0.47	-0.42	-0.68	-0.28	0.00	-0.41	-0.54	-0.42
Baseline effect	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital reallocation effect	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital accumulation effect	0.00	-0.45	-0.47	-0.42	-0.68	-0.28	0.00	-0.41	-0.54	-0.42
B.Relative Price										
Relative price, $\hat{p}$	1.00	0.72	0.71	0.74	0.58	0.82	1.00	0.70	0.66	0.72
Baseline effect	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Capital reallocation effect	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital accumulation effect	0.00	-0.27	-0.28	-0.25	-0.41	-0.17	0.00	-0.29	-0.33	-0.27
$\underline{\phi < 1}$										
C.Relative Wage										
Relative wage, $d\hat{\omega}$	0.00	-0.24	-0.27	-0.21	-0.32	-0.16	0.00	-0.24	-0.39	-0.22
Baseline effect	0.00	0.38	0.38	0.38	0.71	0.22	0.00	0.38	0.38	0.38
Capital reallocation effect	0.00	-0.05	-0.05	-0.05	-0.16	-0.02	0.00	-0.04	-0.05	-0.05
Capital accumulation effect	0.00	-0.57	-0.59	-0.54	-0.87	-0.35	0.00	-0.58	-0.72	-0.56
D.Relative Price										
Relative price, $\hat{p}$	1.00	0.85	0.83	0.87	0.80	0.90	1.00	0.82	0.76	0.85
Baseline effect	1.00	1.38	1.38	1.38	1.71	1.22	1.00	1.38	1.38	1.38
Capital reallocation effect	0.00	-0.18	-0.18	-0.18	-0.38	-0.10	0.00	-0.14	-0.18	-0.17
Capital accumulation effect	0.00	-0.34	-0.36	-0.32	-0.52	-0.21	0.00	-0.40	-0.43	-0.36
$\underline{\phi > 1}$										
E.Relative Wage										
Relative wage, $\hat{\omega}$	0.00	-0.58	-0.60	-0.56	-0.87	-0.37	0.00	-0.54	-0.64	-0.56
Baseline effect	0.00	-0.22	-0.22	-0.22	-0.29	-0.15	0.00	-0.22	-0.22	-0.22
Capital reallocation effect	0.00	-0.02	-0.02	-0.02	-0.04	-0.01	0.00	-0.02	-0.02	-0.02
Capital accumulation effect	0.00	-0.34	-0.36	-0.32	-0.54	-0.21	0.00	-0.31	-0.41	-0.33
F.Relative Price										
Relative price, $\hat{p}$	1.00	0.64	0.63	0.65	0.47	0.77	1.00	0.61	0.60	0.63
Baseline effect	1.00	0.78	0.78	0.78	0.71	0.85	1.00	0.78	0.78	0.78
Capital reallocation effect	0.00	0.07	0.07	0.07	0.09	0.05	0.00	0.05	0.07	0.07
Capital accumulation effect	0.00	-0.21	-0.22	-0.19	-0.32	-0.13	0.00	-0.22	-0.25	-0.21

Notes: Effects of a labor share-adjusted TFPs diffential between tradables and non tradables of 1%. Panels A and B show the deviation in percentage relative to steady-state for the relative price of non tradables $p \equiv p^N/p^T$ and the relative wage of non traded workers $\omega \equiv w^N/w^T$, respectively, and break down changes in a baseline effect (keeping unchanged sectoral capital-labor ratios k^j, the overall capital stock K and the stock of foreign bonds B), a capital reallocation effect (induced by changes in k^j keeping unchanged K and B), a capital accumulation effect (stemming from the investment boom causing a current account deficit in the short-run and therefore requiring a steady-state improvement in the balance of trade). While panels A and B show the results when setting ϕ to one, panels C and D show results for $\phi < 1$ and panels E and F show results for $\phi > 1$; ϕ is the elasticity of substitution between tradables and non tradables; ϵ captures the degree of labor mobility across sectors.

Table 7: Comparison of Predicted Values with Empirical Estimates

	Relative price growth			Relative wage growth		
	$\hat{p}^{predict}$	$\hat{p}^{FMOLS}$	$\frac{\hat{p}^{FMOLS}}{\hat{p}^{predict}}$	$\hat{\omega}^{predict}$	$\hat{\omega}^{FMOLS}$	$\frac{\hat{\omega}^{FMOLS}}{\hat{\omega}^{predict}}$
BEL	0.835	0.830	0.99	-0.342	-0.131	0.38
DEU	0.725	0.607	0.84	-0.512	-0.581	1.13
DNK	0.718	0.471	0.66	-0.523	-0.452	0.86
ESP	0.850	0.836	0.98	-0.318	-0.281	0.88
FIN	0.823	0.733	0.89	-0.360	-0.221	0.61
FRA	0.892	0.841	0.94	-0.253	-0.412	1.63
GBR	0.690	0.922	1.34	-0.567	-0.140	0.25
IRL	0.814	0.737	0.91	-0.374	-0.211	0.56
ITA	0.854	0.767	0.90	-0.313	-0.290	0.93
JPN	0.646	0.915	1.42	-0.634	-0.148	0.23
KOR	0.975	0.651	0.67	-0.125	-0.482	3.86
NLD	0.607	0.800	1.32	-0.695	-0.345	0.50
SWE	0.535	0.918	1.72	-0.807	-0.004	0.00
USA	1.027	0.820	0.80	-0.044	-0.092	2.09
All sample	0.785	0.775	0.99	-0.434	-0.271	0.62

Notes: We denote by superscripts "predict" and "FMOLS" the numerically computed values and fully modified OLS estimates taken from Table 3, respectively; when the ratio of estimates to predicted values is smaller (larger) than one, the model tends to overstate (understate) empirical findings.

A Introducing Physical Capital: The Steady-State

In section 5.3, we use a specific procedure to solve for the steady-state which allows us to break down analytically the relative wage and relative price responses to a productivity differential in three components. Below, we characterize the whole steady-state and use tilde to denote long-run values. Setting $\dot{P} = \dot{K} = \dot{B} = 0$ into (13d), (19) and (20), and inserting short-run static solutions for k^N, Y^N and Y^T, C^N and C^T derived in section 3.3 yields the following set of equations:

$$Z^N\left(1-\theta^N\right)\left[k^N\left(\tilde{K},\tilde{P},\bar{\lambda},Z^T,Z^N\right)\right]^{-\theta^N} = r^\star + \delta, \tag{51a}$$

$$Y^N\left(\tilde{K},\tilde{P},\bar{\lambda},Z^T,Z^N\right) - C^N\left(\tilde{P},\bar{\lambda}\right) - \delta\tilde{K} = 0, \tag{51b}$$

$$r^\star\tilde{B} + Y^T\left(\tilde{K},\tilde{P},\bar{\lambda},Z^T,Z^N\right) - C^T\left(\tilde{P},\bar{\lambda}\right) = 0, \tag{51c}$$

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right). \tag{51d}$$

These four equations jointly determine $\tilde{P}$, $\tilde{K}$, $\tilde{B}$ and $\bar{\lambda}$.

B Data Description for Empirical Analysis

B.1 Data Construction

Our sample consists of a panel of 14 countries (Belgium, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Sweden, the UK and the US) and covers the period 1970-2007, for eleven 1-digit ISIC-rev.3 industries. Following De Gregorio et al. [1994], Agriculture, Hunting, Forestry and Fishing; Mining and Quarrying; Total Manufacturing; Transport, Storage and Communication; and Financial Intermediation are classified as traded industries while Electricity, Gas and Water Supply; Construction; Wholesale and Retail Trade; Hotels and Restaurants; Real Estate, Renting and Business Services; and Community Social and Personal Services are treated as non traded industries. Note that following Schmillen [2011], we have updated the classification of De Gregorio et al. [1994] by treating Financial intermediation as a traded industry.

EU KLEMS database provides data on value added in current and constant prices, labor compensation and employment for each sector, permitting the construction of sectoral value-added deflators and wage rates.

In what follows, subscript i refers to country, t year and j sector ($j = T, N$). Denoting by VA^j the value-added measured at current prices and by VAV^j the value-added in volume, prices are defined as value-added deflators: $p^j_{i,t} = VA^j_{i,t}/VAV^j_{i,t}$. The price of non traded goods in terms of traded goods for country i at year t is therefore calculated as $p_{i,t} = p^N_{i,t}/p^T_{i,t}$.

Wage data for sector j are constructed by dividing labor compensation denoted by $COMP^j$ by employment in that sector, yielding the wage per worker: $w^j_{i,t} = COMP^j_{i,t}/L^j_{i,t}$.

B.2 Construction of Sectoral TFPs

Total factor productivity for sector $j = T, N$ at time t is computed by assuming a Cobb-Douglas production function with two inputs and constant returns to scale:

$$Z^j_t = Y^j_t / \left[(K^j_t)^{1-\theta^j}(L^j_t)^{\theta^j}\right], \tag{52}$$

where Z^j_t is total factor productivity (TFP), Y^j_t is value added, K^j_t is capital input, L^j_t is labor input, and θ^j corresponds to the labor share in value added in sector j. Data for the series of output, labor, and compensation of employees, are taken from EU KLEMS database. The labor share of sector j is the average over the period 1970-2007.

To construct the series for the sectoral capital stock, we proceed as follows. Since national accounts generally do not report series for the aggregate capital stock for the whole period, they were estimated from investment data using the perpetual inventory method. Data on investment at constant prices are taken from OECD's Annual National Accounts since EU KLEMS do not provide such time series.

The gross capital stock was split into traded and non traded industries using sectoral output data. Following Garofalo and Yamarik [2002], for each sector $j = T, N$, we apportion the national capital

Table 8: Panel cointegration tests results (p-values)

	wage equation eq. (2a)	price equation eq. (2b)
Panel tests		
Non-parametric ν	0.045	0.000
Non-parametric ρ	0.158	0.003
Non-parametric t	0.033	0.004
Parametric t	0.013	0.000
Group-mean tests		
Non-parametric ρ	0.429	0.173
Non-parametric t	0.053	0.026
Parametric t	0.001	0.000

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.

Table 9: Sectoral Labor Reallocation (LR) Index (1970-2007)

Country	BEL	DEU	DNK	ESP	FIN	FRA	GBR	IRL	ITA	JPN	KOR	NLD	SWE	USA	All
LR	1.04	0.99	0.47	0.81	1.12	1.13	1.03	0.49	1.23	0.76	1.69	0.34	0.61	0.47	0.87

stock by using sectoral output shares:

$$K_t^T = \varpi_t^T K_t, \qquad \text{and} \qquad K_t^N = \varpi_t^N K_t,$$

where ϖ_t^j is the share of sector j's value added in overall output at year t.

C Results for Cointegration Tests

We report the results of parametric and non parametric cointegration tests developed by Pedroni ([1999]), ([2004]). Cointegration tests are based on the estimated residuals of equations (2a) and (2b). Table 8 reports the tests of the null hypothesis of no cointegration.

D Measures of Sectoral Labor Reallocation

Table 9 presents the measure of labor mobility across sectors for the 14 countries of our sample over the period 1970-2007. The measure of labor reallocation between the traded and the non traded sectors is computed by using (5).

E Data for Calibration

Table 11 shows the non-tradable content of GDP, consumption, gross fixed capital formation, government spending, and labor and gives the share of government spending on the traded and non traded goods in the sectoral output, the shares of capital income in output in both sectors. The last two columns of Table 11 show our estimates of ϵ which captures the degree of labor mobility across sectors and ϕ the elasticity of substitution between traded and non traded goods. Our sample consists of 14 OECD countries, including 11 European countries plus the U.S., Korea and Japan. Our reference period for the calibration corresponds to the period 1990-2007. The choice of this period has been dictated by data availability.

To calculate the non-tradable share of output, employment 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 Schmillen [2011], as detailed in section B.1 (Source: EU KLEMS [2007]). The non-tradable shares of output and labor, shown in columns 2 and 3 of Table 11, average to 63% and 65%, respectively. We calculate the non-tradable share of labor compensation as $\alpha_L = W^N L^N / WL$ where WL corresponds to overall labor compensation (Source: EU KLEMS [2007]). The non-tradable share of compensation of employees, shown in column 7 of Table 11, averages to 65%.

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 [2007]). 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; Transport; Miscellaneous Goods and Services. The remaining items are treated as consumption in non traded goods: Housing, Water, Electricity, Gas and Fuels; Health; Communication; Education; Restaurants and Hotels. Because the item 'Recreation and Culture' is somewhat problematic, we decided to consider it as both tradable (50%) and non tradable (50%) with equal shares. Note that the non-tradable share of consumption shown in column 2 of Table 11 averages to 43%, in line with the share reported by Stockman and Tesar [1995].

With regard to investment, we follow the methodology proposed by Burstein et al. [2004] who treat Housing and Other Construction 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 [2008a]). Due to the lack of information, we consider the item 'Other products' as both tradable (50%) and non tradable (50%) with equal shares. For each country, the period is running from 1990 to 2007, except for Sweden (1993-2007). The series are not available for Belgium and Korea. Non tradable share of investment shown in column 4 of Table 11 averages to 58%, in line with estimates provided by Burstein et al. [2004] and Bems [2008].

Sectoral government expenditure data were obtained from the Government Finance Statistics Yearbook (Source: IMF [2007]) and the OECD General Government Accounts database (Source: OECD [2008b]). Adopting Morshed and Turnovsky's [2004] methodology, the following four sectors were treated as traded: Fuel and Energy; Agriculture, Forestry, Fishing, and Hunting; Mining, Manufacturing, and Construction; Transport and Communications. The sectors treated as non traded are: Government Public Services; Defense; Public Order and Safety; Education; Health; Social Security and Welfare; Housing and Community Amenities; Recreation Cultural and Community Affairs. The non-tradable component of government spending shown in column 5 of Table 11 averages to 90%. The proportion of government spending on the traded and non traded good (i.e., G^T/Y^T and G^N/Y^N) are shown columns 8 and 9 of Table 11. They average 5% and 28%, respectively.

The shares of labor income in output for sector j in country i denoted by θ_i^j are calculated as the ratio of labor compensation $COMP_i^j$ to value added in current prices VA_i^j (Source: EU KLEMS [2007]). The shares of labor income in output for the traded and the non traded sector (i.e. θ^T and θ^N) shown in the columns 10 and 11 of Table 11 average 0.63 and 0.68, respectively. When $k^T > k^N$, the shares of labor income average 0.61 and 0.69 for the traded and the non traded sector, respectively, while if $k^N > k^T$ θ^T and θ^N average 0.72 and 0.64.

Table 10 gives estimates for the (preference) parameter ϵ, for the whole sample and for each country, which captures the degree of labor mobility across sectors. To estimate ϵ, we follow closely Horvath [2000]. Denoting the change in percentage by a hat, we explore the following relationship empirically:

$$\hat{l}_{i,t}^j - \hat{L}_{i,t} = f_i + t_t + \gamma_i \hat{\beta}_{i,t}^j + \nu_{i,t}^j, \tag{53}$$

where $\nu_{i,t}^j$ is an i.i.d. error term, $\gamma_i = \frac{\epsilon_i}{\epsilon_i+1}$, $\hat{l}_{i,t}^j - \hat{L}_{i,t}$ is the worker inflow in sector j of country i at time t due to sectoral labor reallocation, $\beta_{i,t}^j = \frac{W_{i,t}^j L_{i,t}^j}{\sum_{j=1}^M W_{i,t}^j L_{i,t}^j}$ is the ratio of labor compensation of sector j in overall labor compensation of country i at year t when considering M sectors. Country fixed effects are captured by country dummies, f_i and common macroeconomic shocks by year dummies t_t. Building on our panel data estimations, we calculate ϵ_i by computing $\frac{\gamma_i}{1-\gamma_i}$.

We allow for the coefficient γ_i to vary across countries which enables us to estimate ϵ for each country of our sample. Data are taken from EU KLEMS [2007] and data construction are described above. All values are statistically significant at 10%, except Denmark. We have also run the regression (53) over the period 1972-1989 and 1990-2000, respectively. The results for these two sub-periods are shown in the two last columns of Table 10. Column 12 of Table 11 reports estimates when running the regression over the period 1972-2007.

The last column of Table 11 gives estimates of the elasticity of substitution ϕ between traded and non traded goods by running the regression (32) with a time trend. Our dataset covers the fourteen OECD countries of our sample while the period varies across countries. Column 13 of Table 11 reports

Table 10: Panel Data Estimates of eq. (53)

	1972-2007	1972-1989	1990-2007
	$\hat{\epsilon}_i$	$\hat{\epsilon}_i$	$\hat{\epsilon}_i$
BEL	0.305^b (2.18)	0.316 (1.63)	0.293 (1.42)
DEU	0.607^a (2.58)	0.399 (1.49)	0.818^b (2.03)
DNK	0.115 (1.06)	0.129 (0.89)	0.097 (0.59)
ESP	1.648^a (2.70)	4.878 (0.95)	1.067^b (2.29)
FIN	0.509^a (3.19)	0.845^b (2.16)	0.361^b (2.16)
FRA	1.256^b (2.18)	1.256 (1.60)	1.259 (1.46)
GBR	0.936^a (3.42)	0.593^a (2.63)	2.530 (1.54)
IRL	0.242^a (2.71)	0.031 (0.31)	0.417^a (2.81)
ITA	0.733^a (2.57)	0.816^b (2.01)	0.626 (1.56)
JPN	0.998^b (2.55)	1.025^c (1.95)	0.964 (1.63)
KOR	1.795^a (3.15)	3.175^c (1.64)	1.235^b (2.52)
NLD	0.213^c (1.71)	0.106 (0.85)	0.556 (1.48)
SWE	0.402^a (3.10)	0.316^b (2.05)	0.520^b (2.30)
USA	1.791^b (1.98)	1.568 (1.45)	2.053 (1.33)
All sample	0.587^a (10.59)	0.529^a (7.07)	0.651^a (7.46)
Observations	1 050	548	502
Countries	14	14	14

Notes: Fixed effects (country) regressions. ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels. T-statistics are reported in parentheses.

the Fully Modified OLS estimates for ϕ. Since our estimate of ϕ for the Netherlands is negative, we replace its inconsistent value with the fully modified OLS estimate of 1.13 (see Table 5) obtained when running the regression (32) with the (log) GDP per capita instead of the time trend.

Table 11: Data to Calibrate the Two-Sector Model (1990-2007)

Countries	Non tradable Share						G^j/Y^j		Labor Share		Mobility	Substitutability
	Output	Consumption	Investment	Gov. Spending	Labor	Lab. comp.	G^T/Y^T	G^N/Y^N	θ^T	θ^N	ϵ	ϕ
BEL	0.65	0.42	n.a.	0.91	0.68	0.66	0.06	0.30	0.61	0.63	0.30	0.57
DEU	0.65	0.40	0.59	0.91	0.65	0.60	0.05	0.27	0.75	0.63	0.61	1.11
DNK	0.66	0.42	0.53	0.94	0.68	0.68	0.05	0.36	0.63	0.70	0.12	0.73
ESP	0.64	0.46	0.64	0.88	0.66	0.67	0.06	0.24	0.60	0.66	1.65	1.16
FIN	0.58	0.43	0.65	0.89	0.63	0.63	0.06	0.34	0.59	0.73	0.51	0.69
FRA	0.70	0.40	0.61	0.94	0.69	0.68	0.05	0.31	0.70	0.64	1.26	0.74
GBR	0.64	0.40	0.55	0.93	0.70	0.65	0.04	0.29	0.70	0.73	0.94	1.67
IRL	0.52	0.43	0.67	0.89	0.62	0.62	0.04	0.26	0.46	0.69	0.24	0.59
ITA	0.64	0.38	0.52	0.91	0.63	0.62	0.05	0.28	0.71	0.64	0.73	0.69
JPN	0.63	0.43	0.56	0.86	0.64	0.65	0.06	0.22	0.55	0.60	1.00	2.12
KOR	0.52	0.44	n.a.	0.76	0.58	0.56	0.06	0.18	0.73	0.83	1.80	0.07
NLD	0.65	0.40	0.59	0.90	0.70	0.69	0.07	0.32	0.60	0.70	0.21	1.13
SWE	0.64	0.45	0.48	0.92	0.68	0.67	0.06	0.39	0.63	0.71	0.40	1.80
USA	0.68	0.51	0.57	0.90	0.73	0.69	0.05	0.21	0.61	0.66	1.79	0.19
Mean	0.63	0.43	0.58	0.90	0.65	0.65	0.05	0.28	0.63	0.68	0.82	0.93

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 output of sector $j = T, N$; ϵ captures the degree of labor mobility across sectors; ϕ is the intratemporal elasticity of substitution between traded goods and non traded goods.

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IMPERFECT MOBILITY OF LABOR ACROSS SECTORS: A REAPPRAISAL OF THE BALASSA-SAMUELSON EFFECT

TECHNICAL APPENDIX

NOT MEANT FOR PUBLICATION

Olivier CARDI and Romain RESTOUT

Table 12: Panel unit root tests results (second generation)

	Bai and Ng [2002]				
	$\hat{r}$	$Z_{\hat{e}}^c$	$P_{\hat{e}}^c$	MQ_c	MQ_f
p	2	0.797 (0.21)	33.967 (0.20)	2	2
ω	3	0.434 (0.33)	31.246 (0.31)	3	3
$(z^T - (\theta_T/\theta_N)z^N)$	2	1.351 (0.09)	38.112 (0.10)	2	2
$[p - (z^T - (\theta_T/\theta_N)z^N)]$	2	−0.548 (0.71)	23.900 (0.69)	2	2

	Choi [2001]			Pesaran [2007]		Chang [2002]
	P_m	Z	$L^\star$	$CIPS$	$CIPS^\star$	S_N
p	−3.111 (0.99)	4.657 (1.00)	4.594 (1.00)	−2.041 (0.18)	−2.041 (0.18)	10.000 (1.00)
ω	3.993 (0.00)	−3.015 (0.00)	−3.313 (0.00)	−2.299 (0.06)	−2.299 (0.06)	6.896 (1.00)
$(z^T - (\theta_T/\theta_N)z^N)$	−3.033 (1.00)	4.608 (1.00)	4.525 (1.00)	−1.758 (0.51)	−1.758 (0.51)	11.619 (1.00)
$[p - (z^T - (\theta_T/\theta_N)z^N)]$	1.001 (0.16)	−0.629 (0.26)	−0.577 (0.28)	−2.161 (0.09)	−2.161 (0.09)	5.744 (1.00)

Notes: $\hat{r}$ is the estimated number of common factors. For the idiosyncratic components, $P_{\hat{e}}^c$ is a Fisher's type statistic based on p-values of the individual ADF tests. Under H_0, $P_{\hat{e}}^c$ has a χ^2 distribution. $Z_{\hat{e}}^c$ is the standardized Choi's type statistic. Under H_0, $Z_{\hat{e}}^c$ has a $N(0,1)$ distribution. For the idiosyncratic components, the estimated number of independent stochastic trends in the common factors is reported. The first estimated value is derived from the filtered test MQ_c and the second one is derived from the corrected test MQ_f. The P_m test is a modified Fisher's inverse chi-square test. The Z test is an inverse normal test. The $L^\star$ test is a modified logit test. All these three statistics have a standard normal distribution under H_0. $CIPS$ is the mean of individual Cross sectionally ADF statistics (CADF). $CIPS^\star$ denotes the mean of truncated individual CADF statistics. The S_N statistic corresponds to the average of individual non-linear IV t-ratio statistics. It has a $N(0,1)$ distribution under H_0. Corresponding p-values are in parentheses.

A Empirical results

A.1 Robustness Check for Panel Unit Root Tests

The common feature of these first generation tests is the restriction that all cross-sections are independent. However, it is well-known that this cross-unit independence assumption is quite restrictive in many empirical applications. So, we also consider some second generation unit root tests that allow cross-unit dependencies. We consider the tests developed by: i) Bai and Ng [2002] based on a dynamic factor model, ii) Choi [2001] based on an error-component model, iii) Pesaran [2007] based on a dynamic factor model and iv) Chang [2002] who proposes the instrumental variable nonlinear test. The results of second generation unit root tests are shown in Table 12.

In all cases, except for the Choi's [2001] test applied to the relative wage variable (ω), we fail to reject the presence of a unit root in the relative price, the relative wage, the productivity differential, and the difference $\big(p - (a^T/a^N)\big)$, when cross-unit dependencies are taken into account.

A.2 Robustness Check for Cointegration Tests

To begin with, we report the results of parametric and non parametric cointegration tests developed by Pedroni ([1999]), ([2004]). Cointegration tests are based on the estimated residuals of equations (2a) and (2b). Table 13 reports the tests of the null hypothesis of no cointegration. All Panel tests reject the null hypothesis of no cointegration between p and $a^T - a^N$ at the 1% significance level while three Panel tests reject the null hypothesis of no cointegration between ω and $a^T - a^N$ at the 5% significance level. Group-mean t-test confirm cointegration between p and labor share-adjusted productivity differential and between ω and $z^T - \frac{\theta^T}{\theta^N} z^N$ at the 5% and 10% significance level, respectively. This is strong evidence in favor of cointegration between the relative price and relative productivity. Pedroni [2004] explores finite sample performances of the seven statistics. The results reveal that group-mean parametric t-test is more powerful than other tests in finite samples. While the results are somewhat less pervasive for the relative wage equation, group-mean parametric t-test indicate that we cannot reject the null hypothesis of no cointegration for both the relative price and the relative wage equations.

As robustness checks, we compare our group-mean FMOLS estimates and group-mean DOLS estimates with one lag ($q = 1$), with alternative estimators. First, we consider the group-mean DOLS

Table 13: Panel cointegration tests results (p-values)

	wage equation eq. (2a)	price equation eq. (2b)
Panel tests		
Non-parametric ν	0.045	0.000
Non-parametric ρ	0.158	0.003
Non-parametric t	0.033	0.004
Parametric t	0.013	0.000
Group-mean tests		
Non-parametric ρ	0.429	0.173
Non-parametric t	0.053	0.026
Parametric t	0.001	0.000

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.

Table 14: DOLS estimators

	wage equation	price equation		
Estimator	$\hat{\beta}$	$\hat{\gamma}$	$t(\hat{\beta}=0)$	$t(\hat{\gamma}=1)$
DOLS ($q=1$)	-0.270^a (−21.30)	0.779^a (95.22)	0.000	0.000
DOLS ($q=2$)	-0.269^a (−21.13)	0.782^a (100.57)	0.000	0.000
DOLS ($q=3$)	-0.265^a (−21.23)	0.782^a (100.64)	0.000	0.000
DFE	-0.178^a (−3.40)	0.802^a (25.72)	0.001	0.000
MG	-0.217^a (−8.09)	0.760^a (34.98)	0.000	0.000
PMG	-0.019 (−0.76)	0.846^a (52.45)	0.386	0.000
Panel DOLS ($q=1$)	-0.311^a (−7.66)	0.757^a (30.60)	0.000	0.000
Panel DOLS ($q=2$)	-0.312^a (−7.96)	0.755^a (32.76)	0.000	0.000
Panel DOLS ($q=3$)	-0.309^a (−8.27)	0.754^a (34.33)	0.000	0.000

Notes: ^{a}, ^{b} and ^{c} denote significance at 1%, 5% and 10% levels. Heteroskedasticity and autocorrelation consistent t-statistics are reported in parentheses. The last two columns report the p-value of the test of $H_0 : \hat{\beta} = 0$ and $H_0 : \hat{\gamma} = 1$.

estimator with 2 lags ($q = 2$) and 3 lags ($q = 3$). Second, we estimate cointegration relationships (2a) and (2b) using the panel DOLS estimator (Mark and Sul [2003]). We also use alternative econometric techniques to estimate cointegrating relationships (2): the dynamic fixed effects estimator (DFE), the mean group estimator (MG, Pesaran and Smith [1995]), the pooled mean group estimator (PMG, Pesaran et al. [1999]). All results are displayed in Table 14 and show that estimates of $\hat{\beta}$ and $\hat{\gamma}$ are close to those shown in Table 8 of the paper, except for the pooled mean group estimator.

B A Two-Sector Model with Imperfect Mobility of Labor across Sectors

This Appendix presents the formal analysis underlying the results discussed in section 4.

B.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:

$$C\left(C^T, C^N\right) = \left[\varphi^{\frac{1}{\phi}} \left(C^T\right)^{\frac{\phi-1}{\phi}} + (1-\varphi)^{\frac{1}{\phi}} \left(C^N\right)^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}}, \tag{54}$$

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:

$$L\left(L^T, L^N\right) = \left[\vartheta^{-\frac{1}{\epsilon}} \left(L^T\right)^{\frac{\epsilon+1}{\epsilon}} + (1-\vartheta)^{-\frac{1}{\epsilon}} \left(L^N\right)^{\frac{\epsilon+1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon+1}}, \tag{55}$$

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:

$$U = \int_0^\infty \left\{ \frac{1}{1-\frac{1}{\sigma_C}} C(t)^{1-\frac{1}{\sigma_C}} - \gamma \frac{1}{1+\frac{1}{\sigma_L}} L(t)^{1+\frac{1}{\sigma_L}} \right\} e^{-\beta t} \mathrm{d}t, \tag{56}$$

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.

Labor income is derived by supplying labor in the traded sector L^T and non traded sector L^N at a wage rate W^T and W^N, respectively. In addition, households accumulate internationally traded bonds, $B(t)$, that yield net interest rate earnings of $r^\star B(t)$. The flow budget constraint is equal to households' income less consumption expenditure:

$$\dot{B} = r^\star B + W^T L^T + W^N L^N - C^T - PC^N. \tag{57}$$

The current-value for the household's optimization problem is (dropping the time index for the purposes of clarity):

$$\mathcal{H} = U\left[C\left(C^T, C^N\right)\right] + V\left[L\left(L_T, L_N\right)\right] + \lambda\left(r^\star B + W^T L^T + W^N L^N - C^T - PC^N\right),$$

where B is the state variable, λ is the corresponding co-state variable, and C^T, C^N, L^T and L^N are control variables. The first-order conditions are:

$$C^{-\frac{1}{\sigma_C}} \varphi^{\frac{1}{\phi}} \left(C^T\right)^{-\frac{1}{\phi}} C^{\phi} = \lambda, \tag{58a}$$

$$C^{-\frac{1}{\sigma_C}} (1-\varphi)^{\frac{1}{\phi}} \left(C^N\right)^{-\frac{1}{\phi}} C^{\phi} = \lambda P, \tag{58b}$$

$$\gamma L^{\frac{1}{\sigma_L}} \vartheta^{-\frac{1}{\epsilon}} \left(L^T\right)^{\frac{1}{\epsilon}} L^{-\frac{1}{\epsilon}} = \lambda W^T, \tag{58c}$$

$$\gamma L^{\frac{1}{\sigma_L}} (1-\vartheta))^{-\frac{1}{\epsilon}} \left(L^N\right)^{\frac{1}{\epsilon}} L^{-\frac{1}{\epsilon}} = \lambda W^N, \tag{58d}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right), \tag{58e}$$

and the transversality condition $\lim_{t\to\infty} \lambda B(t) e^{-\beta t} = 0$.

Combining (58a) and (58b) yields:

$$\left(\frac{\varphi}{1-\varphi}\right) \frac{C^N}{C^T} = P^{-\phi}. \tag{59}$$

Eq. (59) corresponds to **eq. (14) in the text**.

Combining (58c) and (58d) yields:

$$\left(\frac{\vartheta}{1-\vartheta}\right) \frac{L^N}{L^T} = \omega^{\epsilon}. \tag{60}$$

Eq. (60) corresponds to **eq. (15) in the text**.

Consumption Price Index

The traded and the consumption good are aggregated by means of a CES function given by (54) 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:

$$E_C \equiv C^T + PC^N. \tag{61}$$

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:

$$P_C\left(P(t)\right)C(t) = \min_{\{C^T(t),C^N(t)\}} \left\{C^T(t) + P(t)C^N(t) : C\left(C^T(t), C^N(t)\right) \geq C(t)\right\}. \tag{62}$$

The subutility function $C\,(.)$ is linear homogeneous which implies that total expenditure in consumption goods can be expressed as $E_C(t) = P_C\left(P(t)\right)C(t)$, with $P_C\left(P(t)\right)$ 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

$$P_C = \left[\varphi + (1-\varphi)\,P^{1-\phi}\right]^{\frac{1}{1-\phi}}. \tag{63}$$

The minimized unit cost function depends on relative price of non tradables with the following properties:

$$P'_C = (1-\varphi)\,P^{-\phi}\left(P_C\right)^{\phi} > 0, \tag{64a}$$

$$-\frac{P''_C P}{P'_C} = \phi\left[1 - \frac{(1-\varphi)\,P^{1-\phi}}{P_C^{1-\phi}}\right] = \phi\left(1-\alpha_C\right). \tag{64b}$$

Intra-temporal allocations between non tradable goods and tradable goods follow from Shephard's Lemma (or the envelope theorem) applied to (62):

$$C^N = P'_C C = (1-\varphi)\left(\frac{P}{P_C}\right)^{-\phi} C, \quad \text{and} \quad \frac{PC^N}{P_C C} = \alpha_C, \tag{65a}$$

$$C^T = \left[P_C - PP'_C\right]C = \varphi\left(\frac{1}{P_C}\right)^{-\phi} C, \quad \text{and} \quad \frac{C^T}{P_C C} = (1-\alpha_C), \tag{65b}$$

where the non tradable and tradable shares in total consumption expenditure are:

$$\alpha_C = \frac{(1-\varphi)\,P^{1-\phi}}{\varphi + (1-\varphi)\,P^{1-\phi}},, \tag{66a}$$

$$1-\alpha_C = \frac{\varphi}{\varphi + (1-\varphi)\,P^{1-\phi}}. \tag{66b}$$

Aggregate Wage Index

The representative household maximizes $1 - L(.)$ where $L(.)$ is a CES function given by (55) with $\epsilon > 0$ the intratemporal elasticity of substitution between labor in the traded and non traded sector, given total labor income denoted by R measured in terms of the traded good:

$$R \equiv W^T L^T + W^N L^N \tag{67}$$

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 $R = W\left(W^T, W^N\right)L$, 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, 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 (60) together with total labor income denoted by R measured in terms of the traded good, i.e. $R \equiv W^T L^T + W^N L^N$, we are able to express labor supply in the traded and non traded sector, respectively, as functions of total labor income:

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

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

Plugging these equations into (55), setting $L = 1$ and $R = W$, yields the aggregate wage index:

$$W = \left[\vartheta \left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]^{\frac{1}{\epsilon+1}}. \tag{68}$$

Intra-temporal allocation of hours worked between the traded and the non traded sector follow from Shephard's Lemma (or the envelope theorem):

$$L^T = \frac{\partial W}{\partial W^T} L = W_T L, \quad \text{and} \quad \frac{W^T L}{WL} = 1 - \alpha_L, \tag{69a}$$

$$L^N = \frac{\partial W}{\partial W^N} L = W_N L, \quad \text{and} \quad \frac{W^N L}{WL} = \alpha_L, \tag{69b}$$

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

$$\alpha_L = \frac{(1-\vartheta)\left(W^N\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]},, \tag{70a}$$

$$1 - \alpha_L = \frac{\vartheta\left(W^T\right)^{\epsilon+1}}{\left[\vartheta\left(W^T\right)^{\epsilon+1} + (1-\vartheta)\left(W^N\right)^{\epsilon+1}\right]}. \tag{70b}$$

Alternative Way to Solve for the Household's Maximization Problem

The representative household maximizes lifetime utility (56) subject to the budget constraint:

$$\dot{B}(t) = r^\star B(t) + W\left(W^T(t), W^N(t)\right) L(t) - P_C\left(P(t)\right) C(t). \tag{71}$$

Denoting the co-state variable associated with (71) by λ, the first-order conditions characterizing the representative household's optimal plans are:

$$C = \left(P_C \lambda\right)^{-\sigma_C}, \tag{72a}$$

$$L = \left(\frac{W\lambda}{\gamma}\right)^{\sigma_L}, \tag{72b}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right), \tag{72c}$$

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 $C(.)$ allows a two-stage consumption decision: in the first stage, consumption is determined, and the intratemporal allocation between traded and non-traded goods is decided at the second stage. Applying Shephard's lemma gives $C^T = (1-\alpha_C) P_C C$ and $PC^N = \alpha_C P_C C$, with α_C being the share of non-traded goods in the consumption expenditure. Dividing expenditure on traded goods by expenditure on non traded goods, we find:

$$\frac{C^T}{PC^N} = \frac{(1-\alpha_C) P_C C}{\alpha_C P_C C}, \quad \text{or} \quad \left(\frac{1-\varphi}{\varphi}\right)\frac{C^T}{C^N} = P^\phi. \tag{73}$$

Applying the same logic to the labor supply decision gives the tradable content of labor income $W^T L^T = (1-\alpha_L) WL$ and the non tradable content of total labor income $W^N L^N = \alpha_L WL$. Dividing labor income in the traded sector by labor income in the non traded sector, we find:

$$\frac{W^T L^T}{W^N L^N} = \frac{(1-\alpha_L) WL}{\alpha_L WL}, \quad \text{or} \quad \left(\frac{1-\vartheta}{\vartheta}\right)\frac{L^T}{L^N} = \left(\frac{W^T}{W^N}\right)^{\epsilon}. \tag{74}$$

We write out some useful properties:

$$\begin{aligned}
\frac{\partial W}{\partial W^T}\frac{W^T}{W} &= (1-\alpha_L)\,, \quad \frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L, && \text{(75a)}\\
\frac{\partial W_T}{\partial W^T} &= \frac{\partial^2 W}{\partial \left(W^T\right)^2} = \vartheta\epsilon \left(W^T\right)^{\epsilon-1} W^{-\epsilon}\alpha_L, && \text{(75b)}\\
\frac{\partial W_T}{\partial W^T}\frac{W^T}{W_T} &= \epsilon\alpha_L > 0, && \text{(75c)}\\
\frac{\partial W_T}{\partial W^N}\frac{W^N}{W_T} &= -\epsilon\alpha_L < 0, && \text{(75d)}\\
\frac{\partial W_N}{\partial W^N}\frac{W^N}{W} &= \epsilon\left(1-\alpha_L\right) > 0, && \text{(75e)}\\
\frac{\partial W_N}{\partial W^T}\frac{W^T}{W} &= -\epsilon\left(1-\alpha_L\right) < 0, && \text{(75f)}
\end{aligned}$$

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

B.2 Firms

Both the traded and non-traded sectors use labor, L^T and L^N, according to linearly homogenous production functions, $Y^T = A^T L^T$ and $Y^N = A^N L^N$. 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:

$$A^T = W^T, \quad \text{and} \quad PA^N = W^N \tag{76}$$

Dividing the second equality by the first equality yields

$$P = \Omega\frac{A^T}{A^N}. \tag{77}$$

Eq. (77) corresponds to **eq. (23) in the text**.

B.3 Solving the Model

Model Closure

Abstracting from capital accumulation and government spending, the market-clearing condition in the non traded good market requires that non traded output Y^N is equalized with consumption C^N:

$$C^N = Y^N. \tag{78}$$

Eq. (78) corresponds to **eq. (24) in the text**.

Inserting (76) and plugging (78) into the accumulation equation of foreign bonds (71) yields the market clearing condition for the traded good or the current account dynamic equation:

$$\dot{B} = r^\star B + Y^T - C^T. \tag{79}$$

Short-Run Static Solutions for Consumption and Labor

In this subsection, we compute short-run static solutions for consumption and labor supply. Static efficiency conditions (72a) and (72b) can be solved for consumption and labor which of course must hold at any point of time:

$$C = C\left(\bar{\lambda}, P\right), \quad L = L\left(\bar{\lambda}, W^T, W^N\right), \tag{80}$$

with

$$\begin{aligned}
C_{\bar{\lambda}} &= \frac{\partial C}{\partial \bar{\lambda}} = -\sigma_C\frac{C}{\bar{\lambda}} < 0, && \text{(81a)}\\
C_P &= \frac{\partial C}{\partial P} = -\alpha_C\sigma_C\frac{C}{P} < 0, && \text{(81b)}\\
L_{\bar{\lambda}} &= \frac{\partial L}{\partial \bar{\lambda}} = \sigma_L\frac{L}{\bar{\lambda}} > 0, && \text{(81c)}\\
L_{W^T} &= \frac{\partial L}{\partial W^T} = \sigma_L L\frac{(1-\alpha_L)}{W^T} > 0, && \text{(81d)}\\
L_{W^N} &= \frac{\partial L}{\partial W^N} = \sigma_L L\frac{\alpha_L}{W^N} > 0, && \text{(81e)}
\end{aligned}$$

where we used the fact that $\frac{\partial W}{\partial W^T}\frac{W^T}{W} = (1-\alpha_L)$ and $\frac{\partial W}{\partial W^N}\frac{W^N}{W} = \alpha_L$ (see (75)); 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 (80), (65) can be solved for C^T and C^N:

$$C^T = C^T\left(\bar{\lambda}, P\right), \quad C^N = C^N\left(\bar{\lambda}, P\right), \tag{82}$$

where partial derivatives are

$$C^T_{\bar{\lambda}} = -\sigma_C \frac{C^T}{\bar{\lambda}} < 0, \tag{83a}$$
$$C^T_P = \alpha_C \frac{C^T}{P}\left(\phi - \sigma_C\right) \lesseqgtr 0, \tag{83b}$$
$$C^N_{\bar{\lambda}} = -\sigma_C \frac{C^N}{\bar{\lambda}} < 0, \tag{83c}$$
$$C^N_P = -\frac{C^N}{P}\left[\left(1-\alpha_C\right)\phi + \alpha_C\sigma_C\right] < 0, \tag{83d}$$

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 (80), 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:

$$L^T = L^T\left(\bar{\lambda}, W^T, W^N\right), \quad L^N = L^N\left(\bar{\lambda}, W^T, W^N\right), \tag{84}$$

where partial derivatives are

$$L^T_{\bar{\lambda}} = \frac{\partial L^T}{\partial \bar{\lambda}} = \sigma_L \frac{L^T}{\bar{\lambda}} > 0, \tag{85a}$$
$$L^T_{W^T} = \frac{\partial L^T}{\partial W^T} = \frac{L^T}{W^T}\left[\epsilon\alpha_L + \sigma_L\left(1-\alpha_L\right)\right] > 0, \tag{85b}$$
$$L^T_{W^N} = \frac{\partial L^T}{\partial W^N} = \frac{L^T}{W^N}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, \tag{85c}$$
$$L^N_{\bar{\lambda}} = \frac{\partial L^N}{\partial \bar{\lambda}} = \sigma_L \frac{L^N}{\bar{\lambda}} > 0, \tag{85d}$$
$$L^N_{W^N} = \frac{\partial L^N}{\partial W^N} = \frac{L^N}{W^N}\left[\epsilon\left(1-\alpha_L\right) + \sigma_L\alpha_L\right] > 0, \tag{85e}$$
$$L^N_{W^T} = \frac{\partial L^N}{\partial W^T} = \frac{L^N}{W^T}\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \gtrless 0, \tag{85f}$$
$$\tag{85g}$$

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 (76) can be solved for the sectoral wages:

$$W^T = W^T\left(A^T\right), \quad W^N = W^N\left(A^N, P\right), \tag{86}$$

where partial derivatives are:

$$W^T_{A^T} = \frac{\partial W^T}{\partial A^T} = 1, \tag{87a}$$
$$W^N_{A^N} = \frac{\partial W^N}{\partial A^N} = P, \tag{87b}$$
$$W^N_P = \frac{\partial W^N}{\partial P} = A^N > 0. \tag{87c}$$

Inserting (86) into (84) yields:

$$L^T = L^T\left(\bar{\lambda}, A^T, A^N, P\right), \quad L^N = L^N\left(\bar{\lambda}, A^T, A^N, P\right), \tag{88}$$

where partial derivatives are

$$
\begin{aligned}
L^T_{A^T} &= \frac{\partial L^T}{\partial A^T} = L^T_{W^T} = \frac{L^T}{W^T}\left[\epsilon\alpha_L + \sigma_L\left(1-\alpha_L\right)\right] > 0, && \text{(89a)}\\
L^T_{A^N} &= \frac{\partial L^T}{\partial A^N} = L^T_{W^N} P = P\frac{L^T}{W^N}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, && \text{(89b)}\\
L^T_{P} &= \frac{\partial L^T}{\partial P} = L^T_{W^N} A^N = A^N\frac{L^T}{W^N}\alpha_L\left(\sigma_L - \epsilon\right) \gtrless 0, && \text{(89c)}\\
L^N_{A^T} &= \frac{\partial L^N}{\partial A^T} = L^N_{W^T} = \frac{L^N}{W^T}\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \gtrless 0, && \text{(89d)}\\
L^N_{A^N} &= \frac{\partial L^N}{\partial A^N} = L^N_{W^T} = \frac{L^N}{W^T}\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \gtrless 0, && \text{(89e)}\\
L^N_{P} &= \frac{\partial L^N}{\partial P} = L^N_{W^N} A^N = A^N\frac{L^N}{W^N}\left[\epsilon\left(1-\alpha_L\right) + \sigma_L\alpha_L\right] > 0, && \text{(89f)}\\
& && \text{(89g)}
\end{aligned}
$$

and $L^T_{\bar{\lambda}}$ and $L^N_{\bar{\lambda}}$ are given by (85a) and (85d), respectively.

B.4 Equilibrium Dynamics

Inserting the short-run static solutions for labor in the non-traded sector and consumption in non-tradables given by (88) and (82) into the non traded good market clearing condition (78), and linearizing around the steady-state implies that the dynamics for the relative price of non tradables degenerate, i.e. $P(t) = \tilde{P}$.

Inserting the short-run static solutions for labor in the traded sector and consumption in tradables given by (88) and (82) into the accumulation equation of foreign bonds (79) and linearizing around the steady-state yields:

$$\dot{B}(t) = r^\star\left(B(t) - \tilde{B}\right). \tag{90}$$

Solving and invoking the transversality condition $\lim_{t\to\infty} \lambda B(t) e^{-r^\star t} = 0$ yields:

$$B(t) = B_0. \tag{91}$$

Hence, for the transversality condition to hold, the stock of traded bonds $B(t)$ must be equal to its initial predetermined level. Combining (91) with (79) yields:

$$r^\star B_0 + Y^T = C^T. \tag{92}$$

Eq. (92) corresponds to **eq. (25) in the text**. Because the stock of foreign bonds must stick to its initial value, for the sake of simplicity and without loss of generality, we set $B_0 = 0$.

B.5 The Equilibrium

The equilibrium is defined by the following set of equations:

$$
\begin{aligned}
\left(\frac{1-\varphi}{\varphi}\right)\frac{C^T}{C^N} &= P^\phi, && \text{(93a)}\\
\left(\frac{\vartheta}{1-\vartheta}\right)\frac{L^T}{L^N} &= \Omega^{-\epsilon} && \text{(93b)}\\
P &= \Omega\frac{A^T}{A^N}, && \text{(93c)}\\
\frac{A^T L^T}{A^N L^N} &= \frac{C^T}{C^N}, && \text{(93d)}
\end{aligned}
$$

where $\Omega \equiv W^N/W^T$ is the non traded wage-traded wage ratio or the relative wage. Combining the market clearing conditions in the traded and the non traded sectors given by (92) and (78), respectively, yields (93d) which states that relative supply of tradables must be equal to relative demand of tradables.

Substituting the relative supply of labor in the traded sector given by (60) and demand of tradables in terms of non traded goods given by (59) yields:

$$\frac{A^T}{A^N}\left(\frac{\vartheta}{1-\vartheta}\right)\tilde{\Omega}^{-\epsilon} = \left(\frac{\varphi}{1-\varphi}\right)P^\phi.$$

Using (77) to eliminate the relative wage Ω, the equation can be solved for the relative price of non tradables:

$$P = \Gamma \left(\frac{A^T}{A^N}\right)^{\frac{\epsilon+1}{\epsilon+\phi}}, \quad \Gamma \equiv \left[\left(\frac{\vartheta}{1-\vartheta}\right)\left(\frac{\varphi}{1-\varphi}\right)\right]^{\frac{1}{\epsilon+\phi}} > 0 \tag{94}$$

Denoting by a hat the percentage deviation relative to initial steady-state, (94) can be rewritten as:

$$\hat{p} = (\epsilon+1)\,\Theta^L\left(\hat{a}^T - \hat{a}^N\right), \quad \Theta^L = \frac{1}{\epsilon+\phi}. \tag{95}$$

Eq. (95) corresponds to **eq. (31) in the text**.

Plugging (77) into (94) allows us to solve for the relative wage:

$$\Omega = \Gamma \left(\frac{A^T}{A^N}\right)^{-\frac{\phi-1}{\epsilon+\phi}}, \quad \Gamma \equiv \left[\left(\frac{\vartheta}{1-\vartheta}\right)\left(\frac{\varphi}{1-\varphi}\right)\right]^{\frac{1}{\epsilon+\phi}} > 0 \tag{96}$$

Taking logarithm and differentiating (96) yields:

$$\hat{\omega} = -(\phi-1)\,\Theta^L\left(\hat{a}^T - \hat{a}^N\right), \quad \Theta^L = \left(\frac{1}{\epsilon+\phi}\right). \tag{97}$$

Eq. (97) corresponds to **eq. (30) in the text**.

B.6 Graphical Apparatus

To build 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 model can be summarized graphically by Figure 4(b) that traces out two schedules in the $(y^T/y^N, p)$-space. System (93a)-(93d) which is described below can be reduced to two equations. Substituting (93a) into eq. (93d) yields the goods market equilibrium (henceforth labelled GME) schedule:

$$\left.\frac{y^T}{y^N}\right|^{GME} = \phi p + x, \tag{98}$$

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-non traded output ratio. 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 (93b) into (93c) to eliminate ω yields the labor market equilibrium (LME) schedule:

$$\left.\frac{y^T}{y^N}\right|^{LME} = -\epsilon p + (1+\epsilon)\,\frac{a^T}{a^N}. \tag{99}$$

A rise in the relative price p raises the relative wage ω which induces agents to supply more labor in the non traded sector, and more so if ϵ is larger (i.e., agents are more willing to move across sectors). 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. ϵ tends to infinity, wages between traded and non traded sectors are equalized. Graphically, the LME-schedule becomes an horizontal line. Conversely, as labor mobility becomes more costly, i.e. ϵ is smaller, the LME-schedule becomes steeper in the $(y^T/y^N, p)$-space.

For a given relative price of non tradables, a rise in relative productivity a^T/a^N shifts to the right the LME-schedule by raising traded output relative to non traded output. Since the supply of traded goods is increased, the price of non traded goods in terms of traded goods p must rise, and less so as the elasticity of substitution ϕ between C^T and C^N is larger.

Further, the more costly (in utility terms) labor mobility is, i.e., the smaller ϵ, the less agents are willing to move from the traded towards the non traded good. Graphically, the LME-schedule shifts to the right by a smaller amount.

Labor Demand- and Labor Supply- Schedules

The labor market is summarized graphically in Figure 4(a). Eq. (93b) describes the labor supply-schedule (LS henceforth) in the $(l^T/l^N, \omega)$-space. Taking logarithm yields:

$$\left.\frac{l^T}{l^N}\right|^{LS} = -\epsilon\omega + d, \tag{100}$$

where $d = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. 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 $-1/\epsilon$. Eq. (100) corresponds to **eq. (28) in the text**.

Substituting demand for traded goods in terms of non traded goods (93a) into the market clearing condition given by (93d) yields:

$$\frac{\tilde{Y}^T}{\tilde{Y}^N} = \left(\frac{\varphi}{1-\varphi}\right) P^{\phi}. \tag{101}$$

Substituting first-order conditions from the firms' maximization problem given by (77) and using production functions, i.e. $L^T = Y^T/A^T$ and $L^N = Y^N/A^N$, we get:

$$\frac{\tilde{L}^T}{\tilde{L}^N} = \left(\frac{\varphi}{1-\varphi}\right)\left(\frac{A^T}{A^N}\right)^{\phi-1}\tilde{\omega}^{\phi}.$$

Taking logarithm yields the labor demand-schedule (LD henceforth) in the $(l^T/l^N, \omega)$-space is given by

$$\left.\frac{l^T}{l^N}\right|^{LD} = \phi\omega + (\phi-1)\frac{a^T}{a^N} + x, \tag{102}$$

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, the non traded sector sets higher prices which induces 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 $1/\phi$. Eq. (102) corresponds to **eq. (29) in the text**.

Using (100) to eliminate ω and differentiating (102), the change in the ratio l^T/l^N is given by:

$$\left(\widehat{\frac{l^T}{l^N}}\right) = \frac{\epsilon(\phi-1)}{(\epsilon+\phi)}\left(\hat{a}^T - \hat{a}^N\right). \tag{103}$$

Hence, depending on whether $\phi \gtrless 1$, a rise in the sectoral labor productivities ratio a^T/a^N raises or lowers l^T/l^N.

C Introducing Physical Capital Accumulation

This Appendix presents the formal analysis underlying the results discussed in section 3 and section 5.

C.1 Consumer's Maximization Problem

The representative household chooses consumption, decides on labor supply, and investment that maximizes his/her lifetime utility (56) subject to the flow budget constraint:

$$\dot{B}(t) = r^\star B(t) + R(t)K(t) + W\left(W^T(t), W^N(t)\right)L(t) - P_C\left(P(t)\right)C(t) - P(t)I(t), \tag{104}$$

and capital accumulation which evolves as follows:

$$\dot{K}(t) = I(t) - \delta K(t), \tag{105}$$

where I corresponds to investment expenditure and $0 \leq \delta_K < 1$ is a fixed depreciation rate.

Denoting the co-state variables associated with (104) and (105) by λ and ψ, respectively, the first-order conditions characterizing the representative household's optimal plans are:

$$C = \left(P_C\lambda\right)^{\sigma_C}, \tag{106a}$$

$$L = \left(\frac{W\lambda}{\gamma}\right)^{\sigma_L}, \tag{106b}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right), \tag{106c}$$

$$\frac{R}{P} - \delta + \frac{\dot{P}}{P} = r^\star, \tag{106d}$$

and the transversality conditions $\lim_{t\to\infty} \bar{\lambda} B(t) e^{-\beta t} = 0$ and $\lim_{t\to\infty} P(t) K(t) e^{-\beta t} = 0$; to derive (106d), we used the fact that $\psi(t) = \lambda P(t)$.

Eqs. (106a) and (106b) can be solved for consumption and labor:

$$C = C\left(\bar{\lambda}, P\right), \quad L = L\left(\bar{\lambda}, W^T, W^N\right), \tag{107}$$

where partial derivatives are given by (81).

C.2 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 have the usual neoclassical properties of positive and diminishing marginal products. 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.

Denoting by $k^i \equiv K^i/L^i$ the capital-labor ratio for sector $i = T, N$, enables us to express the production functions in intensive form, i.e. $f\left(k^T\right) \equiv F\left(K^T, L^T\right)/L^T$ and $h\left(k^N\right) \equiv H\left(K^N, L^N\right)/L^N$. Production functions are supposed to take a Cobb-Douglas form: $f\left(k^T\right) = \left(k^T\right)^{1-\theta^T}$, and $h\left(k^N\right) = \left(k^N\right)^{1-\theta^N}$, where θ^T and θ^N represent the capital income share in output in the traded and non-traded sectors respectively. 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:

$$Z^T\left(1-\theta^T\right)\left(k^T\right)^{-\theta^T} = P Z^N\left(1-\theta^N\right)\left(k^N\right)^{-\theta^N} \equiv R, \tag{108a}$$

$$Z^T \theta^T \left(k^T\right)^{1-\theta^T} \equiv W^T, \tag{108b}$$

$$P Z^N \theta^N \left(k^N\right)^{1-\theta^N} \equiv W^N. \tag{108c}$$

These static efficiency conditions state that the sectoral marginal products must equal the labor cost W^j and capital rental rate R.

The resource constraint for capital is:

$$k^T L^T + k^N L^N = K. \tag{109}$$

C.3 Solving the Model

Before providing details of derivation, we find convenient to describe the procedure to solve the model.

Short-Run Static Solutions

Eqs. (106a)-(106b) can be solved for consumption $C = C\left(\bar{\lambda}, P\right)$ with $C_{\bar{\lambda}} < 0$, $C_P < 0$, and for labor $L = L\left(\bar{\lambda}, W^T, W^N\right)$ with $L_{\bar{\lambda}} > 0$, $L_{W^T} > 0$ and $L_{W^N} > 0$. 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 raise hours worked.

Using the fact that consumption in non tradables and tradables are given by $C^N = \frac{\partial P_C(P)}{\partial P} C$ and $C^T = \left(P_C - P P_C'\right) C$ and inserting the short-run static solution for consumption yields: $C^N = C^N\left(\bar{\lambda}, P\right)$ with $C^N_{\bar{\lambda}} < 0$ and $C^N_P < 0$, and $C^T = C^T\left(\bar{\lambda}, P\right)$ with $C^T_{\bar{\lambda}} < 0$ and $C^T_P \gtrless 0$ (depending on whether $\phi \gtrless \sigma_C$).

Using the fact that hours worked in the traded and the non traded sector are given by $L^T = \frac{\partial W(W^T, W^N)}{\partial W^T} L$ and $L^N = \frac{\partial W(W^T, W^N)}{\partial W^N} L$, respectively, and inserting the short-run static solution for labor yields: $L^T = L^T\left(\bar{\lambda}, W^T, W^N\right)$ with $L^T_{\bar{\lambda}} > 0$, $L^T_{W^T} > 0$, $L^T_{W^N} \lesseqgtr 0$, and $L^N = L^N\left(\bar{\lambda}, W^T, W^N\right)$ with $L^N_{\bar{\lambda}} > 0$, $L^N_{W^N} > 0$, $L^N_{W^T} \lesseqgtr 0$. 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 of $(1-\alpha_L)$, workers are induced to supply more labor in the non traded sector. On the other hand, if the cost of shifting is not too high, i.e. if ϵ is not too small, workers are induced to reallocate hours worked towards 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, into the resource constraint for capital (109), (108a)-(108c) and (109) can be solved for the sectoral capital-labor ratio $k^j = k^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$ and the sectoral wage $W^j = W^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$ (with $j = T, N$). Inserting short-run static solutions for sectoral capital-labor ratios and sectoral labor into production functions (16) allows us to solve for sectoral output: $Y^j = Y^j\left(\bar{\lambda}, K, P, Z^T, Z^N\right)$. As in a model assuming perfect labor mobility, an increase in Z^j stimulates output of sector j. A rise in the relative price of non tradables P exerts opposite effects on sectoral outputs by shifting resources away from the traded sector towards the non traded output. Unlike the standard BS model, an increase in $\bar{\lambda}$ (in K) raises Y^T and Y^N as well, regardless of sectoral capital intensities, by raising labor (k^j) in both sectors as long as ϵ is not too large.

Solving for Sectoral Wage Rates and Sectoral Capital-Labor Ratios

Plugging the short-run static solutions for L^T and L^N given by (84) into the resource constraint for capital (109), the system of four equations comprising (108a)-(108c) and (109) can be solved for the sectoral wage rates and sectoral capital labor ratios. Log-differentiating (108a)-(108c) and (109) yields in matrix form:

$$\begin{pmatrix} -\theta^T & \theta^N & 0 & 0 \\ \left(1-\theta^T\right) & 0 & -1 & 0 \\ 0 & \left(1-\theta^N\right) & 0 & -1 \\ (1-\xi) & \xi & \Psi_{W^T} & \Psi_{W^N} \end{pmatrix} \begin{pmatrix} \hat{k}^T \\ \hat{k}^N \\ \hat{W}^T \\ \hat{W}^N \end{pmatrix} = \begin{pmatrix} \hat{P} + \hat{Z}^N - \hat{Z}^T \\ -\hat{Z}^T \\ -\hat{P} - \hat{Z}^N \\ \hat{K} - \Psi_{\bar{\lambda}}\hat{\bar{\lambda}} \end{pmatrix}. \tag{110}$$

where we set:

$$\Psi_{W^T} = (1-\xi)\frac{L^T_{W^T}W^T}{L^T} + \xi\frac{L^N_{W^T}W^T}{L^N}, \tag{111a}$$

$$\Psi_{W^N} = (1-\xi)\frac{L^T_{W^N}W^N}{L^T} + \xi\frac{L^N_{W^N}W^N}{L^N}, \tag{111b}$$

$$\xi \equiv \frac{k^N L^N}{K}. \tag{111c}$$

(111d)

$$\Psi_{\bar{\lambda}} = (1-\xi)\sigma_L + \xi\sigma_L. \tag{111e}$$

The determinant is:

$$G \equiv -\left\{\theta^T\left[\left(1-\theta^N\right)\Psi_{W^N} + \xi\right] + \theta^N\left[\left(1-\theta^N\right)\Psi_{W^T} + (1-\xi)\right]\right\} \lesseqgtr 0, \tag{112}$$

where

$$\Psi_{W^T} = (1-\xi)\epsilon + (1-\alpha_L)(\sigma_L - \epsilon), \tag{113a}$$

$$\Psi_{W^N} = \xi\epsilon + \alpha_L(\sigma_L - \epsilon), \tag{113b}$$

$$\Psi_{W^T} + \Psi_{W^N} = \sigma_L. \tag{113c}$$

Because the sign of $\sigma_L - \epsilon$ is ambiguous, we cannot sign G; while for the baseline calibration, we have $\sigma_L < \epsilon$, because the discrepancy is small, we find convenient to assume $\sigma_L = \epsilon$ 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 purpose, when discussion the results, we assume that $\sigma_L \simeq \epsilon$ so that determinant G is negative.

Sectoral wages can be solved as follows:

$$W^T = W^T\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad W^N = W^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{114}$$

with

$$\frac{\hat{W}^T}{\hat{K}} = -\frac{\left(1-\theta^T\right)\theta^N}{G} > 0, \tag{115a}$$

$$\frac{\hat{W}^N}{\hat{K}} = -\frac{\left(1-\theta^N\right)\theta^T}{G} > 0, \tag{115b}$$

$$\frac{\hat{W}^T}{\hat{P}} = \frac{\left(1-\theta^T\right)\left(\Psi_{W^N}+\xi\right)}{G} < 0, \tag{115c}$$

$$\frac{\hat{W}^N}{\hat{P}} = -\frac{\left\{\theta^T\xi + \theta^N\left(1-\xi\right) + +\theta^N\left(1-\theta^T\right)\Psi_{W^T}\right\}}{G} > 0, \tag{115d}$$

and sectoral capital labor ratios:

$$k^T = k^T\left(\lambda, K, P, Z^T, Z^N\right), \quad k^N = k^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{116}$$

with

$$\frac{\hat{k}^T}{\hat{K}} = -\frac{\theta^N}{G} > 0, \tag{117a}$$

$$\frac{\hat{k}^N}{\hat{K}} = -\frac{\theta^T}{G} > 0, \tag{117b}$$

$$\frac{\hat{k}^T}{\hat{P}} = \frac{\Psi_{W^N}+\xi}{G} < 0, \tag{117c}$$

$$\frac{\hat{k}^N}{\hat{P}} = \frac{\left\{\theta^T\Psi_{W^N} - \left[\left(1-\theta^T\right)\Psi_{W^T} + \left(1-\xi\right)\right]\right\}}{G} > 0, \tag{117d}$$

$$\tag{117e}$$

Partial derivatives of short-run static solutions for sectoral capital-labor ratios are: $k^j_{\bar{\lambda}} < 0$ and $k^j_K > 0$ (with $j = T, N$), $k^N_P \gtrless 0$ and $k^T_P < 0$, $k^N_{Z^T} < 0$ and $k^T_{Z^T} > 0$, $k^N_{Z^N} > 0$ and $k^T_{Z^N} < 0$. Partial derivatives of short-run static solutions for sectoral wage rates are: $W^j_{\bar{\lambda}} < 0$ and $W^j_K > 0$ (with $j = T, N$), $W^N_P > 0$ and $W^T_P > 0$, $W^N_{Z^T} < 0$ and $W^T_{Z^T} > 0$, $W^N_{Z^N} > 0$ and $W^T_{Z^N} < 0$.[65] An increase in the capital stock K raises capital-labor ratios and thereby wage rates in both sectors. A rise in λ induces agents to supply more labor which reduces 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 in 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. As in the standard model, k^N increases or decrease as P appreciates depending on whether $k^T \gtrless k^T$. But the difficulty of reallocating labor across sectors, reduces the possibility to shift labor across sectors which moderates changes in sectoral capital-labor ratios. When ϵ is small, an appreciation in P may result in a decline in k^T.[66]

Solving for Sectoral Labor and Output

Inserting sectoral wages (114) into (84) allows us to solve for sectoral labor:

$$L^T = L^T\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad L^N = L^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right). \tag{118}$$

where

$$\frac{\hat{L}^T}{\hat{K}} = -\left\{\frac{\sigma_L\left(1-\theta^T\right)\theta^N + \alpha_L\left(\sigma_L-\epsilon\right)\left(\theta^T-\theta^N\right)}{G}\right\} \gtrless 0, \tag{119a}$$

$$\frac{\hat{L}^N}{\hat{K}} = -\left\{\frac{\sigma_L\left(1-\theta^N\right)\theta^T + \left(1-\alpha_L\right)\left(\sigma_L-\epsilon\right)\left(\theta^N-\theta^T\right)}{G}\right\} \gtrless 0, \tag{119b}$$

$$\frac{\hat{L}^T}{\hat{P}} = \frac{\sigma_L\left(1-\theta^T\right)\left(\Psi_{W^N}+\xi\right) - \alpha_L\left(\sigma_L-\epsilon\right)\left[\xi + \theta^N\left(1-\xi\right) + \left(1-\theta^T\right)\left(\Psi_{W^N} + \theta^N\Psi_{W^T}\right)\right]}{G} \tag{119c}$$

$$\frac{\hat{L}^N}{\hat{P}} = \sigma_L\frac{\hat{W}^N}{\hat{P}} + \frac{\left(1-\alpha_L\right)\left(\sigma_L-\epsilon\right)\left[\xi + \theta^N\left(1-\xi\right) + \left(1-\theta^T\right)\left(\Psi_{W^N} + \theta^N\Psi_{W^T}\right)\right]}{G} \gtrless 0. \tag{119d}$$

[65] We do not discuss the effects of Z^j (with $j = T, N$) since the interpretation is straightforward.

[66] The reason is that the traded sector experiences a substantial outflow of capital since it is costless to reallocate capital. When workers are reluctant to shift hours worked across sectors, the capital outflow is large enough to reduce k^T.

Substituting short-run static solutions for sectoral capital-labor ratios (116) and sectoral labor (118) into the production function of the traded and non traded sectors (16) yields:

$$Y^T = Y^T\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad Y^N = Y^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right). \tag{120}$$

where

$$\begin{aligned}
\frac{\hat{Y}^T}{\hat{K}} &= \frac{\hat{L}^T}{\hat{K}} + \left(1-\theta^T\right)\frac{\hat{k}^T}{\hat{K}} = -\left\{\frac{(\sigma_L+1)\left(1-\theta^T\right)\theta^N + \alpha_L\left(\sigma_L-\epsilon\right)\left(\theta^T-\theta^N\right)}{G}\right\} \gtrless 0, &\text{(121a)}\\
\frac{\hat{Y}^N}{\hat{K}} &= \frac{\hat{L}^N}{\hat{K}} + \left(1-\theta^N\right)\frac{\hat{k}^N}{\hat{K}} = -\left\{\frac{(\sigma_L+1)\left(1-\theta^N\right)\theta^T + (1-\alpha_L)\left(\sigma_L-\epsilon\right)\left(\theta^N-\theta^T\right)}{G}\right\} \gtrless 0, &\text{(121b)}\\
\frac{\hat{Y}^T}{\hat{P}} &= \frac{\hat{L}^T}{\hat{P}} + \left(1-\theta^T\right)\frac{\hat{k}^T}{\hat{P}}\\
&= \frac{(\sigma_L+1)\left(1-\theta^T\right)\left(\Psi_{W^N}+\xi\right) - \alpha_L\left(\sigma_L-\epsilon\right)\left[\xi+\theta^N\left(1-\xi\right)+\left(1-\theta^T\right)\left(\Psi_{W^N}+\theta^N\Psi_{W^T}\right)\right]}{G} \gtrless 0, &\text{(121c)}\\
\frac{\hat{Y}^N}{\hat{P}} &= \frac{\hat{L}^N}{\hat{P}} + \left(1-\theta^N\right)\frac{\hat{k}^N}{\hat{P}} \gtrless 0. &\text{(121d)}
\end{aligned}$$

C.4 Equilibrium Dynamics

Inserting the short-run static solutions (120), (116) and (82) into the physical capital accumulation equation (19) and the dynamic equation for the relative price of non tradables (106d), the dynamic system is:

$$\begin{aligned}
\dot{K} &= Y^N\left(K, P, \bar{\lambda}\right) - C^N\left(\bar{\lambda}, P\right) - \delta K, &\text{(122a)}\\
\dot{P} &= P\left[r^\star + \delta - Z^N h_k\left(K, P, \bar{\lambda}\right)\right], &\text{(122b)}
\end{aligned}$$

where for the purposes of clarity, we abstract from time-constant arguments of short-run static solutions, i.e., $\bar{\lambda}$, Z^T, and Z^N.

Denoting with a tilde long-run values, linearizing these two equations around the steady-state yields in matrix form:

$$\begin{pmatrix} \dot{K}(t) \\ \dot{P}(t) \end{pmatrix} = \begin{pmatrix} \left(Y_K^N - \delta\right) & \left(Y_P^N - C_P^N\right) \\ -\tilde{P}Z^N h_{kk}k_K^N & -\tilde{P}Z^N h_{kk}k_P^N \end{pmatrix} \begin{pmatrix} K(t) - \tilde{K} \\ P(t) - \tilde{P} \end{pmatrix}. \tag{123}$$

After some manipulations, we find that the trace of the Jacobian matrix denoted by Tr J is:

$$\left(Y_K^N - \delta\right) - \tilde{P}Z^N h_{kk}k_P^N = r^\star > 0, \tag{124}$$

where we used the fact that $\frac{Y^N}{K} = \frac{Z^N \xi h_k}{1-\theta^N}$ and $PZ^N h_{kk}k_P^N = Z^N h_k \theta^N \frac{k_P^N \tilde{P}}{k^N}$.

The determinant of the Jacobian matrix denoted by Det J is:

$$\left(Y_P^N - C_P^N\right)\tilde{P}Z^N h_{kk}k_K^N - \left(Y_K^N - \delta\right)\tilde{P}Z^N h_{kk}k_P^N. \tag{125}$$

Saddle-path stability requires that (125) is negative. For all parametrization and irrespective of the relative capital intensities, this inequality holds. The stable solution becomes thus:

$$\begin{aligned}
K(t) &= \tilde{K} + \left(K_0 - \tilde{K}\right)e^{\mu_1 t}, &\text{(126a)}\\
P(t) &= \tilde{P} + \omega_2^1\left(K_0 - \tilde{K}\right)e^{\mu_1 t}, &\text{(126b)}
\end{aligned}$$

where K_0 is the initial capital stock and $\left(1, \omega_2^1\right)'$ is the eigenvector associated with the stable negative eigenvalue μ_1:

$$\omega_2^1 = \frac{\mu_1 - \left(Y_K^N - \delta\right)}{\left(Y_P^N - C_P^N\right)} \tag{127}$$

For all plausible sets of parameter values, we find numerically $\omega_2^1 < 0$, regardless of sectoral capital intensities, which implies that the relative price of nontradables is negatively correlated with investment along the stable transitional path.

Substituting the short-run static solutions (120), (82) into the accumulation equation of foreign bonds (20), linearizing, solving and invoking the transversality condition yields the stable solution for the stock of foreign bonds:

$$B(t) = \tilde{B} + \Phi(K_0 - \tilde{K})e^{\mu_1 t}, \tag{128}$$

where $\Phi = \left[Y_K^T + \left(Y_P^T - C_P^T\right)\omega_2^1\right] / (\mu_1 - r^\star)$ is found to be negative numerically.

Finally, the intertemporal solvency condition of the economy is:

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right), \tag{129}$$

where B_0 is the initial stock of traded bonds.

C.5 The Steady-State

We now characterize the steady-state and use tilde to denote long-run values. Setting $\dot{P} = \dot{K} = \dot{B} = 0$ into (106d), (122a) and (20) yields the following set of equations:

$$Z^N\left(1-\theta^N\right)\left[k^N\left(\tilde{K}, \tilde{P}, \bar{\lambda}, Z^T, Z^N\right)\right]^{-\theta^N} = r^\star + \delta, \tag{130a}$$

$$Y^N\left(\tilde{K}, \tilde{P}, \bar{\lambda}, Z^T, Z^N\right) - C^N\left(\tilde{P}, \bar{\lambda}\right) - \delta\tilde{K} = 0, \tag{130b}$$

$$r^\star\tilde{B} + Y^T\left(\tilde{K}, \tilde{P}, \bar{\lambda}, Z^T, Z^N\right) - C^T\left(\tilde{P}, \bar{\lambda}\right) = 0, \tag{130c}$$

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right). \tag{130d}$$

These four equations jointly determine $\tilde{P}$, $\tilde{K}$, $\tilde{B}$ and $\bar{\lambda}$.

C.6 Graphical Apparatus

To build intuition regarding steady-state changes, we investigate graphically the long-run effects of a rise in the the ratio of sectoral productivity. To do so, it is convenient to rewrite the steady-state as follows:

$$\frac{\tilde{C}^T}{\tilde{C}^N} = \frac{\varphi}{1-\varphi}\tilde{P}^\phi, \tag{131a}$$

$$\frac{\tilde{L}^T}{\tilde{L}^N} = \frac{\vartheta}{1-\vartheta}\tilde{\omega}^{-\epsilon}, \tag{131b}$$

$$\frac{\tilde{Y}^T\left(1+\upsilon_B\right)}{\tilde{Y}^N\left(1-\upsilon_I\right)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{131c}$$

$$Z^N\left(1-\theta^N\right)\left(\tilde{k}^N\right)^{-\theta^N} \equiv r^\star + \delta, \tag{131d}$$

$$Z^T\left(1-\theta^T\right)\left(\tilde{k}^T\right)^{-\theta^T} = \tilde{P}Z^N\left(1-\theta^N\right)\left(\tilde{k}^N\right)^{-\theta^N} \equiv \tilde{R}, \tag{131e}$$

$$Z^T\theta^T\left(\tilde{k}^T\right)^{1-\theta^T} \equiv \tilde{W}^T, \tag{131f}$$

$$PZ^N\theta^N\left(\tilde{k}^N\right)^{1-\theta^N} \equiv \tilde{W}^N, \tag{131g}$$

where $\tilde{\omega} = \tilde{W}^N/\tilde{W}^T$ is the steady-state relative wage and $\tilde{R}/\tilde{P} = r^\star + \delta$. We denote by $\upsilon_I \equiv \frac{\delta\tilde{K}}{\tilde{Y}^N}$ the ratio of investment to non traded output and by $\upsilon_B \equiv \frac{r^\star\tilde{B}}{\tilde{Y}^T}$ the ratio of interest receipts to traded output. Remembering that $\tilde{Y}^T = Z^T\tilde{L}^T\left(\tilde{k}^T\right)^{1-\theta^T}$ and $\tilde{Y}^N = Z^N\tilde{L}^N\left(\tilde{k}^N\right)^{1-\theta^N}$, the system (131) can be solved for $\tilde{C}^T/\tilde{C}^N$, $\tilde{L}^T/\tilde{L}^N$, $\tilde{k}^T$, $\tilde{k}^N$, $\tilde{W}^T$, $\tilde{W}^N$ and $\tilde{P}$ as functions of $Z^T, Z^N, \left(\frac{1-\upsilon_I}{1+\upsilon_B}\right)$. Then substituting these functions into $\tilde{Y}^N = \tilde{C}^N + \tilde{I}$, $\tilde{K} = \tilde{k}^T\tilde{L}^T + \tilde{k}^N\tilde{L}^N$ and $\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right)$ and substituting short-run static solutions for L^T and L^N (see eq. (84)) which obviously hold at the steady-state, the system can be solved for $\tilde{K}$, $\tilde{B}$ and $\bar{\lambda}$ as functions of Z^T and Z^N. Hence, when solving the system (131), we assume that the aggregate capital stock, foreign bonds and the marginal utility of wealth are exogenous which allows us to separate the static reallocations (or intratemporal) effects from the dynamic (or intertemporal) effects.

Before breaking down the three channels analytically, 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 effects, the tilde is suppressed for the purposes of clarity. The steady state can be described by considering alternatively the labor market or the goods market.

To begin with, we characterize the goods market equilibrium. The steady state can be summarized graphically in Figure 5(b) if $\phi > 1$ and Figure 6(b) if $\phi < 1$. Each figure traces out two schedules in the $(y^T/y^N, p)$-space which are derived below. System (131) which is described below can be reduced to two equations.

Combining (131a) and the market clearing condition (131c) yields:

$$\frac{C^T}{C^N} = \frac{\varphi}{1-\varphi} P^{\phi} = \frac{Y^T + r^\star B}{Y^N - \delta K}, \tag{132}$$

The ratio of traded output to non traded output is:

$$\frac{Y^T}{Y^N} = \frac{(1-\upsilon_I)}{(1+\upsilon_B)} \frac{\varphi}{1-\varphi} P^{\phi}. \tag{133}$$

Taking logarithm yields:

$$\left.\frac{y^T}{y^N}\right|^{GME} = \phi p + x', \tag{134}$$

where $x' = \ln\left(\frac{\varphi}{1-\varphi}\right) + \ln\left(\frac{1-\upsilon_I}{1+\upsilon_B}\right)$. Eq. (134) corresponds to **eq. (36) in the text**.

According to (134), as in the model without capital, 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 $1/\phi$.

Combining (131b) with the steady-state relative wage given by (131f)-(131g), and using the production functions for the traded sector and non traded sectors which imply $\tilde{L}^T = \frac{\tilde{Y}^T}{Z^T\left(\tilde{k}^T\right)^{1-\theta^T}}$ and $\tilde{L}^N = \frac{\tilde{Y}^N}{Z^N\left(\tilde{k}^N\right)^{1-\theta^N}}$, yields:

$$\frac{Y^T}{Y^N} = \frac{\vartheta}{1-\vartheta} \left(\frac{Z^T}{Z^N}\right)^{\epsilon+1} P^{-\epsilon} \left(\frac{\theta^T}{\theta^N}\right)^{\epsilon} \left[\frac{\left(k^T\right)^{1-\theta^T}}{\left(k^N\right)^{1-\theta^N}}\right]^{1+\epsilon}.$$

To eliminate the sectoral capital-labor ratios, we use (131d)-(131e):

$$\frac{\left(k^T\right)^{1-\theta^T}}{\left(k^N\right)^{1-\theta^N}} = P^{-\frac{1-\theta^T}{\theta^T}} \left(r^\star + \delta\right)^{\frac{1-\theta^N}{\theta^N} - \frac{1-\theta^T}{\theta^T}} \frac{\left(Z^T\right)^{\frac{1-\theta^T}{\theta^T}}}{\left(Z^N\right)^{\frac{1-\theta^N}{\theta^N}}} \frac{\left(1-\theta^T\right)^{\frac{1-\theta^T}{\theta^T}}}{\left(1-\theta^N\right)^{\frac{1-\theta^N}{\theta^N}}}.$$

Using the equation above, we have:

$$\frac{Y^T}{Y^N} = P^{-\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]} \frac{\left(Z^T\right)^{\frac{1+\epsilon}{\theta^T}}}{\left(Z^N\right)^{\frac{1+\epsilon}{\theta^N}}} \tilde{\Pi}', \tag{135}$$

where we set

$$\tilde{\Pi}' = \frac{\vartheta}{1-\vartheta} \left(r^\star + \delta\right)^{\left(\frac{\theta^T - \theta^N}{\theta^T \theta^N}\right)(1+\epsilon)} \frac{\left[\left(\theta^T\right)^{\epsilon\theta^T} \left(1-\theta^T\right)^{\left(1-\theta^T\right)(1+\epsilon)}\right]^{1/\theta^T}}{\left[\left(\theta^N\right)^{\epsilon\theta^N} \left(1-\theta^N\right)^{\left(1-\theta^N\right)(1+\epsilon)}\right]^{1/\theta^N}} > 0. \tag{136}$$

Taking logarithm, (135) can be rewritten as follows:

$$\left.\frac{y^T}{y^N}\right|^{LME} = -\left[\epsilon + \left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right] p + \left(\frac{1+\epsilon}{\theta^T}\right) z_T - \left(\frac{1+\epsilon}{\theta^N}\right) z_N + \pi', \tag{137}$$

where $\pi' = \ln \Pi'$. Eq. (137) corresponds to **eq. (37) in the text**.

If $\theta^T = 1$, (137) reduces to (99). If $\theta^T < 1$, the LME-schedule (labelled LME^K in Figures 5(b) and 6(b)) 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 induced to shift hours worked from the traded sector to the non traded sector. As a consequence, 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.

To sum up, the slope of the GME-schedule remains unchanged while the LME-schedule is flatter than that in a model without capital. Higher productivity in tradables relative to non tradables produces a shift to the right the LME-schedule. The relative price of non tradables rises more or increases less than in a model abstracting from physical capital depending on whether $\phi > 1$ or $\phi < 1$.

C.7 The Labor Market

In this subsection, we investigate graphically the long-run effects of a rise in the sectoral productivity ratio A^T/A^N on labor market variables.

Applying logarithm to (131b) yields the labor supply-schedule (henceforth LS-schedule):

$$\left.\frac{l^T}{l^N}\right|^{LS} = -\epsilon \ln \omega + d, \tag{138}$$

where $d = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. Eq. (138) corresponds to **eq. (28) in the text**.

According to (138), 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. Dividing (131g) by (131f) yields:

$$\frac{PZ^N\theta^N\left(\tilde{k}^N\right)^{1-\theta^N}}{Z^T\theta^T\left(\tilde{k}^T\right)^{1-\theta^T}} = \Omega. \tag{139}$$

To eliminate the sectoral capital-labor ratios, we use eqs. (131d)-(131e), i.e.

$$\frac{\left(k^N\right)^{1-\theta^N}}{\left(k^T\right)^{1-\theta^T}} = P^{\frac{1-\theta^T}{\theta^T}}\left(r^\star+\delta\right)^{\frac{1-\theta^T}{\theta^T}-\frac{1-\theta^N}{\theta^N}}\frac{\left[Z^N\left(1-\theta^N\right)\right]^{\frac{1-\theta^N}{\theta^N}}}{\left[Z^T\left(1-\theta^T\right)\right]^{\frac{1-\theta^T}{\theta^T}}}. \tag{140}$$

To eliminate the relative price of non tradables, we combine the market-clearing condition (131c) and the demand for tradables in terms of non traded goods (131a) together with production functions (16):

$$P = \left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B}{1-\upsilon_I}\frac{Z^TL^T\left(k^T\right)^{1-\theta^T}}{Z^NL^N\left(k^N\right)^{1-\theta^N}}\right]^{\frac{1}{\phi}}. \tag{141}$$

Substituting (141) into (140) yields:

$$\begin{aligned}\frac{\left(\tilde{k}^N\right)^{1-\theta^N}}{\left(\tilde{k}^T\right)^{1-\theta^T}} &= \left(r^\star+\delta\right)^{\frac{\phi\left(\theta^N-\theta^T\right)}{\theta^N\left[1+\theta^T(\phi-1)\right]}}\left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B}{1-\upsilon_I}\frac{\tilde{L}^T}{\tilde{L}^N}\right]^{\frac{\left(1-\theta^T\right)}{\left[1+\theta^T(\phi-1)\right]}} \\ &\times\left[\frac{\left(1-\theta^N\right)^{\frac{\left(1-\theta^N\right)\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{\frac{\phi}{\left[1+\theta^T(\phi-1)\right]}}\frac{\left(Z^N\right)^{\frac{\left[\left(1-\theta^N\right)\theta^T\phi-\left(1-\theta^T\right)\theta^N\right]}{\theta^N\left[1+\theta^T(\phi-1)\right]}}}{\left(Z^T\right)^{\frac{\left(1-\theta^T\right)(\phi-1)}{\left[1+\theta^T(\phi-1)\right]}}}.\end{aligned} \tag{142}$$

Substituting first (141) into (139) and then plugging (142) allows us to relate relative labor demand to the relative wage:

$$\frac{L^T}{L^N}\frac{\left(Z^N\right)^{\frac{(\phi-1)\theta^T}{\theta^N}}}{\left(Z^T\right)^{(\phi-1)}}\Theta=\omega^{\left[1+\theta^T(\phi-1)\right]}. \tag{143}$$

where we set

$$\Theta=\left(r^\star+\delta\right)^{\frac{\left(\theta^N-\theta^T\right)(\phi-1)}{\theta^N}}\left(\frac{1-\varphi}{\varphi}\right)\left(\frac{1+\upsilon_B}{1-\upsilon_I}\right)\left(\frac{\theta^N}{\theta^T}\right)^{\left[1+\theta^T(\phi-1)\right]}\left[\frac{\left(1-\theta^N\right)^{\left(1-\theta^N\right)\frac{\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{(\phi-1)}. \tag{144}$$

Applying logarithm to (143) yields the labor demand-schedule (henceforth LD-schedule):

$$\left.\frac{l^T}{l^N}\right|^{LD}=\left[1+\theta^T(\phi-1)\right]\omega+(\phi-1)\left(z^T-\frac{\theta^T}{\theta^N}z^N\right)-\ln\Theta. \tag{145}$$

Eq. (145) corresponds to **eq. (35) in the text**.

Eq. (145) states that, as in a model abstracting from physical capital, the LD-schedule is upward-sloping in the $(l^T/l^N,\omega)$-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 (labelled LD^K in Figures 5(a) and 6(a)) 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.

C.8 The Relative Price and Relative Wage Effects

In this subsection, we first derive the long-run responses of the relative price of non tradables to a productivity differential between tradables and non tradables by assuming perfect substitutability of hours worked across sectors and then we derive steady-state changes of the relative price and relative wage when there is imperfect substitutability of hours worked.

Perfect Mobility of Labor across Sectors: $\epsilon\to\infty$

First-order conditions from the firm's profit maximization evaluated at the steady-state are:

$$Z^T\left(1-\theta^T\right)\left(k^T\right)^{-\theta^T}=PZ^N\left(1-\theta^N\right)\left(k^N\right)^{-\theta^N}\equiv R, \tag{146a}$$

$$Z^T\theta^T\left(k^T\right)^{1-\theta^T}=PZ^N\theta^N\left(k^N\right)^{1-\theta^N}\equiv W. \tag{146b}$$

Dividing the marginal product of labor by the marginal product of capital in each sector yields the sectoral capital-labor ratios:

$$k^T=\frac{1-\theta^T}{\theta^T}\frac{W}{R},\; k^N=\frac{1-\theta^N}{\theta^N}\frac{W}{R}. \tag{147}$$

Substituting sectoral capital-labor ratios (147) into (146b) yields an expression of the steady-state relative price of non tradables in terms of the wage-interest ratio

$$P=\Gamma\frac{Z_T}{Z_N}\times\left(\frac{W}{R}\right)^{\theta^N-\theta^T}, \tag{148}$$

where

$$\Gamma=\frac{\left(\theta^T\right)^{\theta^T}\left(1-\theta^T\right)^{1-\theta^T}}{\left(\theta^N\right)^{\theta^N}\left(1-\theta^N\right)^{1-\theta^N}}. \tag{149}$$

To eliminate the wage rate, use the marginal product of labor in the traded sector (see the LHS term of (146b)) and substitute the sectoral capital-labor ratio (147):

$$W=Z^T\theta^T\left(k^T\right)^{1-\theta^T},\quad\text{or}\quad W=\left[Z^T\left(\theta^T\right)^{\theta^T}\left(1-\theta^T\right)^{1-\theta^T}\left(r^\star\right)^{-\left(1-\theta^T\right)}\right]^{\frac{1}{\theta^T}}. \tag{150}$$

Inserting the wage rate given by (150) into (148) yields a closed-form solution for the steady-state relative price of non tradables:

$$P = \frac{\left(Z^T\right)^{\theta^N/\theta^T}}{Z^N} R^{-\frac{\theta^N-\theta^T}{\theta^T}} \frac{\left[\left(\theta^T\right)^{\theta^T}\left(1-\theta^T\right)^{1-\theta^T}\right]^{\theta^N/\theta^T}}{\left(\theta^N\right)^{\theta^N}\left(1-\theta^N\right)^{1-\theta^N}} \tag{151}$$

Using the fact that $R = P\left(r^\star + \delta\right)$ yields:

$$P = \frac{Z^T}{\left(Z^N\right)^{\theta^T/\theta^N}} \left(r^\star + \delta\right)^{-\frac{\theta^N-\theta^T}{\theta^N}} \frac{\left(\theta^T\right)^{\theta^T}\left(1-\theta^T\right)^{1-\theta^T}}{\left[\left(\theta^N\right)^{\theta^N}\left(1-\theta^N\right)^{1-\theta^N}\right]^{\theta^T/\theta^N}} \tag{152}$$

Finally, taking logarithm and differentiating (152) and denoting by a hat the percentage deviation from initial steady-state yields:

$$\hat{p} = \hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N. \tag{153}$$

Eq. (153) states that the a labor share adjusted productivity differential between tradables and non tradables by 1% raises the relative price of non tradables by 1% in the long-run when assuming perfect mobility of labor across sectors.

Imperfect Substitutability of Hours Worked across Sectors

Plugging (131b) into (143) to eliminate L^T/L^N yields:

$$\omega^{\left[(\epsilon+1)+\theta^T(\phi-1)\right]} = \Lambda\left(\frac{1+\upsilon_B}{1-\upsilon_I}\right)\left[\frac{Z^T}{\left(Z^N\right)^{\frac{\theta^T}{\theta^N}}}\right]^{-(\phi-1)}, \tag{154}$$

where

$$\Lambda = \left(r^\star + \delta\right)^{\frac{\left(\theta^N-\theta^T\right)(\phi-1)}{\theta^N}}\left(\frac{1-\varphi}{\varphi}\right)\left(\frac{\vartheta}{1-\vartheta}\right)\left(\frac{\theta^N}{\theta^T}\right)^{\left[1+\theta^T(\phi-1)\right]}\left[\frac{\left(1-\theta^N\right)^{\left(1-\theta^N\right)\frac{\theta^T}{\theta^N}}}{\left(1-\theta^T\right)^{\left(1-\theta^T\right)}}\right]^{(\phi-1)}. \tag{155}$$

Taking logarithm and differentiating (154) yields the percentage deviation of the relative wage from its initial steady-state following a productivity differential between tradables and non tradables:

$$\hat{\omega} = \frac{1}{\left[(\epsilon+1)+\theta^T(\phi-1)\right]}\left[\left(\mathrm{d}\upsilon_B + \mathrm{d}\upsilon_I\right) - (\phi-1)\left(\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right)\right]. \tag{156}$$

To derive the first term in brackets in the RHS of (156), take logarithm to $\left(\frac{1+\upsilon_B}{1-\upsilon_I}\right)$ which gives $\ln\left(1+\upsilon_B\right) - \ln\left(1-\upsilon_I\right)$, use a Taylor approximation at a first order which implies $\ln\left(1+\upsilon_B\right) - \ln\left(1-\upsilon_I\right) \simeq \upsilon_B + \upsilon_I$, and differentiate which yields the first term in brackets in the RHS of (156). Since $(\epsilon+1)+\theta^T(\phi-1) > \epsilon+\phi$, ω falls by a larger amount in a model with capital than that in a model abstracting from physical capital (for given K and B).

Setting $\Theta^K \equiv \frac{1}{\left[(\epsilon+1)+\theta^T(\phi-1)\right]}$, the long-run response of the relative wage (156) can be rewritten as follows:

$$\hat{\omega} = -\left(\phi-1\right)\Theta^K\left(\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right) + \Theta^K\left(\mathrm{d}\upsilon_B + \mathrm{d}\upsilon_I\right).$$

Adding and subtracting $\Theta^L = \left(\frac{1}{\epsilon+\phi}\right)$ (see (95)), and noting that $\upsilon_B = -\upsilon_{NX}$ where we denote by $\upsilon_{NX} \equiv \left(\tilde{Y}^T - \tilde{C}^T\right)/\tilde{Y}^T$ the ratio of net exports to traded output, allows us to break down the relative wage growth into three components:[67]

$$\hat{\omega} = -\left(\phi-1\right)\left[\Theta^L + \left(\Theta^K - \Theta^L\right)\right]\left[\hat{z}^T - \left(\theta^T/\theta^N\right)\hat{z}^N\right] - \Theta^K\left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right), \tag{157}$$

Eq. (157) corresponds to **eq. (39) in the text**.

[67] Remembering that at the steady state the traded good market clearing condition is $r^\star B + Y^T - C^T = 0$, and rearranging terms yields $-NX = r^\star B$. Dividing the LHS and the RHS by Y^T, we get $\upsilon_B = -\upsilon_{NX}$.

Equating (134) and (137) to eliminate y^T/y^N, taking logarithm and differentiating yields the percentage deviation of the relative price of non tradables from its initial steady-state following a productivity differential between tradables and non tradables:

$$\hat{p} = \frac{(1+\epsilon)}{\theta^T\left[(\epsilon+\phi)+\left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]}\left[\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right] + \frac{1}{\left[(\epsilon+\phi)+\left(\frac{1-\theta^T}{\theta^T}\right)(1+\epsilon)\right]}\left(\mathrm{d}\upsilon_B + \mathrm{d}\upsilon_I\right). \quad (158)$$

According to (158), keeping unchanged the overall capital stock and the stock of foreign bonds (i.e., keeping fixed υ_I and υ_B), following a productivity differential between tradables and non tradables of 1 percentage point, p increases more or rises less than in a model abstracting from physical capital depending on whether ϕ is larger or smaller than one. The reason is that when $\phi < 1$, the non traded sector experiences a capital inflow which exerts a negative impact on p; conversely, if $\phi > 1$, the traded sector experiences a capital inflow which increases traded output and thereby raises more the relative price of non tradables.

Adopting the same procedure as for the relative wage, i.e. adding and subtracting Θ^L, yields the deviation in percentage of the relative price from its initial steady state:

$$\hat{p} = (1+\epsilon)\left[\Theta^L + \left(\Theta^K - \Theta^L\right)\right]\left(\hat{z}^T - \frac{\theta^T}{\theta^N}\hat{z}^N\right) - \theta^T\Theta^K\left(\mathrm{d}\upsilon_{NX} - \mathrm{d}\upsilon_I\right), \quad (159)$$

where $\Theta^K \equiv \frac{1}{[(\epsilon+1)+\theta^T(\phi-1)]} > 0$ and $\Theta^L = \frac{1}{\epsilon+\phi} > 0$. Eq. (159) corresponds to **eq. (40) in the text**.

C.9 Derivation of the Accumulation Equation of Financial Wealth

Remembering that the stock of financial wealth $A(t)$ is equal to $B(t) + P(t)K(t)$, differentiating w.r.t. time, plugging the dynamic equation (106d) for the relative price, inserting the accumulation equations for physical capital (105) and traded bonds (104), yields the accumulation equation for the stock of financial wealth or private savings dynamic equation:

$$\dot{A}(t) = r^\star A(t) + W(t)L(t) - P_C\left(P(t)\right)C(t). \quad (160)$$

We first determine short-run static solutions for aggregate labor supply and aggregate wage index. Inserting short-run static solutions for sectoral wages (114) into the short-run static solution for aggregate labor supply (107), we can solve for total hours worked:

$$L = L\left(\bar{\lambda}, K, P, Z^T, Z^N\right) \quad (161)$$

where partial derivatives are given by

$$L_K \equiv \frac{\partial L}{\partial K} = L_{W^T}W_K^T + L_{W^N}W_K^N, \quad (162a)$$

$$L_P \equiv \frac{\partial L}{\partial P} = L_{W^T}W_P^T + L_{W^N}W_P^N. \quad (162b)$$

Substituting (114) into $W \equiv W\left(W^T, W^N\right)$, we can solve for the aggregate wage index:

$$W = W\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad (163)$$

where partial derivatives are given by

$$W_K \equiv \frac{\partial W}{\partial K} = W_{W^T}W_K^T + W_{W^N}W_K^N, \quad (164a)$$

$$W_P \equiv \frac{\partial W}{\partial P} = W_{W^T}W_P^T + W_{W^N}W_P^N, \quad (164b)$$

where $W_{W^T} = \left(W/W^T\right)(1-\alpha_L)$ and $W_{W^N} = \left(W/W^N\right)\alpha_L$.

Inserting short-run static solutions (161) and (163) into (160), and linearizing around the steady-state yields:

$$\dot{A}(t) = r^\star\left(A(t) - \tilde{A}\right) + M_1\left(P(t) - \tilde{P}\right),$$

with M_1 given by

$$M_1 = \left\{\left(W_K\tilde{L} + \tilde{W}L_K\right) + \left[\left(W_P\tilde{L} + \tilde{W}L_P\right) - \tilde{C}^N - P_C C_P\right]\omega_2^1\right\}.$$

C.10 Solving the Full Model

Plugging the short-run static solutions for consumption in tradables and non tradables given by (82) and for hours worked in the traded and non traded sector given by (84), the steady-state is defined by the following set of equations:

$$Z^N\left(1-\theta^N\right)\left(\tilde{k}^N\right)^{-\theta^N} \equiv r^\star+\delta, \tag{165a}$$

$$Z^T\left(1-\theta^T\right)\left(\tilde{k}^T\right)^{-\theta^T} = \tilde{P}Z^N\left(1-\theta^N\right)\left(\tilde{k}^N\right)^{-\theta^N}, \tag{165b}$$

$$Z^T\theta^T\left(\tilde{k}^T\right)^{1-\theta^T} \equiv \tilde{W}^T, \tag{165c}$$

$$PZ^N\theta^N\left(\tilde{k}^N\right)^{1-\theta^N} \equiv \tilde{W}^N, \tag{165d}$$

$$\tilde{k}^T L^T\left(\bar{\lambda},\tilde{W}^T,\tilde{W}^N\right)+\tilde{k}^N L^N\left(\bar{\lambda},\tilde{W}^T,\tilde{W}^N\right)=\tilde{K}, \tag{165e}$$

$$\tilde{Y}^N = C^N\left(\bar{\lambda},\tilde{P}\right)+\delta\tilde{K}, \tag{165f}$$

$$\tilde{Y}^T = C^T\left(\bar{\lambda},\tilde{P}\right)-r^\star\tilde{B}, \tag{165g}$$

$$\tilde{B}-B_0=\Phi\left(\tilde{K}-K_0\right), \tag{165h}$$

where $\tilde{Y}^T = Z^T L^T\left(\bar{\lambda},\tilde{W}^T,\tilde{W}^N\right)\left(\tilde{k}^T\right)^{1-\theta^T}$ and $\tilde{Y}^T = Z^N L^N\left(\bar{\lambda},\tilde{W}^T,\tilde{W}^N\right)\left(\tilde{k}^N\right)^{1-\theta^N}$. This system of eight equations jointly solve for sectoral capital-labor ratios, $\tilde{k}^T$ and $\tilde{k}^N$, sectoral wage rates, $\tilde{W}^T$ and $\tilde{W}^N$, the relative price of non tradables, $\tilde{P}$, the capital stock, $\tilde{K}$, the stock of foreign assets, $\tilde{B}$, and the shadow value of wealth $\bar{\lambda}$.

Because we restrict ourselves to the analysis of the long-run effects, the tilde is suppressed for the purposes of clarity. Denoting by a hat the percentage deviation relative to initial steady-state, (165a) can be rewritten as:

$$\hat{Z}^N-\theta^N\hat{k}^N=0, \quad \hat{k}^N=\frac{\hat{Z}^N}{\theta^N}>0. \tag{166}$$

Hence a rise in Z^N raises k^N. Taking logarithm and differentiating (165b) yields:

$$\hat{Z}^T-\theta^T\hat{k}^T=\hat{P}+\hat{Z}^N-\theta^N\hat{k}^N=\hat{P}>0, \quad \hat{k}^T=\frac{\hat{Z}^T-\hat{P}}{\theta^T} \tag{167}$$

where we used (166) to get the last equality on the LHS. Taking logarithm and differentiating (165d) yields:

$$\hat{W}^N=\hat{P}+\hat{Z}^N+\left(1-\theta^N\right)\hat{k}^N=\hat{P}+\frac{\hat{Z}^N}{\theta^N}>0, \tag{168}$$

where use has been made of (166). Hence a rise in Z^N increases W^N directly and indirectly by raising P and k^N. Taking logarithm and differentiating (165c) yields:

$$\hat{W}^T=\hat{Z}^T+\left(1-\theta^T\right)\hat{k}^T=\hat{P}+\hat{k}^T=\frac{\hat{Z}^T}{\theta^T}-\left(\frac{1-\theta^T}{\theta^T}\right)\hat{P}>0, \tag{169}$$

where use has been made of (167).

Before taking logarithm and differentiating the market-clearing condition, we express production functions for the traded and non traded sector as percentage deviations relative to initial steady-state. For traded output, we have:

$$\hat{Y}^T=\hat{Z}^T+\hat{L}^T+\left(1-\theta^T\right)\hat{k}^T=\hat{P}+\hat{k}^T+\hat{L}^T=\frac{\hat{Z}^T}{\theta^T}+\hat{L}^T-\left(\frac{1-\theta^T}{\theta^T}\right)\hat{P} \tag{170}$$

where use has been made of (167). For non traded output, we have:

$$\hat{Y}^N=\hat{Z}^N+\hat{L}^N+\left(1-\theta^N\right)\hat{k}^N=\hat{L}^N+\hat{k}^N=\frac{\hat{Z}^N}{\theta^N}+\hat{L}^N, \tag{171}$$

where use has been made of (166).

To determine the steady-state changes of sectoral labor, we take logarithm and differentiate short-run static solutions (84). For hours worked in the traded sector, we have:

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

For hours worked in the non-traded sector, we have:

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

Plugging the steady-state changes of sectoral wage rates given by (168) and (169), the percentage deviation relative to steady-state for hours worked in the traded sector is:

$$\begin{aligned}
\hat{L}^T &= \sigma_L \hat{\bar{\lambda}} + \left\{\alpha_L \left(\sigma_L - \epsilon\right) - \left[\epsilon \alpha_L + \sigma_L \left(1-\alpha_L\right)\right] \left(\frac{1-\theta^T}{\theta^T}\right)\right\} \hat{P} \\
&+ \frac{\left[\epsilon \alpha_L + \sigma_L \left(1-\alpha_L\right)\right]}{\theta^T} \hat{Z}^T + \frac{\alpha_L \left(\sigma_L - \epsilon\right)}{\theta^N} \hat{Z}^N, \\
&= \sigma_L \hat{\bar{\lambda}} + \frac{\left[\epsilon \alpha_L + \sigma_L \left(1-\alpha_L\right)\right]}{\theta^T} \hat{Z}^T + \frac{\alpha_L \left(\sigma_L - \epsilon\right)}{\theta^N} \hat{Z}^N \\
&+ \left[\frac{\alpha_L \left(\sigma_L - \epsilon\right) - \left(1-\theta^T\right) \sigma_L}{\theta^T}\right] \hat{P}.
\end{aligned} \tag{172}$$

Applying a similar procedure for hours worked in the non-traded sector, we have:

$$\begin{aligned}
\hat{L}^N &= \sigma_L \hat{\bar{\lambda}} + \left\{\left[\epsilon \left(1-\alpha_L\right) + \sigma_L \alpha_L\right] - \left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \left(\frac{1-\theta^T}{\theta^T}\right)\right\} \hat{P} \\
&+ \frac{\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right)}{\theta^T} \hat{Z}^T + \frac{\left[\epsilon \left(1-\alpha_L\right) + \sigma_L \alpha_L\right]}{\theta^N} \hat{Z}^N, \\
&= \sigma_L \hat{\bar{\lambda}} + \frac{\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right)}{\theta^T} \hat{Z}^T + \frac{\left[\epsilon \left(1-\alpha_L\right) + \sigma_L \alpha_L\right]}{\theta^N} \hat{Z}^N \\
&+ \left[\frac{\sigma_L \theta^T - \left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right)}{\theta^T}\right] \hat{P}.
\end{aligned} \tag{173}$$

Denoting by $\omega_N \equiv PY^N/Y$ the non-tradable share of output, $\omega_C \equiv P_C C/Y$ the consumption-to-GDP ratio, $\upsilon_I \equiv PI/Y$ the investment-to-GDP ratio, taking logarithm and differentiating the market-clearing condition for the non traded goods $Y^N = C^N + I^N$ with $I^N = I = \delta K$ yields:

$$\omega_N \hat{Y}^N = -\omega_C \alpha_C \sigma_C \hat{\bar{\lambda}} - \omega_C \alpha_C \left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right] \hat{P} + \upsilon_I \hat{K}.$$

Substituting (173) into (171) and collecting terms allows us to rewrite the market-clearing condition for non-tradables as follows:

$$\begin{aligned}
& \hat{\bar{\lambda}} \left[\omega_N \sigma_L + \sigma_C \omega_C \alpha_C\right] + \hat{P} \left\{\omega_N \Psi_N + \omega_C \alpha_C \left[\left(1-\alpha_C\right)\phi + \alpha_C \sigma_C\right]\right\} - \upsilon_I \hat{K} \\
= & -\omega_N \left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \frac{\hat{Z}^T}{\theta^T} - \omega_N \left[\left(\epsilon + 1\right) + \alpha_L \left(\sigma_L - \epsilon\right)\right] \frac{\hat{Z}^N}{\theta^N},
\end{aligned} \tag{174}$$

where

$$\begin{aligned}
\Psi_N &= \left\{\left[\epsilon \left(1-\alpha_L\right) + \sigma_L \alpha_L\right] - \left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right) \left(\frac{1-\theta^T}{\theta^T}\right)\right\}, \\
&= \sigma_L - \frac{\left(1-\alpha_L\right)\left(\sigma_L - \epsilon\right)}{\theta^T}.
\end{aligned} \tag{175}$$

Denoting by $1-\omega_N \equiv Y^T/Y$ the tradable share of output, $\upsilon_B \equiv r^\star B/Y$ the interest receipts-to-GDP ratio, inserting the intertemporal solvency condition (129), taking logarithm and differentiating the market-clearing condition for traded goods $r^\star B + Y^T = C^T$ with $B = B_0 + \Phi\left(K - K_0\right)$ yields:

$$\left(1-\omega_N\right) \hat{Y}^T = -\sigma_C \omega_C \left(1-\alpha_C\right) \hat{\bar{\lambda}} + \omega_C \left(1-\alpha_C\right) \alpha_C \left(\phi - \sigma_C\right) \hat{P} - \upsilon_B \Phi \frac{K}{B} \hat{K},$$

Plugging (170) into (172) and collecting terms allows us to rewrite the market-clearing condition for tradables as follows:

$$\begin{aligned}
& \hat{\bar{\lambda}}\left[(1-\omega_N)\,\sigma_L + \sigma_C\omega_C\,(1-\alpha_C)\right] + \hat{P}\left\{(1-\omega_N)\,\Psi_T - \omega_C\,(1-\alpha_C)\,\alpha_C\,(\phi-\sigma_C)\right\} + \upsilon_B\Omega\frac{\tilde{K}}{\tilde{B}}\hat{K} \\
= \quad & -(1-\omega_N)\left[(\epsilon+1)+(1-\alpha_L)\,(\sigma_L-\epsilon)\right]\frac{\hat{Z}^T}{\theta^T} - (1-\omega_N)\,\alpha_L\,(\sigma_L-\epsilon)\,\frac{\hat{Z}^N}{\theta^N}, \qquad (176)
\end{aligned}$$

where we set

$$\begin{aligned}
\Psi_T &= \left\{\alpha_L\,(\sigma_L-\epsilon) - \left[(\epsilon+1)+(1-\alpha_L)\,(\sigma_L-\epsilon)\right]\left(\frac{1-\theta^T}{\theta^T}\right)\right\} \\
&= (\sigma_L+1) - \frac{\left[(\epsilon+1)+(1-\alpha_L)\,(\sigma_L-\epsilon)\right]}{\theta^T}. \qquad (177)
\end{aligned}$$

Finally, denoting by $\xi_N \equiv K^N/K$ the non-tradable share of capital stock, taking logarithm and differentiating the resource constraint for capital given by (109) yields:

$$(1-\xi_N)\,\hat{k}^T + (1-\xi_N)\,\hat{L}^T + \xi_N\hat{k}^N + \xi_N\hat{L}^N = \hat{K}.$$

Plugging the steady-state changes of sectoral labor given by (172) and (173) into the equation above yields:

$$\begin{aligned}
& \sigma_L\hat{\bar{\lambda}} - \hat{K} + \hat{P}\left\{\sigma_L + (1-\xi_N) - \frac{\left[(1-\xi_N)\,(\epsilon+1)+(1-\alpha_L)\,(\sigma_L-\epsilon)\right]}{\theta^T}\right\} \\
= \quad & -\frac{\hat{Z}^T}{\theta^T}\left[(1-\xi_N)\,(\epsilon+1)+(1-\alpha_L)\,(\sigma_L-\epsilon)\right] - \frac{\hat{Z}^N}{\theta^N}\left[\xi_N\,(\epsilon+1)+\alpha_L\,(\sigma_L-\epsilon)\right], \qquad (178)
\end{aligned}$$

where $\sigma_L + (1-\xi_N) - \frac{[(1-\xi_N)(\epsilon+1)+(1-\alpha_L)(\sigma_L-\epsilon)]}{\theta^T} = (1-\xi_N)\,\Psi_T + \xi_N\Psi_N$.

The system (165) expressed in steady-state deviation relative to the steady-state can be reduced to three equations: i) the market-clearing condition for the non-traded good given by (174), ii) the market-clearing condition for the traded good given by (176), and iii) the resource constraint for physical capital given by (178). This system comprising three equations jointly determines $\hat{P}$, $\hat{K}$, $\hat{\bar{\lambda}}$ in terms of exogenous disturbances $\hat{Z}^T$ and $\hat{Z}^N$.

D 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.

D.1 Households

Previously, we assumed that preferences are separable in consumption and leisure. We relax this assumption which implies that consumption and leisure are 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:

$$\frac{C^{1-\sigma}V(L)^{\sigma}-1}{1-\sigma}, \quad \text{if} \quad \sigma \neq 1, \quad V(L) \equiv \left(1+(\sigma-1)\,\gamma\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}\right) \qquad (179)$$

and

$$\log C - \gamma\frac{\sigma_L}{1+\sigma_L}L^{\frac{1+\sigma_L}{\sigma_L}}, \quad \text{if} \quad \sigma = 1. \qquad (180)$$

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; it is worthwhile noticing that if $\sigma > 1$, the marginal utility of consumption is increasing in hours worked. Importantly, such preferences imply that the Frisch elasticity of labor supply is constant.

The representative household maximizes lifetime utility subject to the flow budget constraint (104) and the accumulation of physical capital (105).

Denoting the co-state variables associated with (104) and (105) by λ and ψ, respectively, the first-order conditions characterizing the representative household's optimal plans are:

$$C^{-\sigma} V(L)^{\sigma} = P_C \lambda, \tag{181a}$$

$$C^{1-\sigma} \sigma \gamma L^{1/\sigma_L} V(L)^{\sigma-1} = W\lambda, \tag{181b}$$

$$\dot{\lambda} = \lambda \left(\beta - r^{\star}\right), \tag{181c}$$

$$\frac{R}{P} - \delta + \frac{\dot{P}}{P} = r^{\star}, \tag{181d}$$

and the transversality conditions $\lim_{t\to\infty} \bar{\lambda} B(t) e^{-\beta t} = 0$ and $\lim_{t\to\infty} \psi(t) K(t) e^{-\beta t} = 0$; to derive (181d), we used the fact that $\psi(t) = \lambda P(t)$.

First-order conditions (181a) and (181b) can be solved for consumption and labor as follows:

$$C = C\left(\bar{\lambda}, P, W\right), \quad L = L\left(\bar{\lambda}, P, W\right). \tag{182}$$

To derive the partial derivatives, we take logarithm and totally differentiate the system which yields in matrix form:

$$\begin{pmatrix} -\epsilon & \epsilon\left(\frac{1+\sigma_L}{\sigma_L}\right)\left[\frac{V(L)-1}{V(L)}\right] \\ (1-\epsilon) & \left\{\frac{1}{\sigma_L} + (\epsilon-1)\left(\frac{1+\sigma_L}{\sigma_L}\right)\left[\frac{V(L)-1}{V(L)}\right]\right\} \end{pmatrix} \begin{pmatrix} \hat{C} \\ \hat{L} \end{pmatrix} \begin{pmatrix} \hat{\bar{\lambda}} + \alpha_C \hat{P} \\ \hat{\bar{\lambda}} + \hat{W} \end{pmatrix}, \tag{183}$$

where we denoted by a hat the deviation in percentage.

Partial derivatives are:

$$\frac{\hat{C}}{\hat{\bar{\lambda}}} = \frac{(1+\sigma_L)}{\sigma}\left[\frac{V(L)-1}{V(L)}\right] - \frac{1}{\sigma} < 0, \tag{184a}$$

$$\frac{\hat{L}}{\hat{\bar{\lambda}}} = \frac{\sigma_L}{\sigma} > 0, \tag{184b}$$

$$\frac{\hat{C}}{\hat{W}} = (1+\sigma_L)\left[\frac{V(L)-1}{V(L)}\right] > 0, \tag{184c}$$

$$\frac{\hat{L}}{\hat{W}} = \sigma_L > 0, \tag{184d}$$

$$\frac{\hat{C}}{\hat{P}} = -\frac{\alpha_C}{\sigma}\left\{1 + (\sigma-1)(1+\sigma_L)\left[\frac{V(L)-1}{V(L)}\right]\right\} < 0, \tag{184e}$$

$$\frac{\hat{L}}{\hat{P}} = -\alpha_C \frac{(\sigma-1)\sigma_L}{\sigma} < 0. \tag{184f}$$

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:

$$L = L\left(\bar{\lambda}, P, W^T, W^N\right), \tag{185}$$

where

$$\frac{\hat{L}}{\hat{W}^T} = (1-\alpha_L)\sigma_L > 0, > 0, \tag{186a}$$

$$\frac{\hat{L}}{\hat{W}^N} = \sigma_L \alpha_L > 0, \tag{186b}$$

$$\tag{186c}$$

Inserting first the short-run static solution for consumption given by (182), consumption in non-tradables, i.e., $C^N = P_C' C$ and tradables, i.e., $C^T = \left[P_C - P P_C'\right] C$, can be solved for C^N and C^T as follows:

$$C^T = C^T\left(\bar{\lambda}, P, W^T, W^N\right), \quad C^N = C^N\left(\bar{\lambda}, P, W^T, W^N\right), \tag{187}$$

where partial derivatives are given by:

$$C_P^T = \frac{C^T}{P}\left(\alpha_C\phi - \sigma_C + \frac{C_P P}{C}\right) \lesseqgtr 0, \tag{188a}$$

$$C_P^N = -\frac{C^N}{P}\left[(1-\alpha_C)\,\phi - \frac{C_P P}{C}\right] < 0, \tag{188b}$$

$$C_{W^T}^T = \frac{C^T}{W^T}(1-\alpha_L)\,\frac{C_W W}{C} > 0, \tag{188c}$$

$$C_{W^T}^N = \frac{C^N}{W^T}(1-\alpha_L)\,\frac{C_W W}{C} > 0, \tag{188d}$$

$$C_{W^N}^T = \frac{C^T}{W^N}\alpha_L\frac{C_W W}{C} > 0, \tag{188e}$$

$$C_{W^N}^N = \frac{C^N}{W^N}\alpha_L\frac{C_W W}{C} > 0. \tag{188f}$$

Inserting first the short-run solution for labor (185), into $L^T = \frac{\partial W(W^T,W^N)}{\partial W^T}L$ and $L^N = \frac{\partial W(W^T,W^N)}{\partial W^N}L$, we are able to solve for L^T and L^N:

$$L^T = L^T\left(\bar{\lambda}, W^T, W^N, P\right), \quad L^N = L^N\left(\bar{\lambda}, W^T, W^N, P\right), \tag{189}$$

where partial derivatives w.r.t. W^T and W^N are given by (85) and partial derivatives w.r.t. P are:

$$\frac{\hat{L}}{\hat{W}^T} = (1-\alpha_L)\,\sigma_L > 0, > 0, \tag{190a}$$

$$\frac{\hat{L}}{\hat{W}^N} = \sigma_L\alpha_L > 0, \tag{190b}$$

$$\tag{190c}$$

D.2 Solving the Model

Plugging the short-run static solutions for L^T and L^N given by (189) into the resource constraint for capital (109), the system of four equations comprising (108a)-(108c) and (109) can be solved for sectoral wages and sectoral capital-labor ratios. Taking logarithm and differentiating (108a)-(108c) and (109) yields in matrix form:

$$\begin{pmatrix} -\theta^T & \theta^N & 0 & 0 \\ \left(1-\theta^T\right) & 0 & -1 & 0 \\ 0 & \left(1-\theta^N\right) & 0 & -1 \\ (1-\xi) & \xi & \Psi_{W^T} & \Psi_{W^N} \end{pmatrix} \begin{pmatrix} \hat{k}^T \\ \hat{k}^N \\ \hat{W}^T \\ \hat{W}^N \end{pmatrix} = \begin{pmatrix} \hat{P} + \hat{Z}^N - \hat{Z}^T \\ -\hat{Z}^T \\ -\hat{P} - \hat{Z}^N \\ \hat{K} - \Psi_{\bar{\lambda}}\hat{\bar{\lambda}} - \Psi_P\hat{P} \end{pmatrix}, \tag{191}$$

where Ψ_{W^T} and Ψ_{W^N} are given by (113a) (113b), respectively, $\xi \equiv \frac{k^N L^N}{K}$ and we set:

$$\Psi_P = (1-\xi)\,\frac{L_P^T P}{L^T} + \xi\frac{L_P^N P}{L^N} = -\alpha_C\frac{(\sigma-1)\,\sigma_L}{\sigma} < 0. \tag{192}$$

Only the partial derivatives w.r.t. P are modified when preferences are non separable in consumption and leisure. Hence, we limit ourselves to these partial derivatives. Short-run static solutions for sectoral wages are:

$$W^T = W^T\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \quad W^N = W^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{193}$$

with

$$\frac{\hat{W}^T}{\hat{P}} = -\frac{\left(1-\theta^T\right)\left(\Psi_{W^N} + \theta^N\Psi_P + \xi +\right)}{G} < 0, \tag{194a}$$

$$\frac{\hat{W}^N}{\hat{P}} = -\frac{\left\{1 + \left(1-\theta^T\right)\Psi_{W^T} - \left(1-\theta^T\right)\xi - \theta^T\left(1-\theta^N\right)\Psi_P\right\}}{G} > 0, \tag{194b}$$

and sectorial capital-labor ratios:

$$k^T = k^T\left(\lambda, K, P, Z^T, Z^N\right), \quad k^N = k^N\left(\bar{\lambda}, K, P, Z^T, Z^N\right), \tag{195}$$

with

$$\frac{\hat{k}^T}{\hat{P}} = \frac{\Psi_{W^N} + \xi + \theta^N \Psi_P}{G} < 0, \tag{196a}$$

$$\frac{\hat{k}^N}{\hat{P}} = \frac{\left\{\theta^T \left(\Psi^{W^N} + \Psi_P\right) - \left[\left(1-\theta^T\right)\Psi_{W^T} + (1-\xi)\right]\right\}}{G} > 0, \tag{196b}$$

$$\tag{196c}$$

To solve the model, insert first short-run static solutions for sectoral wages (193) into sectoral labor (189), then substitute the resulting solutions for sectoral labor and capital-labor ratios (196), production functions can be solved for sectoral outputs.

As mentioned in the text, we break down the long-run relative price and relative wage responses to a productivity differential into three channels: i) a baseline channel when keeping fixed sectoral capital-labor ratios and the overall capital stock, ii) a capital reallocation effect induced by the shift of capital across sectors, iii) a capital accumulation effect stemming from the investment boom causing a current account deficit in the short-run and therefore requiring a trade balance surplus in the long-run. As expected, non separable preferences in consumption and leisure modifies only the capital accumulation channel by influencing private savings and thereby the current account adjustment in the short-run.

E Introducing Traded Investment

The section examines implications of a two-sector model that differentiate between tradable and non-tradable goods in investment. The small open economy produces a traded and a non traded good by means of a production technology described by Cobb-Douglas production functions that uses capital and labor. As previously, the output of the non traded good (Y^N) can be used for private (C^N) and public consumption (G^N), and for investment (I^N). The output of the traded good (Y^T) can be consumed by households and the government (C^T and G^T), invested (I^T), or exported ($Y^T - C^T - G^T - I^T$).

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:

$$I \equiv I\left(I^T, I^N\right) = \left[\varphi_I^{\frac{1}{\phi_I}}\left(I^T\right)^{\frac{\phi_I - 1}{\phi_I}} + \left(1-\varphi_I\right)^{\frac{1}{\phi_I}}\left(I^N\right)^{\frac{\phi_I-1}{\phi_I}}\right]^{\frac{\phi_I}{\phi_I-1}}, \tag{197}$$

where φ_I is the weight of the investment traded input ($0 < \varphi_I < 1$) and ϕ_I corresponds to the intratemporal elasticity of substitution between investment traded goods and investment non traded goods. At each instant, the investment sector minimizes the cost or total expenditure measured in terms of traded goods:

$$E_I \equiv P I^N + I^T, \tag{198}$$

for a given level of output, $I(t)$, where $P(t)$ is the relative price of the non traded good. For any chosen $I(t)$, the optimal basket $(I^T(t), I^N(t))$ is a solution to:

$$P_I\left(P(t)\right) I(t) = \min_{\{I^T(t), I^N(t)\}} \left\{I^T(t) + P(t) I^N(t)(t) : I\left(I^T(t), I^N(t)\right) \geq I(t)\right\}. \tag{199}$$

The subutility function $I(.)$ is linear homogeneous implies that total expenditure in consumption goods can be expressed as $E_I(t) = P_I\left(P(t)\right) I(t)$, with $P_I\left(P(t)\right)$ is the unit cost function dual (or consumption-based price index) to I. The unit cost dual function, $P_I(.)$, is defined as the minimum total expense in investment goods, E_I, such that $I = I\left(I^T(t), I^N(t)\right) = 1$, for a given level of the relative price of non tradables, P. Its expression is given by

$$P_I = \left[\varphi_I + \left(1-\varphi_I\right) P^{1-\phi_I}\right]^{\frac{1}{1-\phi_I}}. \tag{200}$$

Intra-temporal allocations between non tradable goods and tradable goods follow from Shephard's Lemma (or the envelope theorem) applied to (199):

$$I^N = P_I' I = \left(1-\varphi_I\right)\left(\frac{P}{P_I}\right)^{-\phi_I} I, \quad \text{and} \quad \frac{P I^N}{P_I I} = \alpha_I, \tag{201a}$$

$$I^T = \left[P_I - P P_I'\right] I = \varphi_I \left(\frac{1}{P_I}\right)^{-\phi_I} I, \quad \text{and} \quad \frac{I^T}{P_I I} = \left(1-\alpha_I\right), \tag{201b}$$

where the non tradable and tradable shares in total investment expenditure are:

$$\alpha_I = \frac{(1-\varphi_I) P^{1-\phi_I}}{\varphi_I + (1-\varphi_I) P^{1-\phi_I}}, \tag{202a}$$

$$1-\alpha_I = \frac{\varphi_I}{\varphi_I + (1-\varphi_I) P^{1-\phi_I}}. \tag{202b}$$

E.1 Households

The representative household chooses consumption C, decides on labor supply L, and investment I that maximizes his/her lifetime utility (56) subject to the budget constraint:

$$\dot{B}(t) = r^\star B(t) + R(t)K(t) + W\left(W^T(t), W^N(t)\right) L(t) - P_C\left(P(t)\right) C(t) - P_I\left(P(t)\right) I(t), \tag{203}$$

and capital accumulation which evolves as follows:

$$\dot{K}(t) = I(t) - \delta K(t), \tag{204}$$

where I corresponds to investment expenditure and $0 \leq \delta_K < 1$ is a fixed depreciation rate.

Denoting the co-state variables associated with (203) and (204) by λ and ψ, respectively, the first-order conditions characterizing the representative household's optimal plans are:

$$C = (P_C\lambda)^{-\sigma_C}, \tag{205a}$$

$$L = \left(\frac{W\lambda}{\gamma}\right)^{\sigma_L}, \tag{205b}$$

$$\dot{\lambda} = \lambda\left(\beta - r^\star\right), \tag{205c}$$

$$\frac{R}{P_I} - \delta + \alpha_I \frac{\dot{P}}{P} = r^\star, \tag{205d}$$

and the transversality conditions $\lim_{t\to\infty} \bar{\lambda} B(t) e^{-\beta t} = 0$ and $\lim_{t\to\infty} \psi(t)K(t)e^{-\beta t} = 0$; to derive (205d), we used the fact that $\psi(t) = \lambda P_I$. Eqs. (205a) and (205b) can be solved for consumption and labor (see eq. (107)).

E.2 Equilibrium Dynamics

First-order conditions from profit maximization remains unchanged and therefore we do not repeat them (see section C.4). To solve the model, we adopt the same reasoning as in section C.4.

Remembering that the non traded input I^N used to produce the capital good is equal to $P_I' I$, using the fact that $I^N = Y^N - C^N - G^N$ and inserting $I = \dot{K} + \delta_K$, the capital accumulation equation becomes:

$$\dot{K} = \frac{Y^N - C^N - G^N}{P_I'} - \delta K. \tag{206}$$

Inserting short-run static solutions for non traded output (120), consumption in non tradables (82), and the capital-labor ratio in the non traded sector (116) into the physical capital accumulation equation (206) and the dynamic equation for the relative price of non tradables (205d), the dynamic system is:

$$\dot{K} = \frac{Y^N\left(K, P, \bar{\lambda}\right) - C^N\left(\bar{\lambda}, P\right) - G^N}{P_I'} - \delta K, \tag{207a}$$

$$\dot{P} = \frac{P}{\alpha_I}\left[(r^\star + \delta) - \frac{P}{P_I(P)} Z^N h_k\left(K, P, \bar{\lambda}\right)\right], \tag{207b}$$

where for the purposes of clarity, we abstract from time-constant arguments of short-run static solutions, i.e., Z^T, and Z^N.

Denoting with a tilde long-run values, linearizing these two equations around the steady-state yields in matrix form:

$$\begin{pmatrix} \dot{K}(t) \\ \dot{P}(t) \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} K(t) - \tilde{K} \\ P(t) - \tilde{P} \end{pmatrix}, \tag{208}$$

where

$$a_{11} = \left(\frac{Y_K^N}{P_I'} - \delta_K\right) > 0, \tag{209a}$$

$$a_{12} = \frac{\left(Y_P^N - C_P^N\right)}{P_I'} + \frac{\tilde{I}^N \phi_I \left(1-\alpha_I\right)}{\tilde{P} P_I'}, \tag{209b}$$

$$a_{21} = -\frac{\tilde{P}^2 Z^N h_{kk} k_K^N}{\alpha_I P_I} > 0, \tag{209c}$$

$$a_{22} = \frac{\tilde{P} Z^N h_k}{\alpha_I P_I}\left[\theta^N \frac{k_P^N \tilde{P}}{\tilde{k}^N} - (1-\alpha_I)\right]. \tag{209d}$$

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. The term $a_{21}a_{12}$ is always negative, regardless of sectoral capital intensities while the term. If $k^T > k^N$, we have $Y_K^N < 0$ and $k_P^N > 0$; a_{11} is negative while a_{22} is positive as long as $(1-\alpha_I)$ which is the tradable content of investment expenditure is not too large. In this case, we have $a_{11}a_{22} < 0$. If $k^N > k^T$, we have $Y_K^N > 0$ and $k_P^N < 0$. Hence, a_{11} becomes positive while a_{22} becomes unambiguously negative. As a result, we have $a_{11}a_{22} < 0$. To conclude, the saddle-path stability condition is fulfilled regardless of sectoral capital intensities as long as $(1-\alpha_I)$ does not exceed the elasticity of k^N with respect to P.

Assuming that the saddle-path stability condition is fulfilled, the stable solutions for K and P are:

$$K(t) = \tilde{K} + \left(K_0 - \tilde{K}\right) e^{\mu_1 t}, \tag{210a}$$

$$P(t) = \tilde{P} + \omega_2^1 \left(K_0 - \tilde{K}\right) e^{\mu_1 t}, \tag{210b}$$

where K_0 is the initial capital stock and $\left(1, \omega_2^1\right)'$ is the eigenvector associated with the stable negative eigenvalue μ_1:

$$\omega_2^1 = \frac{\mu_1 - a_{11}}{a_{12}} \tag{211}$$

For all plausible sets of parameter values, we find numerically $\omega_2^1 < 0$, regardless of sectorial capital intensities, which implies that the relative price of non tradables and the stock physical capital move in opposite direction.

Remembering that $I^T = (1-\alpha_I) P_I I$ with $I = \dot{K} + \delta K$, the current account equation is given by:

$$\dot{B} = Y^T - C^T - G^T - (1-\alpha_I) P_I \left(\dot{K} + \delta K\right). \tag{212}$$

Substituting the short-run static solutions for traded output (120) and consumption in tradables (82) into the accumulation equation of foreign bonds (212), linearizing, solving and invoking the transversality condition yields:

$$B(t) = \tilde{B} + \Phi(K_0 - \tilde{K}) e^{\mu_1 t}, \tag{213}$$

where $\Phi \equiv \frac{N_1}{\mu_1 - r^\star}$ and

$$\begin{aligned} N_1 = & \left[Y_K^T - \left(\frac{1-\alpha_I}{\alpha_I}\right)\tilde{P} Y_K^N\right] + \left\{\left(Y_P^T - C_P^T\right)\right. \\ & \left. - \left(\frac{1-\alpha_I}{\alpha_I}\right)\tilde{P}\left(Y_K^N - C_P^N\right) - \phi_I \left(\frac{1-\alpha_I}{\alpha_I}\right)\tilde{I}^N\right\}\omega_2^1. \end{aligned} \tag{214}$$

The intertemporal solvency condition of the economy is:

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right), \tag{215}$$

where B_0 is the initial stock of traded bonds.

E.3 The Steady-State

We now describe the steady-state by abstracting from government spending for clarity purpose. Plugging the short-run static solutions for consumption in tradables and non tradables given by (82) and for hours worked in the traded and non traded sector given by (84), the steady-state is defined by the following set of equations:

$$\tilde{P} Z^N (1-\theta_N) \left(\tilde{k}^N\right)^{-\theta_N} \equiv P_I\left(\tilde{P}\right) r^\star + \delta, \tag{216a}$$

$$Z^T (1-\theta_T) \left(\tilde{k}^T\right)^{-\theta_T} = \tilde{P} Z^N (1-\theta_N) \left(\tilde{k}^N\right)^{-\theta_N} \equiv \tilde{R}, \tag{216b}$$

$$Z^T \theta_T \left(\tilde{k}^T\right)^{1-\theta_T} \equiv \tilde{W}^T, \tag{216c}$$

$$P Z^N \theta_N \left(\tilde{k}^N\right)^{1-\theta_N} \equiv \tilde{W}^N, \tag{216d}$$

$$\tilde{k}^T L^T\left(\bar{\lambda}, \tilde{W}^T, \tilde{W}^N\right) + \tilde{k}^N L^N\left(\bar{\lambda}, \tilde{W}^T, \tilde{W}^N\right) = \tilde{K}, \tag{216e}$$

$$\tilde{Y}^N = C^N\left(\bar{\lambda}, \tilde{P}\right) + P_I'\left(\tilde{P}\right)\delta\tilde{K}, \tag{216f}$$

$$\tilde{Y}^T = C^T\left(\bar{\lambda}, \tilde{P}\right) + (1-\alpha_I) P_I\left(\tilde{P}\right)\delta\tilde{K} - r^\star\tilde{B}, \tag{216g}$$

$$\tilde{B} - B_0 = \Phi\left(\tilde{K} - K_0\right), \tag{216h}$$

where $\tilde{Y}^T = Z^T L^T\left(\bar{\lambda}, \tilde{W}^T, \tilde{W}^N\right)\left(\tilde{k}^T\right)^{1-\theta_T}$ and $\tilde{Y}^T = Z^N L^N\left(\bar{\lambda}, \tilde{W}^T, \tilde{W}^N\right)\left(\tilde{k}^N\right)^{1-\theta_N}$. This system of equations jointly solve for sectoral capital-labor ratios, $\tilde{k}^T$ and $\tilde{k}^N$, for sectoral wages, $\tilde{W}^T$ and $\tilde{W}^N$, the relative price of non tradables, $\tilde{P}$, the capital stock, $\tilde{K}$, the stock of foreign assets, $\tilde{B}$, and the shadow value of wealth $\bar{\lambda}$.

E.4 Graphical Apparatus: Rewriting the Steady-State

Before breaking down the three channels analytically, we characterize the steady state graphically, which allows us to emphasize how introducing traded investment modifies the results. We assume that $I\left(I^T, I^N\right)$ takes a Cobb-Douglas form as evidence that $\phi_I = 1$ (see Bems [2008]). The steady-state can be rewritten as follows:

$$\frac{\tilde{C}^T}{\tilde{C}^N} = \frac{\varphi}{1-\varphi}\tilde{P}^\phi, \tag{217a}$$

$$\frac{\tilde{L}^T}{\tilde{L}^N} = \frac{\vartheta}{1-\vartheta}\tilde{\omega}^{-\epsilon}, \tag{217b}$$

$$\frac{\tilde{Y}^T\left(1+\upsilon_B-\upsilon_{I^T}\right)}{\tilde{Y}^N\left(1-\upsilon_{I^N}\right)} = \frac{\tilde{C}^T}{\tilde{C}^N}, \tag{217c}$$

$$\tilde{P} Z^N (1-\theta_N) \left(\tilde{k}^N\right)^{-\theta_N} \equiv P_I\left(\tilde{P}\right)\left(r^\star + \delta\right), \tag{217d}$$

$$Z^T (1-\theta_T) \left(\tilde{k}^T\right)^{-\theta_T} = \tilde{P} Z^N (1-\theta_N) \left(\tilde{k}^N\right)^{-\theta_N} \equiv \tilde{R}, \tag{217e}$$

$$Z^T \theta_T \left(\tilde{k}^T\right)^{1-\theta_T} \equiv \tilde{W}^T, \tag{217f}$$

$$P Z^N \theta_N \left(\tilde{k}^N\right)^{1-\theta_N} \equiv \tilde{W}^N, \tag{217g}$$

where $\tilde{\omega} = \tilde{W}^N/\tilde{W}^T$ is the steady-state relative wage and $\tilde{R}/\tilde{P} = r^\star + \delta$. We denoted by $\upsilon_{I^N} \equiv \frac{\tilde{I}^N}{\tilde{Y}^N}$ ($\upsilon_{I^T} \equiv \frac{\tilde{I}^T}{\tilde{Y}^T}$) the ratio of non traded (traded) investment to non traded (traded) output and by $\upsilon_B \equiv \frac{r^\star\tilde{B}}{\tilde{Y}^T}$ the ratio of interest receipts to traded output.

Because we restrict ourselves to the analysis of the long-run effects, the tilde is suppressed for the purposes of clarity.

E.5 Goods Market Equilibrium

Applying the same procedure as in section C.6, combining (217a) with (217c) yields the GME-equilibrium schedule described by:

$$\left.\frac{y^T}{y^N}\right|^{GME} = \phi p + x', \tag{218}$$

where $x' = \ln\left(\frac{\varphi}{1-\varphi}\right) + \ln\left(\frac{1-\upsilon_{IN}}{1+\upsilon_B-\upsilon_{IT}}\right)$. The goods market equilibrium is upward-sloping in the $(y^T/y^N, p)$-space and its slope is equal to $1/\phi$.

Combining (217b) with (217f)-(217g) and production functions, we get:

$$\frac{Y^T}{Y^N} = \frac{\vartheta}{1-\vartheta}\left(\frac{Z^T}{Z^N}\right)^{\epsilon+1} P^{-\epsilon}\left(\frac{\theta_T}{\theta_N}\right)^{\epsilon}\left[\frac{\left(k^T\right)^{1-\theta_T}}{\left(k^N\right)^{1-\theta_N}}\right]^{1+\epsilon}.$$

Combining (217d) and (217e) yields:

$$\frac{\left(k^N\right)^{1-\theta_N}}{\left(k^T\right)^{1-\theta_T}} = P^{\frac{1-\theta_N}{\theta_N}}\left[P_I\left(r^\star+\delta_K\right)\right]^{\frac{1-\theta_T}{\theta_T}-\frac{1-\theta_N}{\theta_N}}\frac{\left[Z^N\left(1-\theta_N\right)\right]^{\frac{1-\theta_N}{\theta_N}}}{\left[Z^T\left(1-\theta_T\right)\right]^{\frac{1-\theta_T}{\theta_T}}}. \tag{219}$$

Inserting (219) to eliminate sectorial capital-labor ratios yields the LME-schedule:

$$\frac{Y^T}{Y^N} = P^{-\left[\epsilon+\left(\frac{1-\theta_N}{\theta_N}\right)(1+\epsilon)\right]} P_I^{\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)(1+\epsilon)}\frac{\left(Z^T\right)^{\frac{1+\epsilon}{\theta_T}}}{\left(Z^N\right)^{\frac{1+\epsilon}{\theta_N}}}\tilde{\Pi}', \tag{220}$$

where we set

$$\tilde{\Pi}' = \frac{\vartheta}{1-\vartheta}\left(r^\star+\delta\right)^{\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)(1+\epsilon)}\frac{\left[\left(\theta_T\right)^{\epsilon\theta_T}\left(1-\theta_T\right)^{(1-\theta_T)(1+\epsilon)}\right]^{1/\theta_T}}{\left[\left(\theta_N\right)^{\epsilon\theta_N}\left(1-\theta_N\right)^{(1-\theta_N)(1+\epsilon)}\right]^{1/\theta_N}} > 0. \tag{221}$$

As mentioned above, we assume that the aggregator function for inputs of the investment good is Cobb-Douglas since data suggest that $\phi_I = 1$. Taking logarithm, (220) can be rewritten as follows:

$$\left.\frac{y^T}{y^N}\right|^{GME} = -\left\{\epsilon+(1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right)-(1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}p+\left(\frac{1+\epsilon}{\theta_T}\right)\left(z_T-\frac{\theta^T}{\theta_N}z_N\right)+\pi', \tag{222}$$

where $\pi' = \ln\Pi'$.

Setting $\varphi_I = 0$ into (222) implies that the LME-schedule is unambiguously negative in the $(y^T/y^N, p)$-space. This result holds when $\varphi_I > 0$ as long as $\theta^T > \theta^N$ or if θ^T is close to θ^N as data suggest. The slope of the LME-schedule in the $(y^T/y^N, p)$-space is

$$\left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME}_{\vartheta_I>0} = -\frac{1}{\left\{\epsilon+(1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right)-(1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}} \tag{223}$$

The slope of the LME-schedule in the $(y^T/y^N, p)$-space is unambiguously negative and varies between $\frac{1}{\epsilon+(1+\epsilon)\left(\frac{1-\theta^N}{\theta^N}\right)}$ if investment expenditure are traded only (i.e., φ_I is set to one) and $\frac{1}{\epsilon+(1+\epsilon)\left(\frac{1-\theta^T}{\theta^T}\right)}$ if investment expenditure are non-traded only (i.e., φ_I is set to zero).

First, we compare the slope of the LME-schedule when investment expenditure are both traded and non traded with the slope of the LME-schedule in a model abstracting from physical capital. We find that that the LME-schedule in a model abstracting from physical capital is steeper in the $(y^T/y^N, p)$-space if the following condition $\theta^N\left(1-\theta^T\right) > \varphi_I\left(\theta^N-\theta^T\right)$ holds.

Second, we compare the slope of the LME-schedule when investment expenditure are both traded and non traded with the slope of the LME-schedule when investment expenditure are non-traded only (i.e., φ_I is set to 0). Formally, we find that the former is steeper than the latter in the $(y^T/y^N, p)$-space if the following condition holds:

$$\left(\theta_N-\theta_T\right)\varphi_I > 0,$$

where θ_T and θ_N correspond to the labor share in the traded and the non traded sectors, respectively. The LME-schedule when $\varphi_I > 0$ is steeper than the LME-schedule when $\varphi_I = 0$ in the $(y^T/y^N, p)$-space as long as $\theta^N > \theta^T$, i.e. if the traded sector is more capital intensive than the non traded sector.

At this stage, it is useful to summarize our results when focusing on the goods market equilibrium in the $(y^T/y^N, \omega)$-space. We have to consider two cases, depending on whether the traded sector is more or less capital intensive then the non traded sector:

- If $\theta^N > \theta^T$, the following inequalities hold:

$$\left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME} < \left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME}_{\vartheta_I>0} < \left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME}_{\vartheta_I=0} < 0.$$

- If $\theta^T > \theta^N$, the following inequalities hold:

$$\left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME} < \left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME}_{\vartheta_I=0} < \left.\frac{\mathrm{d}p}{\mathrm{d}y^T/y^N}\right|^{LME}_{\vartheta_I>0} < 0.$$

E.6 Labor Market Equilibrium

Taking logarithm, (217b) can be rewritten to give the labor supply-schedule (henceforth LS-schedule):

$$\left.\frac{l^T}{l^N}\right|^{LS} = -\epsilon\omega + d, \tag{224}$$

where $d = \ln\left(\frac{\vartheta}{1-\vartheta}\right)$. 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. Dividing (217g) by (217f) yields:

$$\frac{PZ^N\theta_N\left(k^N\right)^{1-\theta_N}}{Z^T\theta_T\left(k^T\right)^{1-\theta_T}} = \tilde{\omega}. \tag{225}$$

To eliminate the sectoral capital-labor ratios, we use (217d)-(217e), i.e.

$$\frac{\left(k^N\right)^{1-\theta_N}}{\left(k^T\right)^{1-\theta_T}} = P^{\frac{1-\theta_N}{\theta_N}}\left[P_I\left(r^\star+\delta\right)\right]^{\frac{\theta^N-\theta^T}{\theta^T\theta^N}} \frac{\left[Z^N\left(1-\theta_N\right)\right]^{\frac{1-\theta_N}{\theta_N}}}{\left[Z^T\left(1-\theta_T\right)\right]^{\frac{1-\theta_T}{\theta_T}}}. \tag{226}$$

To eliminate the relative price of non tradables, combine the market-clearing condition (217c) and the demand for traded goods in terms of non traded goods (217a) together with production functions (16):

$$P = \left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B-\upsilon_{I^T}}{1-\upsilon_{I^N}}\frac{Z^TL^T\left(k^T\right)^{1-\theta_T}}{Z^NL^N\left(k^N\right)^{1-\theta_N}}\right]^{\frac{1}{\phi}}. \tag{227}$$

Substituting (227) into (226) yields:

$$\begin{aligned}\frac{\left(k^N\right)^{1-\theta_N}}{\left(k^T\right)^{1-\theta_T}} &= \left(r^\star+\delta\right)^{\frac{\phi\left(\theta_N-\theta_T\right)}{\psi}}\left[\frac{1-\varphi}{\varphi}\frac{1+\upsilon_B-\upsilon_{I^T}}{1-\upsilon_{I^N}}\frac{L^T}{L^N}\right]^{\frac{\left[\left(1-\theta^N\right)\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}{\psi}} \\ &\times\left[\frac{\left(1-\theta_N\right)^{\left(\frac{1-\theta_N}{\theta^N}\right)}}{\left(1-\theta_T\right)^{\left(\frac{1-\theta_T}{\theta^T}\right)}}\right]^{\frac{\phi\theta^T\theta^N}{\psi}} \frac{\left(Z^N\right)^{\frac{\left[\theta^T\left(1-\theta^N\right)(\phi-1)-\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}{\psi}}}{\left(Z^T\right)^{\frac{\left(1-\theta^T\right)\phi\theta^N-\left[\left(1-\theta^N\right)\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}{\psi}}},\end{aligned} \tag{228}$$

where we set

$$\psi \equiv \theta^T\left[1+\theta^N\left(\phi-1\right)\right]+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right) \tag{229}$$

Substituting first (227) into (225), we get:

$$\omega = \frac{\theta^N}{\theta^T}\left[\left(\frac{1+\upsilon_B-\upsilon_{I^T}}{1-\upsilon_{I^N}}\right)\left(\frac{1-\varphi}{\varphi}\right)\frac{L^T}{L^N}\right]^{\frac{1}{\phi}}\left(\frac{Z^N}{Z^T}\right)^{\frac{\phi-1}{\phi}}\left[\frac{\left(k^N\right)^{1-\theta_N}}{\left(k^T\right)^{1-\theta_T}}\right]^{\frac{\phi-1}{\phi}}.$$

Then plugging (228) enables us to find a relationship between labor in tradables relative to non tradables and the relative wage along the LD-schedule:

$$\frac{L^T}{L^N} = \omega^{\frac{\psi}{\left[\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}} + \left(\frac{Z^T}{\left(Z^N\right)^{\frac{\theta_T}{\theta_N}}}\right)^{\frac{(\phi-1)\theta^N}{\left[\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}}\Theta', \tag{230}$$

where we set

$$\Theta' = \left(\frac{1-\upsilon_{I^N}}{1+\upsilon_B-\upsilon_{I^T}}\right)\left(\frac{\varphi}{1-\varphi}\right)\left[\left(r^\star+\delta\right)^{(\theta_T-\theta_N)}\left(\frac{\theta_T}{\theta_N}\right)^{\frac{\psi}{\phi-1}}\frac{\left(1-\theta_T\right)^{(1-\theta_T)\theta^N}}{\left(1-\theta_N\right)^{(1-\theta_N)\theta^T}}\right]^{\frac{(\phi-1)}{\left[\theta^T+(1-\varphi_I)(\theta^N-\theta^T)\right]}}. \tag{231}$$

Taking logarithm, (230) can be rewritten to yield the labor demand-schedule (henceforth LD-schedule):

$$\left.\frac{l^T}{l^N}\right|^{LD} = \frac{\psi}{\left[\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}\omega + \frac{\left(\phi-1\right)\theta^N}{\left[\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right]}\left(z^T-\frac{\theta_T}{\theta_N}z^N\right)+\ln\Theta'. \tag{232}$$

The slope of the LD-schedule in the $(y^T/y^N, p)$-space is:

$$\left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD}_{\vartheta_I>0} = \frac{\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)}{\theta^T\left[1+\theta^N\left(\phi-1\right)\right]+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)} > 0. \tag{233}$$

First, we compare the slope of the LD-schedule when investment expenditure are both traded and non traded with the slope of the LD-schedule in a model abstracting from physical capital. We find that the LD-schedule in a model abstracting from physical capital is steeper in the $(l^T/l^N,\omega)$-space if the following condition holds:

$$\left(1-\phi\right)\left[\theta^T+\left(1-\varphi_I\right)\left(\theta^N-\theta^T\right)\right] > 0. \tag{234}$$

The LD-schedule in a model abstracting from physical capital is steeper in the $(l^T/l^N,\omega)$-space than the LD-schedule in a model where $\varphi_I > 0$ as long as $\phi < 1$.

Second, we compare the slope of the LD-schedule when investment expenditure are both traded and non traded with the slope of the LD-schedule when investment expenditure are non traded only (i.e., φ_I is set to 0). Formally, we find that the former is flatter than the latter in the $(l^T/l^N,\omega)$-space if the following condition holds:

$$\left(\phi-1\right)\left(\theta^N-\theta^T\right)\varphi_I > 0. \tag{235}$$

According to (235), when $\phi < 1$ and the traded sector is more capital intensive (i.e. $\theta^N > \theta^T$), the LD-schedule when investment expenditure are both traded and non traded is flatter than the LD-schedule when investment expenditure are non traded.

At this stage, it is useful to summarize our results when focusing on the labor market equilibrium in the $(l^T/l^N,\omega)$-space. We have to consider two cases, depending on whether ϕ is larger or smaller than one. For clarity purpose, we assume that the traded sector is more capital intensive than the non-traded sector (i.e., we impose $\theta^N > \theta^T$):

- If $\phi > 1$ and $\theta^N > \theta^T$, these inequalities hold:

$$\left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD}_{\vartheta_I=0} > \left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD}_{\vartheta_I>0} > \left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD} > 0.$$

- If $\phi < 1$ and $\theta^N > \theta^T$, these inequalities hold:

$$\left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD} > \left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD}_{\vartheta_I>0} > \left.\frac{\mathrm{d}\omega}{\mathrm{d}l^T/l^N}\right|^{LD}_{\vartheta_I=0} > 0.$$

E.7 The Relative Price and Relative Wage Effects of a Productivity Differential

The Relative Price Effect

Equating (218) and (222) to eliminate y^T/y^N and differentiating yields the percentage deviation of the relative price of non tradables from its initial steady-state following a productivity differential between tradables and non tradables:

$$\hat{\tilde{p}} = \frac{\left(1+\epsilon\right)\left[\frac{\theta_N}{\theta_T}\hat{z}^T-\hat{z}^N\right]+\theta^N\mathrm{d}\ln\left(\frac{1+\upsilon_B-\upsilon_{I^T}}{1-\upsilon_{I^N}}\right)}{\theta^N\left\{\left(\epsilon+\phi\right)+\left(1+\epsilon\right)\left[\left(\frac{1-\theta_N}{\theta_N}\right)-\left(1-\varphi_I\right)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}}. \tag{236}$$

To ease the interpretation of the equation, we rewrite the term $\ln\left(\frac{1+\upsilon_B-\upsilon_{I^T}}{1-\upsilon_{I^N}}\right)$ as $\ln(1+\upsilon_B-\upsilon_{I^T}) - \ln(1-\upsilon_{I^N})$, by using a Taylor approximation at a first order which implies $\ln(1+\upsilon_B-\upsilon_{I^T}) - \ln(1-\upsilon_{I^N}) \simeq \upsilon_B - \upsilon_{I^T} + \upsilon_{I^N}$. Then using the fact that $\upsilon_B = -\upsilon_{NX}$, (236) reads:

$$\hat{p} = \frac{(1+\epsilon)\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right] + \theta^N\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right)}{\theta^N\left\{(\epsilon+\phi) + (1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right) - (1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}}$$

When considering that investment is both non traded and traded investment, the labor share-adjusted TFP differential becomes:

$$\frac{\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}(1-\vartheta_I)}. \tag{237}$$

Using (237) and rearranging terms, the long-run response of the relative price given by (236) becomes:

$$\hat{p} = (1+\epsilon)\,\Theta^{KT}\frac{\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}(1-\vartheta_I)} - \frac{\theta^T\theta^N}{\theta^T\vartheta_I + \theta^N(1-\vartheta_I)}\Theta^{KT}\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right) \tag{238}$$

where we set

$$\begin{aligned}\Theta^{KT} &= \frac{\theta^T\vartheta_I + \theta^N(1-\vartheta_I)}{\theta^N\left\{(\epsilon+\phi) + (1+\epsilon)\left[\left(\frac{1-\theta_N}{\theta_N}\right) - (1-\varphi_I)\left(\frac{\theta_T-\theta_N}{\theta_T\theta_N}\right)\right]\right\}}, \\ &= \frac{\theta^T\vartheta_I + \theta^N(1-\vartheta_I)}{(1+\epsilon)\left[\theta^T\vartheta_I + \theta^N(1-\vartheta_I)\right] + (\phi-1)\,\theta^T\theta^N}.\end{aligned} \tag{239}$$

We now break down the long-run relative price response to a productivity differential into three components by adding and subtracting the following terms Θ^K and Θ^L in the RHS of (238):

$$\begin{aligned}\hat{p} &= (1+\epsilon)\left[\Theta^L + \left(\theta^K - \theta^L\right) + \left(\Theta^{KT} - \Theta^K\right)\right]\frac{\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}(1-\vartheta_I)} \\ &\quad - \frac{\theta^T\theta^N}{\theta^T\vartheta_I + \theta^N(1-\vartheta_I)}\Theta^{KT}\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right),\end{aligned} \tag{240}$$

where

$$\Theta^{KT} - \Theta^K = -\frac{\theta^T(\phi-1)\,\vartheta_I\left(\theta^N - \theta^T\right)}{\left\{(1+\epsilon)\left[\theta^T\vartheta_I + \theta^N(1-\vartheta_I)\right] + (\phi-1)\,\theta^T\theta^N\right\}\left\{(1+\epsilon) + (\phi-1)\,\theta^T\right\}} \lesseqgtr 0. \tag{241}$$

While the sign of the numerator is ambiguous as it depends on $\phi \gtreqless 1$ and $\theta^N \gtreqless \theta^T$, the sign of the denominator is unambiguously positive.

The Relative Wage Effect

Equating (224) and (232) to eliminate l^T/l^N, taking logarithm and differentiating yields the percentage deviation of the relative wage ω from its initial steady-state following a productivity differential:

$$\begin{aligned}\hat{\omega} &= -\frac{(\phi-1)\,\theta^N\left(\hat{z}^T - \frac{\theta_T}{\theta_N}\hat{z}^N\right) + \left[\theta^T + (1-\varphi_I)\left(\theta^N - \theta^T\right)\right] - \mathrm{d}\ln\left(\frac{1-\upsilon_{I^N}}{1+\upsilon_B-\upsilon_{I^T}}\right)}{(1+\epsilon)\left[\theta^T + (1-\varphi_I)\left(\theta^N - \theta^T\right)\right] + \theta^T\theta^N(\phi-1)}, \\ &\quad -\frac{(\phi-1)\,\theta^N\left(\hat{z}^T - \frac{\theta_T}{\theta_N}\hat{z}^N\right) + \left[\theta^T + (1-\varphi_I)\left(\theta^N - \theta^T\right)\right]\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right)}{(1+\epsilon)\left[\theta^T + (1-\varphi_I)\left(\theta^N - \theta^T\right)\right] + \theta^T\theta^N(\phi-1)},\end{aligned} \tag{242}$$

where the second line has been obtained by using a Taylor approximation at the first order to rewrite $\ln\left(\frac{1-\upsilon_{I^N}}{1+\upsilon_B-\upsilon_{I^T}}\right)$ as $\ln(1-\upsilon_{I^N}) - (1+\upsilon_B-\upsilon_{I^T}) \simeq -\upsilon_{I^N} - \upsilon_B + \upsilon_{I^T} = (\upsilon_{NX} + \upsilon_{I^T} - \upsilon_{I^N})$.

Inserting Θ^{KT} given by (239) and using the labor share-adjusted TFPs differential (237), the long-run response of the relative wage (242) can be rewritten as follows:

$$\hat{\omega} = -(\phi-1)\,\Theta^{KT}\frac{\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}(1-\vartheta_I)} - \Theta^{KT}\frac{\left[\theta^T + (1-\varphi_I)\left(\theta^N - \theta^T\right)\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}(1-\vartheta_I)}\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right). \tag{243}$$

We now break down the long-run relative wage response to a productivity differential into three components by adding and subtracting Θ^K and Θ^L in the RHS of (243). We get:

$$\begin{aligned}\hat{\omega} &= -(\phi-1)\left[\Theta^L + \left(\theta^K - \theta^L\right) + \left(\Theta^{KT} - \Theta^K\right)\right]\frac{\left[\frac{\theta_N}{\theta_T}\hat{z}^T - \hat{z}^N\right]}{\vartheta_I + \frac{\theta^N}{\theta^T}\left(1-\vartheta_I\right)} \\ &\quad -\Theta^{KT}\left[\theta^T + \left(1-\varphi_I\right)\left(\theta^N - \theta^T\right)\right]\left(\mathrm{d}\upsilon_{NX} + \mathrm{d}\upsilon_{I^T} - \mathrm{d}\upsilon_{I^N}\right), \end{aligned} \tag{244}$$

where $-(\phi-1)\left(\Theta^{KT} - \Theta^K\right)$ is positive as long as the non-traded sector is more labor intensive than the traded sector:

$$-(\phi-1)\left(\Theta^{KT} - \Theta^K\right) = \frac{\theta^T(\phi-1)^2\vartheta_I\left(\theta^N - \theta^T\right)}{\left\{(1+\epsilon)\left[\theta^T\vartheta_I + \theta^N\left(1-\vartheta_I\right)\right] + (\phi-1)\theta^T\theta^N\right\}\left\{(1+\epsilon) + (\phi-1)\theta^T\right\}} \gtrless 0. \tag{245}$$

In order to shed light analytically on the implications of considering that investment expenditure are both traded and non-traded, it is useful to break down the reallocation channel as follows $-(\phi-1)\left[\left(\theta^{KT} - \theta^K\right) + \left(\theta^K - \theta^L\right)\right]$. While $-(\phi-1)\left(\theta^{KT} - \theta^K\right)$ reflects the reallocation channel when investment is non-tradable, the novel term $-(\phi-1)\left(\theta^{KT} - \theta^K\right)$ captures the **user capital cost channel** arising when investment expenditure are both traded and non-traded. To keep things simple, let us assume that the traded sector is more capital intensive than the non-traded sector (i.e., we set $\theta^N > \theta^T$). In this case, $-(\phi-1)\left(\Theta^{KT} - \Theta^K\right) > 0$.[68] Hence, irrespective of whether ϕ is larger or smaller than one, introducing traded investment raises the relative wage compared with a model assuming $\varphi_I = 0$. Intuitively, the user capital cost $P_I\left(r^\star + \delta_K\right)$ increases less when $0 < \varphi_I < 1$ since the investment price index increases in proportion of the non tradable content of investment expenditure, following an appreciation in the relative price, which mitigates the decline in the traded capital-labor ratio k^T. As long as the traded sector is more capital intensive (i.e., $\theta^N > \theta^T$), the non-traded sector experiences a smaller capital inflow which moderates the rise in non traded output compared with that in a model abstracting from traded investment. Graphically, the LD^K-schedule shown in Figure 5(a) would become flatter if $\phi > 1$ while the LD^K-schedule in Figure 6(a) would become steeper if $\phi < 1$. Hence, in either cases, introducing traded investment moderates the decline in the relative wage induced by the capital reallocation channel.

F Empirical Strategy to Estimate Two Pivotal Parameters

In this section, we detail our empirical strategy to estimate two pivotal parameters for the whole sample and for each economy: i) the degree of substitutability of hours worked across sectors ϵ which captures the degree of labor mobility, ii) the elasticity of substitution between traded and non traded goods ϕ .

F.1 Estimates of the Degree of Substitutability of Hours Worked across Sectors ϵ

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 maximizes the following objective function:

$$U = \int_0^\infty (1-\gamma)\ln C(t) + \gamma\ln\left(1 - L(t)\right)e^{-\beta t}\mathrm{d}t, \tag{246}$$

subject to

$$\dot{A}(t) = r^\star A(t) + W(t)L(t) - P_C\left(P(t)\right)C(t). \tag{247}$$

[68]The sign of $\Theta^{KT} - \Theta^K$ depends on sectoral capital intensities. Formally, we have:

$$-(\phi-1)\left(\Theta^{KT} - \Theta^K\right) = \frac{\theta^T(\phi-1)^2\vartheta_I\left(\theta^N - \theta^T\right)}{\left\{(1+\epsilon)\left[\theta^T\vartheta_I + \theta^N\left(1-\vartheta_I\right)\right] + (\phi-1)\theta^T\theta^N\right\}\left\{(1+\epsilon) + (\phi-1)\theta^T\right\}} \gtrless 0.$$

While the denominator is unambiguously positive, the sign of the numerator depends on $\left(\theta^N - \theta^T\right)$. If $\theta^N > \theta^T$, we have $-(\phi-1)\left(\Theta^{KT} - \Theta^K\right) > 0$.

First-order conditions are:

$$\frac{1-\gamma}{C} = (P_C \lambda), \tag{248a}$$

$$\frac{\gamma}{1-L} = W\lambda, \tag{248b}$$

$$\dot{\lambda} = \lambda (\beta - r^{\star}). \tag{248c}$$

The economic system consists of M distinct sectors, indexed by $j = 1, 2, ..., M$ each producing a different good. Along the lines of Horvath [2000], the aggregate leisure index is assumed to take the form:

$$Z(l) = 1 - \left[\int_0^M \left(l^j\right)^{\frac{\epsilon+1}{\epsilon}} \mathrm{d}j \right]^{\frac{\epsilon}{\epsilon+1}}. \tag{249}$$

The agent maximizes (249) subject to

$$\int_0^M w^j l^j \mathrm{d}j = X, \tag{250}$$

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

$$l^j = \left(\frac{w^j}{W}\right)^{\epsilon} L. \tag{251}$$

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

Combining (248a) and (248b), the aggregate wage index is:

$$W = \frac{\gamma}{1-\gamma} \frac{P_C C}{1-L} \tag{252}$$

which allows us to rewrite (251) as follows:

$$l^j = \left(w^j\right)^{\epsilon} L \left(\frac{\gamma}{1-\gamma}\frac{P_C C}{1-L}\right)^{-\epsilon} \tag{253}$$

Firms operate constant returns-to-scale production technologies that use capital k^j and labor l^j:

$$y^j = Z^j \left(l^j\right)^{\theta^j} \left(k^j\right)^{1-\theta^j}. \tag{254}$$

The firm in sector i seeks to maximize the profit function given by:

$$\pi^j = p^j y^j - w^j l^j - r_k k_i, \tag{255}$$

where r^k is the user capital cost. Firms take the wage rate as given and equate the labor's marginal product to the wage to determine demand. First-order conditions are:

$$p^j \frac{\theta^j y_i}{l^j} = w^j, \quad p^j \frac{\left(1-\theta^j\right) y_i}{k^j} = r_k. \tag{256}$$

Eliminating the sectoral wage w^j into (253) by using labor demand given by (256), the equilibrium condition for labor is given by:

$$l^j = \left(\theta^j p^j y^j\right)^{\frac{\epsilon}{\epsilon+1}} L^{\frac{1}{1+\epsilon}} \left(\frac{\gamma}{1-\gamma}\frac{P_C C}{1-L}\right)^{-\frac{\epsilon}{\epsilon+1}}. \tag{257}$$

Summing over the M sectors and using (249), we get:

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

Plugging this equation into (257) yields:

$$l^j = \left(\frac{\theta^j p^j y^j}{\sum_{i=1}^{M} \theta^j p^j y^j}\right)^{\frac{\epsilon}{\epsilon+1}} L, \tag{258}$$

where θ^j is the share of labor income in output of sector j. Hence, we have $\theta^j p^j y^j = w^j l^j$ and $\sum_{i=1}^{M} \theta^j p^j y^j = \sum_{i=1}^{M} w^j l^j$. As in Horvath [2000], we denote by β^j the share of labor compensation of sector j in total labor compensation:

$$\beta^j = \frac{w^j l^j}{\sum_{j=1}^{M} w^j l^j}. \tag{259}$$

Expressing (258) in percentage changes and adding an estimation error term ν results in the M estimation equations:

$$\hat{l}_t^j - \hat{L}_t = \frac{\epsilon}{\epsilon+1}\hat{\beta}_t^j + \nu_t^j, \quad j = 1, ..., M, \tag{260}$$

where we used the fact that

$$W_t L_t = \sum_{i=1}^{M} w_t^j l_t^j, \quad L_t = \sum_{j=1}^{M} \frac{w_t^j}{W_t} l_t^j$$

Totally differentiating the equation above yields:

$$\hat{L}_t = \sum_{j=1}^{M} \beta_{t-1}^j \hat{l}_t^j. \tag{261}$$

We use panel data to estimate (260). Including country fixed effects captured by country dummies, f_i, and common macroeconomic shocks by year dummies, t_t, (260) can be rewritten as:

$$\hat{l}_{i,t}^j - \hat{L}_{i,t} = f_i + t_t + \gamma_i \hat{\beta}_{i,t}^j + \nu_{i,t}^j, \tag{262}$$

where $\gamma_i = \frac{\epsilon_i}{\epsilon_i+1}$ and $\beta_{i,t}^j$ is given by (259); j indexes the sector and i indexes the country. When exploring empirically (30), the parameter γ is alternatively assumed to be identical across countries when estimating for the whole sample or to be different across countries when estimating for each economy.

We split industries into two sectors, i.e., traded and non traded. The sample is running from 1972 to 2007 but run the regression (262) over two sub-periods 1972-1989 and 1990-2007 as well for robustness check. Empirical estimates of γ and $\hat{\epsilon} = \frac{1}{1-\hat{\gamma}}$ over the whole period 1972-2007, and over the sub-periods 1972-1989 and 1990-2007, for the whole sample and for each economy as well are reported in Table 15. Empirical results are consistent with an $\epsilon > 0$. For the whole sample, we find $\hat{\gamma} = 0.370$ over the period 1972-2007. Hence, an increase by 1 percentage point of the share of labor compensation in sector j relative to overall labor compensation shifts employment by 0.37 percentage point towards that sector; using the fact that $\epsilon = \frac{1}{1-\gamma}$, it implies that an increase in wages in sector j by 1% increases labor supply towards this sector by 0.587%. When estimating ϵ for each economy of our sample over the period 1972-2007, all coefficients are statistically significant, as shown in Table 15, except for Denmark. Excluding Denmark, we find that the degree of substitutability of hours worked across sectors ranges from a low of 0.213 for the Netherlands to a high of 1.791 for the US and 1.795 for Korea.

Table 15: Panel Data Estimates of eq. (262)

	1972-2007		1972-1989		1990-2007	
	$\hat{\gamma}_i$	$\hat{\epsilon}_i$	$\hat{\gamma}_i$	$\hat{\epsilon}_i$	$\hat{\gamma}_i$	$\hat{\epsilon}_i$
BEL	0.234^a	0.305^b	0.240^b	0.316	0.227^c	0.293
	(2.85)	(2.18)	(2.14)	(1.63)	(1.84)	(1.42)
DEU	0.378^a	0.607^a	0.285^b	0.399	0.450^a	0.818^b
	(4.15)	(2.58)	(2.08)	(1.49)	(3.69)	(2.03)
DNK	0.103	0.115	0.114	0.129	0.088	0.097
	(1.19)	(1.06)	(1.01)	(0.89)	(0.64)	(0.59)
ESP	0.622^a	1.648^a	0.830^a	4.878	0.516^a	1.067^b
	(7.15)	(2.70)	(5.57)	(0.95)	(4.74)	(2.29)
FIN	0.337^a	0.509^a	0.458^a	0.845^b	0.265^a	0.361^b
	(4.82)	(3.19)	(3.98)	(2.16)	(2.95)	(2.16)
FRA	0.557^a	1.256^b	0.557^a	1.256	0.557^a	1.259
	(4.93)	(2.18)	(3.61)	(1.60)	(3.30)	(1.46)
GBR	0.484^a	0.936^a	0.372^a	0.593^a	0.717^a	2.530
	(6.62)	(3.42)	(4.18)	(2.63)	(5.43)	(1.54)
IRL	0.195^a	0.242^a	0.031	0.031	0.294^a	0.417^a
	(3.36)	(2.71)	(0.32)	(0.31)	(3.98)	(2.81)
ITA	0.423^a	0.733^a	0.449^a	0.816^b	0.385^b	0.626
	(4.45)	(2.57)	(3.65)	(2.01)	(2.53)	(1.56)
JPN	0.499^a	0.998^b	0.506^a	1.025^c	0.491^a	0.964
	(5.10)	(2.55)	(3.95)	(1.95)	(3.21)	(1.63)
KOR	0.642^a	1.795^a	0.760^a	3.175^c	0.553^a	1.235^b
	(8.80)	(3.15)	(6.85)	(1.64)	(5.64)	(2.52)
NLD	0.176^b	0.213^c	0.096	0.106	0.357^b	0.556
	(2.07)	(1.71)	(0.94)	(0.85)	(2.30)	(1.48)
SWE	0.287^a	0.402^a	0.240^a	0.316^b	0.342^a	0.520^b
	(4.35)	(3.10)	(2.70)	(2.05)	(3.49)	(2.30)
USA	0.642^a	1.791^b	0.611^a	1.568	0.672^a	2.053
	(5.53)	(1.98)	(3.72)	(1.45)	(4.05)	(1.33)
R-squared	0.268		0.272		0.290	
All sample	0.370^a	0.587^a	0.346^a	0.529^a	0.394^a	0.651^a
	(16.81)	(10.59)	(10.81)	(7.07)	(12.32)	(7.46)
R-squared	0.221		0.190		0.251	
Observations	1 050		548		502	
Countries	14		14		14	

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

Table 16: Panel Unit Root Tests (p-values)

	LLC (t-stat)	Breitung (t-stat)	IPS (W-stat)	MW (ADF)	MW (PP)	Hadri (Z_μ-stat)
e^T/e^N	0.00	0.95	0.55	0.59	0.10	0.00
p	0.78	0.73	1.00	1.00	0.90	0.00
y	0.00	0.62	0.98	0.95	0.49	0.00

Notes: e^T/e^N is the ratio of expenditure on tradables relative to expenditure on non tradables; p is the relative price of non tradables; y is GDP per capita in volume. For all tests, except for Hadri, the null of a unit root is not rejected if p-value ≥ 0.05. For Hadri, the null of stationarity is rejected if p-value ≤ 0.05.

F.2 Estimates of ϕ: Empirical Strategy

We turn to our second pivotal parameter ϕ. The elasticity of substitution between traded and non traded goods ϕ is estimated by running the regression of logged relative expenditures on logged relative prices as proposed by Stockman and Tesar [1995]. Including country fixed effects captured by country dummies, f_i, we explore the following relationship empirically:

$$e^T_{i,t}/e^N_{i,t} = f_i + +\kappa_i p_{i,t} + \xi_i y_{i,t} + \eta_{i,t}, \tag{263}$$

where $\kappa_i = \phi_i - 1$, e^T_{it}/z^N_{it} is the logarithm of the ratio of expenditure on traded goods to expenditure on non traded goods in country i, p_i is the logarithm of the relative price of non tradables in country i, and y_i is GDP per capita in volume taken from OECD. 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 alternatively capture the wealth effect by time trend, thus replacing $y_{i,t}$ by a trend in (263). When exploring empirically (263), the parameter κ is alternatively assumed to be identical across countries when estimating for the whole sample or to be different across countries when estimating for each economy.

Since the log of relative expenditure and the relative price of non tradables display trends, we run unit root tests, see Tables 16 and 17. By and large, panel unit root tests confirm that all variables are non-stationary. As shown in Table 16, all panel based unit root tests confirm that relative expenditures, the relative price of non tradables and GDP per capita are non stationary, except the Levin, Lin and Chu's [2002] test based on a homogenous assumption for relative expenditure and GDP per capita. As shown by Im, Pesaran and Shin [2003], the "the small sample performance of the t-bar test is reasonably satisfactory and generally better than the test proposed by Levin and Lin". Column 3 of Table 16 reveals that all variables are $I(1)$ according to Im, Pesaran and Shin's [2003] panel based unit root test.

Having checked that all variables are non-stationary, we run cointegration tests. Results for cointegration tests are mixed. More precisely, four of the seven statistics confirm that relative expenditures and relative prices are cointegrated.

We run the regression (263) to estimate the cointegrating vector by using the panel dynamic OLS and the panel fully modified dynamic OLS estimators of Pedroni [2001]. Table 17 reports panel fully modified OLS (FMOLS) and panel dynamic OLS (DOLS) estimates of the coefficients κ and $\phi = 1+\gamma$ for each country.

Table 17: Panel cointegration tests results (p-values)

	Eq. (263)	
	with GDP per capita	without GDP per capita
Panel tests		
Non-parametric ν	0.018	0.056
Non-parametric ρ	0.489	0.313
Non-parametric t	0.421	0.455
Parametric t	0.121	0.055
Group-mean tests		
Non-parametric ν	0.030	0.148
Non-parametric t	0.137	0.340
Parametric t	0.001	0.000

Notes: "without GDP per capita" manes that GDP per capita is replaced with a time trend. 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.

Table 18: Estimates of the Cointegrating Slope Coefficient of (263) with GDP per capita

	$\hat{\kappa}^{DOLS}$	$\hat{\kappa}^{FMOLS}$	$\hat{\phi}^{DOLS}$	$\hat{\phi}^{FMOLS}$
BEL	1.406^c (1.66)	-0.531 (-1.02)	2.406^a (2.85)	0.469 (0.90)
DEU	0.140 (0.69)	-0.951^c (-1.74)	1.140^a (5.57)	0.049 (0.09)
DNK	1.055^c (1.95)	0.758 (1.43)	2.055^a (3.81)	1.758^a (3.31)
ESP	0.424^a (13.87)	-0.215 (-1.45)	1.424^a (46.56)	0.785^a (5.29)
FIN	-1.223^b (-2.28)	-1.120^a (-3.67)	-0.223 (-0.42)	-0.120 (-0.39)
FRA	-0.241 (-1.42)	-0.288^c (-1.68)	0.759^a (4.47)	0.712^a (4.14)
GBR	0.566^a (9.53)	0.226^c (1.70)	1.566^a (26.37)	1.226^a (9.20)
IRL	-0.698^a (-13.51)	-0.361^a (-3.62)	0.302^a (5.83)	0.639^a (6.41)
ITA	-0.794^a (-4.01)	-0.853^a (-5.43)	0.206 (1.04)	0.147 (0.93)
JPN	-2.897^a (-6.98)	-2.973^a (-5.97)	-1.897^a (-4.57)	-1.973^a (-3.96)
KOR	-0.645^b (-2.12)	-0.544^c (-1.68)	0.355 (1.17)	0.456 (1.41)
NLD	0.843^c (1.67)	0.127 (0.32)	1.843^a (3.65)	1.127^a (2.86)
SWE	-0.474^a (-6.76)	-0.138 (-0.54)	0.526^a (7.51)	0.862^a (3.34)
USA	-0.366 (-0.83)	-0.185 (-0.51)	0.634 (1.45)	0.815^b (2.24)
All sample	-0.207 (-2.28)	-0.504^a (-6.38)	0.793 (8.71)	0.496^a (6.29)

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

Table 19: Estimates of the Cointegrating Slope Coefficient of (263) with a Time Trend

	$\hat{\kappa}^{DOLS}$	$\hat{\kappa}^{FMOLS}$	$\hat{\phi}^{DOLS}$	$\hat{\phi}^{FMOLS}$
BEL	-0.364^{a}	-0.429^{a}	0.636^{a}	0.571^{a}
	(-12.24)	(-3.92)	(21.38)	(5.21)
DEU	0.081^{b}	0.108	1.081^{a}	1.108^{a}
	(1.99)	(1.27)	(26.50)	(13.10)
DNK	-0.291^{a}	-0.271^{b}	0.709^{a}	0.729^{a}
	(-2.57)	(-2.30)	(6.26)	(6.20)
ESP	0.119	0.155	1.119^{a}	1.155^{a}
	(1.27)	(0.82)	(11.99)	(6.13)
FIN	-0.351	-0.310	0.649^{b}	0.690^{a}
	(-1.39)	(-1.39)	(2.56)	(3.10)
FRA	-0.357^{c}	-0.265	0.643^{a}	0.735^{a}
	(-1.88)	(-1.40)	(3.40)	(3.88)
GBR	0.939^{a}	0.665^{c}	1.939^{a}	1.665^{a}
	(4.36)	(1.90)	(9.00)	(4.75)
IRL	-0.386^{a}	-0.415^{a}	0.614^{a}	0.585^{a}
	(-28.30)	(-8.48)	(44.93)	(11.95)
ITA	-0.360^{b}	-0.312	0.640^{a}	0.688^{a}
	(-2.52)	(-1.77)	(4.48)	(3.89)
JPN	1.122^{a}	1.123^{a}	2.122^{a}	2.123^{a}
	(3.17)	(3.66)	(6.00)	(6.93)
KOR	-0.948^{a}	-0.931^{a}	0.052	0.069
	(-11.69)	(-9.84)	(0.65)	(0.73)
NLD	-1.138^{a}	-1.120^{a}	-0.138	-0.120
	(-5.26)	(-4.10)	(-0.64)	(-0.44)
SWE	0.878^{a}	0.803^{a}	1.878^{a}	1.803^{a}
	(25.30)	(15.59)	(54.13)	(35.02)
USA	-0.895^{a}	-0.812^{a}	0.105	0.188
	(-4.87)	(-4.34)	(0.57)	(1.00)
All sample	-0.139^{a}	-0.144^{a}	0.861^{a}	0.856^{a}
	(-9.25)	(-3.82)	(57.12)	(22.76)

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

G Quantitative Analysis: Additional Numerical Results

In this section, we provide additional numerical results: i) for the relative price and relative wage responses to a productivity differential between tradables and non tradables when considering a model abstracting for physical capital, ii) for aggregate and sectoral variables when considering a model with physical capital accumulation.

G.1 Relative Price and Relative Wage Responses in a Model without Physical Capital

Table 20 shows the long-run relative price and relative wage responses to a productivity differential between tradables and non tradables when considering a model abstracting for physical capital. Relative wage and relative price responses are given by (30) and (31), respectively.

G.2 Responses of Aggregate and Sectoral Vaariables: Numerical Estimates

Table 21 gives numerical results for the long-run changes of several aggregate and sectoral variables following a productivity differential between tradables and non tradables of 1%. We consider three alternative scenarios (panel B, panel C, panel D): the elasticity of substitution ϕ between traded and non traded goods is set alternatively to one, 0.5 and 1.5. Note that we report in panel A the long-run responses of aggregate variables only when $\phi = 1$ to save space.

Table 20: Quantitative Effects of a Productivity Differential between Tradables and Non Tradables (in %) in a Model without Capital

	Relative Price Effect							Relative Wage Effect						
	BS	Imperfect Labor Mobility						BS	Imperfect Labor Mobility					
	$(\epsilon = \infty)$	$(\epsilon = 0)$	$(\epsilon = 0.5)$	$(\epsilon = 1)$	$(\epsilon = 1.5)$	$(\epsilon = 2)$	$(\epsilon = 4)$	$(\epsilon = \infty)$	$(\epsilon = 0)$	$(\epsilon = 0.5)$	$(\epsilon = 1)$	$(\epsilon = 1.5)$	$(\epsilon = 2)$	$(\epsilon = 4)$
$\phi = 0,5$	1.00	2.00	1.50	1.33	1.25	1.20	1.11	0.00	1.00	0.50	0.33	0.25	0.20	0.11
$\phi = 1$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\phi = 1,5$	1.00	0.67	0.75	0.80	0.83	0.86	0.91	0.00	-0.33	-0.25	-0.20	-0.17	-0.14	-0.09
$\phi = 2$	1.00	0.50	0.60	0.67	0.71	0.75	0.83	0.00	-0.50	-0.40	-0.33	-0.29	-0.25	-0.17
$\phi = 2,5$	1.00	0.40	0.50	0.57	0.63	0.67	0.77	0.00	-0.60	-0.50	-0.43	-0.38	-0.33	-0.23

Notes: Effects of a permanent rise in the sectoral productivity ratio by 1% in a model with labor only. BS: Balassa-Samuleson; ϕ is the elasticity of substitution between tradables and non-tradables; ϵ is the degree of imperfect substitutability in hours worked across sectors.

Table 21: Aggregate and Sectoral Effects of a Productivity Differential between Tradables and Non Tradables (in %) in a Model with Physical Capital

	BS	Bench	Labor supply		Mobility		$k^N > k^T$		Non sep.	Traded inv.
	$(\epsilon = \infty)$	$(\epsilon = 0.8)$	$(\sigma_L = 0.2)$	$(\sigma_L = 1)$	$(\epsilon = 0.1)$	$(\epsilon = 2.5)$	$(\epsilon = \infty)$	$(\epsilon = 0.8)$	$(\sigma = 2)$	$(\varphi_I = 0.35)$
$\phi = 1$										
A.Aggregate										
Consumption, $d\tilde{C}$	1.26	1.30	1.33	1.26	1.32	1.28	1.33	1.39	1.28	1.32
Wage, $d\tilde{W}$	2.44	2.32	2.31	2.32	2.25	2.36	2.68	2.55	2.28	2.48
Labor, $d\tilde{L}$	-0.09	-0.10	-0.05	-0.15	-0.11	-0.10	-0.17	-0.17	-0.08	-0.14
Capital, $d\tilde{K}$	1.42	1.56	1.63	1.50	1.63	1.51	1.43	1.59	1.63	1.99
GDP, $d\tilde{Y}$	2.37	2.24	2.29	2.20	2.16	2.29	2.48	2.35	2.24	2.36
Foreign assets, $d\tilde{B}$	-4.77	-4.12	-4.24	-4.01	-3.61	-4.48	-5.35	-4.07	-4.95	-5.90
B.Sectoral										
Non traded wage, $d\tilde{W}^N$	2.44	2.16	2.15	2.18	2.02	2.27	2.68	2.38	2.11	2.30
Traded wage, $d\tilde{W}^T$	2.44	2.62	2.63	2.61	2.72	2.55	2.68	2.80	2.66	2.73
Traded labor, $d\tilde{L}^T$	0.13	0.05	0.07	0.03	-0.01	0.09	0.09	0.01	0.08	0.02
Non traded labor, $d\tilde{L}^N$	-0.22	-0.14	-0.11	-0.17	-0.10	-0.17	-0.26	-0.18	-0.14	-0.17
sectoral labor ratio, $d\tilde{L}^T/\tilde{L}^N$	0.73	0.36	0.38	0.34	0.14	0.51	0.65	0.33	0.43	0.34
Traded output, $d\tilde{Y}^T$	1.05	1.01	1.03	0.99	0.98	1.03	1.10	1.05	1.03	1.30
Non traded output, $d\tilde{Y}^N$	0.69	0.77	0.80	0.74	0.81	0.74	0.76	0.85	0.78	0.68
sectoral output ratio, $d\tilde{Y}^T/\tilde{Y}^N$	1.73	1.53	1.56	1.51	1.41	1.62	1.64	1.45	1.65	1.49
$\phi < 1$										
C.Sectoral										
Non traded wage, $d\tilde{W}^N$	2.44	2.29	2.28	2.31	2.24	2.34	2.68	2.51	2.20	2.45
Traded wage, $d\tilde{W}^T$	2.44	2.53	2.55	2.52	2.57	2.50	2.68	2.75	2.60	2.68
Traded labor, $d\tilde{L}^T$	0.06	0.01	0.03	-0.01	-0.02	0.03	0.02	-0.02	0.05	-0.01
Non traded labor, $d\tilde{L}^N$	-0.15	-0.10	-0.07	-0.13	-0.08	-0.12	-0.19	-0.15	-0.10	-0.13
sectoral labor ratio, $d\tilde{L}^T/\tilde{L}^N$	0.41	0.19	0.21	0.17	0.06	0.28	0.36	0.19	0.31	0.18
Traded output, $d\tilde{Y}^T$	0.87	0.79	0.81	0.77	0.74	0.82	1.00	0.95	0.81	1.12
Non traded output, $d\tilde{Y}^N$	0.82	0.89	0.92	0.85	0.92	0.86	0.85	0.92	0.90	0.79
sectoral output ratio, $d\tilde{Y}^T/\tilde{Y}^N$	1.40	1.28	1.31	1.24	1.19	1.34	1.35	1.25	1.47	1.26
$\phi > 1$										
D.Sectoral										
Non traded wage, $d\tilde{W}^N$	2.44	2.08	2.07	2.10	1.91	2.21	2.68	2.29	2.04	2.19
Traded wage, $d\tilde{W}^T$	2.44	2.67	2.68	2.67	2.79	2.59	2.68	2.84	2.70	2.76
Traded labor, $d\tilde{L}^T$	0.20	0.07	0.10	0.05	-0.00	0.12	0.15	0.03	0.09	0.04
Non traded labor, $d\tilde{L}^N$	-0.29	-0.17	-0.14	-0.20	-0.11	-0.21	-0.32	-0.21	-0.17	-0.20
sectoral labor ratio, $d\tilde{L}^T/\tilde{L}^N$	1.01	0.46	0.48	0.45	0.17	0.67	0.93	0.43	0.52	0.45
Traded output, $d\tilde{Y}^T$	1.22	1.17	1.20	1.15	1.14	1.20	1.20	1.12	1.19	1.44
Non traded output, $d\tilde{Y}^N$	0.56	0.68	0.71	0.65	0.74	0.64	0.66	0.81	0.69	0.59
sectoral output ratio, $d\tilde{Y}^T/\tilde{Y}^N$	2.02	1.69	1.72	1.67	1.52	1.82	1.92	1.59	1.77	1.65

Notes: Effects of a permanent rise in the sectoral productivity ratio by 1%. Panels A and B show the deviation in percentage relative to steady-state for aggregate and sectoral variables, respectively. Responses are scaled by initial GDP, except for long-run changes of capital, overall labor, aggregate and sectoral wage rates (percent of steady state). Responses of sectoral labor are scaled by initial steady-state overall labor while responses of sectoral outputs are scaled by initial steady-state GDP.

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