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On the importance of statistical governance quality and accurate targets for fiscal rules' performance

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Abstract

Following last economic crises, a debate challenged fiscal rules arguing alternatively between discard or reform them. Economic literature developed that effective fiscal rules must be simple, clear and credible. Although difficult to reconcile, these conditions can be approximated if statistics provide accurate measures of indicators targeted by fiscal rules. Focusing on the Golden rule (GR) of public finance, the paper demonstrates the importance of statistical governance quality and accurate targets for fiscal rules' performance. Using United Kingdom data, its shows that the GR is neither simple nor clear since its target measurement is sensitive to national accounts methodologies. We also raise concerns on GR credibility as its target forecast is accompanied by uncertainty, as depicted in a stochastic VAR analysis. Main conclusions show that the performance of GR is sensitive to the quality of its target measurement, and fiscal rules must rely on transparent statistics and accurate targeted indicators.

Keywords: Fiscal Rules, Golden Rule, Public Sector, Net investment, National Accounts, VAR analysis.

JEL Codes: C1, E22, H60, H83.

Note: The views expressed in this document are those of the author and do not necessarily reflect the position of the Banque de France.

1 Introduction

The energy crisis and recent dynamic of inflation involved large and price-targeted fiscal policy interventions. Following the important fiscal impulses already engaged with the pandemic crisis, this leads to unprecedent level of public debt in many economies in the world. The fiscal slippages push forward inflation pressures and central banks to raise interest, with negative consequences on public debt service and fiscal sustainability. A back to sound public finance thus appears urgent to restore a coordinate policy-mix, and to range monetary and fiscal policies in a stability region. Discussions on fiscal discipline instruments are thus becoming more prominent and the debate around the future of fiscal rules is a burning discussion. As illustraton, the reform of the EU governance rules requires political agreements as well as efforts in the harmonisation of different technical points and highlights the importance of statistical governance transparency.

In this challenging context for governements, namely restoring sound public finance while preserving investment, some defend the use of a Golden rule of public finance that targets the public budget balance excluding net public investment. However, this target is difficult to calculate. Lack of statistical transparency and technical issues in calculating the indicators targeted by fiscal rules may rise some problems in assessing their performance. This issue might be reinforced when the credibility of the target is low. This must be the case for low transparent or volatil target. This analysis focuses on the GR as its target might be concerned by all these issues. This paper thus addresses the following question: "How the sensitivity of the Golden rule's target measurement may affect its performance assessment?"

As discussed by Debrun and Jonung [2019], who developped the fiscal rules trilemma[1], the design of fiscal rules matters for fiscal rules' performance. When designin fiscal rules, the choice of the targeted indicator is crucial and our work relates to the importance of the use of accurate targets to provide proper measure of fiscal rules peformance. Under-accurate fiscal rules' targets may indeed shape the final measures of the target itself and thus affect the performance measurement

[1]In particular, Debrun and Jonung [2019] developped that an optimal fiscal rules must find a balance between simplicity, flexibility and enforceability.

and perception. Thus, to answer the main problem, our analysis studies the sensitivity of the measurement of the target of the Golden rule according the Debrun and Jonung [2019] trilemma.

Our analysis first tests if the Golden rule target is clear and simple. To do so, we focus on the sensitivity of the performance of the Golden rule of public finance, measured as the compliance with its target, to the measurement of its target (by definition the public budget balance excluding net investment) with a focus on the measurement of the public net investment, measured as the difference between public gross fixed capital formation (thereafter GFCF) and general government consumption of fixed capital (thereafter CFC). The empirical exercise consists in reproducing the national account methods to compute CFC, obtain net investment series and corresponding Golden rule's target to highlight the complexity and sensitivity of its computation. This lack of simplicity and clarity may lead to difficulty in monitoring and assesing its compliance. However, this approach does not allow to observe the impact of CFC changes on other key national accounts indicators that may have retroactive effects on net investment itself, such as GDP. As CFC enters into GDP calculation, its variations thus account for net investment as well as on GDP and all variables depending on GDP evolution and expressed as ratio to GDP (which relates to many fiscal rules' targets).

The second empirical exercise of our study adresses this lack when testing if the target of the Golden rule is creadible. A credible rule might target an indicator which is “policy appropriable”. An appropriable fiscal indicator might be forecasted with as low as possible uncertainty to provide credible pluri-annual budgetary plans. We thus conduct a stochastic VAR analysis which aims at highlighting the uncertainty around the Golden rule target forecast. The VAR thus uses a specification linking public net investment (as it enters into the target of the Golden rule) to public CFC shocks in relation to all other variables included in the VAR (as it is important in both net investment and GDP calculation) which addresses the shortcomings of the first approach. This VAR analysis focuses on the uncertainty around the projected series of public net investment, as highlighted in the fanchart. Focusing on the forecasts' uncertainty shows the risk associated with the choice of a fiscal rule's target which is difficult to accuratly forecast.

We identified one country that have adopted a Golden rule and provides relevant publicy data for our analysis: the United Kingdom (UK) on the Office for National Statistics (ONS) website[2]. Consequently, the UK can reasonnably serve as a relevant case study to provide recommendations to economies interested in the issues relying on the Golden rule. This analysis simulates different public net investment series to assess the impact of its variations on the compliance with the Golden rule in the UK from 1996 to 2018[3].

The existing literature on the Golden rule mostly focused on the advantages or side-effects of its adoption for the economy (see, for an empirical assessment, Monperrus-Veroni and Saraceno [2005] that followed the approach of Eichengreen and Wyplosz [1998]; or Creel and Saraceno [2010] for discussion). This analysis does not entered into this field of literature. Also, the goal of this paper is not to consider the peril fiscal rules as in Blanchard et al. [2020], nor to propose an alternative solution for SGP reform as in Darvas et al. [2018] or Debrun and Jonung [2019]. It aims at providing key highlights on the importance of statistical governance quality, and warnings on computational issues for the net public investment which is the major component to adjust the Golden rule of public finance. More generally, it cautions that all fiscal rules are concerned by the importance of targeting indicators that are accurately computed and forecasted.

The Golden rule looks as relevant study case as it may seem attractive because it may comply with two main characteristics of Debrun and Jonung [2019]'s fiscal rules' trilemman, namely flexibility and enforceability. Indeed, it may be flexible by relaxing pressure on public productive investment and it (thus) looks more easy to comply with, leading to greater enforceability. Nevertheless, it targets an indicator which may not be understandable nor simple to measure, leading to a lack in simplicity. Mathieu and Sterdyniak [2013] pointed out that"(One existing) theory advo-

[2]Despite it lived the EU, we see several reasons to use the UK as a training case and provide main takeaways for both national and supranational fiscal rules in EU economies. First, during our study period the UK was still a member of the EU. Second, the UK experienced a Golden rule until 2009 and thus could be an applicable training case for our work.

[3]Despite the UK abandoned the Golden rule in 2009, the measure of the Golden rule target relies on statistical choices and not necessarily on the adoption of a Golden rule per se to handle the public finance. Indeed, the UK still follows a budget balance rule since 2010. In that sense, if public deficit is under control, changes in public deficit excluding net investment may be only affected by the statistical assumptions made in our approach, and which influence the net public investment measure.

cates the implementation of a "Golden rule of public finances" in order to reduce the governments' bias for running excessive deficits: current expenditure must be financed through taxation, while investment which will benefit future generations may be financed through borrowing. It is however difficult to measure investment".

Our work is thus inherent to the debate on fiscal rules performance as their performance assessment could be affected by the accuracy of national accounts indicators used as target of fiscal rules. According to Kopits and Symansky [1998]'s definition of an ideal fiscal rule, such optimal rule should target a target that might be clear, simple, credbible. Fiscal rules should therefore target indicators that are accurately computed and all statistical decisions to compute the net public investment may have consequences on the Golden rule target and its compliance, as well as on policy recommendations. Obviously, the accuracy of fiscal rules target relies on the quality of statistics ensured by institutions governance. Institutions should ensure quality standards and guarantee the confidentiality of information. Statistical governance has became a prominent discussion as it matters for cross-countries comparison, data reliability, economic policies evaluation such as the assessment quality of statistics underlying the macroeconomic imbalances procedure (MIP) or government commitment regarding fiscal rules compliance.

Our results are decomposed in two parts.

The empirical exercise relying on testing national account methods to compute CFC and net investment, provides the following evidences: i) the use of different detailed levels of public assets and/or activities to compute general government CFC may imply variations up to 0.8percentage points (pp) of GDP in general government net investment; ii) the changes in the form of the depreciation profile may involve changes in the general government net investment up to 0.75pp of GDP and the changes in its parameters, in particular the depreciation rate, imply changes around 0.2pp of GDP in the general government CFC measure which are translated to public net investment.

The results from VAR analysis show that the uncertainty around the forecasted series of public net investment range between 0.6 and 1.65 ppGDP. These takeaways reflect important implications for the evaluation of the Golden rule compliance.

All these results converge to the same conclusion that statistical governance should promote transparency and support accurate methodologies behind CFC and net investment computation. Adopting a Golden rule requires strong national accounts' strategies to provide accurate series. These conclusions apply to all fiscal rules targeting indicators that are difficult to calculte and predict.

The rest of the paper is structured as follows. The section 2 exposes the data and stylized facts on the Golden rule and net investment measures in the UK. The section 3 develops the empirical strategy, section 4 provides the results and section 5 concludes the paper.

2 Data and stylized facts on UK public net investment and the Golden rule

This section is devoted to detail how the Golden rule target is computed with a focus on highlighting the difficulty behind statistical methods to compute it.

By definition, as it should ensure intergenerational equity by making "the cost of public expenditures be spread over time in a manner that reflects the intertemporal distribution of the benefits generated by those expenditures" (Robinson [1998]), the Golden rule targets the general government budget balance that excludes net investment.

There exists two famous versions of the Golden rule: the nominal one and the structural one[4]. The nominal Golden rule aims at ensuring the equilibrium in the general government nominal budget balance excluding net investment. The UK version of the fiscal Golden rule adopted in 1998 stipulated that the general government should borrow only to invest and not to finance current expenditure. Consequently, the general government balance excluding general government net investment, had to be balanced over a business cycle[5]. According to Creel and Saraceno [2010],

[4] "Structural" refers to the cyclical adjustment of the budget balance to exclude the effects of the business cycle.

[5] In Creel and Saraceno [2010], the nominal case studied sets that the public balance excluding net investment should be superior to 0.03.

the nominal budget balance corresponds to government "Net lending (+) or net borrowing (−)" and net investment is obtained using the government consumption of public capital as depreciation. According to UK's definition, the nominal Golden rule may be written:

$$GG\ BB + (I - \delta k) \geq 0 \tag{1}$$

where GG BB corresponds to the general government Budget Balance, I is the general government gross investment (in percent of GDP), k is the general government capital stock (in percent of GDP) which depreciates at rate δ (which has no units). The alternative structural form of the Golden rule uses the structural public budget balance instead of the total one. Thus, the structural version may be written:

$$GG\ BB_s + (I - \delta k) > 0 \tag{2}$$

According to these definitions, it appears that the general government net investment measurement is crucial for the Golden rule target measurement and, thus, for its performance assessment. Net investment is a national accounting indicator resulting from capital stock measurement series. Indeed, the age-price profile applied on gross investment series allows to derive both capital stock and CFC (also called depreciation). The net investment is strictly equal to gross investment (GFCF) less CFC. Such basic accounting definition is true for private and general government sectors. To compute public capital stock, public CFC and net investment, the paper follows the System of National Accounts (2008)'s assets classification which sets the asset boundary for fixed assets as they correspond to goods and services which are used in production for more than one year[6]. Nervetheless, the GFCF series by detailed asset type are not readily available for the public sector in the OECD data sources[7].

To get the GFCF at assets level for the general government sector our approach consists first

[6]It breaks down the assets into different categories, namely: Dwellings, Other buildings and structures (which covers Buildings other than dwellings, other structures, land improvements), Machinery and equipment (which represents transport equipment, ICT equipment, other machinery and equipment), weapons systems, cultivated biological resources (which be decomposed in animal resources yielding repeat products, tree crop and plant resources yielding repeat products), Costs of ownership transfer on non-produced assets, Intellectual property products (Research and development, Mineral exploration and evaluation, Computer software and databases (Computer software, Databases), Entertainment, literary or artistic originals, Other intellectual property products.

[7]An inconsistency is also observed since the net capital stock for Dwelling in public sector is different from 0 while GFCF in dwellings for public sector is equal to 0.

in computing the share of the total general government GFCF in total economy GFCF (equation 3). Then we apply these shares to total GFCF series available at asset and industries breakdown (equation 4) in industries/activities in which we can reasonably assume that general government sector operates[8]. The share is not applied when the industry/activity is Public administration which only covers public sector.

$$Share\ of\ GG\ sector = \frac{General\ Government\ GFCF}{Total\ Economy\ GFCF} \tag{3}$$

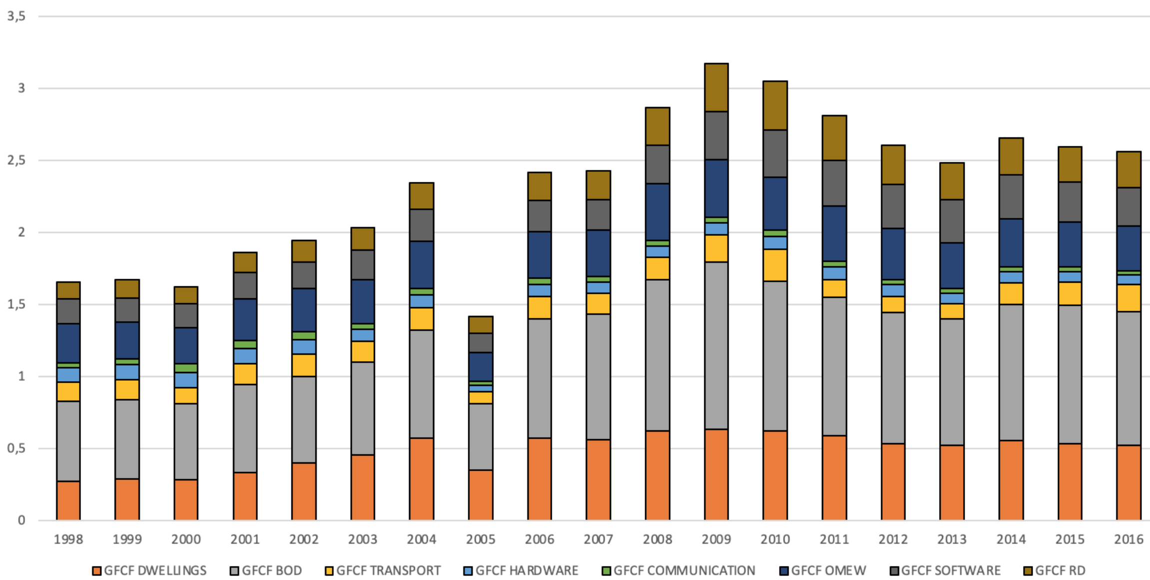
$$GG\ GFCF_{k,j} = Share\ of\ GG\ sector * GFCF_{k,j} \tag{4}$$

Where GG stands for "General Government", k represents each industry and j each asset (from SNA classification). This paper assumes that the public share is constant across assets in total economy[9]. Nevertheless, this share is time-variant allowing adjustment in the time which may matter during crises where public sector may be increasingly active to provide fiscal support.

Figure 1 illustrates public share of the different assets in public GFCF between 1998 and 2016. This paper gives a particular attention to the assets that represent large part of total GFCF and that have long service life, such as Building Other than Dwellings (BOD) as depicted in Figure 1 , because they may intensively drive capital stock measurement, CFC and thus net investment.

[8] As illustration "Electricity, gas, steam and air conditionning supply" is excluded as it is fully privatized in UK since 1990.

[9] For example, if the share of general government GFCF represents 8% of total GFCF in a given year, the asset "R&D" will represent 8% of GFCF in the inductry "Professional, scientific and technical activities" for general government sector for this year.



Note: *See Appendix 1 for further details on SNA assets classification. GFCF stands for Gross Fixed Capital Formation. BOD = Building Other than Dwellings. OMEW= Other Machinery and Equipment and Weapons systems. RD= Research and development. Software and R&D are classified under Intellectual Property products in ONS. Hardware and Telecommunication equipment are classified as ICT equipment in ONS. Cultivated biological resources are discarded as they are equal to 0 in public sector. Variables are expressed in total GDP percentage.
Source: Author based on OECD national accounts database.

Figure 1: **Decomposition of General Government Gross Fixed Capital Formation in the United Kingdom, by Assets SNA boundary* type (in % of GDP) between 1998 and 2016**

3 Empirical strategies

This section first develops the national accounts' methods to compute net investment and deduce the Golden rule target (section 3.1). It aims at studying the clarity and simplicity of the rule by highlighting how complex its computation in national accounts might be sensitive to statiscal choices. Indeed, the section 3.1 provides a sensitivity analysis of the public CFC and public net investment to adjust the target of the Golden rule, ceteris paribus. However, public CFC enters into the composition of GDP in national accounting, implying some endogeneous interaction with the target of the Golden rule. In this view, the first approach has some limits. Then, the second part of this section aims at studying the credbility and the appropriability of the Golden rule by highlighting how uncertain its target is to forecast (section 3.2). It conducts a stochastic VAR analysis to highlight the uncertainty around the calculation of public net investment that reflects the difficulty of providing credible projections in budgetary plans. It also adresses the lacks of the previous empirical exercise as the VAR takes into account the connexion between all variables included in the model, in particular public net investment and GDP.

3.1 Sensitivity analysis using national accounts methods: testing the simplicity and clarity of the Golden rule

The Measuring Capital OECD Manual (OECD [2009]) developed methodologies to compute CFC (depreciation level) used to obtain net investment. The first one operates using the net capital stock and the second applied directly the rate of depreciation (OECD [2009]). Both of these, respectively, undirect and direct methods depend on the availability of GFCF series. The first approach is an undirect methodology because it applies the Perpetual Inventory Method (PIM) to retrieve the CFC. As this is the most implemented approach, we retain it for our analysis. Indeed, countries mostly use the Perpetual Inventory Method as they apply a depreciation function directly to gross series of assets investment as described in Appendix 2. To compute the CFC for a year, one needs the total change in the net capital stock between the end of year considered and the end of the previous year. For investment I (at constant prices) in industry k, asset i at time t, and using a geometric depreciation rate δ_i, the capital stock A of each asset in each industry can be estimated using the PIM method as follows[10]:

$$A_{k,i,t} = (1 - \delta_i)A_{k,i,t-1} + I_{k,i,t} \tag{5}$$

The Equation 5 above presents the most detailed as possible level to compute the capital stock since it is computed for each asset in the SNA asset boundary, in each industry. Nevertheless, this PIM may be applied following a set of major assumptions that may affect the results. Among them we investigate: the level of computation of the CFC series, the depreciation patterns (depreciation profile and parameters).

[10]Equation 5 relates PIM using a geometric model.

The sensitivity to the level of computation of general government CFC: According to the OECD [2009] and APO/OECD [2021] the accuracy of the total net capital stock and CFC series rely on the detail of the asset breakdown of investment series. The more disaggregated the asset breakdown, the more accurate the resulting net capital stock and CFC estimates. This study analyses the sensitivity of net capital stocks and CFC at different levels of aggregation across assets: i) it computes net capital stocks and CFC for each asset type in each different industry, which are later aggregated to obtain total net capital stocks, total CFC and net investment for the general government sector; ii) it computes net capital stocks and CFC for each asset type aggregated across industries and hence using an asset-specific depreciation rates common to all industries.

The sensitivity of Consumption of Fixed Capital to the depreciation pattern: The age-price profile, also called depreciation profile or pattern, reflects the loss in value of a capital that aged[11]. Typically, the depreciation pattern that applies to a single asset of a cohort of assets is combined with a retirement function so to construct a so-called combined age-price/retirement profile[12]. The OECD [2009] describes different approaches to estimate the combination of age-price function with retirement function: i) using empirical evidence on average service life of the assets and set up an assumption about the functional form of the depreciation pattern; ii) using information on used asset prices from second-hand asset markets and estimate depreciation using econometric approaches; iii) derive the age-price profile from the age-efficiency profile.

In the first approach, the depreciation pattern may be assumed to follow different forms, namely straight-line or geometric. The straight-line (also called linear) model[13] of depreciation imposes a constant amount loss in the asset value for every period. This constant loss is equal to 1/T where T corresponds to the service life of the asset. When using the geometric form, the asset value depreciates at a constant rate often noted as δ.

[11] Following APO/OECD [2021], it can be "illustrated by the pattern followed by the relative prices for different vintages of the same (homogenous) capital good".

[12] Indeed, all assets of a certain type (e.g. trucks) acquired in a given year constitute a cohort of assets. It is very unlikely that all the assets in a given cohort will retire or be discarded at the same age. For this reason, a retirement function is introduced, so to bring a distribution to account for different survival patterns.

[13] However, the Straight-line approach for the age-price profile supposes a constant depreciation and may be not optimal as it does not properly reflect how certain assets depreciate.

The second approach aims at supporting the assumptions made in the first approach but requires price information on new and used assets to estimate depreciation which are not available for our analysis[14].

The third approach consists in deriving the age-price profile from age-efficiency profiles. From the 2019 revision of Blue Book, the Office for National Statistics in the UK uses a hyperbolic age-efficiency profile to derive the depreciation pattern while it previously used linear depreciation combined with a normal retirement function[15] (Eurostat/OECD [2013]).

This study compares different series of the public CFC and net investment which were computed following different approaches. The OECD data serves as a Benchmark since it publishes ONS official sources which corresponds to the most recent methodology of ONS. The analysis first uses a geometric profile. It then uses a straight-line to test how the change in ONS methodology, switching from a combined normal retirement/straight-line age price-profile to the new methodology described above, affects the net investment series.

The sensitivity of CFC to the depreciation pattern's parameters: Depreciation patterns rely on depreciation rate (δ) and age service life (ASL) of the assets. In the absence of econometric estimates of (geometric) depreciation rates[16], δ has sometimes been estimated with the "declining balance method" and on the basis of information about ASL (see Hulten and Wykoff [1981]): $\delta \equiv \frac{DBR}{ASL}$ where DBR[17] is an estimated declining-balance rate and ASL the average age service life of the asset. A common approach consists in setting DBR equals to 2.

Table 1 shows that the service life of the assets differs considerably across countries. As example, the Other Buildings have an average service life 3-4 times longer in UK than in France. It may

[14] These studies often estimate a geometric depreciation rate (which is constant by definition) using second-hand asset prices and most studies concern the USA (Hulten and Wykoff [1981b], Koumanakos and Hwang [1988], Hall [1971], Griliches [1960] or Jorgenson and Stiroh [1994]) but are also extended to other countries such as Canada (Baldwin et al. [2015]) or Japan (Suga [2018]).

[15] The frequency of the normal distribution is symmetrical and 95% of the probabilities are ranged around two standard deviations to the mean. Such property is not under debate regarding its usefulness for a retirement pattern.

[16] A convex age-price/retirement profile is obtained by combining an age-price profile for individual assets and a retirement profile for all assets in a cohort. Hulten and Wykoff [1981] argued in favor of using a geometric profile as reasonable approximation and there a geometric cohort depreciation rate.

[17] Double declining balance rate imposes the strong hypothesis that efficiency of an asset is the same all over its life but simplify the exercise in a presence of low data availability.

	UK	Germany	France	Netherlands	New Zealand	South Korea
Dwellings	59	40 – 95	–	75	70	55
Other buildings	19 – 100	15 – 100	25 – 30	30 – 50	45 – 65	47 – 55
Other Structures	19 – 100	15 – 100	25 – 30	30 – 50	45 – 65	47 – 55
Land improvements	19 – 100	–	–	1	30 – 58	17
Machinery and equipment	10 – 30	5 – 30	9 – 21	5 – 35	4 – 33	5 – 15
Transportation equipment	9 – 25	8 – 25	7 – 15	5 – 30	5 – 32	6 – 30
Computer software and databases	5	5 – 30	5	3	4	6
R&D	4 – 12	5 – 30	10	–	10	9 – 11

Source: ONS, Blue Book 2019 United Kingdom. Note: The present analysis is based on the most recent ASL numbers for UK.

Table 1: **Service life of assets in different economies**

introduce huge differences in depreciation rates for the same asset across countries and hence in capital stocks and CFC[18]. The ONS [2019] explained that the revisions of average service life they implemented range from -45 to 0 years (see Appendix 3) with a biggest impact observed on net capital stock coming from assets with long service life that need to be accurately retrieved. This reinforces the importance of statistical governance transparency in the production and use of these data. The last part of the statistical sensivity exercise thus consists in changing the ASL by using alternatively the old values of assets service life that hold before the ONS revision and the ones that hold in the current methodology. Such sensitivity exercise involves changes in the depreciation rate which still be computed using the double declining balance rate formula under a geometric profile.

3.2 A stochastic VAR analysis for public net investment : testing the credibility and appropriability of the Golden rule's target

We conduct a VAR analysis that focuses on the uncertainty around the public net investment forecasts. Our strategy first relies on the accounting definition of public net investment for UK:

$$Net\ investment_t = GFCF_t - CFC_t \tag{6}$$

[18] See in particular OECD [2009] page 11-12 for further discussion.

To represent the uncertainty around public net investment we produce the fanchart of the series. To do so, we compute the stochastic series of GFCF and CFC (series that include shocks) obtained using a stochastic VAR with 5000 boostrap replications shocks. The shocks are computed using quaterly data and then annualized to reconstitue the net investment series as described in Equation 6 above. The simplified form of our VAR might be written as follow;

$$y_t = A_t y_{t-1} + ... + A_p y_{t-p} + u_t \tag{7}$$

Where y_t correspond to the vector of endogeneous variables we identify as influencing each other, namely the public GFCF, public CFC, the spread (as difference between 10years interest rates and Euribor), the real GDP growth rate, the inflation (HICP) and debt growth. Except GFCF and CFC, all variables are available at quaterly frequencies. We thus have to transform annual to quaterly frequency our series of GFCF and CFC to conduct the VAR analysis. To do so, we use official public GFCF series and public CFC derived from geometric profile as computed in the first part of our analysis. Both are quaterlized to enter in the var using the is denton-cholette, which performs a simple interpolation that meets the temporal additivity constraint.

The VAR model is estimated with 3 lags as recommended by appropriate statistical tests and as it is the smallest order that eliminates serial correlation up to order 12. To insure the stationarity of the VAR and avoid cointegration relation (see Johanson, 1991) we use the first-difference for the following variables: public investment, public CFC, public debt and inflation. The GDP growth rate and the spread are used in level. We introduced time dummies for the quarters 1, 2 and 3 of 2005 as public GFCF in UK was submitted to statistical definition changes as depicted in Figure 1.

4 Results

4.1 Results from sensitivity analysis through national accounting exercise

This section exposes the results[19] from the sensitivity tests. For space purpose, only public net investment series, computed as the difference between general government GFCF and general government CFC, and the general government budget balance excluding net investment are reported. The sensitivity analysis relies on changes in:

i) The detail levels of the Gross Fixed Capital Formation series introduced in the Perpetual Inventory Method to compute the capital stock and retrieve the depreciation (CFC): we compare to the benchmark, series computed at the asset and activity breakdown and at the asset breakdown only[20];

ii) The depreciation pattern: by using alternatively a geometric profile for the entire cohort of assets and a combined normal retirement/straight-line profile[21]. One series corresponds to the old official series from ONS before their revision in the Blue Book of 2019. As the ONS old methodology what different in terms of age-price profile and average service life, We produce another series, using the same age-price profile as the ONS old methodology but that the current average service life. This approach allows us to distinguish variations due to the age-price profile and from the the ASL. These scenarios are compared to the ONS series that employed an age-efficiency profile to derive the age-price profile (reflected in Benchmark series);

iii) The depreciation rate: generated by changing the average service life of the assets. The series are computed using a geometric profile (as it is a reasonable approximation for the cohort of assets according to Hulten and Wykoff [1981], OECD [2009]) and the most disaggregated level (assets and activities level of public sector).

[19]One may note that, as often in capital stock and CFC measurement exercises, (public) GCFC series are not long enough for our empirical exercize. We adopted a methodology of extending backwards the series based on the GDP growth rate as the GFCF series are available from 1995 while some assets have an average service life superior to 60 years in the old methodology which is problematic for PIM application. See Appendix 4 for further discussion on GFCF backward extension.

[20]In this subsection, all the series are computed using the geometric approach as recommended by OECD [2009].

[21]The combination of a normal retirement with straight-line depreciation function corresponds to ONS old methodology.

The results of the 3 different subsections support the clear evidence that the net investment series and thus the budget balance excluding net investiment are highly sensitive to the methodological choices. The GR target is thus neither simple nor clear. The variations in the target might be important leading to different perception in terms of GR performance. This seeks for transparent statistical governance and the implementation of a lot of efforts to provide enough underlying statistical series to compute the GR target in view of considering it as a fiscal rule for a country.

4.1.1 Sensitivity to the level of capital stock's calculation

Table 2 confirms that the detail of the GFCF series breakdown (i.e. across assets and industries vs. across assets only) is important for the accuracy of general government net investment series. Consequently, the availability of detailed data and the availability of long time series of GFCF are essential to conduct accurate estimations for series that enter into the Golden rule target calculation.

	Benchmark (in %)	Aggregated Industries level (in %)	Industries and assets breakdown (in %)
1996-2018	0,52	0,76	0,51
1996-2006	0,23	0,62	0,36
2006-2012	0,91	1,15	0,87
2012-2018	0,63	0,66	0,45

Note: Benchmark refers to OECD series computed as the difference beteen OECD series of general government GFCF and general government CFC.
Source: author.

Table 2: **Sensitivity of UK general government net investment average to the level at which net capital stock is computed (in % of GDP)**

Differences between the most detailed series and the Benchmark series are low in the different subperiods and we observe no difference in average over 1996-2018 period. This is not the case for the less detailed level which fails to reflect the evolution of net investment. As the less detail series may vary over time and produce more sensitive government net investment series, countries may consider the most detailed series of general government GFCF to compute the depreciation. This recommendation is in line with OECD [2009] and requieres that countries investigate a lot of efforts as some EU members do not aldready have such detailed data which might finally be problematic in the Golden rule assessment. Otherwise, when long time series of GFCF are not available for a country, the use of the backwards extension based on GDP approach may be a reasonnable approach as differences gradually disappear when moving in time.

4.1.2 Sensitivity to depreciation patterns/age-price profile

This section shows the sensitivity results of the general government net investment and the general government budget balance excluding net investment to changes in the depreciation pattern by using alternatively a geometric profile for the entire cohort of assets and a combined normal retirement/straight-line profiles. The latter scenario is represented in two series: one that we calculate ourselves and the former is the official ONS series before the implementation of their revision in 2019 (reported as "ONS old methodology"). These methodologies are also compared to the approach that uses an age-efficiency profile to derive the age-price profile, according to the ONS current methodology, and reported through Benchmark series.

	Benchmark	Straight-line profile, ONS old methodology	Combined normal retirement/straight line profiles	Geometric profile
1996-2018	0,52	1,10	0,68	0,51
1996-2006	0,23	0,61	0,56	0,36
2006-2012	0,91	1,42	0,89	0,87
2012-2018	0,63	1,57	0,68	0,45

Note: ONS refers to Office for National Statistics in United Kingdom. The ONS old methodology employed a combined normal retirement/straight-line. According to OECD metadata in National Account table 14.A, data are sourced from "statistics reported to OECD by member countries in their answers to annual national accounts questionnaire" and thus retrieved the ONS new methodology series. Benchmark thus reflects the ONS current approach.
Source: author.

Table 3: **Sensitivity of UK general government net investment average to the depreciation pattern (in % of GDP)**

Results from table 3 highlight that the choice of the depreciation pattern is a strong determinant of the net investment. The differences in general government net investment are around 0.2 percentage point of GDP on average for the entire period 1996-2018 (up to 0.9pp of GDP between the ONS old methodology and benchmark series for the period 2012-2018).

The table 4 reflects the changes in the target of the Golden rule, namely the general government budget balance excluding net investment. It shows that the change in the ONS methodology involved 0.6pp of GDP differences as reflected by the difference between the old methology and the benchmark (which correspond to the new ONS method reported by the OECD). The ONS old methodology incorporates a different function and different average service life for assets than in the current benchmark. To distinguish what comes from the change in the age-price profile what comes from the the ASL, our series based on a combined normal retirement/straight line profile incorporates the new assets service life. Our series in column 3 produces more satisfactory results as they look closer to the benchmark. So it's the average service life of the assets that explains why our approach is closer to the benchmark results. The change in depreciation profile was responsible for only 0.2% difference on average for the entire period 1996-2018 as depicted by the difference between the benchmark and column 3. Finally, results suggest that the geometric profile looks as reasonnable assumption to fit the benchmark results without investing high technical approach, such as in the benchmark (which relies on the hyperbolic profile).

	Benchmark	Straight-line profile, ONS old methodology	Combined normal retirement/straight line profiles	Geometric profile
1996-2018	-3,1	-2,5	-3,0	-3,1
1996-2006	-1,4	-1,0	-1,1	-1,3
2006-2012	-5,6	-5,1	-5,6	-5,6
2012-2018	-3,9	-2,9	-3,8	-4,1

Note: ONS refers to Office for National Statistics in United Kingdom. The ONS old methodology employed a combined normal retirement/straight-line. According to OECD metadata in National Account table 14.A, data are sourced from "statistics reported to OECD by member countries in their answers to annual national accounts questionnaire" and thus retrieved the ONS new methodology series. Benchmark thus reflects the ONS current approach.
Source: author.

Table 4: **Sensitivity of the general government Budget Balance excluding net investment (in % of GDP)**

Table 4 provides evidence that methodological choices regarding CFC computation, and thus net investment computation, involve important consequences for the Golden rule target and its performance assessment. For example, ff some budgetary orientations planified the budget balance excluding net investment to be above -3% of GDP over 2012-2018 period, the old ONS methodology of the ONS would have conclude that the UK is compliant with the plan while the benchmark not. Similarly, if a the reference of -1.2% has been retained as threasold over 1996-2006, the UK would has been compliant regarding columns 2 and 3 (both using a combined normal retirement/straight line profile) while not in columns 1 and 4. In short, the depreciation pattern highly matters to determine the net investment and thus the Golden rule target, with important implications for its performance evaluation.

4.1.3 Sensitivity to changes in depreciation rate

This subsection conducts a sensitivity analysis to changes in the depreciation rate by changing the assets average service life according to the changes in the average service life introduced by the 2019 ONS revisions of the Blue Book (ONS [2019]) and depicted in Appendix 3.

	Public Consumption of Fixed Capital -OLD ASSETS SERVICE LIFE- (in % of GDP)	Public Consumption of Fixed Capital -NEW ASSETS SERVICE LIFE- (in % of GDP)	Average difference (in GDP percentage points)
1996-2018	1,3	1,5	-0,2
1996-2006	1,1	1,2	-0,1
2006-2012	1,4	1,6	-0,2
2012-2018	1,7	1,9	-0,2

Note: As recommended by OECD [2009], we used the most detailed series (assets and activities breakdown) and geometric profile to compute the public CFC series. Difference referred to the difference between series using new ASL and series using old ASL.
Source: author.

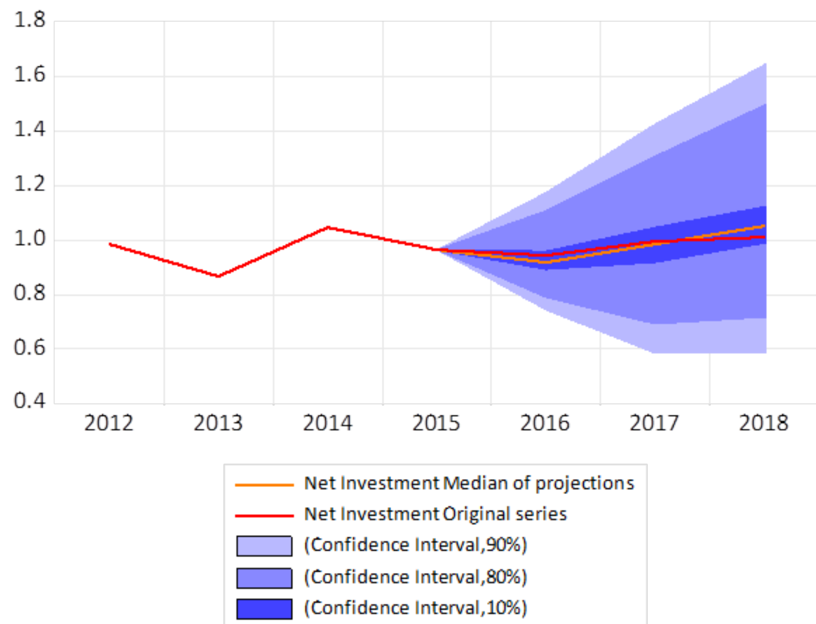
Table 5: **Sensitivity of consumption of fixed capital (in % of GDP) to changes in depreciation rate/assets service life**

In table 5, we observe that the new assets service life produce higher general government CFC. Appendix 5 reports the results for the net general government investment. The new ASL are shorter implying that assets depreciate faster (see Appendix 3). Consequently, over the same periods, the new values of assets life imply higher depreciation/higher general government CFC. Moreover, Buildings Other than Dwellings (BOD) assets life have lost 28 years of lenght of life while they represent the higher share of the general government GFCF. Such a huge change in BOD may drive the capital stock measurement and thus general government CFC. This finding is in line with ONS [2019] which showed that the main changes in net capital stock after the modification of assets service life, are due to the assets with long service life as Dwellings or BOD.

However, the consequences look less significant than in our previous tests since the variations do not exceed 0.2 percentage points of GDP. However, the DDR method used to derive the depreciation rate might be underoptimal and other more sophisticated formulations (such as econometrically derived depreciation rates) could produce different depreciation rates and induce a higher sensitivity of the CFC. All these changes of public CFC are reflected in public net investment series as 1 per 1 since CFC is deducted from public GFCF to obtain public net investment in our analysis.

4.2 VAR results

Our VAR is estimated using out of sample approach. The estimation period is 1996Q1-2015Q4. The forecasts are over 2016Q1-2018Q4 and are compared to our original series of public net investment from the first empirical part[22].



Note: Only last years of the period are reported for space purpose. Source: author.

Figure 2: **Fanchart of public net investment in the UK**

[22]Net investment series correspond to series of section 4.1.1 that use geometric profile and detailed assets and sub-sector breakdown.

As both public CFC and net investment series are differenciated to make them stationary, looking at Impulse Response Function migh not provide adequat information on net investment reaction to CFC shocks. Consequently, we prefer focusing on net investment forecasts uncertainty to complete our analysis.

Our results provide median projections with the 10% confidence interval that includes the original series of public net investment. Our VAR is robust against autocorrelation and heteroscedasticity of the residuals. Our model looks thus well-specified to forecast the series of net investment. However, the fanchart looks large and thus the uncertainty around the computation of public net investment too. The public net investment may reach 1.65% of GDP at best, and may decline up to 0.6% of GDP in the worst scenario, in 2018. Using public net investment series as an adjustement variables in fiscal rules to met fiscal discipline objectives might thus be risky as the uncertainty around the methodology to compute and to forecast it is important.

5 Conclusion

Our analysis does not discuss the relevance of the Golden rule for the EU framework and does not claim to propose an optimal rule. This paper warns against the use of fiscal rules whose targets are sub-optimal regarding Kopits and Symansky [1998] criteria and do not manage the Debrun and Jonung [2019]' trilemma. Focusing on the Golden rule as illustration case, we study the importance of statistics for indicators targeted by fiscal rules. We first tested the relevance of the GR target regarding the simplicity and clarity criteria mentionned in the Debrun and Jonung [2019]' trilemma. Then, we tested the credibility of its target. This paper proposed a sensitivity analysis of the indicator targeted by the Golden rule, namely the general government budget balance excluding general government net investment.

To do so, we first conducted a senstivity analysis of the national accounts methods to derive the net investment measure:

i) We tested how the detail of the breakdown of GFCF series at which capital stock is computed matters for the capital stock level and CFC in general government sector. In line with OECD [2009] and APO/OECD [2021], this study compared the impact of using an asset/industry breakdown and an asset breakdown only of GFCF series and found important differences in the series.

ii) Also, the public CFC (and thus net investment) measure is highly sensitive to the form of the combined retirement/age-price profile and to the depreciation rate. Regarding the depreciation profile form, as the United Kingdom switched from a Straight-line depreciation form to a depreciation form derived from a hyperbolic age efficiency profile, we observed the differences generated by such changes. We also concluded that the use a geometric profile is a good compromise in providing accurate series using an understanble and transparent methodology, easy to use by different statistical institutions. On the other hand, general government CFC is also sensitive to changes in the depreciation rate introduced by modifications in assets service life. Shorter service lives increase depreciation rates and thus increases the CFC. This result is even more important when the changes affect assets with long service life and which represent a large share of general government GFCF such as Building Other than Dwellings. Any countries should conduct empirical evidence of the assumptions engaged and justify the relevance of any change in the methodology to ensure the accuracy of net investment series that enters that defines the target of the Golden rule of public finance. Economists and statisticians from institutions in charge of fiscal monitoring may also conduct such empirical analysis to provide statistical recommendations.

These results support that the Golden rule target is neither simple nor clear to compute. The choice of a fiscal rule targeting such an opaque indicator must be based on strong and transparent statistical governance.

Second, our paper tested the credibility criterion of the Golden rule by providing empirical evidence on the uncertainty around net investment forecasts. A stochastic VAR analysis allows to complete our study by highlighting the volatility of the forecasted series while considering the connection CFC to other drivers of net investment. The fanchart ranges between 0.6 and 1.65 ppGDP which reflect large uncertainty in the forecasts. This sets additional risk for a Golden rule's performance assessment as it relies to a target forecasted with large uncertainty.

The implementation of a Golden rule would only offer a second-best solution and requires efforts to conduct in countries' national accounts statistics before its application. Implementing such a rule before without improving statistical governance can undermine the assessment of the Golden rule performance and lead to errors in judgements. Indeed, a country could be seen as badly (highly) disciplined regarding the Golden rule target whereas the general government balance excluding net investment is affected by the methodology underlying the computation of the depreciation. Such a rule could exacerbate some limits/defaults of the fiscal rules, including the well-known lack of simplicity as experienced in the European context. Finally, it is also important to remember that these results are important for the calculation of the GDP (since the CFC is included in its calculation), and therefore for many indicators derived from GDP and/or are linked to it.

These conclusions should be applied to all rules whose indicators are insufficiently clear or credible, because the consequences for measuring their performance would be dramatically affected.

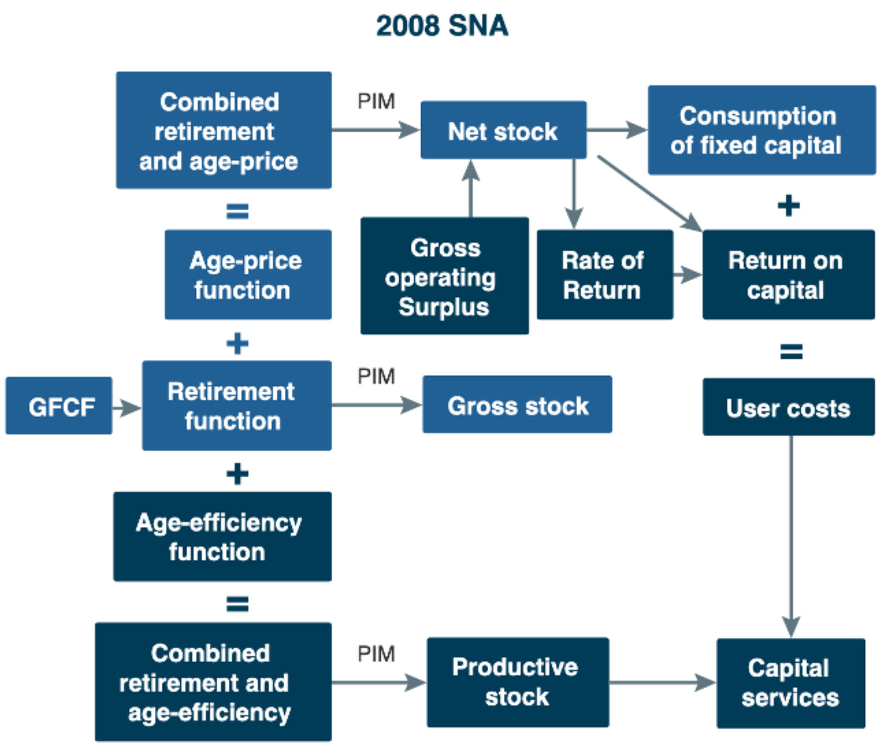
Appendices

Appendix 1: System of National Account classification of Assets

2008 SNA code	Produced fixed assets
N111	**Dwellings**
N112	**Other buildings and structures**
N1121	**Buildings other than dwellings**
N1122	**Other structures**
N1123	**Land improvements**
N11M	**Machinery and equipment and weapons systems**
N1131	Transport equipment
N1132	ICT equipment
N11321	Computer hardware
N11322	Telecommunications equipment
N11O	Other machinery and equipment and weapons systems
N115	Cultivated biological resources
N117	Intellectual property products
N1171	Research and development
N1172	Mineral exploration and evaluation
N1173	Computer software and databases
N1174	Entertainment, artistic and literary originals
N1179	Other intellectual property products

Source: APO/OECD [2021]

Appendix 2: Schema of Capital Stocks measurement in System of Nantional Account (SNA, 2008)



Source: Office for National Statistics

Appendix 3 :Assets' life introduced in Blue Book 2019 vs old version

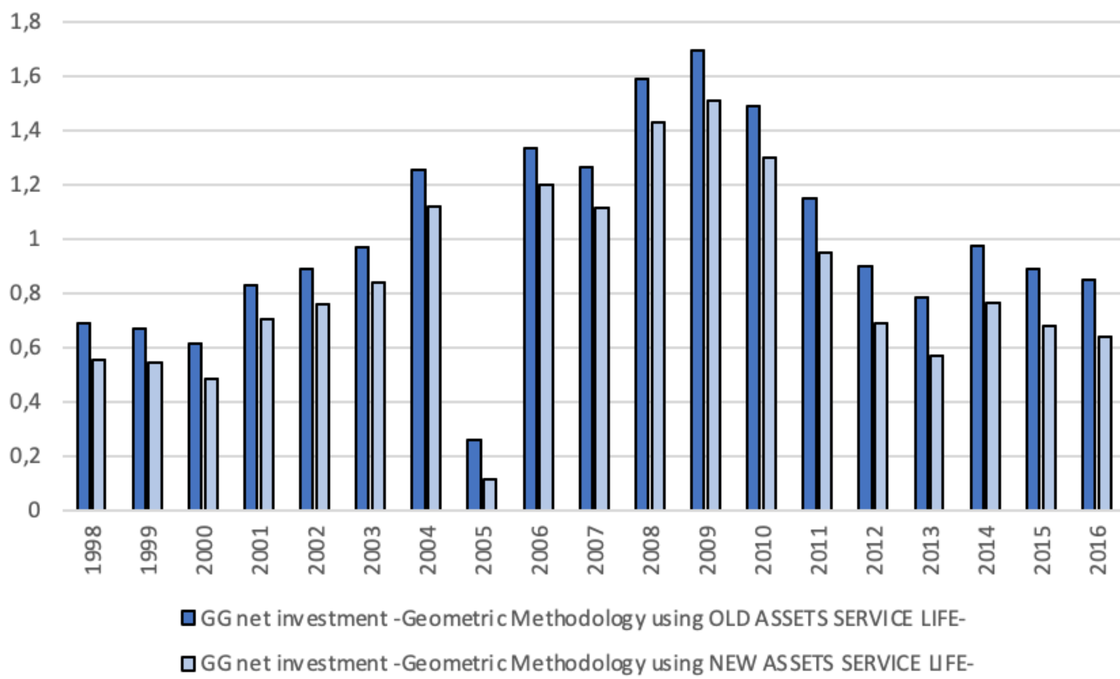
Asset description	Last estimation	Weighted old lives (years)	Weighted new lives (years)	New-old life (years)
Dwellings	Dean, 1964	59	50	-9
Other buildings	Dean, 1964	65	37	-28
Other structures	Dean, 1964	65	48	-17
Land improvements	Dean, 1964	65	20	-45
Transport equipment	Dean, 1964	11	15	4
Telecommunication equipment	NIESR, 1993	9	18	9
Computer hardware	Vaze, 2001	5	5	0
Machinery and equipment	Dean, 1964 and NIESR, 1993	26	21	-5
Weapons systems	Based on other countries, 2014	20	20	0
Cultivated Biological Resources	ONS	10	6	-4
Computer software and databases	Vaze, 2001	5	5	0
Entertainment, literary and artistic originals	Goodridge, 2008	15	10	-5
Research & Development	ONS, 2014	7	9	2
Mineral exploration and evaluation	ONS	10	15	5

Source: Office for National Statistics

Appendix 4: Box on the issue of the initial capital stock measurement

The series of GFCF used in this analysis starts in 1995 while some assets have long service life as dwellings. This is thus an issue to consider when computing capital stock using the Perpetual Inventory Method. To solve this issue, GFCF series are extrapolated using GDP growth rates before 1995. When long enough series of GFCF data are not available, historical GDP data should be used to extend backwards the GFCF series. Following growth theory, such approach assumes that the growth rates of GFCF and GDP are reasonably close. Historical GFCF data do not include exceptional increase or decrease in capital stock due to exceptional events such as wars or natural catastrophes that dramatically affect volumes of assets. The use of GDP growth to extend backwards GFCF series may help to capture the impact of events such on GFCF series. Such computational challenge is important for several eurozone countries since the length of GFCF series is not the same across members. Countries such as Germany or France present long time series while some East European members don't. Consequently, the choice of the methodology to compute the initial capital stock may affect the accuracy of the net capital stock and CFC series. However, this aspect of capital stock measurement is not further discussed in the present study.

Appendix 5: Sensitivity of general government net investment to changes in depreciation rate



Source: Authors using geometric pattern.

References

APO/OECD. The sensitivity of capital services measurement: measure all assets and the cost of capital. OECD Publishing, 2021.

J. Baldwin, L. Huku, and M. Tanguay. The Measurement of Quality Changes from Vintage Price Data." In Price Indexes and Quality Change. . The Canadian Productivity Review, 2015.

O. Blanchard, A. Leandro, and J. Zettelmeyer. Redesigning the EU Fiscal Rules: From Rules to Standards. Mimeo, contribution presented to the 72nd Economic Policy Panel Meeting, 2020.

J. Creel and F. Saraceno. European fiscal rules after the crisis. Journal of Innovation Economics and Management, pages 95–122, 2010.

Z. Darvas, P. Martin, and X. Ragot. European Fiscal Rules Require a Major Overhaul. Notes du conseil d'analyse economique, 47, 2018.

X. Debrun and L. Jonung. Under threat: Rules-based fiscal policy and how to preserve it. European Journal of Political Economy, 57, 2019.

B. Eichengreen and C. Wyplosz. The stability pact: More than a minor nuisance? Economic Policy, 1998.

Eurostat/OECD. Eurostat-OECD, survey of national practices in estimating net stocks of structures. 2013.

Z. Griliches. The demand for a durable input: U.s. farm tractors, 1921–57. in the demand for durable goods, edited by arnold harberger. University of Chicago Press, 1960.

R.E. Hall. The Measurement of Quality Changes from Vintage Price Data." In Price Indexes and Quality Change. . Harvard University Press, 1971.

C.R. Hulten and F.C. Wykoff. The estimation of economic depreciation using vintage asset prices: An application of the Box-Cox power transformation. Journal of Econometrics, 1981.

C.R. Hulten and F.C. Wykoff. he Measurement of Economic Depreciation. In Depreciation, Inflation, and the Taxation of Income from Capital, edited by Charles R. Hulten,. The Urban Institue Press, 1981b.

D. W. Jorgenson and K. Stiroh. Computers And Growth. Economics of Innovation and New Technology, 1994.

G. Kopits and S.A. Symansky. Fiscal Policy Rules . Occasional Paper No. 162, 1998.

P. Koumanakos and J.C Hwang. The forms and rates of economic depreciation: The canadian experience. Paper presented at the 50th anniversary meeting of the Conference on Research in Income and Wealth, 1988.

C. Mathieu and H. Sterdyniak. Do we need fiscal rules? Revue de l'OFCE 2013/1 No 127, pages 189–233, 2013.

P. Monperrus-Veroni and F. Saraceno. Reform of the SGP: reducing or increasing the nuisance? OFCE Working Paper, 2005.

OECD. Measuring Capital, OECD Manual 2009: Second edition. OECD Publishing, 2009.

ONS. National Accounts articles: Changes to the capital stock estimation methods for Blue Book 2019. 2019.

M. Robinson. Measuring Compliance with the Golden Rule. Fiscal Studies, 19:447–462, 1998.

Y. Suga. Measurement of Depreciation Rates using Microdata from Disposal Survey of Japan. 2018.