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European Commission
Directorate-General for Economic and Financial Affairs

Trend Capital when Goods and Capital Market Frictions Exist

Valerie Vandermeulen and Werner Roeger

Abstract:

In the aftermath of the financial crisis, it had become clear the Euro Area was suffering from insufficient investment. Actual capital stock was below benchmark capital, the amount of capital you need to support trend labour and total factor productivity (TFP) growth rates. The current COVID-19 pandemic might enlarge the gap between benchmark and actual capital, since both the private and public sector are facing limitations to invest. In the current paper, benchmark capital is estimated based on trend supply side conditions and trend in capital and goods market frictions, to investigate whether such a gap exists in the Euro Area and the US and how it has evolved over time.

The paper is based on the European Commission's production function method and uses trend labour supply and TFP as basis for trend supply side conditions. The first order condition of the Cobb-Douglas production function are used to calculate goods market and capital market frictions. Capital costs are estimated using world interest rate as a rental price of capital, adjusted for depreciation, taxes and relative investment prices.

In the past, benchmark capital was driven by strong growth in supply side factors, but since trend labour and TFP growth rates have declined, capital and goods market frictions are becoming more important in explaining benchmark capital growth. The paper shows that after the 2008 crisis, a gap occurred between benchmark capital and actual capital. As of 2012, the gap started to close, but benchmark capital growth was very low in the Euro Area, much below that of the US. Just before the current 2020 crisis, the capital gap was closed in the Euro Area and was positive in the US, but it is expected that actual capital growth might stop again due to the limitations to private and public investment.

JEL classification: D1, D2, D3, E6, H2, H21, J08, J2.

Keywords: labour taxation, capital taxation, inclusive growth.

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1. INTRODUCTION

In literature two opposing views exist on whether benchmark or trend capital is different from the actual capital stock. *On the one hand*, several reasons can be given why actual capital is equal to potential. Menashe and Yakhin (2004), Denis et al. (2006) and Cotis et al. (2004), amongst others, believe that full utilisation of the existing capital stock in the economy will equal the maximum potential output contribution of capital. The CBO (2001, 2014) and Andrle (2013) state that the capital stock might vary during the business cycle, but that in fact the potential flow of capital services will always be proportional to the size of the actual capital stock and not to the amount currently being used and that these cyclical fluctuations are so small that the contribution of capital to growth can be seen as constant. *On the other hand,* a more dynamic view on output suggests that the current capital stock might not be consistent with economic fundamentals (D'Auria, et al., 2010), and thus not equal to potential. Capital misalignment or capital shocks can, for example, occur when too much capital was accumulated because of a housing bubble or a stock price bubble (D'Auria, et al., 2010); when there is excessive credit loosening or tightening by banks; when unexpected shocks arise to term spreads, loans and bank loan deposit ratios; or when shocks to house prices or other assets leading to an adjustment in capital (Hubrich, et al., 2013). Especially in the aftermath of the financial crisis there is the widespread opinion that Europe is suffering from insufficient investment, and therefore that actual capital stock is below its potential level.

The question can be summarised as follows: is the drop in investment after 2008 in the EU a downward adjustment to excessive pre-crisis investment levels, or is it really abnormally low (D. Gros, 2014)? To make this distinction, it is necessary to know the benchmark rate of capital formation. Research on benchmark capital is rather limited. In 2013 a working paper at the OECD calculated a capital stock gap, measured as the difference between actual and filtered capital stock. A positive capital gap was found, largest just before the 2008 crisis, while becoming smaller in more recent years, and turning negative for a few countries since 2008 like Germany, the US and Japan (Turner, 2013; Giorno,et.al., 1995). Baldi et al. (2014) found more pronounced negative capital gaps since 2008 for many euro area countries. They estimated a (negative) investment gap of 2% of GNP in the period 2010 until 2012 for all euro area countries. In the years before 2008 they found that actual investment was much higher than trend investment for countries like Greece, Spain, Portugal, Ireland, Italy and Ireland. However, countries like Germany, Finland and the Netherlands also had a negative investment gap in this pre-crisis period, suggesting that investment was too low for these countries over the period 1999-2012. Döttling et al. (2017) relate the existence of an investment gap to a decrease in competition, increased concentration and decreased anti-trust enforcement, especially in the US. They describe how in the EU concentration has been stable, but product market regulation has declined while anti-trust regulation has increased. They find that the low investment is more cyclical in the EU and more of a structural nature in the US. The existence of intangibles also plays a role, but it cannot explain the full weakness in investment. The rise of the relative importance of intangibles could, according to Döttling et al. (2017), lead to a higher equilibrium value of investment because intangible assets might be more difficult to accumulate.

This paper looks at the relationship between trend capital formation and supply side conditions. It follows a similar approach as Gros (2014), but it makes direct use of estimated supply side trends, such as employment trends (which includes the growth rate of population in working age, the trend participation rate, the NAWRU and trend growth rate of hours worked per person) and total factor productivity (TFP) trends. On top of this, the benchmark capital stock will be influenced by several trend frictions. Capital frictions are defined as the difference between the marginal product of capital, adjusted for capital gains and losses on that capital (depreciation), and the short-term interest rate (Hall 2018). Goods market frictions are incorporated into the mark-up. The paper finds that there exist long run trends in both the capital and goods market frictions. A combination of the *supply side trends* and the *friction trends* build up the benchmark capital stock.

The next section describes how benchmark capital can be calculated. Part 3 shows an estimate of benchmark capital growth for the US and several Euro Area countries. The paper ends with a discussion and conclusion in part 4.

2. DEFINING AND MEASURING BENCHMARK CAPITAL

2.1 METHODOLOGY

In standard potential output calculations, as in the EU's commonly agreed method (CAM) (Havik et al., 2014), the actual capital stock is used for calculating potential output. Our goal is to decompose variations in the actual capital stock into trend and cyclical components. As is well known from theories of investment, capital depends on economic trend and cyclical conditions. In order to be as close as possible to the CAM methodology we use trend components such as technology trends and labour trends as calculated in that method for estimating the capital trend. However we need to use additional information such as trends in capital cost, trends in financial frictions and competition trends to fully account for the trend in capital. Therefore our starting assumption to calculate benchmark capital stock is an aggregate Cobb-Douglas production function, of the same form as used by CAM.

$$y_t = \alpha l_t + (1-\alpha)k_t + tfp_t \qquad \text{(eq. 1, production function, in log levels)}$$

> *y: log of real GDP, l: log of total hours worked in the economy, k: log of real capital stock, tfp: log of total factor productivity, measured as the Solow residual, α: income elasticity, t: time indicator.*

The CAM takes the capital stock as given, while we want to measure cyclical fluctuations in the capital stock. Therefore we extend the model and introduce a standard neoclassical model of investment. Firms make investment and employment decisions based on profit maximisation, given the technology and relative factor prices, allowing for the existence of mark-ups (goods market friction) and based on an assessment of capital costs. Concerning capital cost we allow that a fraction $(1-\beta)$ of investment is based on constant required rate of return, while a fraction β is based on current financial market conditions. This choice reflects the fact that in empirical investment equations, the elasticity of the capital stock with respect to capital cost is not equal to one, but approximately 0.25. All types of investment face some type of capital frictions linked to a risk premium or additional collateral constraints (see below).

Based on these assumptions, the optimal level of capital in year t is given by (full derivation in Annex 1)

$$k_t = \frac{\log(1-\alpha)}{\alpha} + l_t + \frac{tfp_t}{\alpha} - \frac{\mathrm{mup_t}}{\alpha} - \frac{cf_t + \beta cc_t + (1-\beta)\overline{cc}}{\alpha} \qquad \text{(eq. 2, capital stock equation)}$$

> *cc: log of financial market driven capital costs, $\overline{cc}$: log of constant required rate of return, cf: log of capital frictions/risk, mup: log of mark-up or goods markets frictions, β: capital elasticity of capital costs and frictions*

Trend capital stock is defined as the level of the capital stock which would be consistent with the trend of each element. Trend **employment** (l_t^T) and trend **TFP** (tfp_t^T) come from the CAM (see Havik et al. 2014).

A measure of the **mark-up** is identified from the labour demand equation (consistent with the Cobb Douglas technology), using information on wages, employment and GDP. The mark-up is equal to the inverse of the labour share (De Loecker and Warzynksi (2012)).

$$l_t = \log(\alpha) + y_t - w_t - mup_t \qquad \text{(eq. 3, labour equation)}$$

w: log of real wages (nominal wages divided by the GDP deflator)

The existence of a trend mark-up (mup_t^T) is investigated using an HP filter (with lambda equal to 10) of the actual mark-up.

For **financial market capital cost** $(cc)^T$ the rate of return is used, adjusted for depreciation, taxes and relative investment prices. Trend capital costs is calculated using an HP filter (with lambda equal to 10).

$$cc_t = \log(R_t + \delta_t) - \log(1 - T_t) + \log\left(\frac{PI_t}{PY_t}\right) \qquad \text{(eq. 4, capital cost)}$$

R: rate of return, δ: depreciation, T: taxes, PI: investment price inflation, PY: GDP price inflation

The rate of return is defined as the standard rental price of capital which reflects the cost of capital, firms face when wanting to invest. Two considerations need to be made. First, since the focus is on growth of the capital stock consistent with fundamentals, the concept of the natural interest rate is applied (Laubach and Williams (2003)). This concept defines a rate of return consistent with the supply of savings; approximated by the growth rate of consumption, adjusted for an estimate of the rate of time preference and the intertemporal rate of substitution[1]. As we will describe in the data section, we will take a rather simplified approach to estimating the natural rate of return, as suggested by Laubach and Williams (2003), i.e. the natural interest rate is approximated using real GDP growth rates. Second, given the high degree of international financial market integration, the concept of a world natural rate is used, since this better reflects the opportunity of households to invest in international financial markets. Therefore, we will be using world GDP growth rates as an approximation of the rate of return.

The **constant required rate of return,** which reflects the safe rate, is defined as the average of the market rate of return over time. By adding a constant return we capture that investment decisions are not only based on the current interest capital cost but on a more long run return target.

The interest rate (either the loan rate or the safe rate) used for defining capital cost does not fully reflect the risk associated with investment. Investors are likely to ask for a risk premium or they impose additional collateral constraints. We subsume this under the heading **financial or capital friction**. Frictions in financial markets can constrain investment decisions (Döttling (2017)). Unfortunately, there is no directly observable measure of capital frictions, therefore we rely on the neoclassical model of investment which postulates a relationship between the marginal product of capital (adjusted for the mark up) and capital cost, including risk. Putting all observable parts of equation 2 onto the RHS gives:

[1] More formally, the natural interest rate is computed by the formula $R = \sigma gc + \theta$, where (gc) is the growth rate of consumption, σ: the inverse of intertemporal elasticity of substitution, θ: pure rate of time preference.

$$cf_t = \log(1-\alpha) - \alpha k_t + \alpha l_t + tfp_t - mup_t - \beta cc_t - (1-\beta)\overline{cc}_t \qquad \text{(eq. 5, capital frictions)}$$

We will put special emphasis on the evolution of capital frictions as identified here, since an increase in financial frictions could itself be a sign that we are missing important developments in financial markets which restrict investment. In order to distinguish between cyclical and trend variations in risk we use an HP filter (with lambda equal to 10).

And so trend capital stock can be calculated

$$k_t^T = \frac{\log(1-\alpha)}{\alpha} + l_t^T + \frac{tfp_t^T}{\alpha} - \frac{\mathrm{mup}_t^T}{\alpha} - \frac{\beta (cc_t)^T + (1-\beta)\overline{cc}_t{}^T + cf_t{}^T}{\alpha} \qquad \text{(eq. 6, trend capital)}$$

Trend capital stock will increase when trend labour and trend TFP increase. An increase in these two production factors will go together with an increase in the complementary capital stock production factor. When trend capital costs increase, it becomes relatively more expensive to increase the capital stock and thus the capital stock will decrease. When one of the two trend frictions increase, it will become more difficult for capital to adjust to changes in TFP or labour and thus trend capital stock will decrease.

Trend capital stock growth is equal to:

$$\Delta k_t^T = \Delta l_t^T + \frac{1}{\alpha}\Delta tfp_t^T - \frac{1}{\alpha}\Delta mup_t^T - \frac{\beta}{\alpha}\Delta (cc_t)^T - \frac{1}{\alpha}\Delta cf_t^T \qquad \text{(eq. 7, trend capital growth)}$$

Δ : first difference of log levels (approximate growth rates)

By adding an investment decision to the Solow model the analysis in this paper moves from the Solow model to the neoclassical growth model. The Solow model has a very simple savings and investment decision (households save a fraction of current income and this is turned into investment). In the neoclassical growth model the investment decision is based on a comparison between the marginal product of capital (return on capital) and the capital cost. In addition goods and financial market frictions are considered. Also by using a world interest rate financial openness is taken into account. However, what remains the same is the form of the neoclassical production function which is identical in the Solow model and the neoclassical growth model. Thus, moving to this approach does not affect the calculation of TFP and other variables in the production function. The only thing which is replaced, is the investment rule, which is somewhat ad hoc in the CAM method. It would be replaced by a more micro founded investment equation.

2.2 DATA

The dataset includes information from the European Commission Autumn 2020 forecast on Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Italy (IT), The Netherlands (NL), Portugal (PT), the US and an EA aggregate (which aggregates the individually available countries). The country selection is only driven by data availability.

Data on capital, labour and TFP for the period 1960-2020 come from Eurostat and data for 2021 and 2022 come from the Commission's 2020 Autumn forecast[2] (all data are extracted from the Ameco database).

[2] European Economic Forecast. Autumn 2020 | European Commission (europa.eu)

Capital is measured as the net capital stock at 2010 prices in national currencies[3]; labour is the total annual hours worked in 1000 hours, and TFP is calculated as the Solow Residual of the production function as in the Forecast exercises of the Commission. Data on the trend variables (for labour and TFP) are taken from the Commission's 2020 Autumn forecast.

For calculating the capital cost, information is needed on the depreciation rate, world growth rate, relative investment prices, investment inflation and taxes. The depreciation rate is calculated based on the capital stock and investment data. Both investment price inflation data and the price deflator of GDP come from the Ameco database.

Based on the corporate tax rates, capital allowances and share of assets, a composite tax indicator is calculated (using EU Klems data). The tax indicator is calculated as follows:

$$Taxindicator = \frac{1-\sum_{i=(B,M,P)} s_i * \frac{capallow_i}{100} * corptax}{1-corptax}$$

s: share of each asset (buildings B, machines M and patents P), capallow: capital allowances for each asset type, corptax: corporate tax rate in that sector.

Following Laubach and Williams (2003) the world natural interest rate is approximated using real world GDP growth rates (OECD). Since firms are making their investment decisions not solely on this year's interest rate, but they try to incorporate information about past interest rates and expected future interest rates, a moving average over a period of seven years is applied to the growth rate of world GDP. The inverse of intertemporal elasticity of substitution is set equal to 1. The pure rate of time preference is set equal to 0.5%.

$$R_t^* = 1 * \mathrm{MA}\left(\frac{WGDP_t}{WGDP_{t-1}} - 1\right) + 0.005$$

WGDP: real world GDP, MA: 7 year moving average (t-3 to t+3)

We assume that α=0.65 for all countries. This is similar to the Commission approach in the forecasting exercises and leads to a simplification of the model. Capital and goods market frictions are calculated within the model. We assume that the capital stock reacts slowly to changes in capital costs and frictions. We therefore set the ratio $\frac{\beta}{\alpha} = 0.25$ (and thus β=0.25*0.65=0.1625[4]).

Since the capital gap is estimated simultaneously but separately for each country, it was decided to work with an unbalanced panel and not to limit the data in time (maximum period is 1970-2022).

[3] All countries are euro area countries, which makes aggregation easier.

[4] Looking at the data would even suggest using a smaller β of 0.1, based on the results of the following panel regression: $dk_t = 1.0\ dy_t - 0.1\ dcc_t$.

3. RESULTS

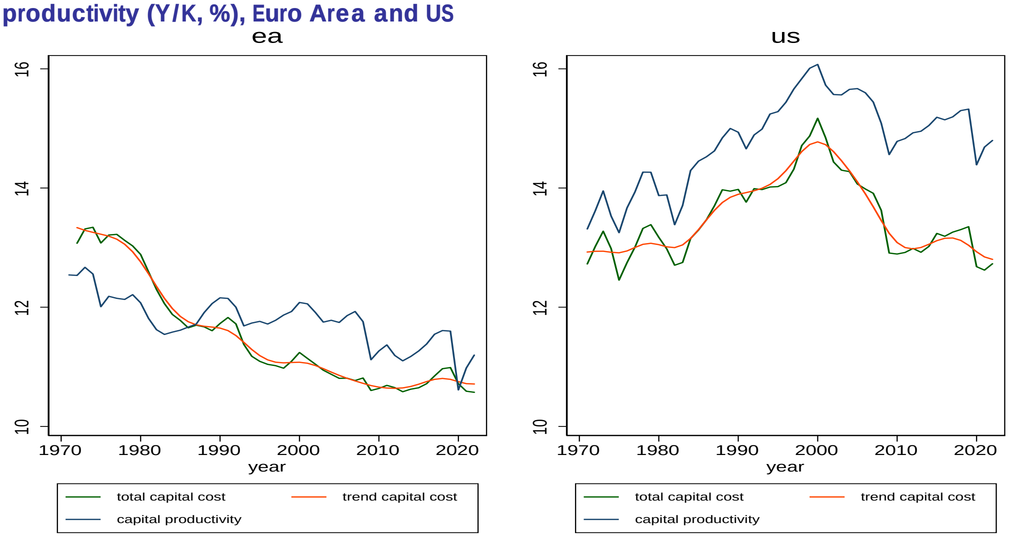
In the main section of the text the Euro Area (as the sum of the individual countries) and US graphs are included. The individual member states graphs are added in Annex 2.

3.1 CAPITAL COST AND CAPITAL PRODUCTIVITY

The first graph shows capital productivity, calculated as output over capital stock and the estimate of the capital costs including capital frictions, for the EA and US. Capital productivity and capital costs are expected to have very similar patterns. Differences could indicate mismeasurement or elements missing from the capital cost estimate.

Average capital costs have been declining in the EA from 1985 until 2012. Since 2012 the capital costs were increasing, but dropped again in 2020 and 2021. This is in line with capital productivity, although the two measures are not identical. Capital productivity shows a strong decrease in 2008. Although capital costs also decreased, they decreased much less and a bit delayed. Looking at the US, the story is a bit different. Capital costs increased in the first part of the sample until 2000, after which it decreased until 2008. In 2008 the capital costs dropped and stayed quite constant afterwards, with another drop in 2020. A more important difference is in capital productivity, where the US shows a rising trend and a widening gap to capital cost developments. This widening gap could partly be explained by the rising role of intangibles, especially in the US (Corrado et al. (2016)), which pushes up capital productivity (described by amongst others Döttling et al. (2017)) but is less reflected in a rising capital cost.

Figure 1. **Capital cost measures: actual and trend capital cost (including capital frictions, %) and capital productivity (Y/K, %), Euro Area and US**



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

3.2 CAPITAL COST ELEMENTS

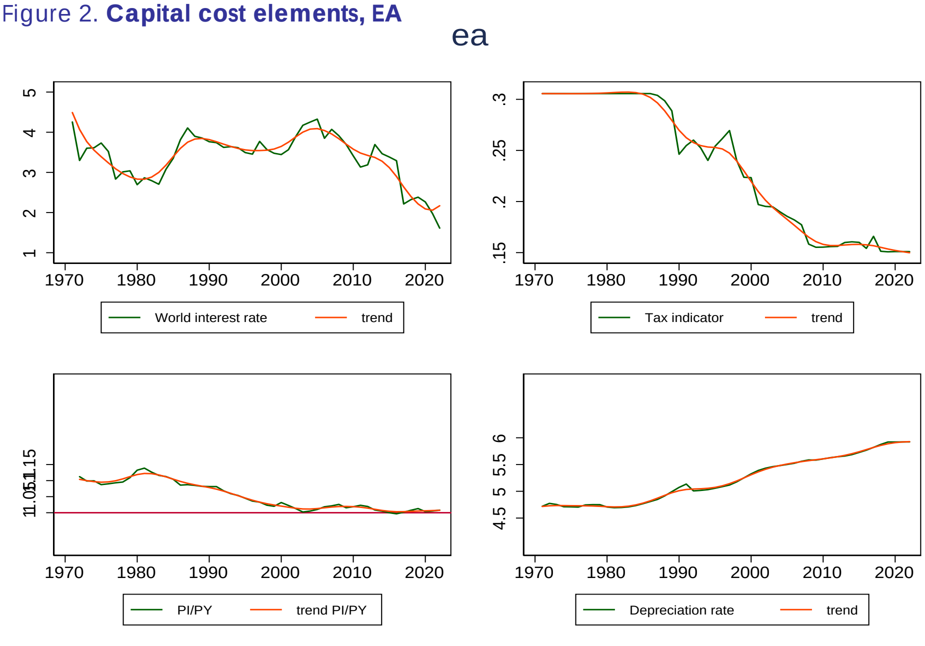
Figures 2 and 3 show the elements of capital cost, capital frictions and the mark-ups, for the US and the EA. The scales of the graphs for both countries are identical to make comparison easier. Trend capital and goods market frictions are explained more in detail in the next section.

World interest rates are of course identical for the EA and the US, fluctuating between 2.5 and 5%. The trend decreased until 1980 and increased steadily afterwards. The world interest rate is a moving average over seven years of world GDP growth rates (see before). The large drop in world GDP in 2020 is smoothened out over seven years and is therefore not clearly visible in the graphs. It does lead to a trend which is declining slightly in the last years of the sample. Also in literature it is not clear yet whether one can expect interest rates to increase or decrease after 2020 (Jolles and Meyermans, 2021).

For the EA the tax indicator shows a strong decline until 2008, after which the taxes remain rather stable until the end of the sample. The relative price of investment also decreased strongly until 2000, after which the ratio of investment price to output price fluctuates around one. The depreciation rate has remained quite stable, slightly increasing from 4.5% to 6%. Of each of these components a trend indicator is calculated, using the HP filter. Trend world interest rates start of low in the 1980s after which it increases until 1990. In the period 1990-2000 the rate remains quite stable. Early 2000s the rate increased and after 2005 it decreased. Since 2010 the rate is stable again.

For the US data on corporate taxes show a one year increase in 1987 and then a considerable drop in 2018. This was due to a cut in corporate taxes[5]. The relative price of investment shows a similar pattern as in the EA, but keeps on decreasing also after 2000, and is now below one. The US faced an increase in depreciation, to above 7% and above the EA average.

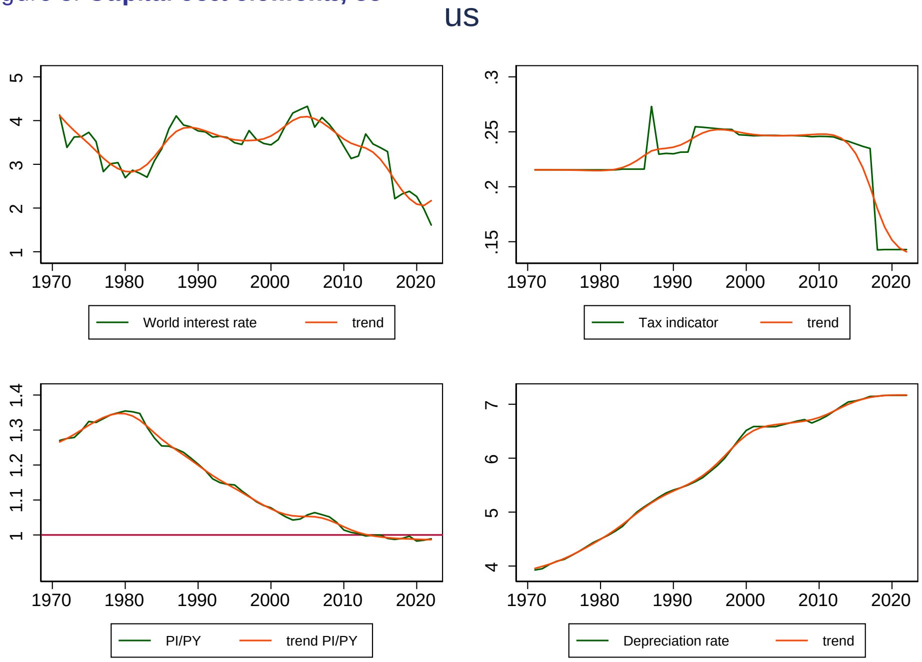
Figure 2. **Capital cost elements, EA**



Source: world interest rate: OECD, Tax indicator: EU-Klems, prices and depreciation rate from Eurostat and Commission's 2020 Autumn forecast.

[5] There was a permanent cut in US federal corporate tax rate for profits in excess of $10 million from 35% to 21% in December 2017.

Figure 3. **Capital cost elements, US**



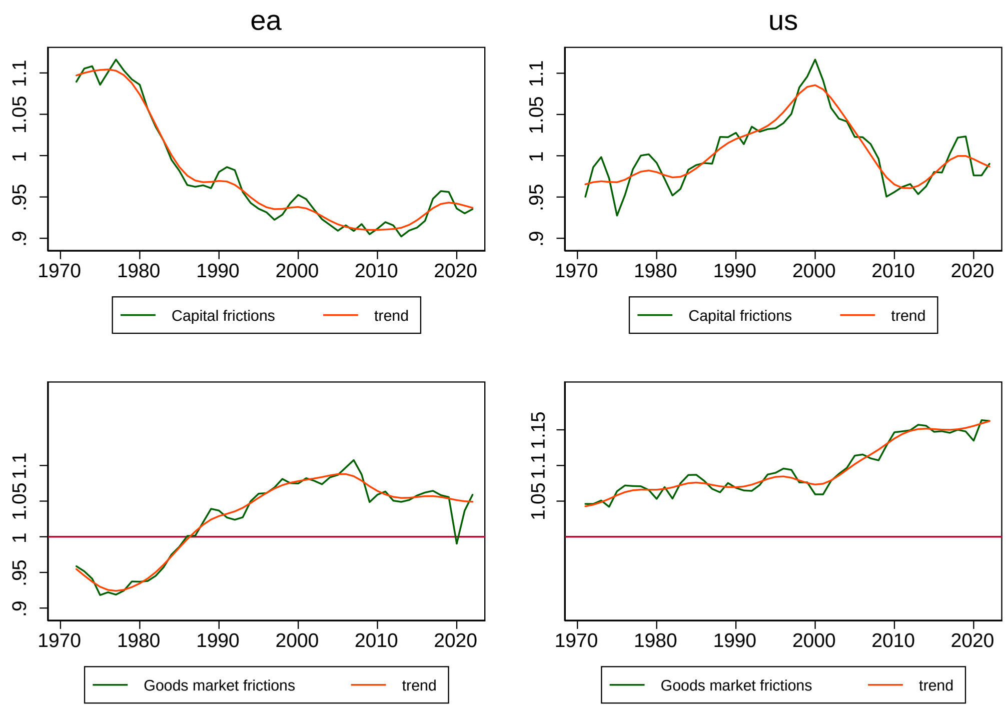
Source: world interest rate: OECD, Tax indicator: EU-Klems, prices and depreciation rate from Eurostat and Commission's 2020 Autumn forecast.

3.3 CAPITAL AND GOODS MARKET FRICTIONS

Figure 4 shows the *capital frictions* in both the Euro Area and the US. They are defined as the difference between the marginal product of capital adjusted for goods market mark ups and capital cost (the return received by providers of financial capital) (Hall, 2011). The capital frictions show a downward trend as of 1975 in the EA, which is in line with expectations. In section 2.2 we mentioned that an increase in financial frictions could be a sign that we are missing important developments in financial markets which restrict investment, but this doesn't seem to be the case, at least not for the sample as a whole. Since 2000 the capital frictions have been quite stable and at a much lower level then at the beginning of the sample. This suggests that viewed from a cost of investment perspective, conditions for undertaking investment were improving over time. In 2008 the marginal product of capital decreased a lot, due to the crisis, but at the same time the capital costs decreased (interest rates) and as such the capital frictions did not decrease substantially. After 2008, the capital frictions increases until around 2018. This increase is also visible in other financial risk indicators, such as the loan rate spreads and net credit tightening which increased strongly after the 2008 crisis (Kollmann et al., 2016). However, these alternative indicators decreased again rapidly after the crisis, while our estimate of financial frictions keeps on increasing until 2018. Actual capital frictions dropped considerably in 2020, due to the sharp fall in marginal product, leading to a slowdown in the trend at the end of the sample.

Capital frictions in the US show an upward trend which starts in the mid-80s and peaks in 2000. The dating of this increase coincides with the occurrence of higher equity premia as, for example, measured by Farhi and Gourio (2018). They interpret this as a higher perception of risk in US financial markets. It must however be admitted that this has not prevented the dot com bubble, which was however a less severe (an quite localised event in the US stock market) compared to the financial crisis in 2009, which occurred after a period of financial market innovations which were introduced in the early 2000s. The loan rate spreads (an alternative indicator for financial frictions) increased in 2008, but started decreasing again as of 2011 (Kollmann et al., 2016). The net credit tightening only showed a two year peak in 2008 and 2009 (Kollmann et al., 2016). The financial frictions indicator in the current paper recovered less rapidly after the 2008 crisis. Also in the US the actual capital frictions dropped considerably in 2020, due to the sharp fall in marginal product, leading to a decrease in the trend at the end of the sample.

Figure 4. **Capital frictions and goods market frictions, Euro area (left column) and US (right column)**



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

De Loecker and Eeckhout (2017) report that the capital share moves with the inverse of the *mark-up measure (goods market friction)*, meaning that when mark-ups increase there will be a reduction in capital investment. Even if capital does not adjust at a yearly frequency, on average over a long enough time horizon the capital to output share is expected to evolve. Capital formation will be mainly influenced by the trend in the mark-up, more than by short term movements in the mark-ups. In the 1980s, Europe experienced a striking increase in the mark-up. In the period 2009-2015 mark-ups in the EA show a decreasing trend. Thum-Thysen and Canton (2015, 2017) found that mark-ups are positively correlated with stringency of product market regulations. The tendency of product market regulations to become less strict in the EU could imply a decrease in the mark-ups. Moreover, the 2008 economic crisis had an adverse impact on the mark-ups of firms in Europe (Deutsche Bundesbank, 2017). This sharp drop in the mark-up was also found by Weche and Wamback (2018) based on micro-level data for the EU. Actual mark-ups seemed to start increasing again as the economy recovered, but the trend seems to differ amongst countries. In Germany and Italy we find that mark-ups are trending downwards (which is also what Cavalleri et al. (2019) described) but in Belgium and Portugal mark-ups show a more upward trend. For all countries, the new crisis in 2020 has led to a sharp fall in the mark-up, limiting the possibilities for an increase in trend mark-up in the last few years.

Looking at the US, an upward trend in the mark-up is visible. For the US there is no break in the trend for the period after 2008. The mark-up in the US has been higher than one over the whole sample and is in general higher than in the EU. According to De Loecker and Eeckhout (2020) mark-ups were reaching heights multiple times higher than ever seen, mainly driven by the existence of superstar firms. Calligaris et al. (2018) add to this that the rise of digitally strong firms might also cause upward pressure on the mark-ups in the US. The current crisis has interrupted the rise for just one year and it is expected that the trend will continue to increase. The divergent findings between Europe and the United States may suggest that different factors have been at play. In a recent report by the European Commission (2021) it is described how different policies can explain differences. Examples include the more lax anti-trust policies in the US and a lack of international coordination in corporate taxation leading to profit-shifting.

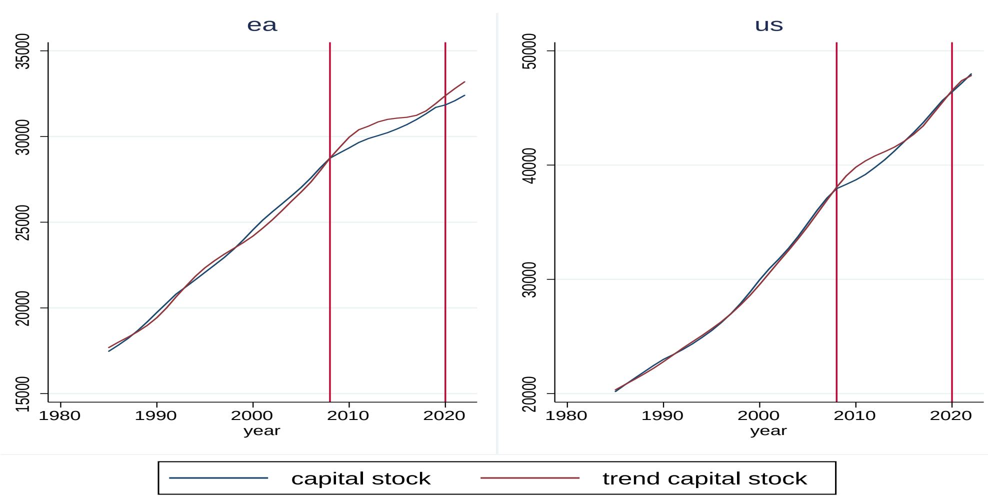
Both the US and EA have seen a rise in competitive pressure due to globalisation, but this overall trend is likely to have been augmented in Europe by the European integration process. By way of contrast, the fact that a large number of newer, internet-based firms, which in some cases have pronounced market power owing to network effects, primarily have their origins and bases in the United States may have played a role there (Deutsche Bundesbank, 2017).

3.4 TREND CAPITAL STOCK LEVEL AND GROWTH RATES

Before 2008, actual capital stock was above the benchmark in the EA (see Figure 5), showing that too much capital was accumulated compared to the other production factors and relative to the costs of capital. After the 2008 crisis a large gap between actual and trend capital stock arose in the EA. Benchmark capital grew strongly, while actual capital stock stagnated. But over time the gap was closing, until the newest crisis arose in 2020. Due to lower levels of investment in the private and public sector, actual capital stock once again seems to not grow at the same speed as benchmark capital. For the US the gap between actual and the benchmark occurred also around 2008, but was less large than in the EU and closed faster. The expectation is that also in the US a new capital gap might arise.

Looking at the end of the sample it seems that although actual capital stock was growing at a faster pace than trend capital after 2010 this has changed in 2020. Again, trend capital growth is picking up and is stronger than actual capital stock growth, especially in the Euro Area. This suggests that the most recent crisis, caused by the Covid-19 pandemic, is holding back actual capital growth. However, the estimates for the final years of the sample (2020 and especially 2021) are still very uncertain.

Figure 5. **Capital stock, actual and benchmark (trend), EA and US**

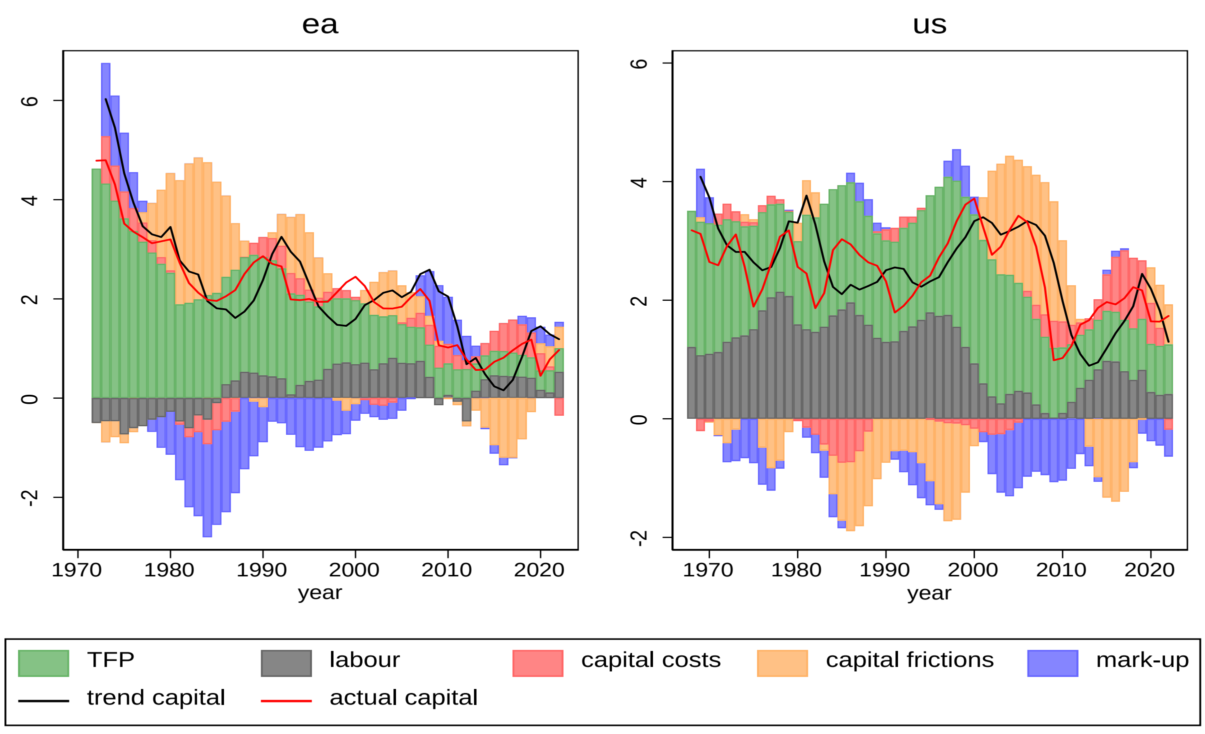


Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

Figure 6 shows the decomposition of trend capital growth into its components. Trend capital growth in the EA was historically mainly driven by trend TFP. Since trend TFP growth has declined strongly over time, capital growth has also declined. Since 2000, its contribution has been more constant. The contribution of trend capital costs to trend capital growth has fluctuated strongly and has been positive since 2008. Trend capital frictions used to have a positive impact on the capital stock growth rate until 2008, but has been pulling down capital stock growth since then. The mark-up pushed up capital growth in the beginning of the sample, but was hampering further capital stock growth since 1980 until middle of 2000s. Since 2014 economic fundamentals (shown in labour and TFP) suggest more capital growth, but frictions are holding back further growth in benchmark capital. The current crisis is not expected to lower benchmark capital stock growth considerably. Capital frictions remain large and it is expected that TFP growth still asks for capital stock growth to be strong. The main component contributing to a temporary drop in trend capital stock growth is the zero trend labour growth during 2020. As soon as this picks up again in 2021, trend capital stock is expected to grow strongly above actual capital growth.

Looking at the US, the labour component is more important to explain trend capital growth rates in the earlier period than in the EU. In the period 2000-2010 labour contribution decreased strongly. In the first years, capital frictions still pushed for a strong growth in trend capital, but as of 2008 trend capital growth dropped to a low level, but higher than in the EU. Since then the contribution of mark-up is negative, offset by labour, TFP and capital costs. Capital costs are very advantageous for capital growth (they are low) and are pushing up the benchmark capital stock. Most of the drop in trend capital costs is due to the change in actual taxes in 2017, which lead to a decreasing trend tax rate as of 2014.

Figure 6. **Trend capital stock growth rate and its components, EA and US**



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

4. CONCLUSION AND DISCUSSION

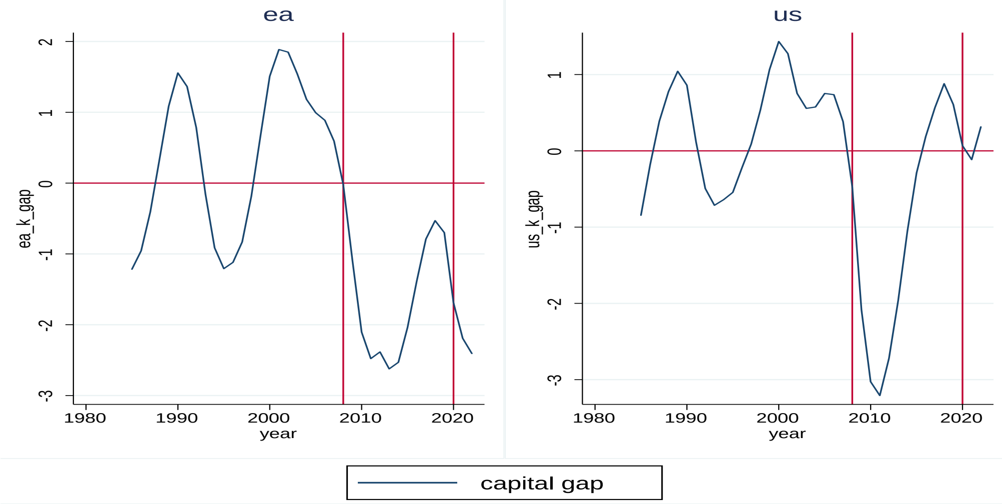
This paper tries to account for movements in the trend capital stock by looking at relevant trends of drivers as suggested by investment theory. A major driver of capital growth trend are trends in employment and trends in TFP as identified by CAM. In a world with roughly constant capital costs, stationary capital frictions and competition in goods markets, capital growth trends should be largely explained by employment and TFP trends. Our analysis reveals, however that capital costs and frictions show trends themselves. We identify a falling trend in capital cost, especially in the EU which is supportive to trend capital growth. Goods market frictions show an upward trend especially in the US. This has contributed negatively to US capital growth in the early 2000s. Medium term cycles in capital frictions have contributed positively to capital growth in the 2000s before the financial crisis but have contributed negatively afterwards.

After the 2008 economic crisis *capital frictions* showed a flattening, bottoming out of the trend. Uncertainty was increasing which dissuaded investment. Although by some measures, economic uncertainty has fallen in recent years, long-standing uncertainties persist, including how population ageing and climate change will be dealt with (OECD, 2015). In the 2020 crisis the marginal product of capital dropped sharply, while the interest rates remained unchanged, leading to a decrease in capital frictions. This in fact leads benchmark capital to increase, suggesting that more investment is needed (on top of more investment needed to compensate for a possible drop due to the cyclical downturn in the economy).

Looking at the *goods market frictions* one can see that these frictions were increasing strongly until 2008 in the EA, after which they declined until 2014 (Thum-Thysen and Canton, 2017). During this period, the decline in the trend mark-ups boosted trend capital growth, lifting it above actual capital growth rates. Without the mark-up trend, actual capital growth would have been in line with potential capital growth. Recent regulatory reforms in product markets in some countries and generally improved corporate balance sheets should boost the prospects for investment, although there is more to do (OECD, 2015), which can be seen by the levelling off of the impact of the goods markets frictions after 2014. In the US the goods market frictions show an upward trend since 2000 (De Loecker and Eeckhout, 2017). This leads to negative pressure on trend capital growth rates over almost this whole period.

In the EU capital growth was below the benchmark between 2002 and 2014. Even though actual capital growth was increasing until 2008, it was growing less strong than the benchmark. This lead to a declining *capital gap* (measured as the ratio of actual capital over potential capital) over those years. Since 2010 capital growth is stronger than the benchmark, but it is taking some time to close the gap that was created in the earlier years. In the US the divergence between benchmark and actual capital growth was largest after 2008, but by 2011 actual growth was again higher than the benchmark, and therefore the capital gap in the US is closing faster than in the EA. Provisional data on 2020 and a forecast for 2021 and 2022 suggest that the new crisis might lead to another drop in the capital gap, just when the EA was closing the gap. However, the implications of the Covid-19 pandemic on the economy are not yet clear. Jolles and Meyermans (2021) provide a literature review of the structural economic impact of the pandemic and come to the conclusion that the impact can go in two directions, for many elements. For example, savings can increase and remain at a higher level because of pent-up demand is not as strong as the need for precautionary savings. However, at the same time, increases in unemployment might unable employees to save as much as they did before. Similarly the impact of the crisis on the interest rates is unsure. On the one hand, increased savings and low investments can put downward pressure on interest rates, while increasing public debt might at the same time push up interest rates. The uncertainty of the impact of the crisis and the limited data available warrant some caution when drawing conclusions about the opening of the capital gap at the end of the sample.

Figure 7. **Capital gap, EA and US**



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

By adding a capital gap to the *output gap*, a first step could be taken to incorporate information about the financial cycle into potential output calculations. Borio et al. (2013) have argued that by not taking into account financial cycle information when calculating an output gap, one is missing out on essential information about the economy. The impact of financial crises on potential output can be discussed (Furceri and Mourougane, 2012), but by calculating a capital gap at least part of the financial cycle is taken into account (through interest rates, relative prices of investment, taxes etc.).

Future research could investigate the impact of using the HP filter in calculating the trend elements. Using an HP filter has the advantage of being easy to interpret and replicate, but it has a well-known disadvantage related to the importance that is given to the last data points in the filter. One possible solution could be to recast the investment estimation into a state space form and then the investment gap could be backed out by the Kalman Filter. For this to work, goods cyclical indicators are needed to help the filtering process. This method might limit the analysis of the separate components as we describe in this paper and for sure increases the complexity of the analysis, but it could be investigated in the future.

When wanting to increase benchmark capital growth rates, which will in turn lead to higher potential growth rates in an economy, all elements need to be addressed. Macroeconomic policy is needed to address deficient demand and a reduction in policy-related uncertainty needs to be accompanied by structural policies to increase longer-term economic growth (OECD, 2015). Reducing regulatory uncertainty is needed to make sure irreversible investment in an industry is not negatively affected by uncertainty about future payoffs (e.g. Bernanke (1983)). For example, investment in efficient energy production and conservation could be stimulated by decreasing the uncertainty about the future path of climate policies. Competition policy needs to be strengthened to come to a stronger international cooperation and equal treatment across countries. Within Europe, important steps are taken with the national recovery and resilience plans being developed. Not only investments will be part of these plans (and supported by the European Union Recovery and Resilience Fund), but they will be accompanied by reforms aiming at increasing the competitiveness and resilience of the European economies.

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6. ANNEX 1 – DERIVATION OF CAPITAL GROWTH RATE

Cobb Douglas **Production Function**[6]

$Y_t = L_t^{\alpha} K_t^{1-\alpha} TFP_t$ or in log levels $y_t = \alpha l_t + (1-\alpha) k_t + tfp_t$ (eq. A1)

Y: real GDP, L: total hours worked in the economy, K: real capital stock, TFP: total factor productivity, measured as the Solow residual, α: income elasticity, t: time indicator.

Profit of a competitive firm

$$PR_t = Y_t - W_t L_t - CC_t^{\beta}\, \overline{CC}^{(1-\beta)}\, CF_t\, K_t$$

PR: profit, W: wages, CC: financial market capital cost, $\overline{CC}$*: constant rate of return, CF: capital frictions, β: capital elasticity of capital costs and frictions*

Profit **maximisation** when $MC_t/(1-M_t) = MR_t$

MC: marginal costs, MR: marginal revenues, M: mark-up

First order condition for capital, using the production and profit function.

$$\frac{\partial \pi_t}{\partial K_t} = \left(\frac{\partial Y_t}{\partial K_t}\right) - \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta} CF_t}{(1-M_t)} = 0$$

$$\left(\frac{\partial Y_t}{\partial K_t}\right) = (1-\alpha)\frac{Y_t}{K_t} = \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta} CF_t}{(1-M_t)}$$

$$\Rightarrow \quad (1-\alpha) K_t^{(1-\alpha)-1} L_t^{\alpha} TFP_t - \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta} CF_t}{(1-M_t)} = 0$$

[6] Small letters indicate log levels, capital letters indicate levels.

- ⇨ $(1-\alpha)K_t^{(1-\alpha)-1}L_t^{\alpha}TFP_t = \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta}CF_t}{(1-M_t)}$
- ⇨ $(1-\alpha)K_t^{-\propto} = \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta}CF_t}{(1-M_t)\,L_t^{\propto}TFP_t}$
- ⇨ $K_t^{-\alpha} = \frac{(CC_t)^{\beta}\overline{CC}^{1-\beta}CF_t}{(1-\alpha)(1-M_t)\,L_t^{\propto}TFP_t}$
- ⇨ $K_t^{\alpha} = \frac{(1-\alpha)(1-M_t)\,L_t^{\alpha}TFP_t}{(CC_t)^{\beta}\overline{CC}^{1-\beta}CF_t}$

Or in log levels $\alpha k_t = \log(1-\alpha) - mup_t + \alpha l_t + tfp_t - \beta(cc_t) - (1-\beta)\overline{cc} - cc_f$

$$k_t = \frac{\log(1-\alpha)}{\alpha} + l_t + \frac{tfp_t}{\alpha} - \frac{\mathrm{mup_t}}{\alpha} - \frac{cf_t + \beta cc_t + (1-\beta)\overline{cc}}{\alpha} \qquad \text{(eq. A2)}$$

The mark-up is calculated using the first order condition for labour.

$$\frac{\partial \pi}{\partial L} = \left(\frac{\partial Y_t}{\partial L_t}\right)(1-M) - W = \alpha L_t^{\alpha-1}K_t^{(1-\alpha)}TFP_t(1-M_t) - W_t = 0$$

- ⇨ $\frac{P_t \alpha Y_t}{L_t}(1-M_t) - W_t = 0$
- ⇨ $\alpha\frac{P_t Y_t}{W_t}(1-M_t) = L_t$
- ⇨ $\frac{L_t W_t}{\alpha P_t\, Y_t} = 1 - M_t$

Or in log levels $-mup_t = l_t + w_t - p_t - y_t - \log(\alpha)$

Financial market capital cost consists of the cost of capital which firms face when wanting to invest, approximated by the world natural interest rate (R), adjusted for inflation (π), depreciation (δ), taxes (T) and relative investment prices ($\frac{PI}{PY}$).

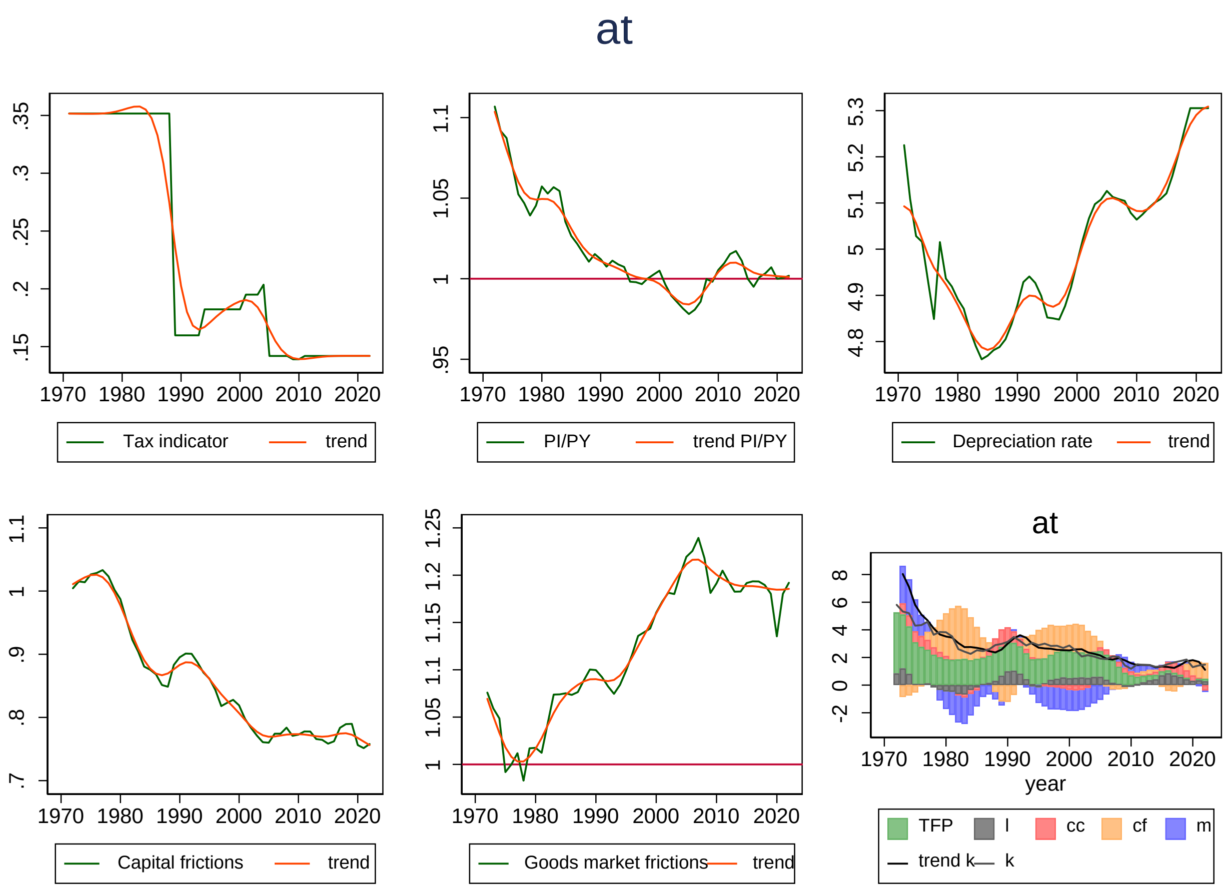
$$cc_t = \log(R_t - \Pi_t + \delta_t) - \log(1-T_t) + \log\left(\frac{PI_t}{PY_t}\right)$$

To calculate **capital frictions** we again use equation A2 and fill in the known variables, including cc.

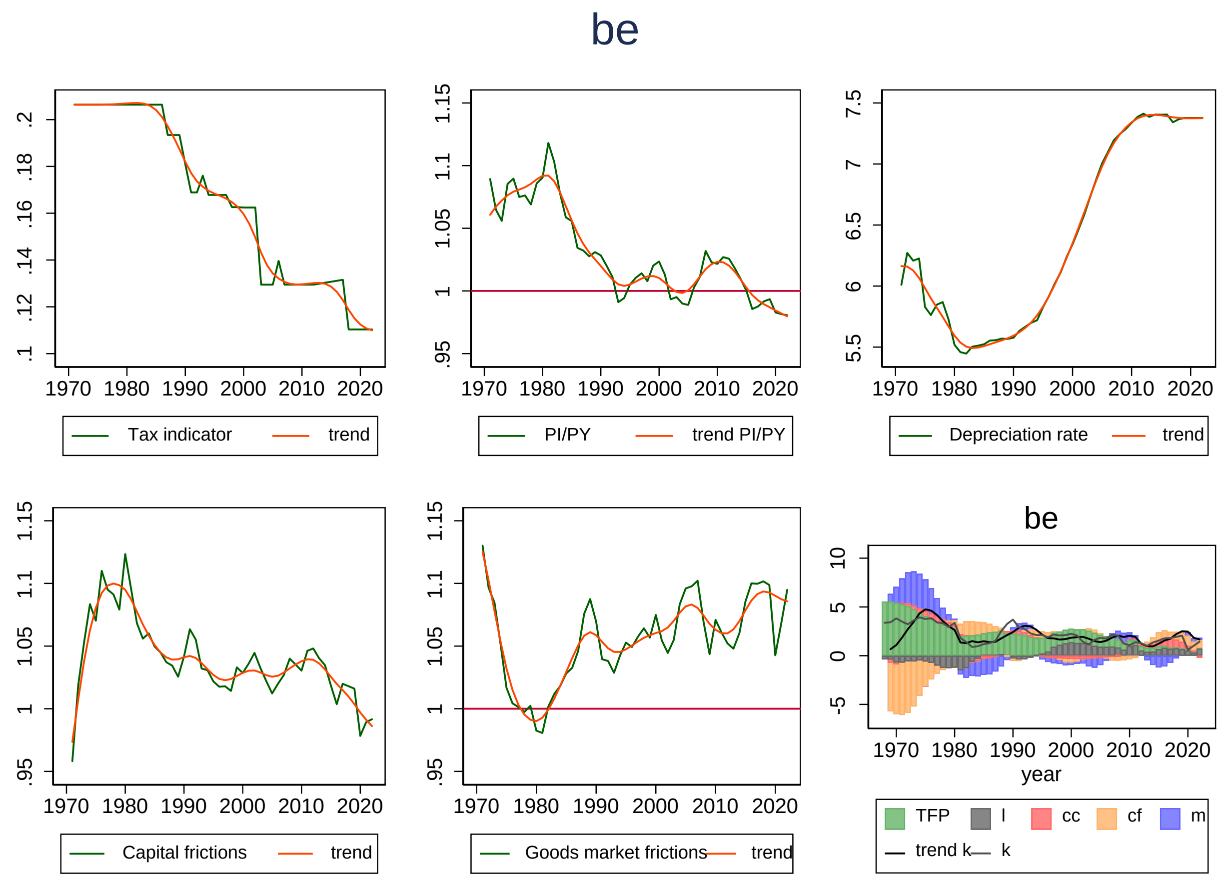
$$\frac{cf_t + \beta cc_t + (1-\beta)\overline{cc}}{\alpha} = \frac{\log(1-\alpha)}{\alpha} + l_t + \frac{tfp_t}{\alpha} - k_t - \frac{\mathrm{mup_t}}{\alpha}$$

- ⇨ $cf_t + \beta cc_t + (1-\beta)\overline{cc} = lo\,g(1-\alpha) + \alpha l_t + tfp_t - \alpha k_t - mup_t$
- ⇨ $cf_t = lo\,g(1-\alpha) + \alpha l_t + tfp_t - \alpha k_t - mup_t - (\beta cc_t + (1-\beta)\overline{cc})$

7. ANNEX 2 – RESULTS FOR INDIVIDUAL COUNTRIES



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).



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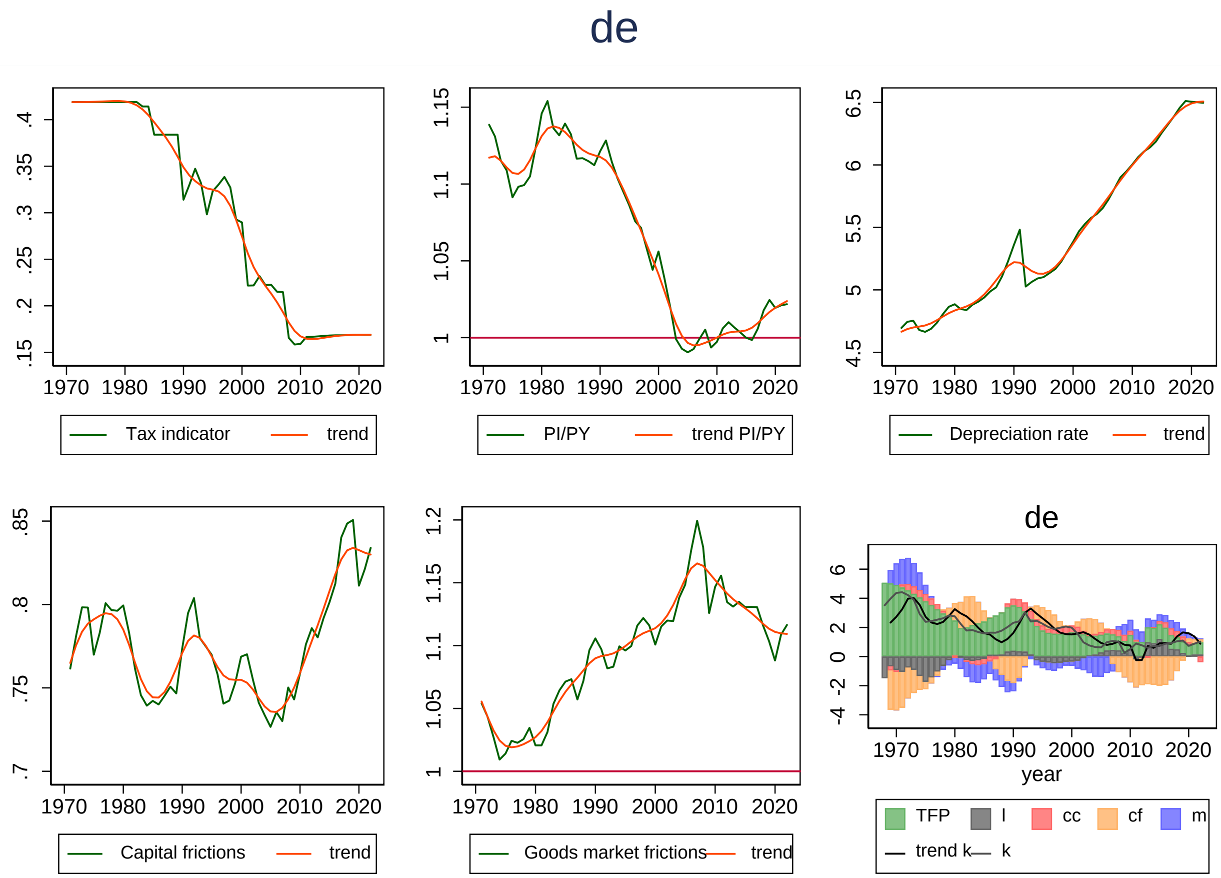
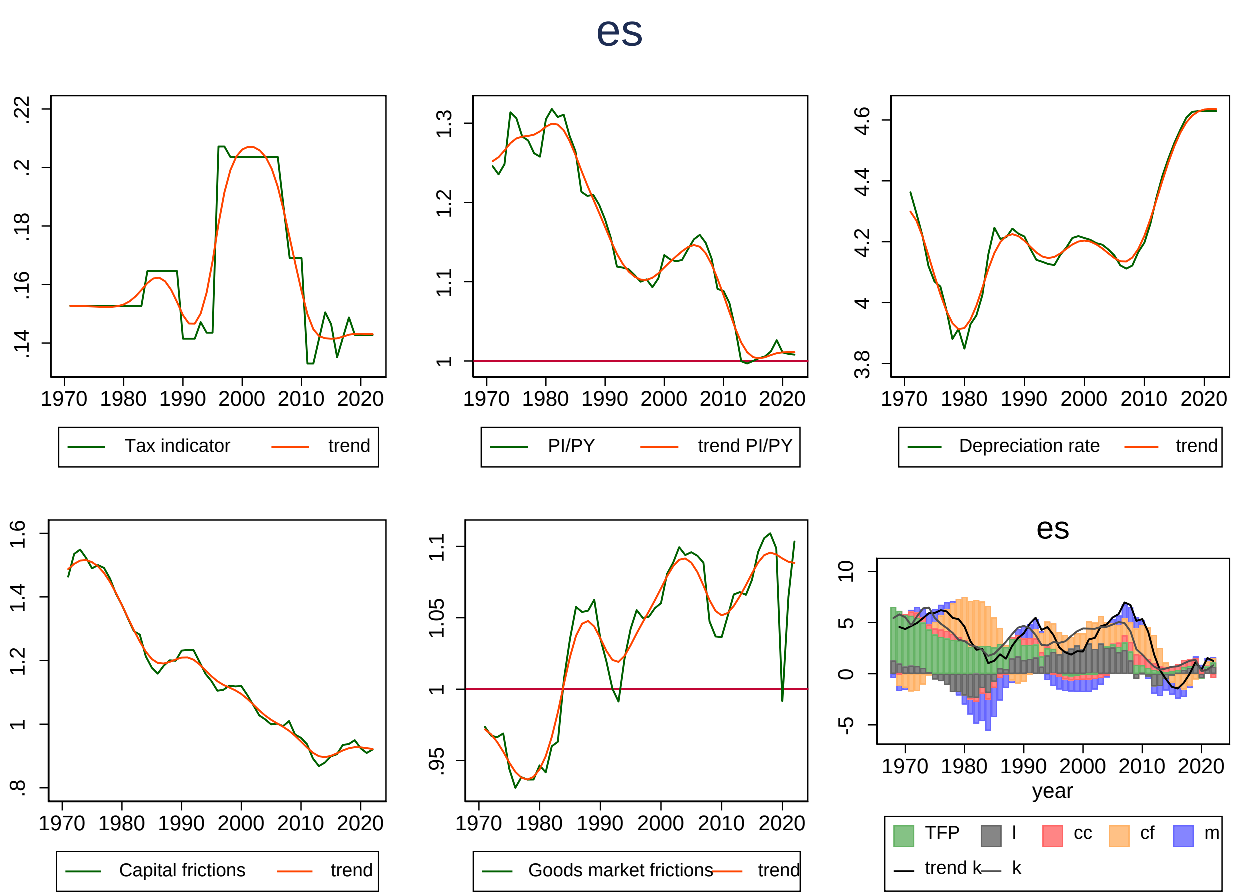


Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).



Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

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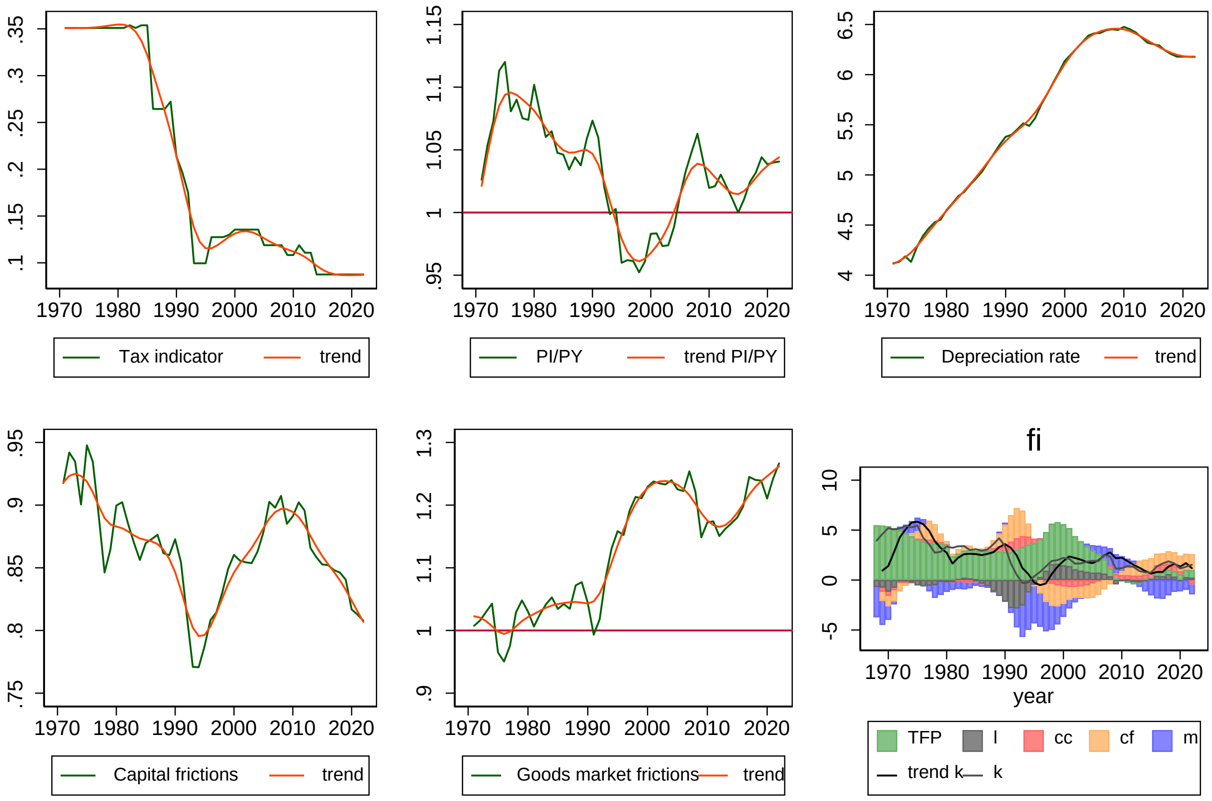

Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

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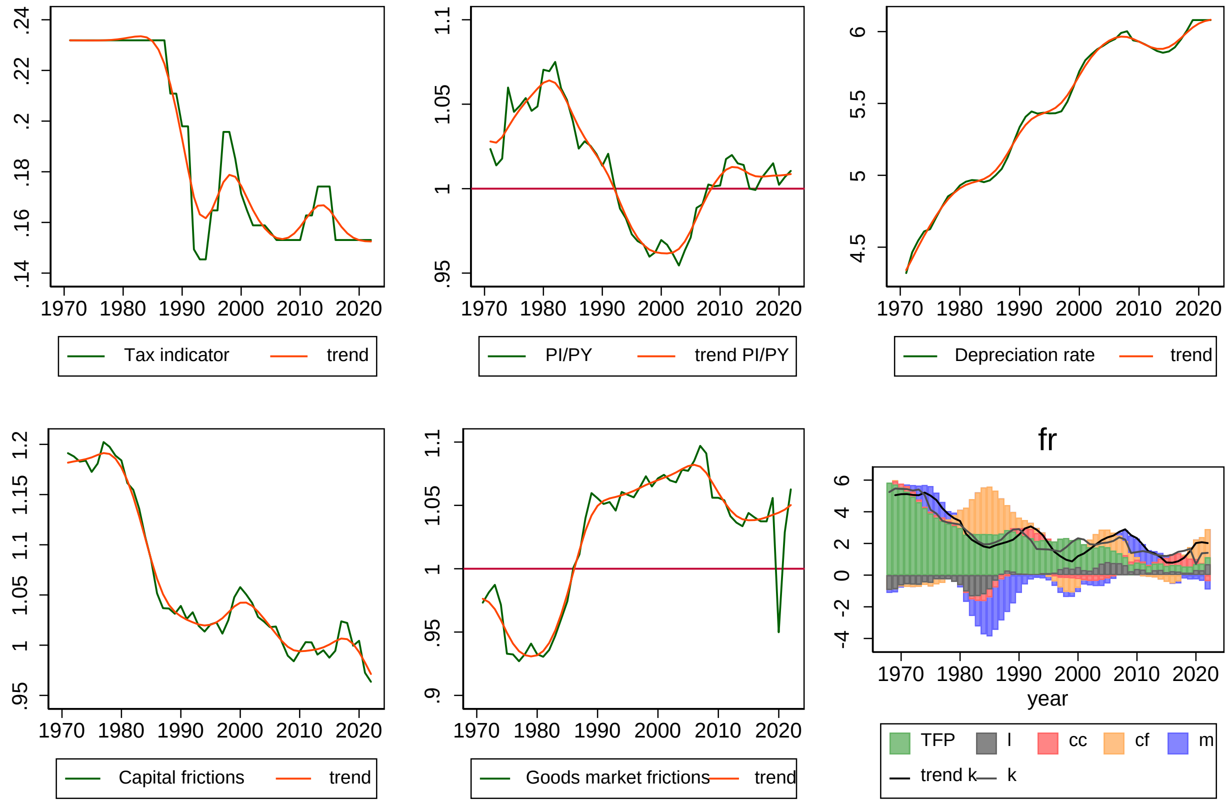

Note: there was a one-off in corporate taxes for France in 2017, which has been taken out of the data to calculate trend taxes.

Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).

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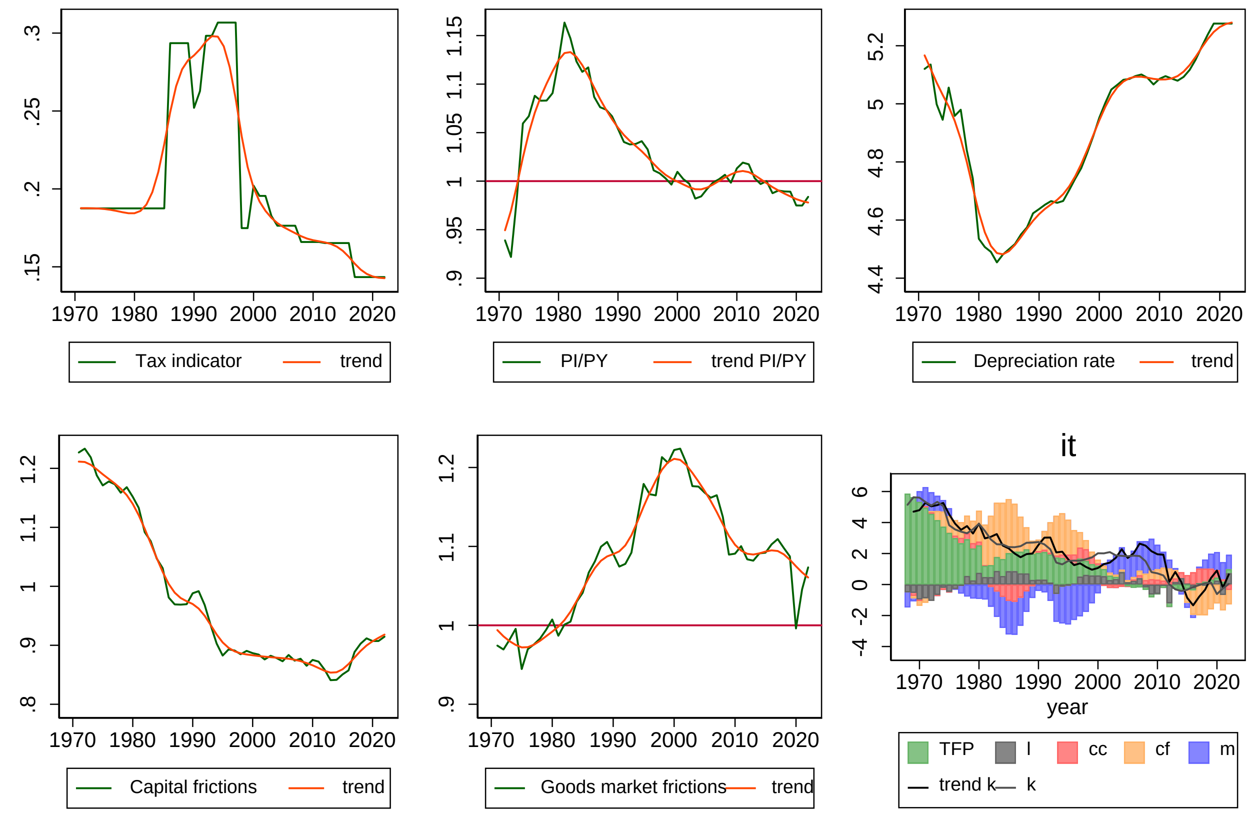
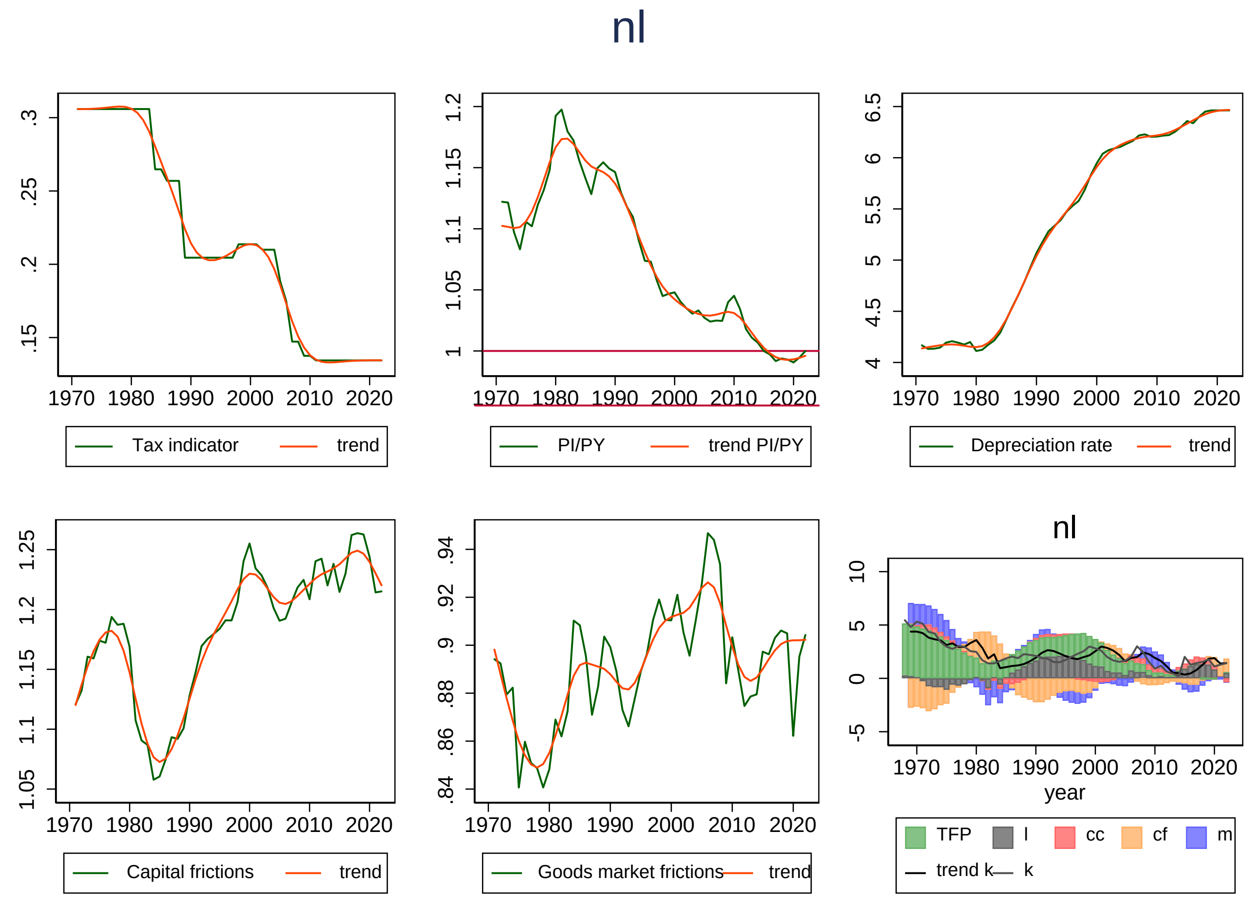


Source: own calculation based on data from Eurostat, Commission's 2020 Autumn forecast, EU-Klems and OECD (please see section 2.2 for a description of the data).



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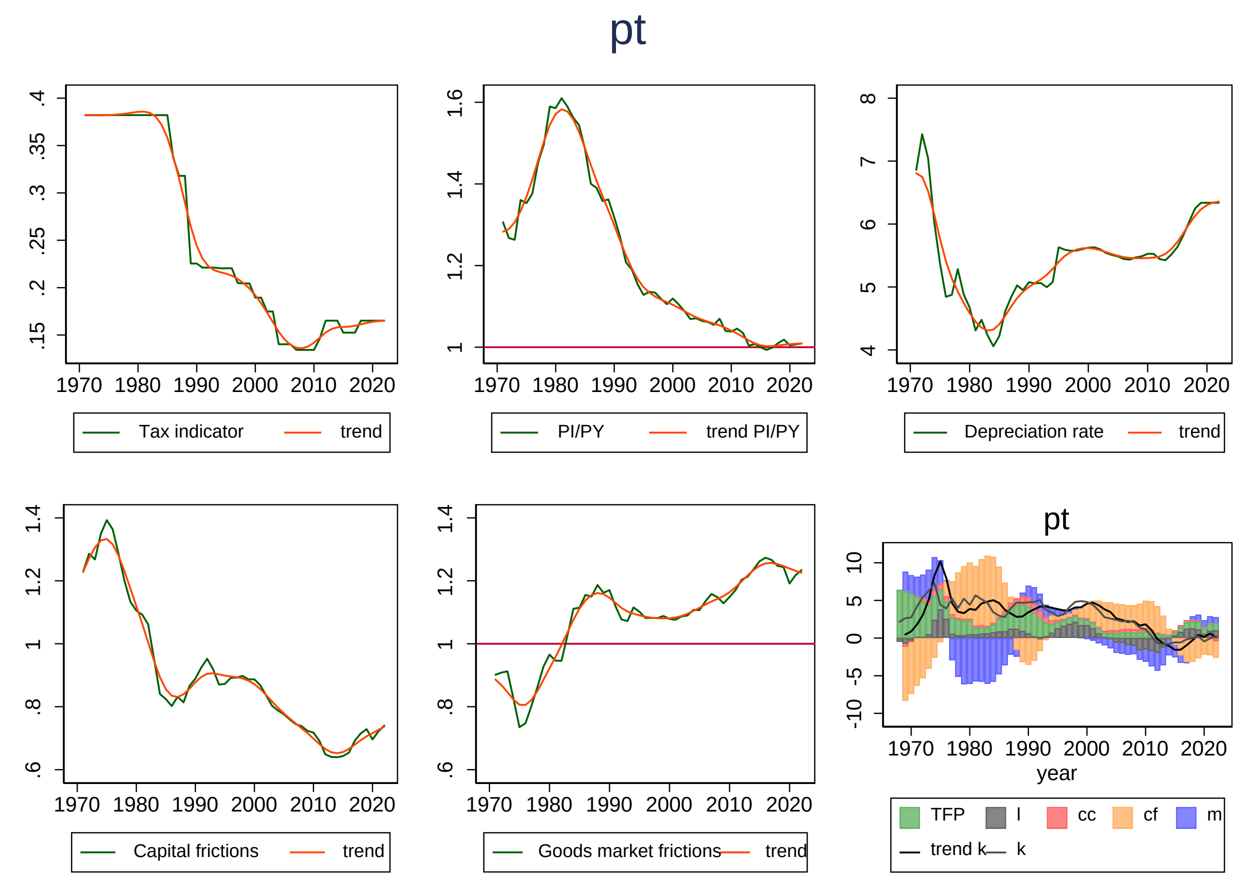

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