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ABSTRACT

We study the behaviour of Lithuania relative to other 25 EU countries, looking specifically at convergence in terms of GDP per capita and its growth accounting components: capital accumulation, labour and its subcomponents, i.e. participation and employment, and the Total Factor Productivity (TFP). We find that Lithuanian Real GDP per capita shows indeed a convergence path similar to the other Baltic States and they all belong to the second club (includes part of the periphery and the other new member states). The convergence paths of labour or capital accumulation do not seem significantly different compared to the ones of other EU members. The Lithuanian transition path in TFP has become plateau after the crisis but this is seemingly not a divergence factor. Two components show noticeable changes in behaviour after 2010: the growth in total factor productivity (TFP) considerably slows down, and the employment-population ratio appears to increase accounting for around one third of the annual GDP growth in Lithuania. In addition, we explore several transition scenarios for Lithuania to the EU-25 average.

Keywords: Lithuania, convergence, economic integration, GDP per capita, TFP, capital, labour.

JEL codes: O47, F15, F45.

1. INTRODUCTION

In the course towards convergence, it is likely that economies experience various forms of transitional behaviours. Some economies may converge faster than others, while some may exhibit transient divergence. Also, it is possible that an economy starts with a high converging speed, and then diverges temporarily due to an adverse shock, before moving to the common steady-state path again. Such behaviours can be caused by cross-sectional heterogeneity or different evolution in rates of technological progress. Furthermore, when considering a panel of countries, there is no guarantee that all countries will converge to a common path. However, countries may form a club convergence where overall convergence is rejected (i.e. this is the case when we find more than 1 club). Therefore, it is important to accommodate those features into the evaluation of economic convergence across a group of countries and to understand what needs to be done to improve or foster convergence from studying its drivers, as pointed out also by Cœuré (2018). Growth in output per capita in Lithuania has slowed down in the aftermath of the recent financial crisis, i.e. falling from 7.5 percent on average in 2000-2008 to 5.5 percent in 2010-2018 at an annual rate. In spite of such a decrease, Lithuania remains one of the fastest growing economies in Europe, therefore contributing to the economic convergence of Lithuania to the EU-25 average.

In the first part of this paper, we study the behaviour of Lithuania relative to other 25 EU countries, looking specifically at convergence in terms of GDP per capita and its growth accounting components: capital accumulation, labour and subcomponents, i.e. participation rate and employment, and the Total Factor Productivity (TFP). We analyse both the general convergence path and the club convergence. We find that Lithuanian Real GDP per capita shows indeed a convergence path similar to the other Baltic States and they all belong to the second club (includes part of the periphery and the other new member states). The convergence paths of labour or capital accumulation do not seem significantly different compared to the ones of other EU members. The Lithuanian transition path in TFP has become plateau after the crisis but this is seemingly not a divergence factor. Three clubs are detected for TFP, with Lithuania belonging to the second one with Latvia, Austria, Finland, Poland, Slovenia and the UK.

Then, we conduct a Solow-type growth accounting exercise. Two components show noticeable changes in behaviour after 2010: the growth in total factor productivity (TFP) considerably slows down, whereas the employment-population ratio appears to increase accounting for around one third of the annual GDP growth in Lithuania. In addition, we consider several transition scenarios for Lithuania to the EU-25 average, where we explore what growth rates of capital per capita and TFP would be needed, consistent with the labour force participation projections of the Bank of Lithuania, for a given timing target. Growth shortfalls are reflected in both capital per capita and TFP, where capital per capita is required to grow at a relatively faster rate than TFP during the catching-up period.

2. A BRIEF LITERATURE REVIEW

We present the literature review in three main strands. First, we discuss main approaches for addressing the issue of convergence. Second, we present the contributions by applying the Phillips and Sul (2009) methodology. Last but not least, we provide a brief review on the applications of growth accounting for analysing the sources of growth.

The seminal work of Barro and Sala-i-Martin (1992) applies the neoclassical growth model as a framework to study convergence across the 48 contiguous U.S. states. The authors show that the U.S. states provide clear evidence of convergence in the sense that poor economies tend to grow faster than rich ones in per capita terms. In addition, Barro and Sala-i-Martin (1992) obtain similar results when considering per capita gross domestic product from a broad sample of countries when controlling for a set of variables that proxy for differences in steady-state characteristics. Using a similar framework, Mankiw et al. (1992) show that, holding population growth and capital accumulation constant, countries converge at about the rate the augmented Solow model predicts. The convergence in this manner is also known as the β- convergence, where the used models often assume that the transition parameter and growth rate are homogenous; therefore cross-sectional and temporal heterogeneity, as discussed above, are not accommodated.

In addition to the β- convergence, another common approach to growth convergence considers the notion of σ-convergence, i.e. when the dispersion of real per capita income across a group of economies falls over time. For instance, Tsionas (2000) examines real gross state products and finds that the cross sectional variance has fluctuated very little for the period from 1977 to 1996. Young et al. (2008) argue that σ-convergence may not accompany β-convergence and demonstrate that σ-convergence cannot be detected at the county level across the United States, or within the large majority of the individual U.S. states considered separately. Meanwhile, Evans (1996) examines the time-varying pattern of the cross-sectional variance of the logarithm of per capita output and shows that that under growth convergence the cross-sectional variance should be stationary. According to Phillips and Sul (2009), given the potential heterogeneity, for instance, the convergence speed, the rate of technical parameter or the initial technical endowment and steady-state levels, the cross-sectional variance can manifest nonstationary characteristics depending on whether the convergence rate of the transition path is slower or faster than the divergence rate of common trend that economies experience.

Different from these approaches, the methodology proposed by Phillips and Sul (2009) takes into account cross-section heterogeneity among economies and evolution in rates of technological progress over time. This framework therefore allows for transitional behaviour among economies that includes convergence to a common steady-state path as well as various forms of transitional divergence and convergence, including club convergence. Concerning the convergence analysis based on the Phillips and Sul (2009), some recent works have been done about GDP per capita paths of convergence in the European Union and new member states in specific, also using Phillips and Sul (2009) approach. For instance, Dobrinsky and Havlik (2014), Borsi and Metiu (2015) and Lastauskas and Marchesini (2019) look at a similar panel of countries at annual frequency. Dobrinsky and Havlik (2014) analyse specifically new EU Member States of Central and Eastern Europe in comparison with the overall EU. They point out that the convergence process in this countries has been ongoing, the start of their transition from plan to market at the beginning of the 1990s (see also Cuaresma et al., 2012), but the assessment depends very much on the convergence indicator and the chosen time span. Dobrinsky and Havlik (2014) also look at possible factors affecting GDP growth in the new EU member states, pointing at a significant role of general government balance and price competitiveness rather than private credit flows, in line also with Comunale (2017). Borsi and Metiu (2015) use annual data for EU-27 from 1970 to 2010, finding once more that clustering is not necessarily related to EMU membership but rather based on a clear separation between the new and old EU member states.

A different outcome is found in Lastauskas and Marchesini (2019), using annual data for the whole EU 28 and filtering the series with the linear projection-based filtering technique proposed by Hamilton (2018). They also find two clubs for GDP per capita but not a separation between old and new members. Only Ireland and Luxembourg belong to the first one and the other EU members converging to the same equilibrium, even if at almost zero speed. These authors cover also real labour productivity per hour worked (data 2001-2017), among other variables: long term bond yields, price level and government debt as a share of GDP. Labour productivity can be seen as part of TFP and can be useful to complement our convergence results for this factor. The authors detect 6 clubs with a seventh one actually diverging (Bulgaria and Finland). As stressed by the authors, this pronounced heterogeneity found in labour productivity convergence paths can signal once again large diversity of the commodity and labour markets structure and of mechanisms of resource allocation.

Summing up the literature on convergence, it is good noting that: frequency of the data, measurement and filtering, sample size and the country coverage could matter in the detection of clubs, as these characteristics may change the whole result of grouping. With this caveat in mind, almost all these contributions somehow agree that the convergence of new EU members to EU levels is most likely to continue, but it will proceed more slowly in the incoming years *ceteris paribus*, i.e. if no further structural reforms will be implemented. Especially Cuaresma et al. (2012) stress the importance of rising productivity via innovation and the demographic developments. The latter may pose huge challenges for the sustainability of public finance in these countries and therefore the need to reform labour market, attracting skilled labour force, and the pension system.

Our work is also related to the literature that uses the Solow-type growth accounting to understand the sources of growth in GDP per capita. Growth accounting breaks down growth in output per capita into growth in capital, growth in labour and growth in productivity change, and is viewed as a primary step for analysis of determinants of output per capita growth over time (e.g. Fernald (2015), Fernald, Hall, Stock and Watson (2017)) and cross-country differences in levels of output per capita (e.g. Barro (1991), Hall and Jones (1999)). Barro (1999) provides an overview of the accounting exercise, and with modifications of Jones (2002) and Basu and Fernald (2002), growth accounting is used to further study contributions of the factors driving productivity. In our application, we use growth accounting to study contributions of the input factors and productivity into fast growth observed in Lithuania before the financial crisis and slower growth observed thereafter. In addition, we conduct counterfactual exercises, guided by our convergence analysis, which incorporate projections about labour force participation to determine average contributions of the input factors and productivity that are required to reach the EU average level after a certain period.

3. DESCRIPTION OF THE METHODOLOGIES

3.1. Convergence paths and clubs detection

In order to analyse the paths and convergence clubs, we follow the approach suggested by Phillips and Sul (2009) for real income in two steps: i) constructing a transition curve and ii) detecting the club convergence clusters.

We make this analysis for real GDP per capita first, and then for the components in the production function, i.e. capital accumulation, labour and subcomponents, i.e. participation rate and employment, and the Total Factor Productivity (TFP).

a) Constructing a transition curve

The transition path for each economy is measured by using the variable for each country as the relative share among all economies in relative terms with respect to the average value of the considered sample, in our case EU-25. Specifically, the transition path of income of country i, denoted by h_{it}, is the relative share of per capita log real income of i in total income as shown by:

$$h_{it} = \frac{\log y_{it}}{\overline{\log y_t}}$$

where $\overline{\log y_t}$ is the cross-section average of log per capita real income in the panel.

Under certain regularity conditions on the growth paths, h_{it} eliminates the common growth components and provides a measure of each country's share in common growth and technological progress. Moreover, the notation t in h_{it} indicates that this measure is time dependent, thus helps to trace out a transition curve for economy i. Similarly, we obtain the transition path for labour variables, capital and TFP as will be discussed below.

b) Detecting the club convergence clusters

The clustering procedure can be summarized briefly in the following steps:

- Step 1: Order the countries based on the amount of final period income.[5]
- Step 2: Form a core primary group of k* countries, where the size of the core group is selected to *maximize* a convergence test statistic developed by Phillips and Sul (2007).
- Step 3: Sieve the data for new club members, i.e. adding one country at a time to the core group and evaluating the inclusion of this country into the core based on a certain criterion. This means that if all countries in the panel converged, they would belong to one single club convergence. Otherwise, we move to the next step.
- Step 4: Form a second group from those countries for which the sieve condition fails in Step 3. If these remaining countries form a converge club, we conclude that there are two convergence club groups: the core and the second one. Otherwise, we repeat step 1 through step 3 to see if this second group can be divided into further convergence clusters. If not, the remaining countries show divergent behaviour.

3.2. The growth accounting framework

Growth accounting decomposes output growth into a set of components which let us explore the evolving behaviour of the components linked to the economy-wide output growth. Originally developed by Solow

[5] The clusters of countries may theoretically change if we use in Step 1 either a) the amounts in the final period or b) the average of the last half period of data, as the only two options in Phillips and Sul (2009). The authors, in this regard, stress that the final outcomes should be instead robust to initial data orderings. In our case, there is also a rationale for opting for the first method a) as the alternative method b) might give an excessive weight to the crisis years. This robustness check is also available on request. In this case more clubs are generally detected. For instance for TFP we have four clubs but with Lithuania still belonging to the second group. The results for the EU periphery are also overall confirmed.

(1957) and extended by Jorgenson and Griliches (1967), growth accounting is based on the Cobb-Douglas production function. Output is produced using:[6]

$$GDP_t = TFP_t L_t^{0.65} K_t^{0.35}.$$

where GDP_t is the output at time t, L_t is the employment, K_t is the capital stock, and TFP_t is the total factor productivity. Given this production function, we obtain the following growth-accounting decomposition:

$$\Delta \ln\left(\frac{GDP_t}{Pop_t}\right) = 0.65\Delta \ln\left(\frac{L_t}{Pop_t}\right) + 0.35\Delta \ln\left(\frac{K_t}{Pop_t}\right) + \Delta \ln(TFP_t)$$

$\frac{GDP_t}{Pop_t}$: Real GDP per capita

$\frac{L_t}{Pop_t}$: Employment - population ratio which is expanded as

$$\frac{L_t}{Pop_t} = \frac{L_t}{LabForce_t} \times \frac{LabForce_t}{Pop_t}$$

$\frac{K_t}{Pop_t}$: Capital per capita

In the final expression, GDP per capita growth is related to the growth rates of the employment rate (the employment-labour force ratio),[7] labour force participation rate (the labour force-population ratio), capital per capita and TFP.

3.3. Design of transition scenarios

What is the required growth rate of capital per capita and TFP to reach the EU-25 average by 2030 or 2040? This question involves projections of the variables of the EU-25 average and Lithuania. We here assume that GDP per capita, capital per capita and TFP in the EU-25 average continue to grow at their historical quarterly growth rates over 1998Q1-2018Q3 of 0.56 percent, 0.59 percent and 0.27 percent, respectively. For the employment-population ratio of Lithuania, we assume that the growth rate equals the average growth rate computed from the Bank of Lithuania projections for labour participation rate.

In determining the rates at which GDP per capita, capital per capita and TFP in Lithuania are required to grow to reach the EU-25 average, we consider two designed scenarios described below:

Design 1: We first compute the growth rate of GDP per capita of Lithuania which is required to reach the EU-25 GDP per capita average level. Given this rate and the projections of the employment-population ratio, we obtain the required growth rates for capital per capita and TFP for Lithuania and compare with their historical average rates.

Design 2: We calculate the growth rates of capital per capita and TFP in Lithuania required reaching their respective EU-25 average levels. These growth rates of capital per capita and TFP are then compared with their historical average growth rates. The resulting GDP growth rate in Lithuania is calculated for the period 2019-2030 (2019-2040).

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[6] As discussed in Havik et al. (2014), the mean wage share for the EU countries being used as guidance for the estimate of the output elasticity of labour, which are close to the conventional mean values of 0.65 and 0.35. Therefore, these values are imposed for all countries. A potential extension of this study is to consider a variety of production function that are tailored for each countries.

[7] Note that the employment rate is usually defined as the employed to the working age population. In this study, we define it slightly different as employment-labour force to highlight the role played by the participation rate.

In these scenarios, the average rates of the EU-25 average variables are assumed to remain constant. Although this assumption is debatable, the scenarios provide descriptive information about the importance of capital per capita and TFP during the process of catching-up, and can be used to intuitively delineate the role of these variables given changes in the assumptions.

4. DATA DESCRIPTION

Our sample covers 25 EU member states from 1997Q2 to 2018Q4. Only three EU members: Bulgaria, Croatia and Malta are not included in the analysis because of limited data availability. We use seasonally adjusted real GDP per capita in quarterly frequency from Eurostat; the same applies for labour variables. Participation rate is Labour Force/Population and Employment rate is Labour Supply/Labour Force. Labour is the product of them multiplied by Population. As for capital accumulation rate, we construct the quarterly series using the capital accumulation process where the depreciation rate is estimated to match with AMECO annual data. Lastly, technology (TFP) is taken as residual from the production function (Cobb-Douglas), using coefficients from EU Commission as shown in Havik et al. (2014).[8]

We do not pre-filter our data series for the convergence exercise. As reported by Phillips and Sul (2009), the regression model can be either computed directly from the logarithm of the series as h_{it}, as in our case, or by using filtered data that removes business cycles.[9] We also replicate our exercises using, instead of quarterly real GDP from Eurostat, the annual data series from Penn (different measures of real GDP or GDP at PPP) covering all the 28 EU countries.[10] In this case, T dimension is pretty small (data 1990-2017) and this could create too many possibly meaningless clubs (see Phillips and Sul (2009)).[11] We find that there are no major differences between using annual real GDP or annual GDP at PPP (the correlation of the series is around 0.99). The comparison is available in Appendix Table A.1.[12] We also compare the GDP series abovementioned with the chain linked GDP from Eurostat. The latter series start only in 2000, so we look at the same sample in case of Penn data too.[13] Clubs detected with annual series from Eurostat are comparable with the ones detected by using annual Penn data for real GDP or GDP at PPP, as also pointed out in Dobrinsky and Havlik (2014).

In the second part, where we look at growth decomposition, we consider two subsample periods with the first period ending in 2008Q4 and the second starting in 2010Q1, as output growth in Lithuania slows down after the recent financial crisis, to study the changes in behaviour of the driving factors of economic growth.

[8] A further decomposition of TFP into the degree of excess capacity and level of efficiency is an interesting topic for consideration.
[9] For an analysis by applying the linear projection-based filtering technique proposed by Hamilton (2018) to the annual series, see Lastauskas and Marchesini (2019).
[10] In the literature the most common series are at annual frequency for GDP per capita at PPP. For instance, Lastauskas and Marchesini (2019) use annual data for PPP-adjusted real GDP per capita at constant 2011 international dollars (World Bank data for the period 1995-2017 for EU28, i.e. including Bulgaria, Croatia and Malta). Beyond frequency, measurement, and sample is the country coverage that could matter, as countries inclusion may change the whole result of grouping.
[11] In this case, we can detect up to 7 clubs.
[12] We also perform the test for clubs merging in case of annual data. We indeed confirm the same number of clusters as in Table A.1.Test's outcomes are available on request.
[13] Results are available on request.

5. MAIN RESULTS

5.1. Convergence patterns and clubs

The complete set of outcomes is provided in Table 1 and in Charts 1 to 4. For GDP per capita (Chart 1) and TFP (Chart 4) respectively, clubs are represented by different colours: green and orange, if 2 clubs, and green, orange and red if 3 clubs. We disentangle only 1 club for the other components, i.e. capital and labour; therefore we do keep different colours for each country (Chart 2 and 3). If the country experiences a divergent behaviour its cell is left blank in the table and its name highlighted in the charts. In the charts, the straight line equal to 1 represent the average EU25, as the transition path for each economy is measured as the relative share among all economies.

[Insert Table 1 here]

[Insert Chart 1-4 here]

We find that Lithuanian Real GDP per capita shows indeed a convergence path similar to the other Baltic States. They all belong to the second club. We detect only two clubs for real GDP per capita. The log-t test by Phillips and Sul (2009) confirms that club 1 and 2 should be indeed two separated clubs and we cannot merge them. The first club members list mainly the so-called "core EU" countries, i.e. Luxembourg, Germany and Austria, and also include Denmark, Sweden (Nordic countries) and Ireland. The latter have experienced a jump in GDP per capita since the 2000s. The periphery of the EU and all the new member states belong to the second club that has been detected. The results of the test are available in Table 2.

[Insert Table 2 here]

Our outcomes are very much in line with Dobrinsky and Havlik (2014): there is still a considerable within-group variation in EU and the new member states are still part of the same cluster. The Lithuanian convergence to average EU has continued before and during/after the crisis albeit at a slightly reduced speed in the latter. We find that this is mainly due to the performance in TFP after the crisis. Overall, as pointed out in a recent FT article[14] and in Alcidi (2019), the new member states are continuing in their path for convergence even those hit hardest by the crisis have continued to catch up after very deep but relatively short recessions. The periphery is also recovering, with the notable exception of Italy. Ultimately, Alcidi (2019) also stresses the importance of general cohesion EU policies for growth and income convergence. Along this line, Comunale (2019) finds a crucial role for EU funds in boosting long-run growth in new member states; this is the case of capital transfers if well managed and efficiently allocated, for instance to more productive sectors.[15]

A different outcome is found in Lastauskas and Marchesini (2019), using annual data for the whole EU 28. They also find two clubs but with only Ireland and Luxembourg belonging to the first one and the other EU members converging to the same equilibrium, even if at almost zero speed.

As for capital accumulation we do find only one single club for all EU25. The transition paths are relatively similar and very flat for old EU member states, Hungary and Slovakia. For Lithuania this seems not to be a

[14] "EU economies have converged since last elections", Valentina Romei for FT, 13. May 2019. Available at this link: https://www.ft.com/content/23cf4eec-345d-11e9-bd3a-8b2a211d90d5

[15] The possible negative effect in the short-run can be due to demand effects which may dominate as the investments they financed took time to generate a growth impact or may be caused by the negative effect on the current account.

divergence factor and after the crisis the path is even converging more quickly reaching 0.9. A similar result can be found in the case of Poland, Latvia and especially Estonia. There is overall more dispersion below the level of one (i.e. perfect convergence level), where all the new member states are located. Therefore, even if we recognise only 1 club, there is still room for improvement for Lithuania in terms of overall convergence to EU average.

For labour variables, the differences in the convergence path are relatively small and all the EU states appear to have converged. The Baltics are more sensitive to the crisis but this has only effects in the short-run, this can be seen in Chart 3 by noting that transition paths for the Baltics follow a cyclical pattern: they begin to fall from 1997, trough three to four years later, rise and then peak after five to six years, fall sharply coincident with the financial crisis, and return and exceed the average EU level over the next eight years. This pattern suggests that the transition after the sharp fall in 2010 took place at a pace within the range observed before the onset of the crisis. For the overall labour variable, 2 clubs are detected (Table 2), with Lithuania belonging to the first one together with most of the other EU members (except Italy and Cyprus). Some divergent economies have been spotted among the EU periphery (Greece), also in line with Alcidi (2019). Only 1 club has been found for participation rate. For the employment rate, only Italy and Cyprus belong to the second club and Greece is not converging, however the test of club merging, even if negative, is only significant at 15% (see Table 2).

Lastly, Technology (TFP) seems to be a key factor in Lithuania, but also in almost all the EU countries, in line with Bańbura et al. (2018) and Cœuré (2018).[16] The TFP transition path in Lithuania has been plateau after the crisis[17] however it does not appear as a divergence factor given a similar decrease in other EU countries. In line with the evidence: potential GDP growth is lower in the post-crisis period as documented in Constantinescu and Nguyen (2018). For TFP, 3 clubs are detected and Lithuania is in the second one with Latvia, Austria, Finland, Poland, Slovenia and the UK (Estonia is at borderline between clubs 2 and 3). Testing for the possibility of merging the clubs, confirms the presence of 3 separated clusters for TFP (see Table 2). The TFP, as calculated as residuals from Cobb-Douglas production function, can capture many aspects of an economy. In the literature some robust factors that can affect TFP performance have been identified. And they are: investments in education and ICT, trade openness, integration in Global Value Chains (GVCs)[18] and regulation in the labour and products markets (see Burda and Severgnini (2009), Cuaresma et al. (2012), Danquah et al. (2014), Gehringer et al. (2016) and Cœuré (2018)). The reforms in the latter affect TFP, for instance, also via the efficiency of capital allocation across firms (Bańbura et al., 2018).

In addition, Lastauskas and Marchesini (2019) analyse the convergence clubs for the annual real labour productivity per hour worked, giving us more information about part of the Lithuanian TFP performance.[19] The authors detect 6 clubs with a seventh one actually diverging (Bulgaria and Finland). Lithuania is in the sixth club together with Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Lithuania, Latvia, Poland, Portugal, Romania and Slovenia. As stressed by the authors, this pronounced heterogeneity found in labour

[16] Cœuré (2018) quantifies the contribution of each factor and find TFP (and capital accumulation in minor part) to be the main drivers for growth in new member states.
[17] See also Lastauskas and Marchesini (2019) for real labour productivity
[18] Further integration in GVCs and foreign direct investments are key factors in supporting TFP via transfer of technology as stressed by Cœuré (2018).
[19] The issue with small T dimension is known (Philiips and Sul (2009)) and Lastauskas and Marchesini (2019), for this reason, test for possible merging of clubs that have been erroneously detected as separated following Schnurbus et al. (2017).

productivity convergence paths can signal once again large diversity of the commodity and labour markets structure and of mechanisms of resource allocation.

As a check, we augment the TFP values only for Lithuania, *ceteris paribus*, looking at which point we could have seen a switch to the first club. We increased the TFP values for Lithuania by 1% at time starting from 5% increase in TFP, capturing the moment in which the country experienced the switch. Lithuania would have needed more than 30% more TFP in the last 20 years to being able to belong to the first club (if the other EU countries remain at the same historical level).[20]

5.2. Growth decomposition

After having looked at the convergence paths and clubs of GDP per capita and its components, we look more in depth at the growth-accounting decomposition in case of Lithuania and some transition scenarios.

Chart 5 shows the results of the historical growth-accounting decomposition for Lithuania. In each year, the average contributions of the components are presented at annual rates, with the total sum of the contributions being equal to the GDP per capita growth (solid line). Table 3 summarizes the growth decomposition for Lithuania in two subsample periods of 1998Q1-2008Q4 and 2010Q1-2018Q3, and compares the results for Lithuania to those obtained for the EU-25 average.

[Insert Chart 5 here]

[Insert Table 3 here]

In the pre-2008 period, we see that TFP plays an important role accounting for a large fraction of the GDP per capita growth, about 4.15 percent in 1998Q1-2008Q4. After 2010, TFP growth noticeably slows down, staying only about 2 percent per year on average in 2010Q1-2018Q3.

Another point emerging from this growth accounting exercise is that the growth in employment rate and labour force participation rate show a clear cyclical pattern over the business cycles. The sum of their growth contributions accounts for a small portion of GDP per capita growth in the pre-2008 period; whereas after 2010, these variables, in total, amount to around one third of the GDP per capita growth, in almost every period. Specifically, the two labour components account for a total of 1.73 percent on average, equivalent to one third of the GDP per capita growth after 2010, a much greater proportion than the corresponding feature prior to 2009.

5.3. Transition scenarios

Chart 6 shows the required growth rates for Lithuania to reach the EU-25 average by 2030. The upper panels are based on the first scenario design, whereas the lower panel shows the result from the second scenario design.

[Insert Chart 6 here]

The upper-left panel shows that GDP per capita is required to grow at around 2 percent on average to make this transition possible. The labour force participation rate is projected to follow a cyclical pattern, that is it starts after 2019 with a fast growth, but it eventually slows down, which overall suggests that, on average by 2030 or 2040, its growth rate does not exceed 12 basis points for each year. For the other two components in

[20] Results are available on request.

Lithuania, the quarterly growth rate of capital per capita is required to be around 3.7 percent assuming that TFP continues to grow at its average quarterly rate of 0.63 percent. Whereas in the upper-right panel, we assume that if capital per capita continued to grow at its average rate, then the rate of TFP growth would be required to be around 1.46 percent to achieve the 2 percent GDP per capita growth.

The lower panel shows the rates computed based on the second scenario design and suggests that the rates of 2.6 percent and 1.06 percent would be needed on average in every quarter for capital per capita and TFP to reach their EU-25 average levels by 2030, respectively.

Overall, a comparison between the rates required and the typical growth rates since 1998 suggests that the growth shortfalls are reflected in the both capital per capita and TFP. Furthermore, a relatively faster growth would be needed for capital per capita, since its share in GDP growth is relatively smaller and capital per capita of the EU-25 average is assumed to grow at 0.59 percent, which is higher than the rate of 0.27 percent assumed for TFP, these rates are the respective average growth rates since 1998Q1.

Chart 7 shows the required growth rates for the relative scenarios to reach the EU-25 average by 2040. As we consider a transition scenario over a longer horizon, the required rates computed following both designs become closer and closer to the historical averages.

[Insert Chart 7 here]

Recently, Bańbura et al. (2018) pointed out that the assessment of whether the current investment level relative to its 2007 level is low varies across countries in the euro area, the level of business investment remains below its pre-crisis level in some countries. For that, it is likely that increasing uncertainty seems to have played an important role following the financial and sovereign debt crises. Aside from the capital stock level and investment drivers, TFP is an important determinant of economic growth. Compare to the pre-crisis level, TFP growth in the post-2009 reduced by half, a notion which is in line with Constantinescu and Nguyen (2018) who find that the potential growth decreased significantly. A similar finding is obtained by Podpiera et al. (2017) for Lithuania. This result is also consistent with IMF (2015), which finds that the financial crisis has lowered potential growth in both advanced and emerging market economies. In addition, according to IMF (2015), an ageing population is another potential factor contributing to the decline of potential output growth.

6. CONCLUSIONS

The new member states are continuing in their path for convergence even those hit hardest by the crisis have continued to catch up after very deep but relatively short recessions. They are still in the same club in terms of real GDP per capita. Regarding capital accumulation and labour variables, most countries are in a single club, hence supporting the convergence. Though there is still room for improvement for Lithuania in terms of overall convergence to EU average. When it comes to the TFP, although the transition path of TFP suggests a direction towards the convergences, it has been weaken since the crisis. Particularly, the TFP's transition path in Lithuania has been plateau after the crisis. In addition, we can detect more clubs for the TFP, with Lithuania being in the second one together with Latvia, while Estonia seems to have performed worse. Lithuania would have needed more than 30% more TFP in the last 20 years to being able to belong to the first club.

This paper documents that the slow growth after 2009 is to the largest extent explained by slower TFP growth. This slowdown is partly offset by the increase in the growth rates of the employment-labour force

ratio and labour force participation rate. The transition scenarios suggest the growth rates for capital per capita and TFP to meet the EU-25 average of GDP per capita. The respective rates of the variables depend on the timing target.

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Annex: Tables and figures

Table 1: Club convergence results: summary

	GDP per capita	Capital Acc. per capita	Labour (LS/Pop)	Employment rate (LS/LF)	Participation rate (LF/Pop)	TFP
AT	1	1	1	1	1	2
BE	2	1	1	1	1	1
CY	2	1	1	2	1	3
CZ	2	1	1	1	1	3
DE	1	1	1	1	1	1
DK	1	1	1	1	1	1
EE	2	1	1	1	1	3
EL	2	1			1	3
ES	2	1	2		1	3
FI	2	1	1	1	1	2
FR	2	1	1	1	1	1
HU	2	1	1	1	1	3
IE	1	1	1	1	1	1
IT	2	1	2	2	1	3
LT	**2**	**1**	**1**	**1**	**1**	**2**
LU	1	1	1	1	1	1
LV	2	1	1	1	1	2
NL	1	1	1	1	1	1
PL	1	1	1	1	1	2
PT	2	1	1	1	1	3
RO	2	1	1	1	1	3
SE	1	1	1	1	1	1
SI	2	1	1	1	1	2
SK	2	1	1	1	1	1
UK	2	1	1	1	1	2

Note: clubs are here represented by different colours. If the cell is blank, the country is not converging to the EU 25 average. For employment rate the test of merging clubs is significant at 15%.

Table 2: Coefficients and test for clubs merging

(a) **GDP per capita**

Log(t)	Club(1)	Club(2)
Coefficient	0.058	0.156
T-stat	2.598	15.301

The log-t test for the merge of Club 1+2			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	**-0.0771****	0.0077	-10.0159

(b) **Labour**

Log(t)	Club(1)	Club(2)
Coefficient	0.344	2.480
T-stat	8.457	1.706

The log-t test for the merge of Club 1+2			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	0.3358*	0.0477	7.0356

The log-t test for the merge of Club 2+3			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	-0.8830*	0.0371	-23.8307

Note: the 3rd club refers to the non-converging economies.

(c) **Employment rate**

Log(t)	Club(1)	Club(2)	Club(3)
Coefficient	0.361	0.213	-5.950
T-stat	2.640	0.179	-3.149

The log-t test for the merge of Club 1+2			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	0.9010	0.1502	5.9980

The log-t test for the merge of Club 2+3			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	-2.6755	0.1496	0.1496

Note: the 3rd club refers to the non-converging economies.

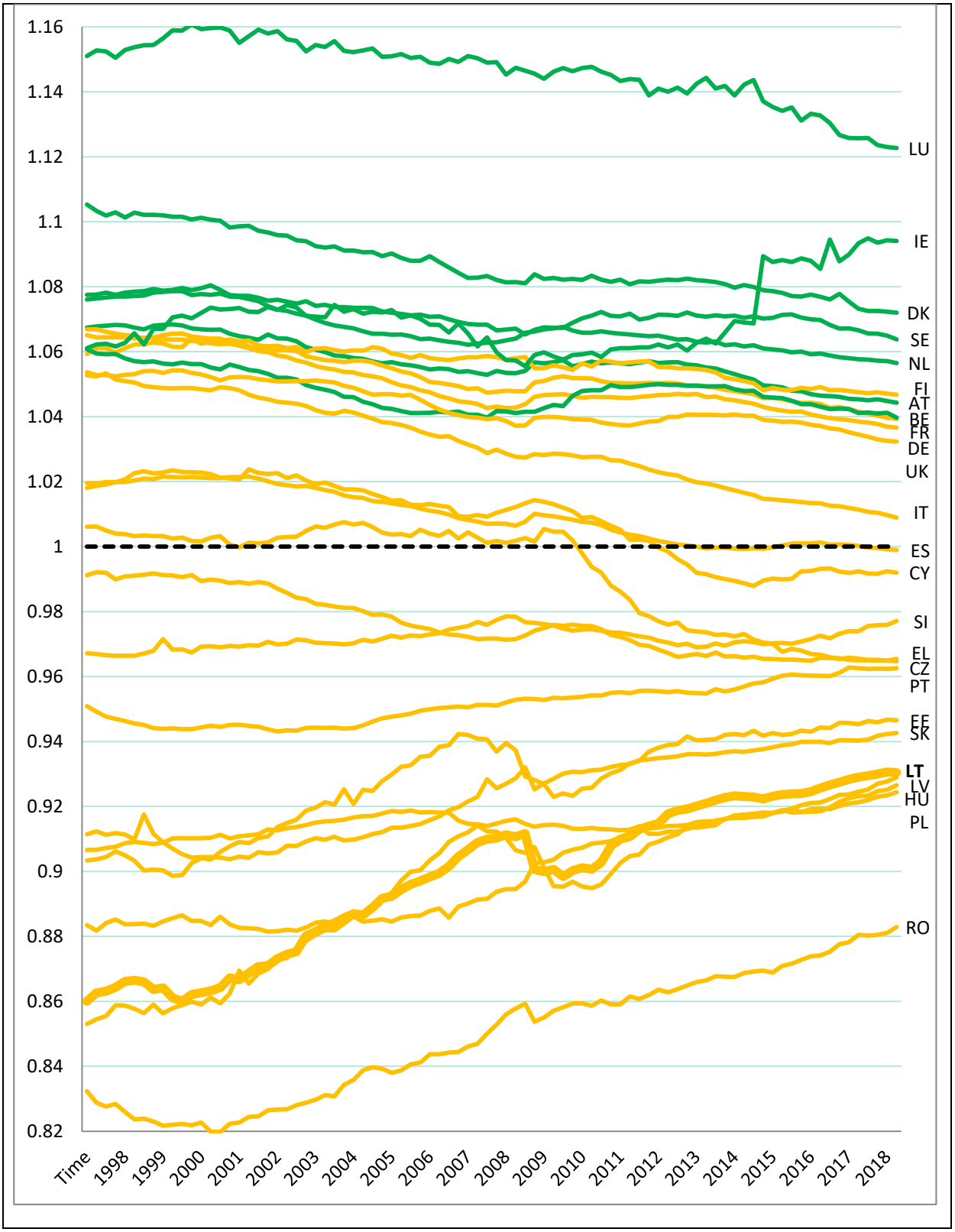
(d) **Total Factor Productivity**

Log(t)	Club(1)	Club(2)	Club(3)
Coefficient	-0.074	0.160	0.059
T-stat	-1.084	5.236	1.698

The log-t test for the merge of Club 1+2			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	**-0.1182***	0.0275	-4.2982

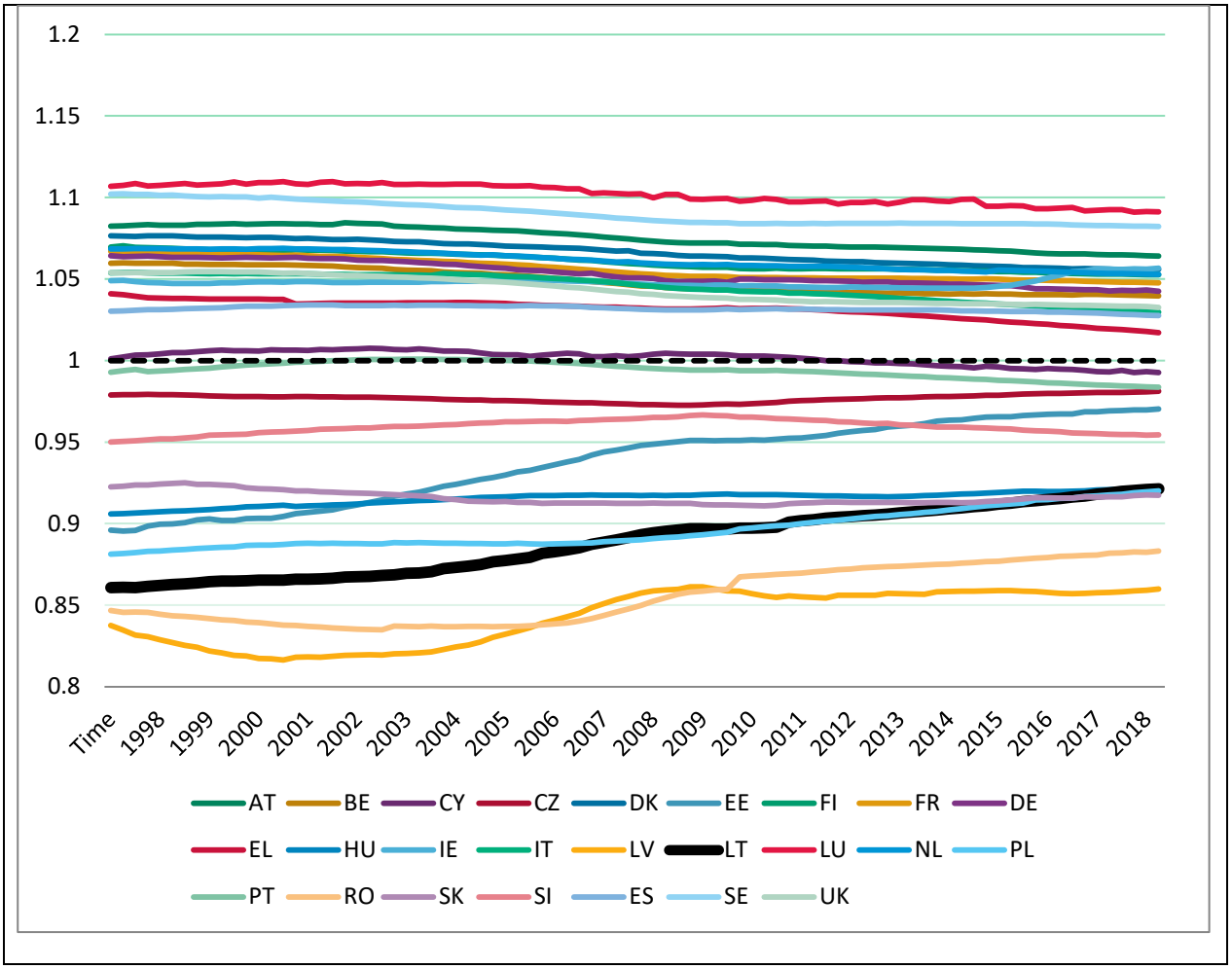
The log-t test for the merge of Club 2+3			
Log(t)	Coefficient	Standard Errors	T-Stat
Coefficient	**-0.0624***	0.0179	-3.4924

Chart 1: Convergence paths and clubs for real GDP per capita



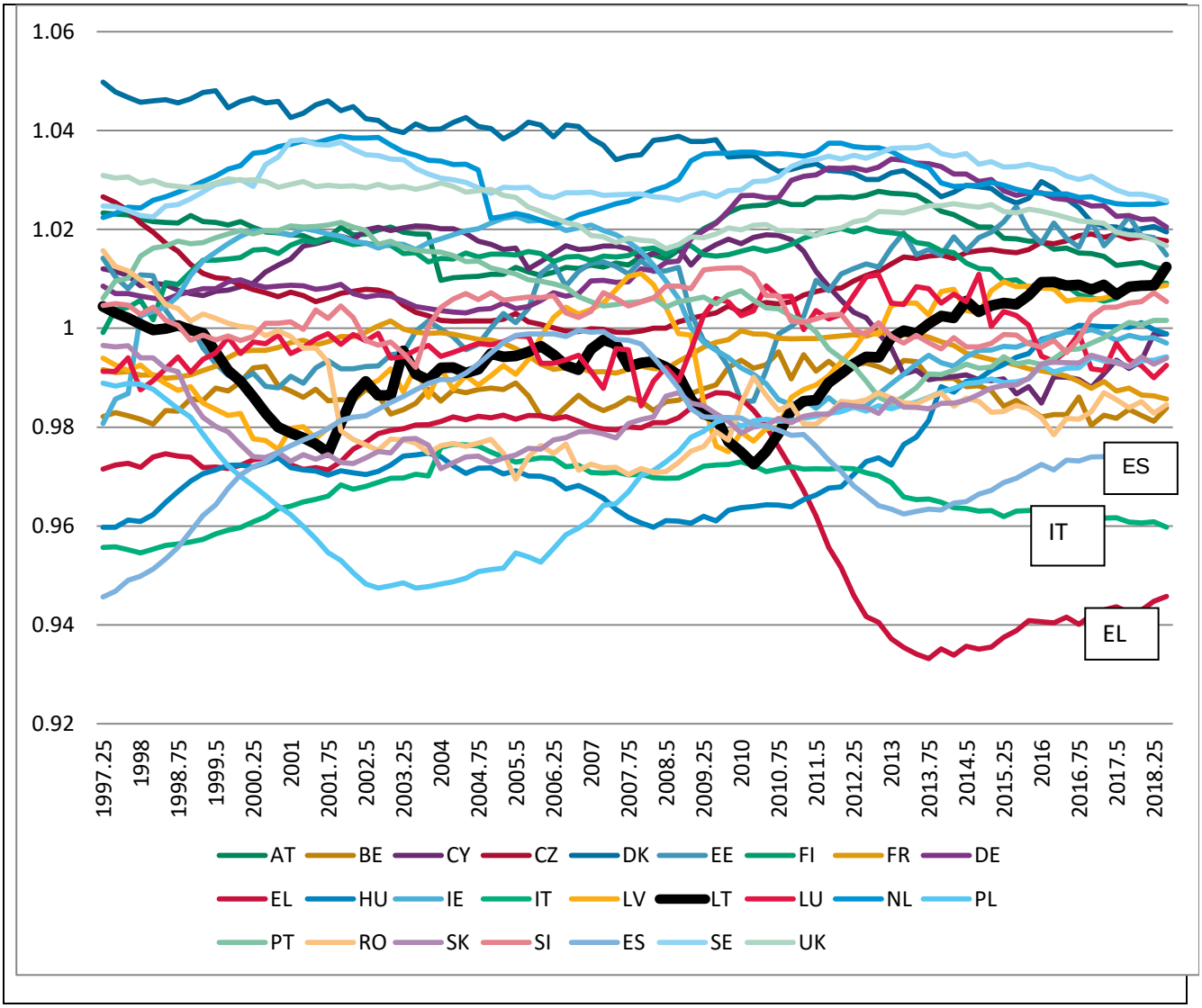
Note: Authors' calculation on Eurostat and EU Commission AMECO data. Club 1 members are in green, club 2 members are in orange. Lithuanian line is bolded for readers' convenience. Some countries are borderline between clubs 1 and 2, namely: AT, BE, DE, FR, and FI.

Chart 2: Convergence paths for capital accumulation per capita



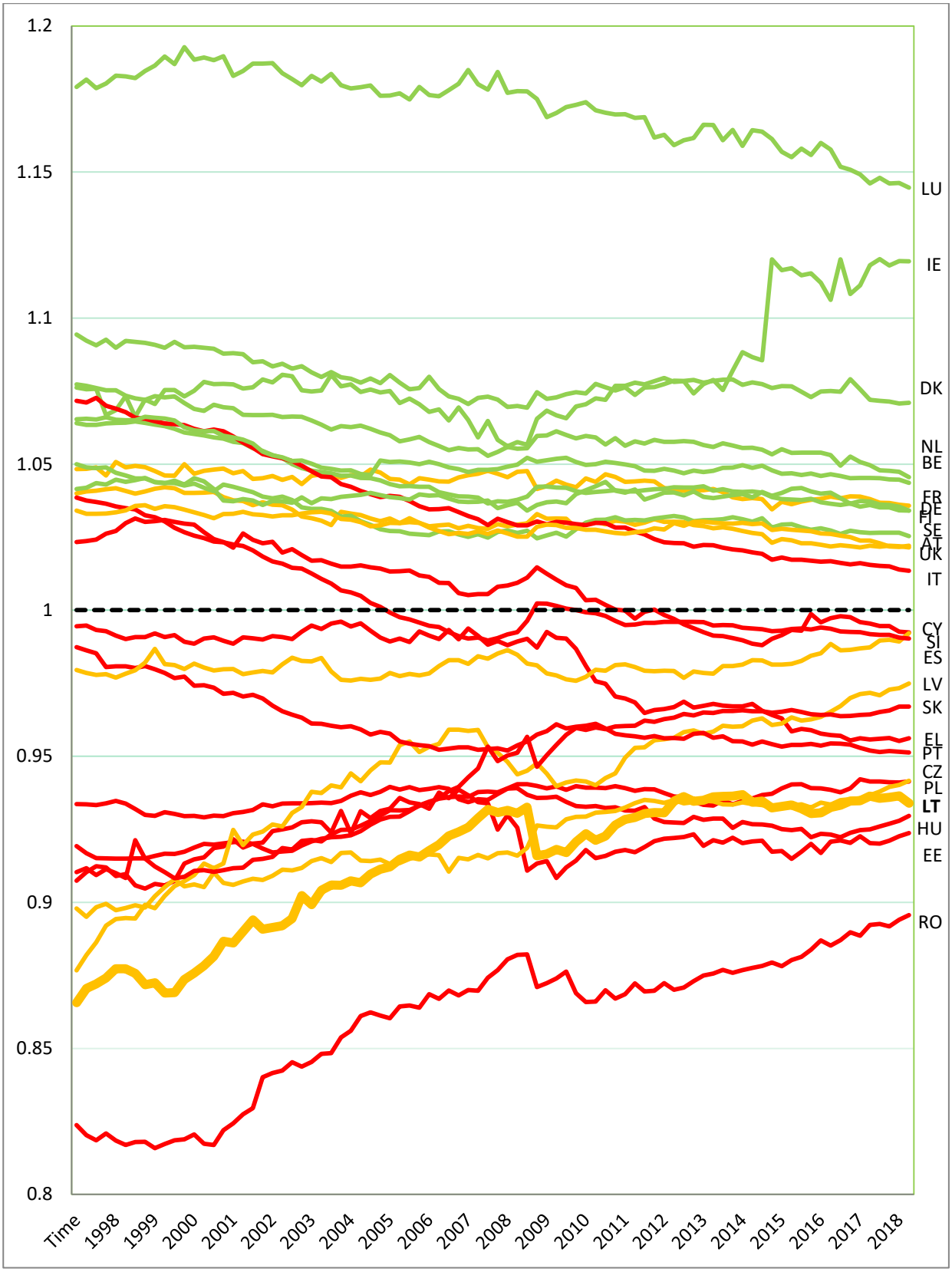
Note: Authors' calculation on Eurostat and EU Commission AMECO data. Only 1 club has been detected.

Chart 3: Convergence paths for labour



Note: Authors' calculation on Eurostat and EU Commission AMECO data. 2 clubs have been detected. Only ES and IT belong to club 2. EL is not converging. These three countries are highlighted in Chart 3. This has a much smaller scale compared to Chart 1 or 2. Lithuania is in black and bold.

Chart 4: Convergence paths and clubs for TFP



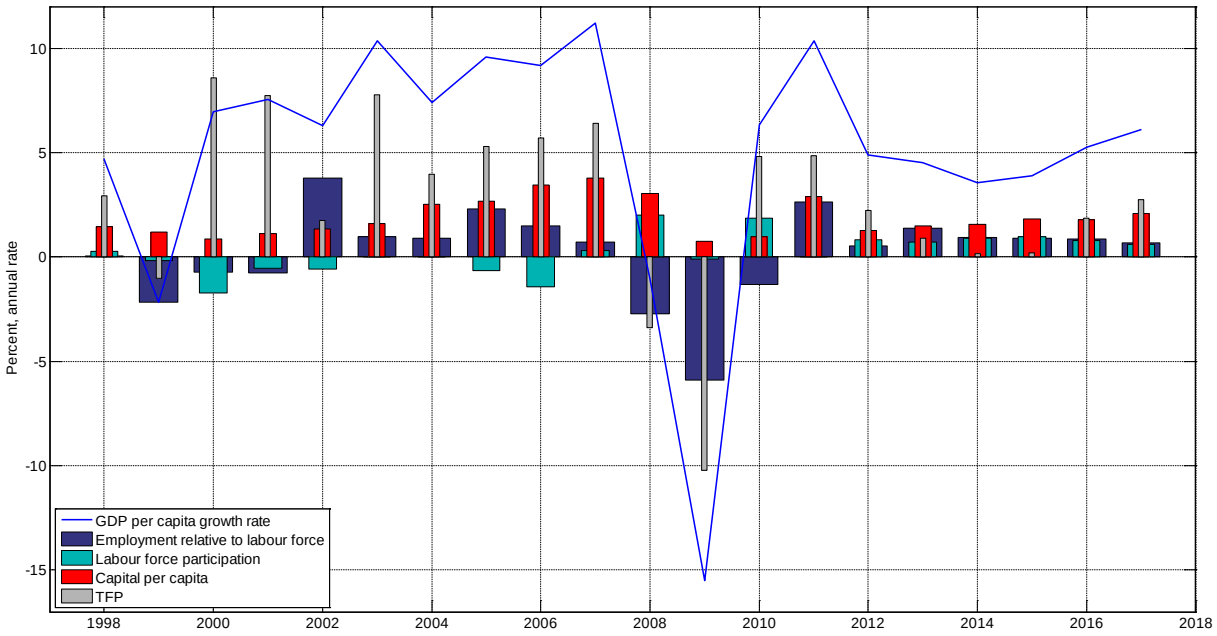
Note: Authors' calculation on Eurostat and EU Commission AMECO data. Club 1 members are in green, club 2 members are in orange and club 3 members are in red. Lithuanian line is bolded for readers' convenience.

Table 3: Growth decomposition for Lithuania and EU-25 average

	Lithuania		EU-25 Average	
Component	**1998Q1-2008Q4**	**2010Q1-2018Q3**	**1998Q1-2008Q4**	**2010Q1-2018Q3**
GDP per capita	6.36	5.46	2.76	2.34
Employment - labour force ratio	0.35	0.81	0.15	0.27
Labour force participation rate	-0.23	0.92	0.25	0.35
Capital per capita	2.10	1.73	0.96	0.66
TFP	4.15	2.00	1.40	1.05

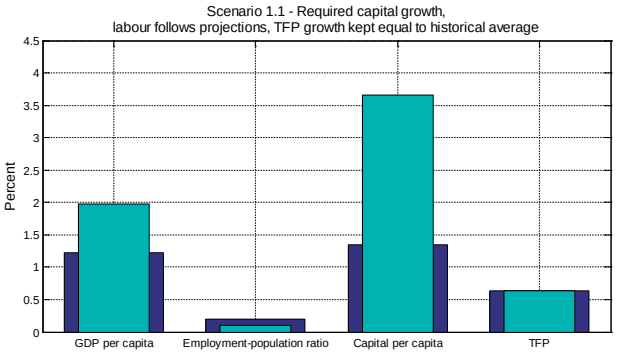
Note: Indented rows in each column sum up to the growth rate of GDP per capita.

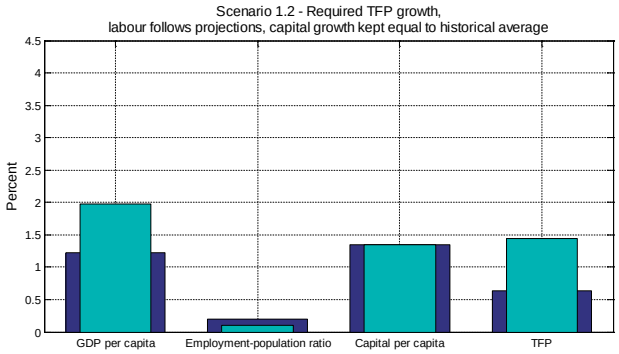
Chart 5: Growth shares explained by components (%), comparison to the EU-25 average

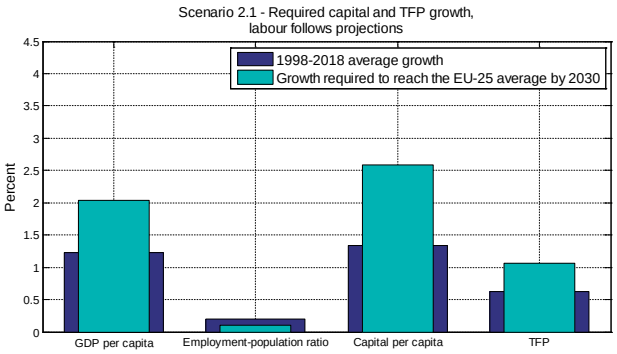


Note: In each year, the average contribution of the components is presented at an annual rate, with the total sum of the contributions equal to the GDP per capita growth (solid line).

Chart 6: Required growth rates for Lithuania to reach the EU-25 average by 2030

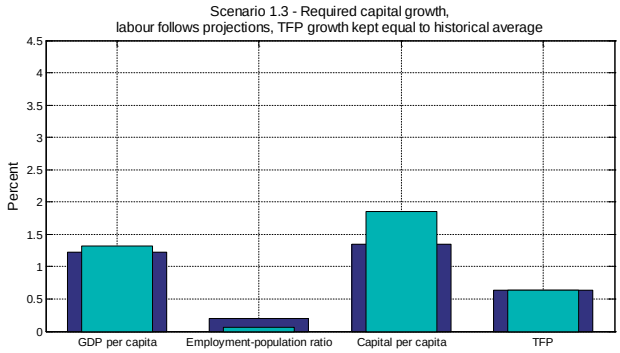


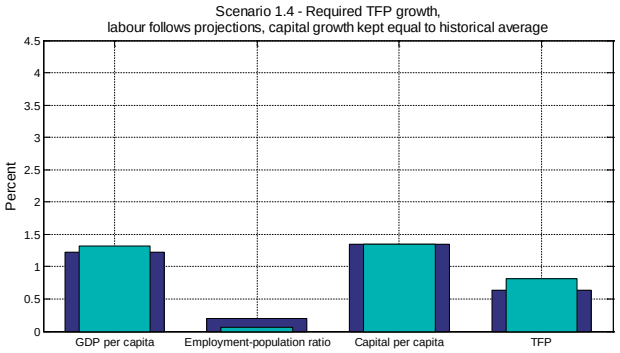


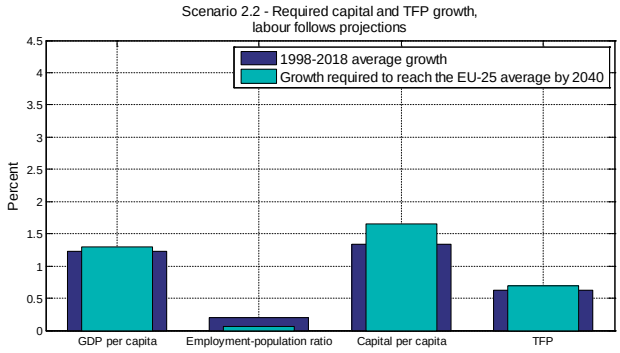


Note: The panels show the required growth rates computed for GDP per capita, employment-population ratio, capital per capita and TFP. The upper panels are based on the first scenario design, whereas the lower panel shows the results from the second scenario design.

Chart 7: Required growth rates for Lithuania to reach the EU-25 average by 2040







Note: See the notes to Chart 6.

Appendix

Table A.1: Club convergence results with **annual data** from Penn 9.1

	rgdpe	**rgdpo**	**rgdpna**
AT	4	3	3
BE	3	3	3
BG	5	4	4
HR	5	4	5
CY	7		6
CZ	4	3	3
DK	5	3	4
EE	5	4	5
FI	5	4	4
FR	1	1	1
DE			
EL	5	4	4
HU	5	4	4
IR	3	3	3
IT	2	2	2
LV	6	5	5
LT	**5**	**4**	**4**
LU	6	5	
MT	7		6
NL	3		3
PL	1	1	1
PT	5	4	4
RO	1	1	3
SK	4	4	4
SI	6	5	5
ES	2	2	2
SE	4	3	3
UK	1	1	1

Note: rgdpe is expenditure-side real GDP at chained PPPs (in mil. 2011US$)/population, rgdpo is output-side real GDP at chained PPPs (in mil. 2011US$)/population and rgdpna is the real GDP at constant 2011 national prices (in mil. 2011US$)/population.

Table A.2: Club convergence results **with HP-filtered quarterly data**

	Real GDP per capita HP	**Real GDP per capita as in Table 1**
AT	1	1
BE	1	2
CY	2	2
CZ	2	2
DE	1	1
DK	1	1
EE	2	2
EL	2	2
ES	2	2
FI	1	2
FR	1	2
HU	2	2
IE	1	1
IT	2	2
LT	**2**	**2**
LU	1	1
LV	2	2
NL	1	1
PL	2	1
PT	2	2
RO	2	2
SE	1	1
SI	2	2
SK	2	2
UK	2	2

Note: in the HP filter we use the smoothing parameter lambda equal to 1,600, taking the trend component.