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Competitiveness and Productivity in the Baltics: Common Shocks, Different Implications

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ABSTRACT: This paper examines competitiveness and productivity in the Baltics. Focusing on recent developments, it asks why Russia's war in Ukraine led to a prolonged recession and strong decline in competitiveness in Estonia, while Latvia and Lithuania shielded their economies more effectively. The paper starts by documenting a deterioration in export performance across the region. Using a constant share decomposition, it finds that, unlike in Latvia and Lithuania, Estonia's declining export share has been mainly linked to a reduction in the 'intensive margin'—a sign of weakening external competitiveness and declining relative productivity. Multivariate filtering techniques and estimates of the real effective exchange rates based on historical productivity trends, consistent with Balassa-Samuelson, confirm that differences in long-term total factor productivity growth have affected external competitiveness. While Estonia's post-GFC slowdown in productivity growth and real exchange rate appreciation have eroded its competitive edge, Latvia and Lithuania have shown greater resilience, aided by more balanced real effective exchange rates and, for Lithuania, stronger corporate balance sheets. A micro-econometric analysis further reveals that resource misallocation, particularly in the services sector, has been a key driver of declining productivity in the region. These findings underscore the need for targeted reforms to improve allocative efficiency, boost productivity, and restore competitiveness in the Baltic region.

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Authors' E-Mail Addresses:	sarmendariz@imf.org; cderesende@imf.org; afan@imf.org; gferrucci@imf.org; bhu2@imf.org; snaik@imf.org; cugur@imf.org

* The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of the International Monetary Fund (IMF), its Executive Board, or its management.

WORKING PAPERS

Competitiveness and Productivity in the Baltics: Common Shocks, Different Implications

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EA	Euro area
EST	Estonia
EU	European Union
GFC	Global financial crisis
GVA	Gross value added
GVC	Global value chain
LTU	Lithuania
LVA	Latvia
NFC	Nonfinancial corporation
PPP	Purchasing power parity
REER	Real effective exchange rate
TFP	Total factor productivity

1. Introduction

The three Baltic economies—Estonia, Latvia, and Lithuania—have faced unprecedented shocks over the past few years. While the region proved resilient to the economic effects of the pandemic, the shock triggered by Russia's invasion of Ukraine has led to more severe supply disruptions and a sharp increase in inflation. Inflation has now receded, but the level of prices, wages and other input costs has risen relative to the euro area, leaving lasting scars on the Baltic economies. Since 2022, income convergence has stalled, with slowing or even falling GDP growth depending on the country. Productivity has decelerated, partly reflecting labor hoarding. Export market shares have shrunk. These developments have raised concerns about the competitive position, potential growth, and convergence prospects for the region, amid a challenging geopolitical environment.

But even before the recent shocks hit the region, signs of productivity slowdown, erosion of competitiveness, and a general deceleration in the catch-up process had emerged in the Baltics, albeit with significant differences across countries. After regaining independence in the early 1990s, Estonia, Latvia, and Lithuania had rapidly caught up with the more advanced EU economies. However, the global financial crisis (GFC) had brought a sharp recession to the region. Post-GFC, productivity growth in these countries has slowed significantly and never fully recovered to pre-crisis rates or relative to the global frontier. Lithuania has fared better than the other two Baltic economies, with higher productivity growth, better export performance, and generally faster income convergence. Since 2017, Lithuania has overtaken Estonia as the country with the highest GDP per capita (in PPP terms) in the region. However, for the Baltics the slowdown in growth has been noticeable, foreshadowing deep-rooted structural issues, which hinder long-term growth.

Structural challenges include adverse demographic trends, which pose long-term fiscal pressures, insufficient financial deepening, which constrain private investment, and persistent inefficiencies in healthcare, education, and the labor market, which result in labor shortages and skill mismatches—as documented in Vandeplas and Thum-Thysen (2019) and IMF (2024a, b, and c). The looming energy transition compounds these issues. Combined with a more fragmented global environment and heightened geopolitical risks, these are significant challenges for small open economies that are heavily reliant on foreign trade for growth, such as Estonia, Latvia, and Lithuania.

Against this backdrop, this paper examines competitiveness in the three Baltic states over the past two decades, with a particular focus on the ramifications of the shocks of the past two years and the challenges ahead. Russia's invasion of Ukraine has triggered a sharp increase in energy and other input costs throughout the region, with different effects across the three Baltic economies. Estonia, for instance, has been hit more strongly, experiencing nine consecutive quarters of recession, while Latvia and Lithuania have faced more limited disruptions. A key objective of this study is to investigate the underlying factors for these divergent outcomes, as understanding these differences is crucial for seizing future growth opportunities and enhancing competitiveness for the region.

This paper finds that differences in long-term productivity growth, especially related to TFP dynamics, have had significant implications for external competitiveness in the region. In Estonia, a sharp slowdown in TFP growth after the GFC, alongside real exchange rate appreciation, has eroded the country's competitive edge, contributing to its current economic struggles. In contrast, Latvia and Lithuania have shown greater resilience, benefiting from less severe declines in productivity, an undervalued REER entering the crisis, and, in the case

of Lithuania, stronger corporate balance sheets. Looking into the root causes of these developments, a micro-econometric analysis using firm-level data points to resource misallocation as a key factor behind declining productivity in all three countries, with the services sector being particularly affected. Addressing these structural challenges will require targeted reforms in product, capital, and labor markets to improve allocative efficiency and, in turn, support productivity growth and restore competitiveness.

The paper is structured as follows. The next section provides several stylized facts on productivity and competitiveness across the three Baltic economies. Using a constant market share decomposition, it shows that, unlike in Latvia and Lithuania, a significant portion of the decline in Estonia's export market share can be attributed to the 'intensive margin', i.e., a shrinking share of Estonia's exports in the main destination markets—a sign of weakening external competitiveness and declining relative productivity. Section 3 uses multivariate filtering techniques to assess the extent to which the real effective exchange rate was broadly aligned with an equilibrium value consistent with past developments in productivity, according to a standard Balassa-Samuelson hypothesis. It argues that a key factor explaining the relatively more benign economic outturn for Lithuania, compared to Estonia and, to a lesser extent, Latvia, is the extent to which these countries were able to draw from accumulated buffers (an undervalued real exchange rate) to cushion the shock. Section 4 argues, based on micro-econometric analysis on firm-level data, that resource misallocations may have contributed to faltering productivity. Drawing on these findings, it proposes actionable strategies for mitigating the identified challenges and capitalizing on emerging opportunities. Section 5 concludes.

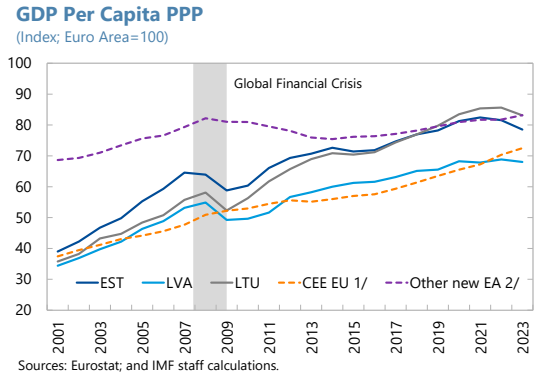
2. Stylized Facts

2.1 Economic convergence has decelerated over time amid differences within the region

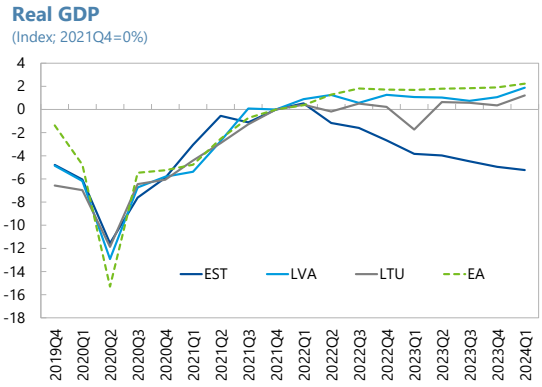
After regaining independence, all Baltic countries experienced a period of steady convergence towards the income levels of the euro area. This era of fast growth and rapid regional economic convergence, however, gave way to diverging country paths after the GFC. While Lithuania soon returned to its pre-GFC growth trend, the speed of convergence decelerated significantly for Estonia and Latvia. By 2017, Lithuania had already surpassed Estonia as the Baltic country with the highest per capita income (in PPP terms) relative to the euro area, as illustrated in Figure 2.1.

With the pandemic, the region's income convergence came to a halt and country disparities were further accentuated by the onset of Russia's war in Ukraine. While Lithuania and Latvia experienced only mild and shallow recessions, Estonia has grappled with a more prolonged economic downturn.

Figure 2.1. Income Convergence in the Baltics



Sources: Eurostat; and IMF staff calculations.
1/ CEE EU: HUN, POL, BGR, HRV, ROU.
2/ Other new EA: SVN, SVK, CYP.

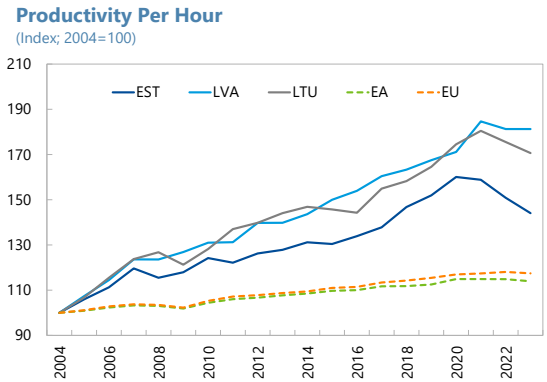


Sources: World Economic Outlook, IMF; and IMF staff calculations.

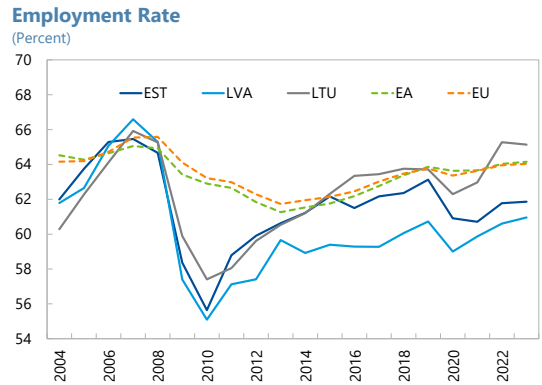
2.2 Labor productivity has also decelerated while labor reallocation towards more productive activities has been generally limited

Boosted by EU accession tailwinds, the three Baltics recorded strong gains in employment and labor productivity during 2004-2008, outpacing other European countries (Figure 2.2). However, labor productivity slowed down after the GFC, especially in Estonia, where trend productivity growth decoupled from those of Lithuania and Latvia. The gap has widened further since the pandemic, also reflecting a more negative trend in Estonia. Despite stalling economic activity, Latvia and Lithuania achieved their highest employment rates in over a decade in 2022-23, amid tight labor markets. This reflected labor hoarding, which partly explains the negative productivity growth during this period. In contrast, Estonia's declining labor productivity has coincided with a less dynamic labor market, with the employment rate remaining still lower than before the pandemic.

Figure 2.2. Labor Productivity and Employment



Sources: Eurostat; Haver Analytics; and IMF staff calculations.



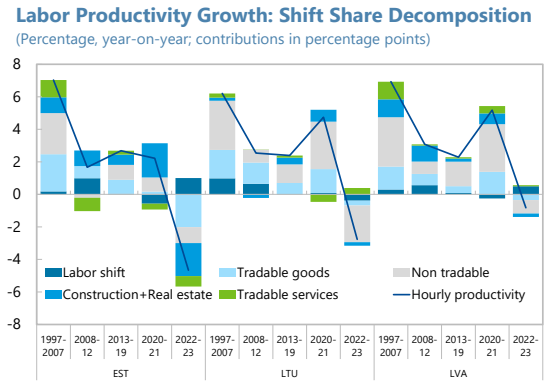
Sources: Eurostat; Haver Analytics; and IMF staff calculations.

Through shift-share analysis, labor productivity growth can be broken down into three different effects: (i) labor productivity growth within industries; (ii) the effect of shifting labor inputs across industries; and (iii) an interaction term between these two factors. For simplicity, the last two terms can be aggregated into the total effect of the labor shift—or shift effect—on productivity. The aim of this approach is to evaluate the contribution

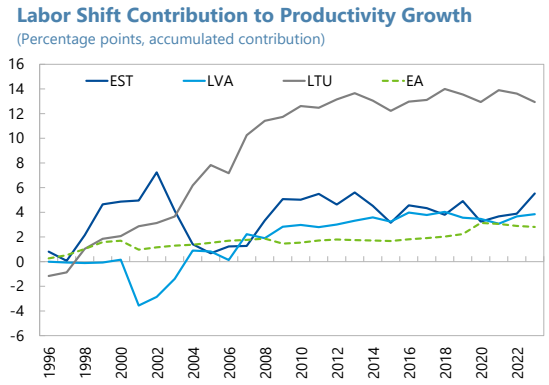
of specific sectors to aggregate labor productivity growth and the extent to which labor is reallocated towards the most productive sectors.

Evidence shows that, aside from differences in aggregate paths, labor productivity within sectors has evolved differently across the three Baltic countries over the past few decades (Figure 2.3). Estonia, for instance, has gained more from construction and real estate activities compared to Lithuania and Latvia and less from manufacturing (tradable) and, especially, other non-tradable sectors. These compositional differences have been amplified by recent shocks, with a stronger correction in both tradable and non-tradable sectors in Estonia compared to Lithuania and Latvia.

Figure 2.3. Shift-Share Decomposition and Labor Shift Contribution to Productivity Growth



Sources: Eurostat; Haver Analytics; and IMF staff calculations



Sources: Eurostat; Haver Analytics; and IMF staff calculations.

Reallocation of labor towards more productive sectors appears to have been generally limited for the region, with a more significant role only for Lithuania in the years leading up to the GFC. Since the GFC, all three Baltic countries have hardly recorded any material gain from labor reallocation.

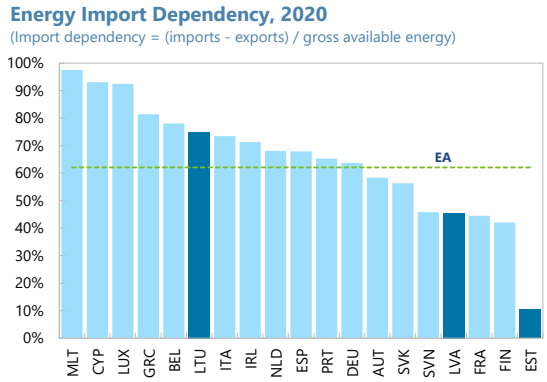
2.3 Lithuania has suffered a negative terms-of-trade shock recently; the rest of the region less so

Russia's war on Ukraine triggered a significant increase in import price inflation in all three Baltic countries, but Lithuania experienced the strongest impact. Among other things, this reflects Lithuania's higher dependency on imported energy and its greater reliance on gas and electricity relative to Latvia and Estonia, which, in contrast, benefit from a more diversified energy mix towards renewables and other energy sources (Figure 2.4).

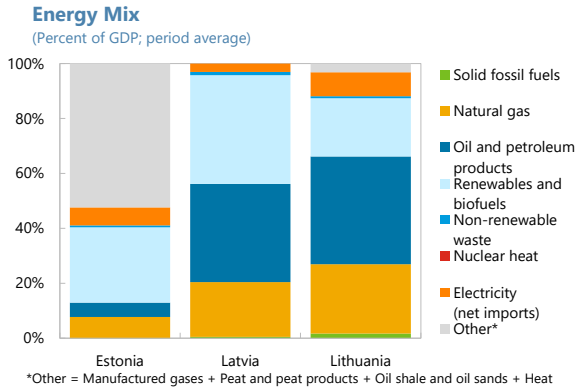
Despite facing higher imported inflation, however, export price growth in Lithuania was lower than in the other Baltic countries, as the country's pass-through of the external shock to export prices was more limited than in the rest of the region. As a result, Lithuania recorded one of the largest deteriorations in the terms-of-trade[1] in the euro area. In contrast, Estonia and Latvia recorded improvements in their terms-of-trade, as exporters pass on raising input costs into export prices.

[1] Measured as the ratio between export and import prices.

Figure 2.4. Energy Mix, Import Prices, and Terms of Trade

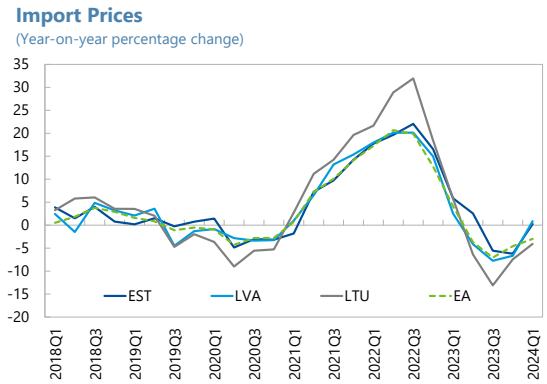


Sources: Eurostat; Haver Analytics; and IMF staff calculations.

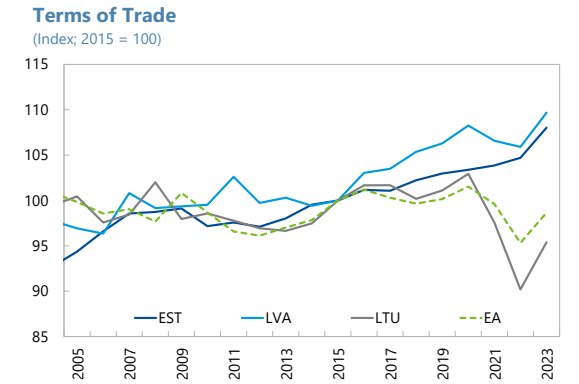


*Other = Manufactured gases + Peat and peat products + Oil shale and oil sands + Heat

Sources: Eurostat; Haver Analytics; and IMF staff calculations.



Sources: Haver Analytics; Eurostat; and IMF staff calculations.

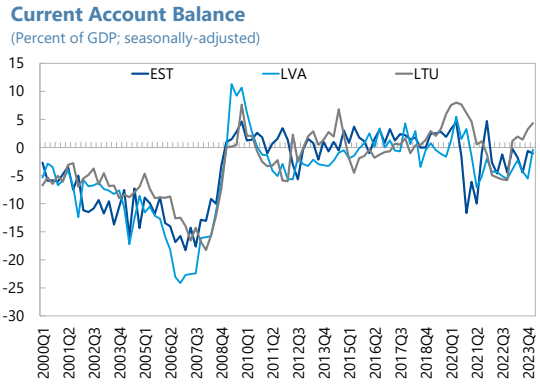


Sources: Eurostat; Haver Analytics; and IMF staff calculations.

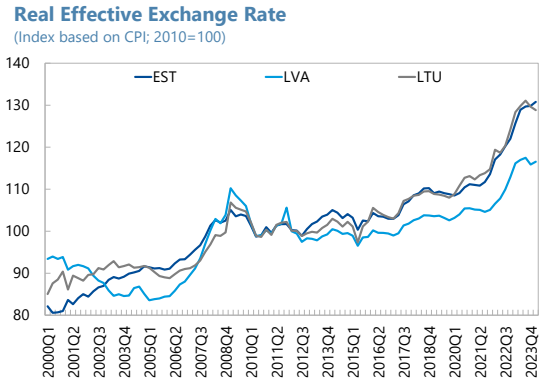
2.4 Despite the terms-of trade shock, Lithuania's current account has moved back to surplus, while it remains in deficit for the rest of the region

In the period leading up to the GFC, the Baltics accumulated sizable external imbalances. In 2008, internal devaluations paved the way to major swings in their current accounts, from large deficits to surpluses (Figure 2.5). Subsequently, all three economies achieved more balanced external positions (Bakker and Korczak, 2017) until their current accounts slipped into deficit following the recent shocks. In Lithuania, however, this effect has been only temporary, with export volumes expanding more rapidly than in Estonia and Latvia and driving the current account back to surplus.

Figure 2.5. External Balance



Sources: Statistical Authorities; and Haver Analytics.

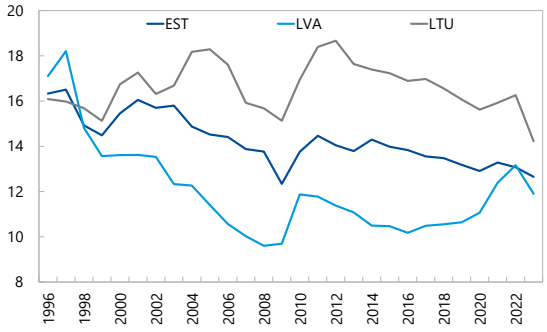


Source: Information Notice System, IMF.

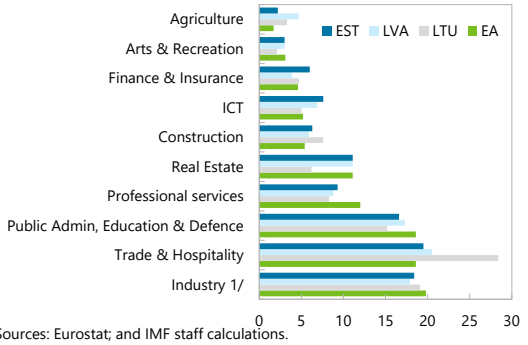
2.5 Production and export composition varies significantly across the Baltics

After regaining independence, the three Baltic countries exhibited broadly comparable shares of manufacturing in total output. Over the following years, the gross value added of manufacturing, however, declined rapidly in Estonia and Latvia, while remaining elevated in Lithuania (Figure 2.6). While the contribution of manufacturing production in gross value added has also started to decline in Lithuania in more recent years, significant differences persist in the economic structure of the three countries.

Figure 2.6. GVA in Manufacturing and Economic Structure



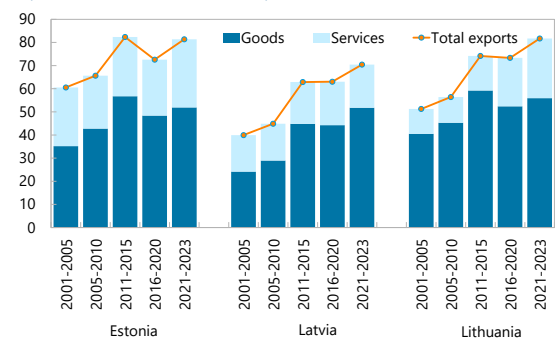
Sources: Eurostat; Haver Analytics; and IMF staff calculations.



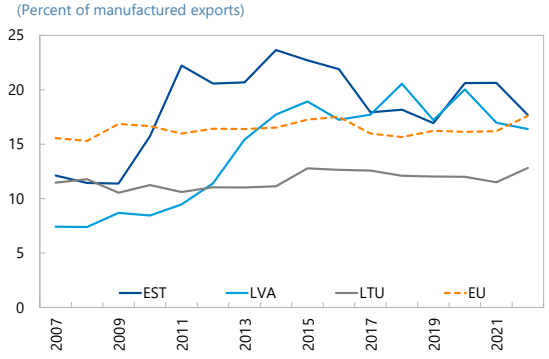
Sources: Eurostat; and IMF staff calculations.
1/ Includes manufacturing, mining and quarrying, electricity, water and other utilities.

Underscoring the crucial role of foreign trade as an engine of growth and convergence in the Baltic economies, exports as a percentage of GDP have steadily increased in the three economies over the past decades (Figure 2.7). This growth has been particularly strong in Lithuania, where services exports have surged since 2010. However, despite Lithuania's larger share of manufacturing, the technological content of its exports is lower than that of Estonia and Latvia. This underscores Lithuania's greater reliance on more traditional manufacturing output, its product specialization, and its lower GVC participation relative to Estonia (Banh et al., 2020). The relatively low technological content of Lithuania's exports may explain the country's position as a price taker in export markets and is consistent with the terms-of-trade puzzle discussed in previous sections.

Figure 2.7. Technological Content of Exports and Re-Exports of Manufactured Goods



Sources: Eurostat; Haver Analytics; and IMF staff calculations.

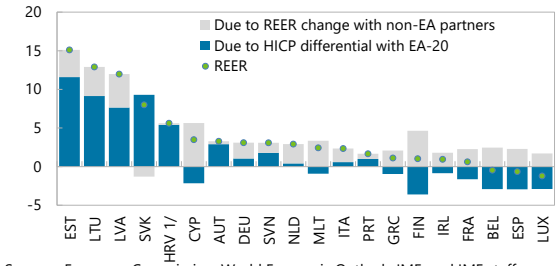


Sources: World Bank; and IMF staff calculations.

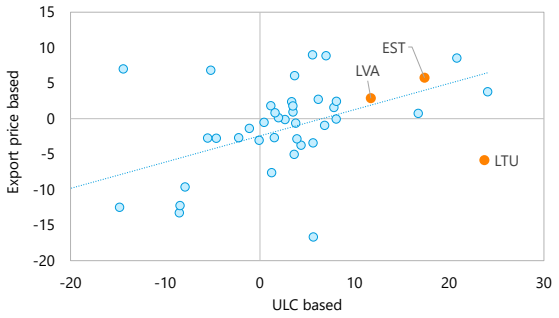
2.6 The region has faced a sharp real exchange rate appreciation (with some caveats)

In recent years, the Baltics have experienced large inflation differentials relative to their trading partners, along with high nominal labor costs. While inflation has now eased, prices, wages and other input costs have shifted up, resulting in significant appreciation of the real effective exchange rate (REER) for the three countries (Figure 2.8). That said, Lithuania has experienced real exchange rate depreciation when measured in terms of export prices, given the more muted pass-through described above.

Figure 2.8. Real Effective Exchange Rate



Sources: European Commission; World Economic Outlook, IMF; and IMF staff calculations.
1/ For the period between 2021Q4-2022Q4, there is also a bilateral exchange rate effect between the Croatian Kuna and the Euro which is incorporated in the HICP differential component.



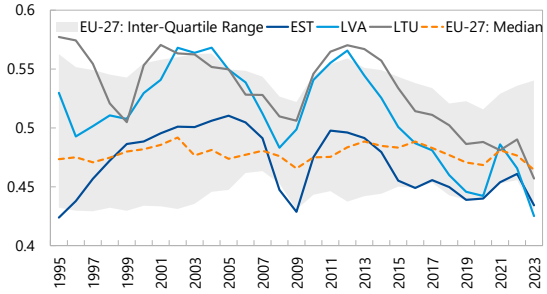
Sources: European Commission; and IMF staff calculations.

2.7 Corporate balance sheets have remained healthy

Baltic nonfinancial corporations have managed to preserve sizable profit shares throughout the last three decades (Figure 2.9). Unprecedented public support in response to the pandemic has allowed companies to contain leverage (even in the case of traditionally more indebted Latvian firms) and improve their solvency and liquidity positions. When measured in terms of net financial wealth—defined as the difference between total financial assets and liabilities—the position of Lithuanian corporations has been consistently stronger than Estonia, Latvia, and other EU member states in recent years, and it has further improved lately.

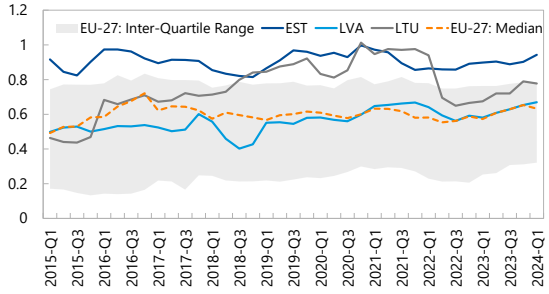
Figure 2.9. Financial Indices of Non-Financial Corporations

NFC Profit Shares
(Ratio)



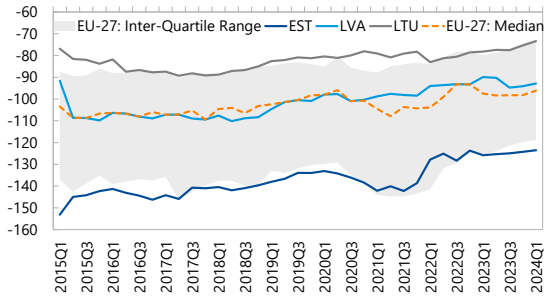
Sources: Eurostat; Haver Analytics; and IMF staff calculations.
Note: Profit share has been measured as gross operating surplus/gross value added.

NFC Liquidity: Current Ratio
(Ratio)



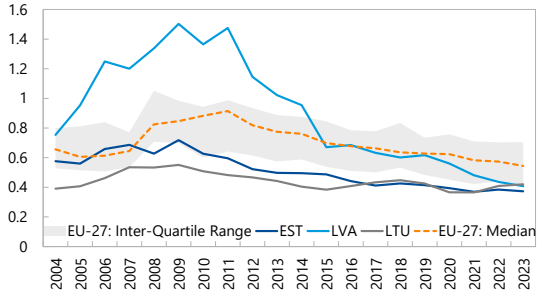
Sources: Eurostat; Haver Analytics; and IMF staff calculations.
Note: Current ratio has been measured as current financial assets/current financial liabilities.

NFC Net Financial Liabilities
(Percent of GDP)



Sources: European Central Bank; Eurostat; Haver Analytics; and IMF staff calculations.
Note: Net financial liabilities is measured as total financial assets - total financial liabilities.

NFC Leverage: Debt to Equity
(Ratio)



Sources: European Central Bank; Eurostat; Haver Analytics; and IMF staff calculations.
Note: Debt to Equity ratio has been measured as (debt securities+loans)/total equity.

2.8 Export market shares have recently declined across the Baltics, with Estonia suffering the largest drop

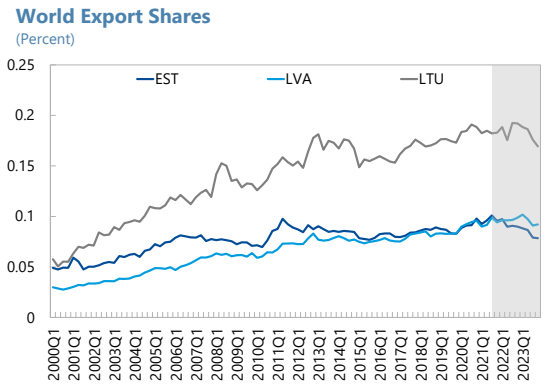
The Baltics are small open economies with strong trade ties to one another and to the Nordic countries. Due to the limited size of their domestic markets, these economies have relied heavily on foreign trade for income growth and economic convergence since regaining their independence. As a result, trade openness—defined as the sum of exports and imports as a percentage of GDP—has risen steadily, and in 2023 stood at 154.9 percent in Estonia, 149 percent in Lithuania, and 138 percent in Latvia, all exceeding the EU average of about 100 percent. All three economies primarily engage in trade with one another and with other European countries, in part reflecting their integration with the EU (Figure 2.10). Their strong dependence on exports for growth and convergence highlights the need to maintain external competitiveness as a core aspect of their development strategy.

The export market shares of Estonia, Latvia and Lithuania grew substantially prior to the GFC (Figure 2.10). However, after 2008, Estonia's share flattened, while Lithuania's and, to a lesser extent, Latvia's continued to rise, supported by sustained export expansion outpacing growth in foreign markets. By the end of 2019, the Lithuanian export share was 0.17 percent of global exports, over three times higher than in early 2000. In Lithuania, the large internal devaluation following the GFC set the stage for a strong export-led recovery that has extended until recently. This trend has continued even after the first set of trade sanctions to Russia in

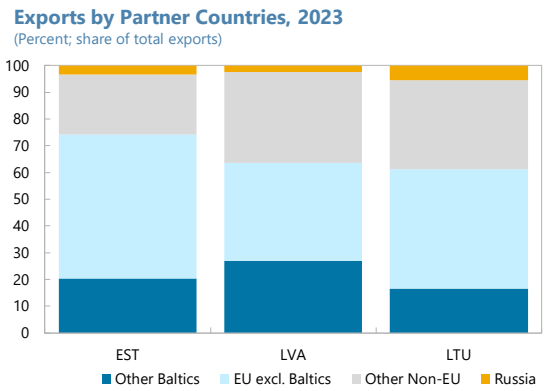
2015, which resulted in a temporary 10 percent loss of market shares in a single year. Lithuanian companies successfully diversified towards other markets, particularly the EU where the market share increased from around 0.3 in 2014 to close to 0.4 percent.

All three Baltic economies, however, experienced losses of export market shares in the post-pandemic period. Market share losses over 2021Q3 to 2023Q4 were moderate in Lithuania and Latvia, at -7 percent and -6 percent respectively, and particularly large in Estonia, at -23 percent. These differences emerged despite similar inflation differentials with trading partners. In Lithuania, the correction was mostly concentrated outside the EU and came after a decade of steady gains, while Estonia and Latvia had already experienced broadly constant market shares in the decade prior to 2021.

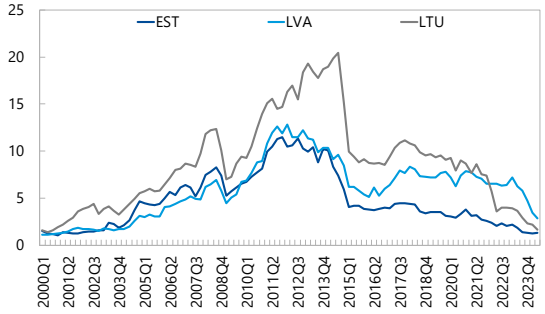
Figure 2.10. Export Market Shares



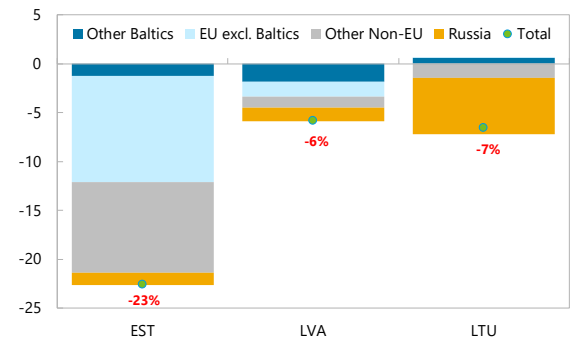
Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.



Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.



Sources: Direction of Trade Statistics, IMF; National Statistical Authorities; Haver Analytics; and IMF staff calculations.

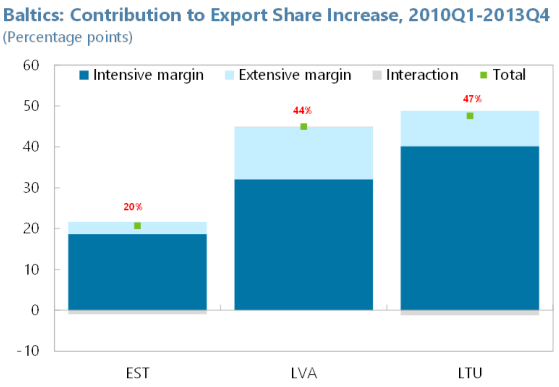


Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.

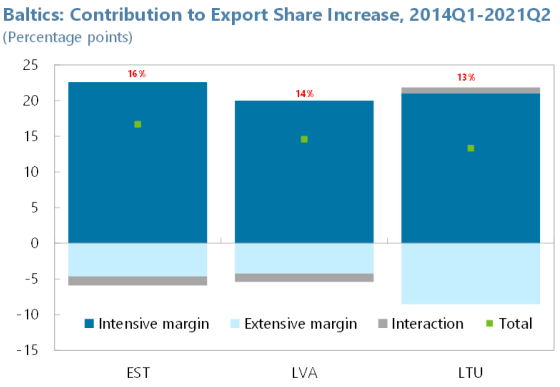
A protracted fall in trade shares signals difficulties of exporters in keeping up with competition in destination markets and may be a symptom of structural weaknesses. Using a constant market share methodology, it is possible to decompose changes in a country's market shares into three different components: an intensive margin—or competitiveness effect, measuring the portion of the change in the market share that is attributable to higher penetration margins; an extensive margin—or composition effect, that measures the portion of the change in the market share that is attributable to the change in the size of the destination markets; and the interaction of both factors. The methodological details can be found in Annex I.

Figure 2.11 shows the constant market share decomposition for the three Baltic countries over different time periods. In the post-GFC period, from 2010Q1 to 2013Q4, large competitive gains were accompanied by moderate growth in export markets. Latvia and even more Lithuania gained market shares, while progress was more contained for Estonia. In the following period between 2014Q1 and 2021Q2, the Baltics remain relatively competitive, outweighing less favorable dynamics in destination markets. During this phase developments were broadly comparable across the three Baltic countries.

Figure 2.11. Constant Market Share: Baltics Comparison



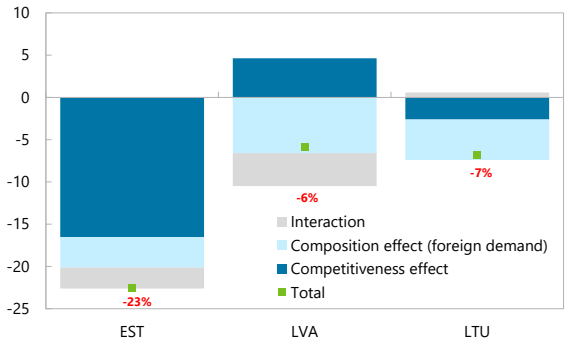
Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.



Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.

In the post-pandemic period, results suggest diverging trends across the region. A moderate loss of export share in Lithuania reflects for the most part demand developments in trading partners—particularly the impact of sanctions on Russia and Belarus, a large share of which are re-exports with little value added—rather than competitiveness factors. The same largely applies to Latvia, which managed to post some modest competitive gains. In contrast, Estonia's larger loss of market share is mostly explained by a competitiveness effect (Figure 2.12).

Figure 2.12. Export Share in Goods 2021-2023



Sources: Direction of Trade Statistics, IMF; and IMF staff calculations.

2.9 A few key open questions

These stylized facts shed some light on the Baltic region: a decelerating economic convergence as these countries approach the per capita income levels of more advanced economies, the productivity slowdown—a challenge faced by the European economy more broadly—and the economic effects of the more recent shocks, the pandemic and Russia's invasion of Ukraine. But they also leave several questions unanswered. Why despite common shocks, similar increases in inflation and a broadly comparable real exchange rate appreciation, these countries experienced such different behavior in their export market shares? To what extent these divergences reflect conjunctural developments or are more deeply rooted in structural differences? And has allocative efficiency played any role?

This section has offered some early intuition: a more muted pass-through from import to export prices, itself a reflection of a different production and export composition, and stronger corporate balance sheets may contribute to explain different ability to absorb supply-side shocks. The next section will provide a more systematic approach to competitiveness in the Baltics within the framework of the Balassa-Samuelson hypothesis.

3. TFP Growth, the Balassa-Samuelson Hypothesis, and Competitiveness in the Baltics

3.1 The Balassa-Samuelson hypothesis: a brief overview

The Balassa-Samuelson effect explains the link between differences in productivity growth among tradable goods sectors across countries and disparities in wages, services prices, purchasing power parity (PPP), and exchange rates (for a good summary see Devereux, 2014).[2] It attributes persistent movements in real exchange rates over time and across countries to cross-country differentials in sectoral total factor productivity (TFP). Higher productivity growth in tradable goods sectors tends to increase local input costs and therefore the prices of non-tradable goods. Since the law of one price tends to apply to tradable goods, this raises local prices, leading to real exchange rate appreciation. This effect suggests that currencies of more productive countries tend to appreciate, with the gap widening as incomes increase, an implication supported by the observation that price levels are higher in wealthier countries (the "Penn effect").[3]

For the Baltic region, the Balassa-Samuelson hypothesis implies a REER appreciation reflecting faster TFP growth compared to trading partners. As a corollary, declining productivity growth combined with continued REER appreciation, as observed in the Baltics during the post-GFC period, can lead to loss of competitiveness.[4]

The goal of this section is to construct a TFP-consistent REER for the Baltic countries. The difference between actual REER and TFP-based REER can be used as an indicator of competitiveness. The analysis can shed light on the divergent paths of economic growth and export performance observed across the Baltic countries in response to recent external shocks. It can help to address several important research questions. Can the secular REER appreciation observed in the Baltics be fully accounted for by TFP dynamics? Are there distinct paths of TFP and potential GDP growth among the three Baltic countries? Do the diverging paths of TFP-based REER provide a plausible explanation for the recent differences in economic performances within the Baltic region? If so, can we disentangle the role played by structural and cyclical factors?

A substantial body of literature examines the Balassa-Samuelson effect in catching-up economies—see Mihaljek and Klau (2008) for a comprehensive review. The analysis in this section departs from this literature in three important ways.

First, we use an estimation strategy that better identifies the Balassa-Samuelson effect, without conflating it with the so-called Baumol-Bowen effect—a positive correlation between differences in productivity growth

[2] Balassa (1964), and Samuelson (1964).

[3] Summers and Heston (1991).

[4] See Comunale, Nguyen, and Soofi-Siavash (2019) for a study of the convergence process in Lithuania.

between tradeable and non-tradeable and the relative price of non-tradables—which is a necessary but not sufficient condition for the Balassa-Samuelson effect. Many existing studies tend to use the relative price of non-tradables as dependent variable and include productivity growth differentials between tradables and non-tradables as regressors in a panel set-up of annual observations.[5] In our empirical strategy, we focus on the REER as dependent variable to identify the Balassa-Samuelson effect.

Second, empirical investigations of the Balassa-Samuelson effect frequently rely on labor productivity as a proxy for TFP because data on capital stock, essential for TFP estimation, is often unavailable. This overstates true differences in TFP, potentially resulting in a biased estimation of the Balassa-Samuelson effect. Instead, we use a measure of TFP derived from a Cobb-Douglas production function imposed on quarterly data.[6]

Finally, existing studies agree that the Balassa-Samuelson model mainly explains real exchange rate dynamics over very long-time horizons.[7] This motivates the unique approach used in this section, which relies on a cointegration framework to establish a long-run relationship between REER and TFP. To our knowledge, our study is the first to test the REER-TFP nexus in a cointegrating setting**.** This approach allows for a detailed assessment of both long- and short-term dynamics of the REER and is critical for a discussion of competitiveness in the Baltics at higher frequencies, particularly considering the recent economic downturn observed in the region.

3.2 Data and methodology

The analysis is based on quarterly data from 1995 to mid-2023. Estimates of TFP are obtained from a standard Cobb-Douglas production function using real GDP, labor, and capital data. The estimated TFP series is then plugged in a cointegrating equation with the REER to assess the Balassa-Samuelson hypothesis. In the process, estimates of the factors driving both actual and potential GDP in the Baltics are also provided.

We start by obtaining TFP as a Solow residual from a growth accounting exercise, using a standard Cobb-Douglas production function on quarterly data (Figure 3.1):[8]

$$ln\, a_t = ln\, y_t - (1-\alpha)\, ln\, k_t - \alpha\, ln\, l_t$$

where a_t, y_t, k_t, and l_t are the levels of TFP, real GDP, capital, and labor respectively. Components y_t and k_t are both measured in millions of constant 2015 euros, while l_t is in thousands of hours worked per quarter. The quarterly stock of capital is obtained by applying quarterly investment flows to annual stock data from the European Commission's Annual Macro-Economic Database (AMECO) and estimates of depreciation rates. The resulting series is then multiplied by a measure of industrial capacity utilization to get an estimate of the effective capital stock, k_t. The labor input is constructed by multiplying the number of employees (e_t) by the

[5] For example, De Gregorio et al. (1994), IMF (1999), and Mihaljek and Klau (2008) employ this approach, which is also known as the 'domestic' version of the Balassa-Samuelson hypothesis. This approach does not account for price equalization between the tradable and non-tradable sectors, nor for the relative factor intensities in production observed domestically versus abroad. For a non-exhaustive list, see BIS (2003).

[6] Since capital accumulation raises output while holding labor constant, measured output per worker also rises. The resulting bias—disconnecting the increase in productivity from exchange rate appreciation—is likely to be greater for relatively capital-intensive tradables goods than for non-tradables goods, as well as for countries with relatively higher endowments of capital.

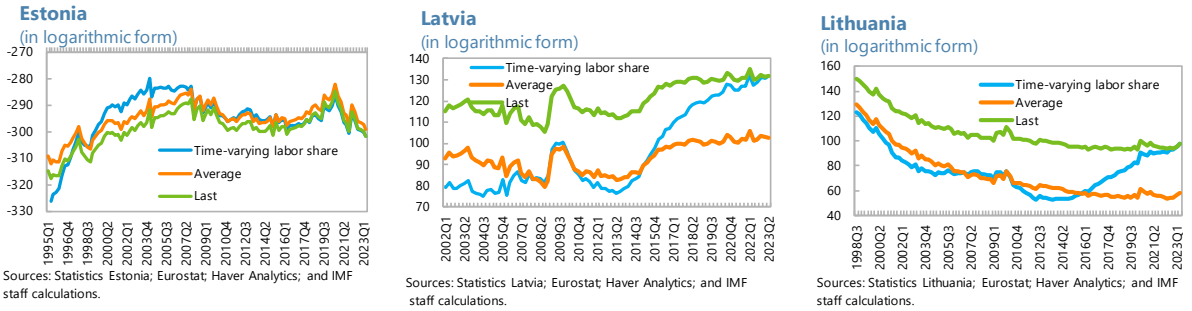
[7] For example, Chinn and Johnson (1996).

[8] OECD (2014).

average number of hours worked per employee (h_t). For the labor share, α_t, a smooth trend of the ratio of compensation of employes to GDP is used.[9]

Next, we estimate a cointegrating relationship between the estimated TFP and the REER. Rejection of the null hypothesis of no cointegration provides evidence for the Balassa-Samuelson effect. After confirming that both series are integrated,[10] Johansen cointegration tests find at least one cointegrating relationship between the two variables for different specifications regarding exogenous regressors in the cointegration vector and/or short-term dynamic equations.[11] Table AII.1 in Annex II provides evidence of the Balassa-Samuelson effect for all three Baltic countries, indicating a long-run relationship between TFP and REER. Therefore, cointegrating relationships between TFP and the REER can be estimated.[12]

Figure 3.1. Estimates of TFP



Sources: Statistics Estonia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Latvia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Lithuania; Eurostat; Haver Analytics; and IMF staff calculations.

Following this, we use the fitted values from the cointegrating regressions to construct measures of TFP-based REER, as the implied long-term relationship between the two series (Figure 3.2). The gap between actual and TFP-based REER indicate deviations from the Balassa-Samuelson hypothesis and can be seen as a measure of competitiveness in the Baltics. A negative gap between actual and TFP-based REER indicates an undervalued REER relative to its long-term norm, giving the country a competitive advantage, and vice versa.[13]

[9] While in Estonia, the labor share α_t is relatively stable and mean-reverting, it has increased markedly in both Latvia and Lithuania since around 2015. Therefore, in deriving TFP, we use a smooth, time-varying labor share for all three countries, instead of a fixed calibrated value (e.g., its historical average or the last observed value). This approach introduces an extra term in the decomposition of the drivers of GDP growth, i.e.:

$$(1 + g_t^y) = (1 + g_t^a) + (1 - \alpha_t)(1 + g_t^k) + \alpha_t(1 + g_t^l) + [\ln \alpha_t - \ln(1 - \alpha_t)]\Delta\alpha_t.$$

The last term in the above decomposition of the GDP growth rate (g^y)—which includes the growth rate of TFP (g^a), capital (g^k), and labor (g^l)—represents the effect of changes in the labor share $(\Delta\alpha_t)$. This effect on GDP is negative for $\alpha_t < 0.5$.

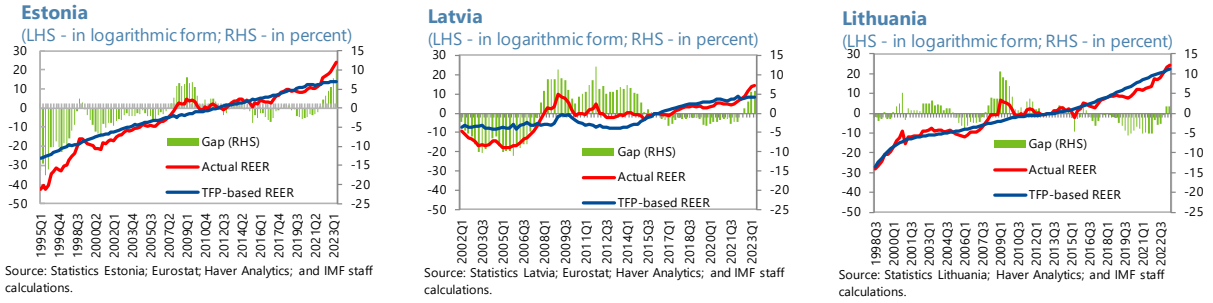
[10] Using Augmented Dickey-Fuller tests with a test specification that includes both a constant and a deterministic linear trend, with lags selected automatically based on Schwartz information criteria. Results available from the authors.

[11] For Latvia, no cointegrating relationship with TFP was found when using the actual REER series. The HP-trend of the REER series was used instead. See Annex II, Table AII.1.

[12] See Annex II, Table AII.2. In all cases, the Dynamic Ordinary Least Squares (DOLS) method is used, with automatic lead/lag selection based on the Schwartz Information Criterion. Several specifications regarding assumptions for trend and the inclusion of a lag of the (log) REER were tested. We selected the specification with the expected positive signal for the link between REER and TFP, considering the best in-sample fit measured by the R^2 coefficient.

[13] A somewhat related but different concept of notional REER is the value-added real effective exchange rate, which aggregates bilateral value-added price changes, proposed by Bems and Jonhson (2017).

Figure 3.2. Actual and TFP-Based REER in the Baltics, 1995-2023[1]



Source: Statistics Estonia; Eurostat; Haver Analytics; and IMF staff calculations.

Source: Statistics Latvia; Eurostat; Haver Analytics; and IMF staff calculations.

Source: Statistics Lithuania; Haver Analytics; and IMF staff calculations.

[1] Latvia: 2002Q2-2023Q2; Lithuania: 1998Q3-2023Q2.

3.3 Implications: Estonia and Latvia saw their earlier advantages eroding, while Lithuania gained a competitive edge over time

Prior to the GFC, both Estonia and Latvia experienced a prolonged period of negative REER gaps. During this time, the actual REER was consistently below the estimated TFP-based REER, resulting in an undervalued real exchange rate relative to its counterfactual TFP-based equilibrium. This provided a competitive edge in both countries. In Estonia, the negative REER gaps were largely driven by rapid TFP growth. In contrast, in Latvia a depreciating REER and a low TFP growth were at least initially contributing factors. In Lithuania, the estimated REER gap only turned negative in 2005-2007. As a result, both Estonia and Latvia benefitted from a competitive advantage during this period, while in Lithuania this effect was less noticeable.

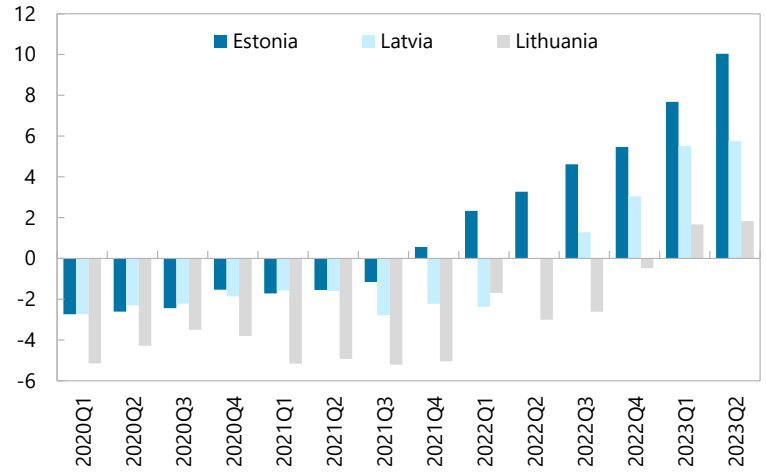
This competitive advantage, however, was significantly eroded after the GFC, reflecting a phase of declining TFP growth. Then, periods of negative REER gaps gave way to periods of positive gaps after 2008. Negative REER gaps became significantly smaller and shorter-lived, while positive gaps—led by slower TFP growth and an overvalued real exchange rate in the case of Latvia—were larger and more frequent relative to the previous period, indicating some erosion of competitiveness. In contrast, Lithuania saw its actual REER gradually falling below the estimated TFP-based REER, as its economy was becoming more competitive.

In recent years, a decoupling between actual and TFP-based REER has emerged for all Baltic countries, reflecting rapid real exchange rate appreciation. Declining TFP growth has driven REER gaps into positive territory for Latvia and even more so Estonia, as competitive pressures escalated. In contrast, stronger TFP growth and a more undervalued real exchange rate provided Lithuania with larger buffers to deal with the shock and retain export shares, consistently with the stylized facts laid out in the previous section.

Figure 3.3 zooms in the REER gaps in the post-pandemic period. A significant divergence between the actual and TFP-based REER emerged in late 2021 in Estonia, coinciding with the onset of the current downturn in that country. The REER gap turned positive as TFP deceleration turned into an outright decline and compounded with protracted real exchange rate appreciation. This analysis suggests that the overvalued real exchange rate has likely reduced Estonia's ability to absorb recent shocks, leading to a marked decline in export market shares and economic activity. The positive REER gaps materialized later for Latvia and especially Lithuania and were not as large as in Estonia. In other words, Estonia's competitive disadvantage has started earlier, has grown faster, and has become more pronounced than in Latvia and Lithuania. The

larger REER gap for Estonia is consistent with the country's difficulties in retaining export market shares and its growth underperformance relative to the other Baltics.

Figure 3.3. REER Gaps in the Baltics



Source: Statistical Authorities; Haver Analytics; and IMF staff calculations.

3.4 Disentangling cyclical and structural drivers of growth

To identify cyclical and structural components of TFP and other drivers of GDP growth in the Baltics, we construct estimates of potential GDP for the three countries. This is particularly important for the analysis of the post-pandemic period, when different TFP growth patterns across Baltic countries emerged. While the role of cyclical factors tends to average out to zero over extended periods, that is not the case over shorter periods of time. The adopted methodology combines the growth accounting described above with an estimate of potential GDP obtained through a multivariate Kalman filter.[14] Signals from high-frequency indicators of economic slack—monthly confidence indices (for consumer, industry, construction, and retail sectors), unemployment rate, and industrial capacity utilization—are combined with quarterly GDP in a state-space model to decompose cycle and trend in GDP data. The high-frequency signal variables help pin down the cyclical component of GDP and identify potential GDP ($\bar{y}_t$) as the unobserved trend.[15]

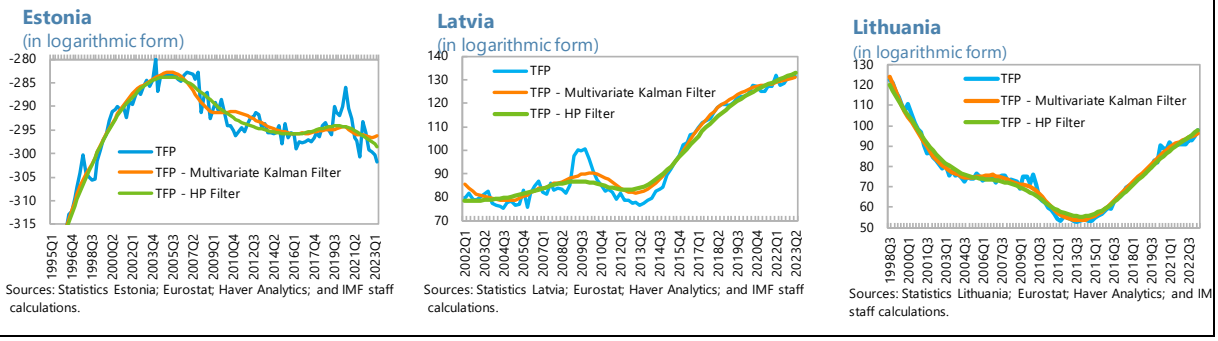
Structural (i.e., trend) TFP can be estimated through the same process described above. The production function used to estimate the TFP series from the unfiltered series of labor, capital, and real GDP can be applied to the corresponding filtered series (i.e., smooth trends). The trend TFP series, $\bar{a}_t$, is obtained from running the same equation for the HP-filter trends of effective capital ($\bar{k}_t$), employment ($\bar{e}_t$), and hours worked ($\bar{h}_t$). The decompositions of both actual and potential GDP help distinguish between cyclical and structural (i.e., low frequency) drivers of real GDP over the sample period. While the TFP series obtained from the unfiltered

[14] A similar approach is used by Fernald and Li (2021) for the United States, Bannister et al. (2020) for Australia and New Zealand, IMF (2013a and b) for Portugal and Brazil, IMF (2014) for South Africa, Anand et al. (2014) for Emerging Asia, and IMF (2018) for Bangladesh.

[15] See also Blagrave et al. (2015), Benes and N'Diaye (2004), and IMF (2017).

series of inputs and outputs captures the effects of both cyclical (short-term developments such as labor hoarding, short-term skills mismatch, etc.) and structural factors (i.e., low-frequency effects of institutions, business environment and practices, education, R&D, etc.), applying this methodology to the filtered series singles out just the structural factors. Figure 3.4 displays the unfiltered TFP series, and the structural TFP resulting from the multivariate filter approach. For comparison, the HP-trend of the estimated TFP series is also reported in the figure.

Figure 3.4. Estimates of Structural TFP



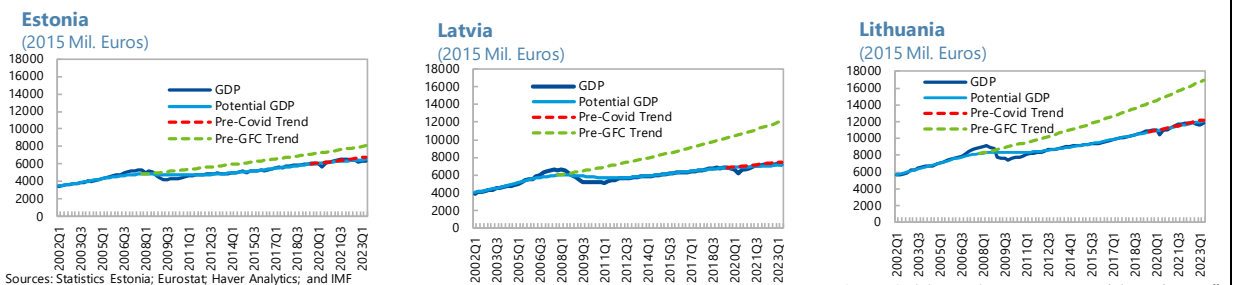
Sources: Statistics Estonia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Latvia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Lithuania; Eurostat; Haver Analytics; and IMF staff calculations.

In performing this exercise, we divide the sample into three subperiods: pre-GFC (i.e., 1995-2008), post-GFC (i.e., 2009-2019), and post-pandemic (i.e., 2020-2023Q2). Consistent with the stylized facts discussed in section 2 and the analysis of TFP-based REER developed earlier in this section, estimates of potential GDP suggest scarring effects for all the Baltics following the GFC along with a more pronounced impact of the recent external shocks on Estonia. Similar scarring effects, albeit less pronounced, also occurred after the pandemic (Figure 3.5).

Figure 3.5. Quarterly Real GDP



Sources: Statistics Estonia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Latvia; Eurostat; Haver Analytics; and IMF staff calculations.

Sources: Statistics Estonia; Eurostat; Haver Analytics; and IMF staff calculations.

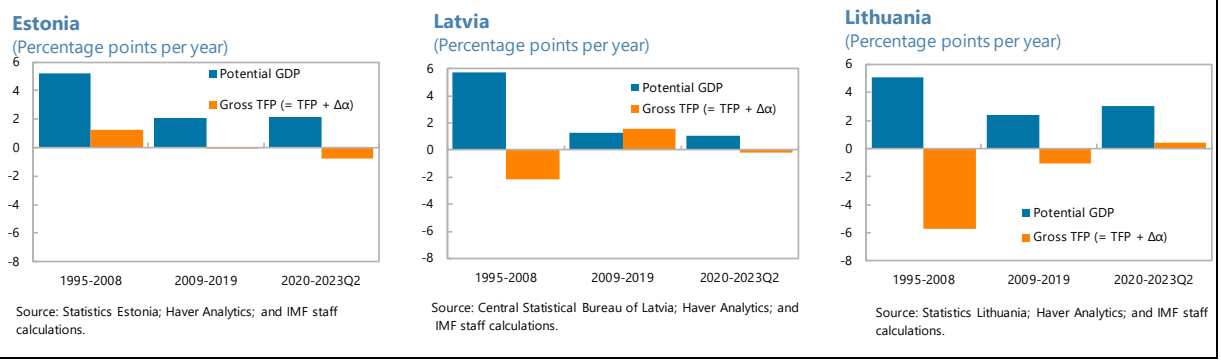
In addition, potential GDP growth has declined steadily in the Baltics since the GFC. Not only has the level of potential GDP not recovered to its pre-shock trend, but the growth rate of potential GDP has also declined across the Baltics after the GFC.[16] Figure 3.6 shows that potential growth fell from above 5 percent in the pre-

[16] The counterfactual constant-growth, pre-GFC trends in Figure 3.5 are merely illustrative and likely overestimate the sustainable long-run growth rate at the time, since growth slows down as countries converge to higher per capita income levels.

GFC period in all Baltic countries to around 1 percent in Latvia, 2 percent in Estonia, and between 2.5 and 3 percent in Lithuania post-GFC.

Figure 3.6 also shows that structural 'gross TFP' (GTFP) growth—defined as the combined contributions of TFP growth and the change in labor share (see footnote 8)—has diverged significantly across the three countries over time. While in Estonia GTFP growth has declined from above 1 percent pre-GFC to negative growth post-GFC, Lithuania experienced the opposite dynamics, with trend GTFP growth accelerating over time towards positive territory. Latvia's GTFP growth also accelerated after the GFC but has decelerated again in the post-pandemic period, becoming negative more recently. The different contributions of trend GTFP to potential GDP across the Baltics suggest that Estonia and (to a lesser extent) Latvia currently face structural productivity challenges while in Lithuania structural GTFP growth is mildly supporting potential GDP growth.[17]

Figure 3.6. Average Potential GDP and Structural TFP Growth



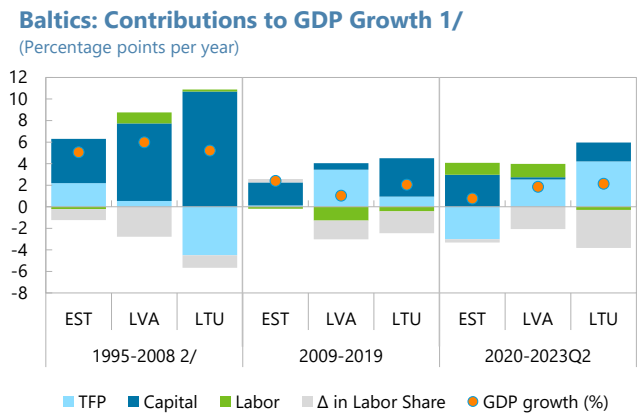
Source: Statistics Estonia; Haver Analytics; and IMF staff calculations.

Source: Central Statistical Bureau of Latvia; Haver Analytics; and IMF staff calculations.

Source: Statistics Lithuania; Haver Analytics; and IMF staff calculations.

Figure 3.7 displays a summary of the growth decomposition exercise on unfiltered GDP data across the three Baltic countries. Capital accumulation has largely driven the income convergence process. Prior to the GFC, all three countries experienced rapid GDP growth, mainly driven by capital accumulation. This is typical of a period of capital deepening and fast income convergence. Capital has remained a major driver of GDP growth for Estonia and Lithuania over the full sample, while in Latvia its contribution has significantly declined post-GFC. In contrast, the contribution of labor to GDP growth has been far more limited across the Baltics, acting as a

Figure 3.7. Contribution to GDP Growth in the Baltics



Source: IMF staff calculations.
1/ Growth rates calculated as difference in natural logarithims of original series.
2/ Latvia: 2002Q2-2008; Lithuania: 1998Q3-2008

[17] After accounting for the negative effects of the changing labor share in potential GDP growth (see footnote 8), structural TFP growth becomes significantly larger than potential GDP growth in the second and last subsamples for Latvia and Lithuania, respectively (see Figure 3.7 and Tables AII.3-5 in Annex II). For a given observed path of potential GDP growth, the changing labor share implies a larger offsetting effect on TFP, which is calculated as a residual. One possible interpretation is that the latter could be capturing TFP-enhancing effects of structural transformation towards more labor-intensive sectors.

drag on growth especially in the case of Latvia.[18]

As noted earlier, TFP has increasingly become a driver of growth for Latvia and especially Lithuania, while Estonia has experienced declining and eventually negative TFP growth. After providing a significant contribution to GDP growth in the pre-GFC period, Estonia's TFP growth has faded, accounting for most of the decline in GDP growth since the GFC. Unfavorable TFP dynamics are estimated to be at the root of Estonia's underperformance in the post-pandemic period, with the decline in average TFP growth in Estonia surpassing that of actual GDP growth and explaining almost 90 percent of the fall in potential GDP growth (Table 3.1).

Table 3.1. Changes in Average GDP Growth Rates Between 1995-2008 and 2020-2023Q2
(Percentage points per year)

	Estonia			Latvia			Lithuania		
	Total	Trend	Cyclical	Total	Trend	Cyclical	Total	Trend	Cyclical
GDP	-4.3	-3.1	-1.2	-4.1	-4.7	0.6	-3.1	-2.0	-1.0
TFP	-5.2	-2.7	-2.5	2.0	1.3	0.7	8.7	8.5	0.2
K	-1.1	-2.3	1.1	-7.0	-7.6	0.6	-8.9	-8.1	-0.9
L	1.3	1.3	0.1	0.2	0.9	-0.7	-0.5	-0.1	-0.4
Δα	0.7	0.7	0.0	0.7	0.7	0.0	-2.4	-2.3	0.0

Source: IMF staff estimates

While TFP, labor, and capital have all contributed positively to GDP growth during the recent downturn in Latvia (Figure 3.7), more favorable TFP dynamics has better shielded the Lithuanian economy from the negative impact of the recent external shocks. In sharp contrast to Estonia, Lithuania has experienced an acceleration in structural TFP growth since the GFC (Table 3.1) while capital accumulation decelerated but remains an important driver of growth (Figure 3.7), with its recent deceleration being a largely cyclical and reflecting declining capacity utilization (Table AII.5, Annex II).

3.5 A few key takeaways

This section has provided estimates of potential GDP, GDP growth decompositions, and TFP for the three Baltic countries. These estimates were used to assess the different drivers of actual and potential GDP growth in these countries over 1995-2023, and the nexus between real exchange rate and TFP as implied by the Balassa-Samuelson hypothesis. An estimated TFP-based REER was used to measure competitiveness in the Baltics.

Faced with common external shocks, the three Baltic countries experienced significant increases in prices relative to trading partners and rapid real exchange appreciation. However, long-term differences in TFP growth, resulting in notable differences in external competitiveness and GDP growth, likely affected each country's ability to absorb the common shocks.

[18] Annex II shows a detailed decomposition, distinguishing between cyclical and structural factors.

Potential GDP growth in the Baltics has fallen since the GFC, largely due to a steady decline in TFP growth, especially for Estonia. Some decline in potential GDP growth typically accompanies the process of income convergence, as capital accumulation decelerates. However, the largest contributor to the reduction in potential GDP growth for Estonia has been a decline in TFP growth. This decline has been significantly more pronounced in Estonia than in Latvia and, especially, Lithuania, which in contrast has experienced an acceleration in TFP growth in recent years.

Not only has TFP growth declined in Estonia since the GFC, but unlike Latvia and Lithuania, the level of TFP has dropped since 2020. This decline in TFP growth includes a structural component, likely linked to the scarring effects of recent shocks.

Differences in TFP dynamics across the Baltic countries have implications for competitiveness. Pre-GFC, fast TFP growth underpinned Estonia's competitive advantage, even at times of real exchange rate appreciation. In contrast, during that period, Latvia's competitiveness, and to a lesser extent, Lithuania's, were mainly driven by periods of depreciating REER amidst low TFP growth.

Post-GFC, decelerating TFP growth combined with protracted REER appreciation has eroded the Baltics' competitiveness, with a stronger erosion for Estonia. The latter faced the most pronounced decline in TFP growth among the Baltics. More recently, significant real exchange rate appreciation has compounded the effect of declining TFP, turning into a competitive disadvantage and leaving the country more vulnerable to recent shocks than the rest of the region.

This loss of competitiveness may be an important factor in Estonia's protracted economic downturn. In Estonia, a (positive) wedge between the actual and TFP-based REER has started earlier, has grown faster, and has become wider than in the other Baltics, affecting the country's competitive position to a greater extent than in Latvia and Lithuania.

4. The Role of Allocative Efficiency in Productivity Growth

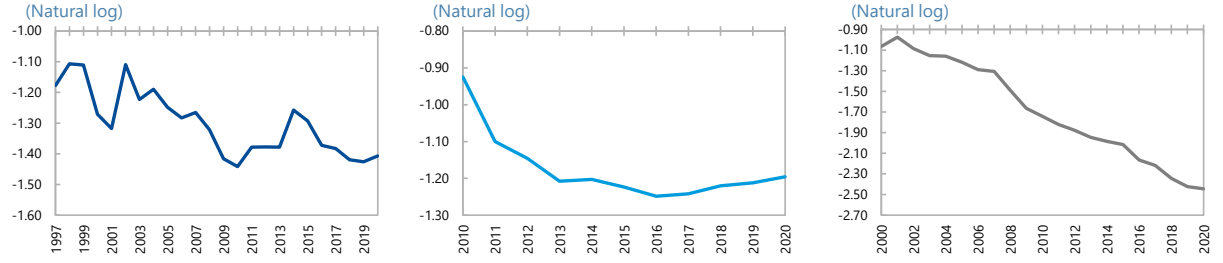
4.1 Allocative efficiency has declined in the Baltic region

Resource allocation is an important factor underpinning economic growth, as aggregate productivity growth depends on both within-firm growth and the efficiency of factor allocation across firms. In an ideal world, resources flow to where productivity is the highest until the marginal return of an input is equalized across firms and sectors. This section explores the role of allocative efficiency in promoting TFP growth and supporting competitiveness. Intuitively, allocative efficiency is measured as the wedge between TFP in an ideal case scenario and an alternative scenario with distortions in capital, labor, and output markets. It is reflected in the dispersion of marginal revenue products of capital and labor, which is the marginal revenue generated by one additional unit of these production factors. The analysis in this section finds that allocative efficiency has worsened generally in all three Baltic economies, and especially in Estonia and Lithuania over the past two

decades. In Estonia, there was a limited and short-lived recovery after the GFC. In Latvia, there was a mild recovery after 2016 (Figure 4.1).[19]

In most cases, resource misallocation started before the GFC.[20] In the years leading up to the financial crisis, most countries, including the three Baltic economies, experienced real estate bubbles characterized by rapidly rising property prices and speculative investment. Resources were disproportionately allocated to the construction and real estate sectors. This expansion led to excessive borrowing and investment in sectors with lower productivity or unsustainable projects, resulting in misallocation of resources, and thereby worsening allocative efficiency. Government policies such as subsidies, tax incentives, or regulatory frameworks may have also adversely influenced the allocation of resources in the economy.

Figure 4.1. Allocative Efficiency in the Baltics



Sources: Orbis; EUKLEMS; and IMF staff calculations. Sources: Orbis; EUKLEMS; and IMF staff calculations. Sources: Statistics Lithuania; EUKLEMS; and IMF staff calculations.

4.2 Methodology and data

Following Hsieh and Klenow (2009) and IMF (2024), allocative efficiency is measured based on the following assumptions: i) firms' production follows a Cobb-Douglas production function; ii) the aggregation of outputs features constant elasticity of substitution; iii) there are distortions in capital, labor, and output markets; and iv) firms maximize their profits under monopolistic competition.[21] In this framework, a firm's output price is set at a fixed markup over its marginal cost. The allocation of capital and labor depends not only on firm productivity, but also on existing distortions in capital, labor, and output markets. In an ideal world without distortions, TFP at the sector level is an aggregation of the technology component at the firm level. With distortions on factor and output markets, TFP is lower than in the ideal case. The difference between the two scenarios reflects the level of allocative efficiency. Specifically, for each unit decline in allocative efficiency, there is a corresponding one-unit decline in TFP growth (see Annex III for further details).

Data for Estonia and Latvia are from Orbis. For Lithuania, we rely on administrative data from Statistics Lithuania. Table 4.1 presents descriptive statistics for the firms in the sample. Table 4.2 shows the number of observations by year and points to severe data limitations for Latvia—where the sample coverage is much

[19] The unit for the vertical axis is the natural log of TFP. Each unit decline in allocative efficiency implies a one-unit decline in TFP growth rate.

[20] The Orbis dataset has very limited coverage for Latvian firms for the years before 2010. Therefore, we cannot estimate allocative efficiency for the years before the GFC in the case of Latvia.

[21] See Annex III for details on the methodology. For our calculation, we drop sectors such as education, health, and public administration because these sectors are not market oriented.

more limited both in terms of time and number of firms—, which should be born in mind when interpreting the results. We also acknowledge the fact that the Orbis data overrepresents big firms for both Estonia and Latvia.

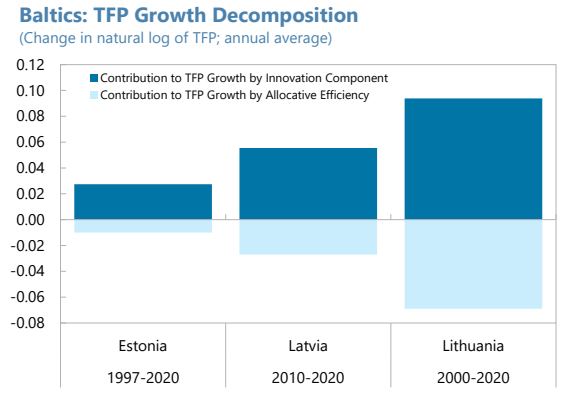
4.3 Decomposition of TFP growth

A decomposition exercise is useful in assessing the impact of efficiency on TFP growth using the following steps: First, aggregate the calculated allocative efficiency up to the sector level, then aggregate it to the country level. Second, decompose country-level TFP growth into innovation and allocative efficiency components of TFP growth. The two components are captured by the two terms on the right-hand side of Equation (1):

$$\Delta lnTFP_{ct} = \Delta \ln IN_{ct} + \Delta lnAE_{ct} \qquad (1)$$

The results show that deteriorating allocative efficiency, or increasing resource misallocation, has negatively affected TFP growth in all three Baltic economies during their respective sample periods (Figure 4.2).

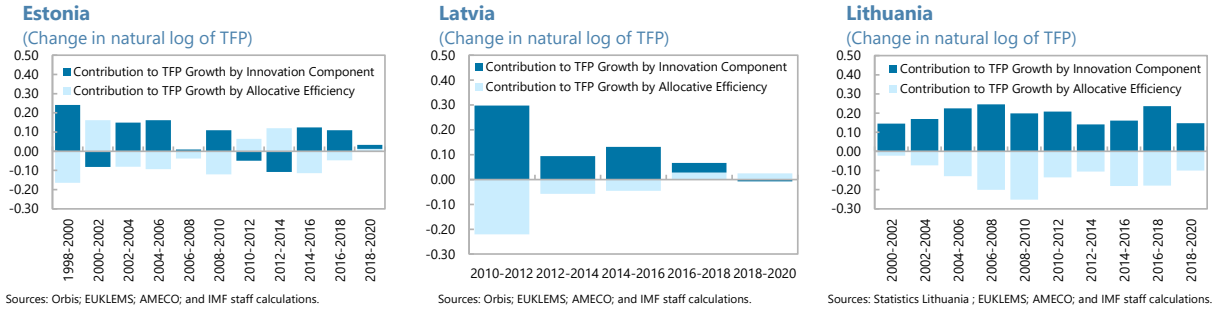
Figure 4.2 TFP Growth Decomposition



Sources: Orbis; Statistics Lithuania; EUKLEMS; AMECO; and IMF staff calculations.

The role of allocative efficiency has varied over time for the Baltic economies, especially before and after the GFC (Figure 4.3). The contribution of allocative efficiency to productivity growth in Estonia was largely negative before the GFC, turned positive during the post-crisis recovery period, but worsened again in recent years. In general, as unviable firms exit the market during economic crises, allocative efficiency tends to improve. In Latvia, the improvement in allocative efficiency during 2016-20 may have been driven by a combination of factors, including a market correction in asset prices, a reassessment of risk, structural reforms, an increased focus on efficiency by businesses, market discipline, and policy interventions that may have facilitated more efficient resource allocation. The results find a broadly consistent pattern in the role of allocative efficiency for the Baltic economies, which is in line with some previous empirical studies of productivity developments before and after the GFC (for instance, see Blanchard et al., 2013). In general, previous studies find negative contribution of allocative efficiency to productivity growth prior to the GFC and positive contribution during crisis recovery (Benkovskis 2015). However, in the case of Latvia, we find recovery in allocative efficiency only after 2016. This could be due to the use of Orbis data instead of business register data. We also note the difference in methodology. For instance, in contrast to Benkovskis (2015), we do not include negative-value-added firms in the sample.

Figure 4.3. TFP Growth Decomposition



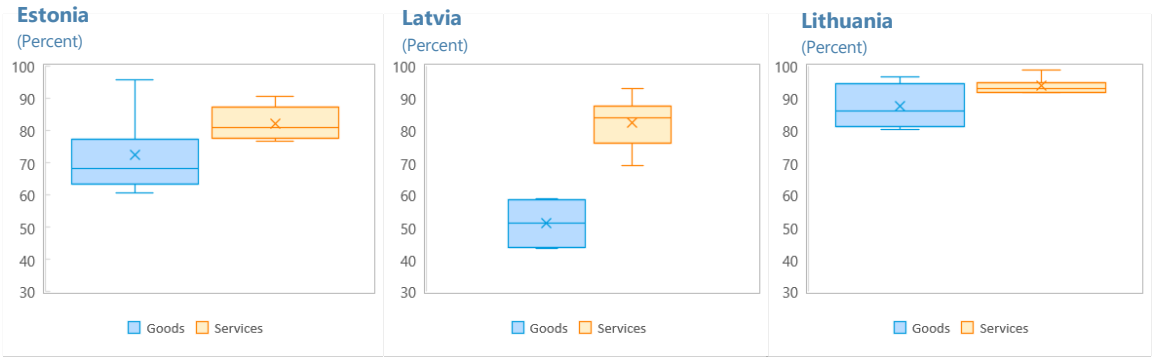
4.4 Heterogeneity in allocative efficiency across the Baltic economies

Productivity loss due to worsening allocative efficiency has been greater for the service sectors than for the goods sectors. The difference in TFP loss between goods and services sectors is about 10 percentage points for Estonia, 30 percentage points for Latvia, and 7 percentage points for Lithuania (Figure 4.4).[22] Services sectors generally tend to have more market frictions and barriers to competition compared to goods sectors.[23] There may be more product differentiation in services, and firms tend to have greater market power than those in goods sectors. Inefficiencies may also reflect regulatory hurdles, licensing requirements and entry barriers that restrict competition and impede resource reallocation. As a result, inefficient firms in services may persist for longer than in goods sectors. In addition, information and communication technology as well as professional services rely on highly skilled workers. Skill shortages in these sectors may have resulted in deteriorating allocative efficiency, leading to productivity losses and constraining growth. Certain services in the Baltic region such as telecommunications, energy and transport may have limited competition, leading to less efficient allocation of resources. The services sectors are typically more labor-intensive than the goods sectors. Labor market frictions in the Baltic economies such as skill mismatches can contribute to the deterioration of allocative efficiency. The gap between services and goods sectors seems more prominent for Latvia, though this may partly reflect the data limitations discussed above.

[22] The greater estimated productivity loss due to resource misallocation in Lithuania may reflect the fact that the administrative dataset used has greater coverage of small and micro enterprises.

[23] The productivity differential between goods and services may also reflect, at least in part, measurement problems, i.e. the fact that productivity is more difficult to measure in services than in goods.

Figure 4.4. TFP Loss Due to Misallocation by Sector Type



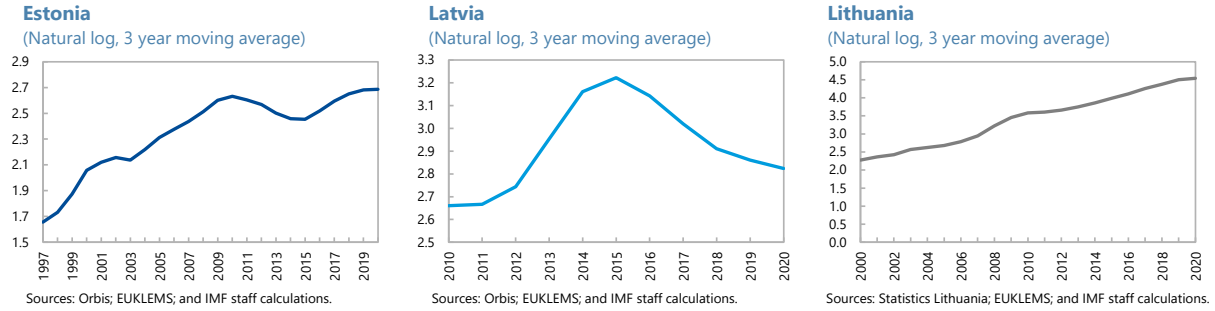
Sources: Orbis; Statistics Lithuania; and IMF staff calculations.
Note: The middle lines in the bars represent the median, the x the mean, the bars the interquartile range, and the whiskers the minimum and maximum values across samples in the group. The sample periods for each country are the following: Estonia (1997-2020), Latvia (2010-2020), and Lithuania (2000-2020).

The allocative efficiency as indicated by the dispersion of marginal revenue product of capital (MRPK) varies across the Baltic economies (Figure 4.5).[24] A proxy for resource misallocation in the capital market is the dispersion of marginal revenue product of capital (Hsieh and Klenow 2009). In an ideal world without any distortions, the MRPK is equal to the marginal cost of capital and equalizes across firms. With distortions, there is a dispersion in the MRPK. For instance, we can think of a hypothetical scenario with two otherwise identical firms: one has low productivity but easier subsidized access to credit, while the other has high productivity but must pay a higher premium on access to credit because of distortions in capital markets. If resources were allocated in an optimal manner, more capital would flow to the high productivity firm, such that the marginal revenue product of capital is equal to the marginal cost of capital. The extent to which the marginal revenue product of capital is dispersed is a measure of the severity of capital misallocation. Figure 7 indicates some improvement in allocative efficiency in terms of capital allocation in Latvia during 2016-20. In Estonia, the variance of MRPK declined after the GFC but went back up in more recent years during 2015-20. In Lithuania, the variance of MRPK increased over time generally throughout the sample period.[25]

[24] The dispersion in the marginal revenue product of capital reflects distortions in the capital market. It is one of the factors underlying overall resource misallocation.

[25] In contrast, we do not find evidence of an increase in the dispersion of the marginal revenue product of labor in Latvia, which is consistent with findings in the literature (for instance, see Benkovskis, 2018). For Estonia and Lithuania, the variance of MRPL declined during 2013-2020 and the post-GFC period, respectively.

Figure 4.5. Variance of Marginal Revenue Product of Capital (MRPK)



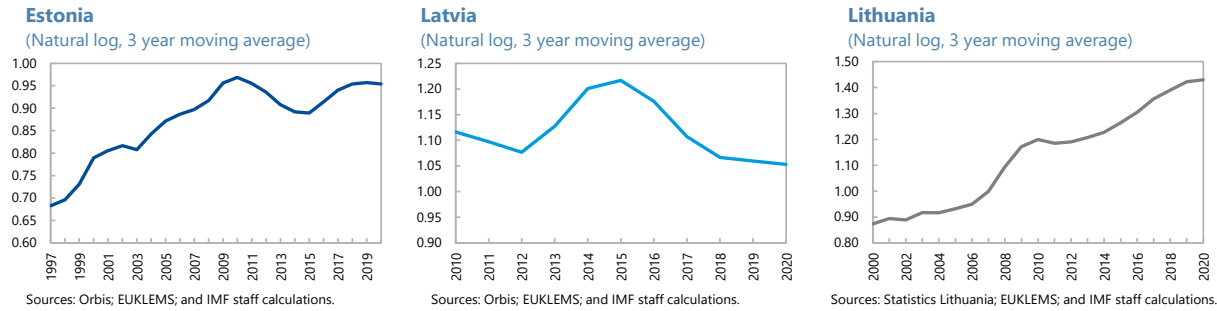
Sources: Orbis; EUKLEMS; and IMF staff calculations.

Sources: Orbis; EUKLEMS; and IMF staff calculations.

Sources: Statistics Lithuania; EUKLEMS; and IMF staff calculations.

The allocative efficiency as shown by the dispersion in revenue productivity also exhibits heterogeneity across the Baltic economies (Figure 4.6). The variance of revenue productivity across firms is also an indicator of resource misallocation, which reflects distortions in the output market. Unproductive firms may coexist with productive firms if the economy is not sufficiently dynamic and if resources are not guided by strong market discipline (Decker et al 2017). A wide dispersion in productivity levels among firms or sectors within an economy suggests that capital, labor, and technology are not being allocated in an optimal manner. Some firms may be operating at significantly higher levels of productivity than others, indicating that resources are misallocated towards lower-productivity firms. Such dispersion may be due to market distortions, such as barriers to entry, imperfect competition, information asymmetry, or government intervention. A wide dispersion in firm-level productivity implies a potential for improvement in resource allocation. Figure 4.6 suggests that allocative efficiency in Latvia improved in terms of the equalization of productivity across firms in the more recent years of 2016-20. In contrast, allocative efficiency worsened over time in Estonia and Lithuania, despite a limited recovery in Estonia during the post-GFC period of 2010-15.

Figure 4.6. Variance of Total Factor Productivity of Revenue (TFPR)



Sources: Orbis; EUKLEMS; and IMF staff calculations.

Sources: Orbis; EUKLEMS; and IMF staff calculations.

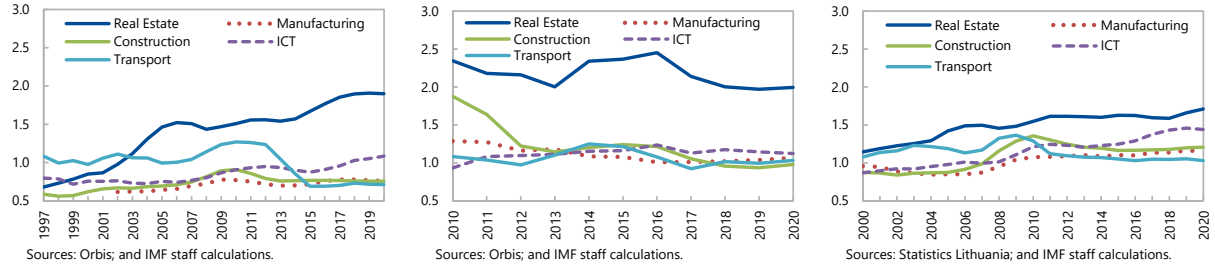
Sources: Statistics Lithuania; EUKLEMS; and IMF staff calculations.

Likewise, the evolution of allocative efficiency as reflected by the dispersion in TFPR by sector varies across the Baltic economies. Allocative efficiency in the real estate sector worsened over time in Estonia and Lithuania but improved slightly in Latvia during 2016-20 (Figure 4.7). In the construction sector, we observe a similar pattern for Estonia and Lithuania, where there is a deterioration in allocative efficiency before the GFC, and a recovery in the post-GFC period of 2010-20. In contrast, in Latvia, we observe an improvement during 2010-20. In industries with limited competition and higher barriers to entry, firms may face less pressure to improve productivity or innovate. And with less competition, inefficient firms may survive along with more productive firms, leading to wider dispersion in productivity. Industries such as construction, real estate, and transport tend to involve heterogeneous resources and assets. In the case of real estate, factors such as location, property

quality, and market demand can vary significantly and lead to dispersion in productivity among firms. Rapid increases in real estate prices driven by speculation rather than fundamental demand can lead to misallocation of resources. Restrictive zoning laws and regulations may limit firms' ability to respond quickly to changes in demand, causing delays in new construction, which reduces the efficiency of resource allocation. The picture on the other sectors such as transport, manufacturing and ICT also seems mixed with variation across the Baltic economies. However, it is worth noting that allocative efficiency moderately improved in the transport sector in Estonia and Lithuania after the GFC.

However, there are some caveats to the abovementioned findings at the sector level, due to measurement problems. For instance, multinational companies play a prominent role in the Baltic region. The value added of Baltic subsidiaries of global companies may be underestimated because of transfer pricing. Under such circumstances, the measured dispersion of TFP is higher and the calculated potential loss of TFP for Baltic firms due to worsening allocative efficiency may be overestimated. Another issue is that the investment in research and development by Baltic subsidiaries may be registered within the parent companies overseas. As a result, the total factor productivity of Baltic subsidiaries may be overestimated. This bias would also lead to an overestimation of the potential TFP loss due to deteriorating allocative efficiency. For example, Benkovskis (2018) offers a detailed discussion of the potential bias in the estimation of allocative efficiency due to the product fragmentation among firms. The study finds that resource misallocation is overestimated for industries where a great proportion of firms are re-exporters.

Figure 4.7. Variance of TFPR across Firms by Sector

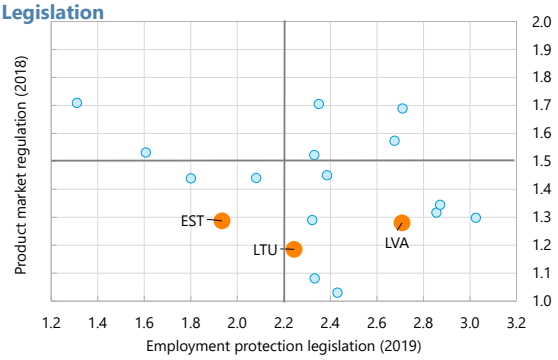


4.5 Exploring the relationship between allocative efficiency and regulation

The Baltic economies have relatively light product market regulation as compared to other advanced economies, with variation in labor market regulation. Latvia has more stringent labor market regulation, as compared to the rest of the Baltic economies and other advanced economies (Figure 4.7). According to the OECD Employment Protection Legislation indicator, Latvia has relatively strict employment protection in terms of higher severance pay for low tenure employees, stricter definitions of unfair dismissal including the exclusion of non-performance related reasons, and generous availability for re-instatement after an employee's dismissal. It is more costly to dismiss an individual worker under a regular contract in Latvia than other OECD economies.

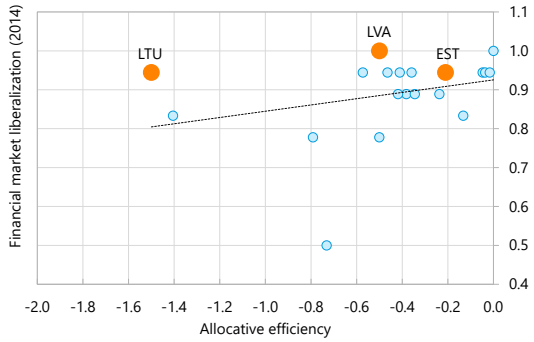
Figure 4.8. Regulation and Allocative Efficiency

Product Market Regulation and Employment Protection Legislation



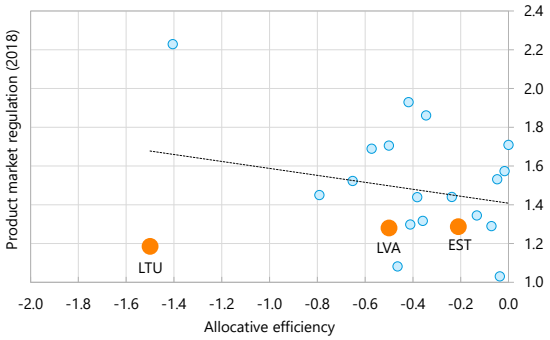
Source: OECD.

Allocative Efficiency and Financial Market Liberalization



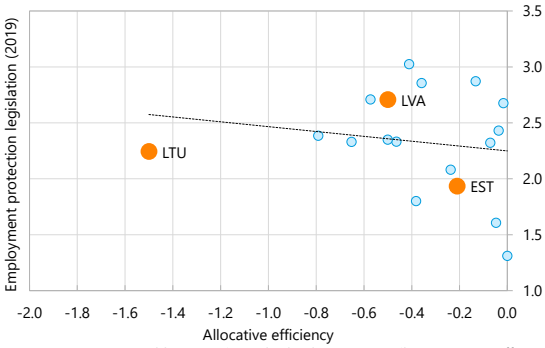
Sources: IMF structural reforms dataset; IMF World Economic Outlook, Chapter 3 (April 2024); IMF staff estimations.

Allocative Efficiency and Product Market Regulation



Sources: OECD; IMF World Economic Outlook, Chapter 3 (April 2024); IMF staff estimations.

Allocative Efficiency and Employment Protection Legislation



Sources: OECD; IMF World Economic Outlook, Chapter 3 (April 2024); IMF staff estimations.

Note: The calculated allocative efficiency values are standardized using the USA as the bechmark. Lithuania is an outlier, as we use administrative data for Lithuania, which represents small and micro firms to a greater extent.

Structural reforms may help improve allocative efficiency, support productivity growth, and retain competitiveness for the Baltic economies. Less regulation in product market and more liberalization in financial and labor markets are generally associated with better allocative efficiency (IMF, 2024). Indicators of product market regulation and financial market liberalization place Baltic economies in a favorable position compared to other advanced and emerging market economies (Figures 4.8). However, previous studies suggest that distortions in the capital market hampered productivity growth of firms in Latvia and Lithuania (Benkovskis, 2015; Foda et al, 2024). Indeed, one could be concerned over the tight credit conditions and limited access to finance by small firms. When it comes to labor market liberalization, evidence from the IMF structural reforms and OECD employment protection legislation datasets suggests some room for improvement (Figure 4.8). Labor market measures protecting jobs in economic downturns may come at the cost of labor market flexibility. For instance, recent research on Estonia suggests that government programs such as job retention schemes in response to the pandemic may have hampered efficient labor allocation and led to productivity losses (Meriküll and Paulus, 2024).

4.6 Key takeaways

In summary, resource misallocation has negatively affected total factor productivity growth in all three Baltic economies on average throughout the sample periods. In Estonia, allocative efficiency worsened generally over time, despite a limited and short-lived recovery after the global financial crisis (GFC). In the case of Latvia,

allocative efficiency has slightly improved after 2016, but the recovery has been limited. Productivity loss due to resource misallocation is more pronounced for services than for goods sectors. In Estonia, in industries such as real estate, allocative efficiency deteriorated in the years leading up to the GFC. For some Latvian industries such as real estate and transport, allocative efficiency worsened more significantly during the early period of 2012-2015. In the case of Lithuania, resource misallocation has generally worsened over time. Structural reforms in product, capital, and labor markets can help improve allocative efficiency, and therefore promote productivity growth and enhance competitiveness for the Baltic economies.

Table 4.1. Descriptive Statistics of the Firm-Level Dataset in 2020

	Estonia				Latvia				Lithuania				Total			
	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median
Number of firms	21,417				2,342				39,310				63,069			
Number of employees	1	2,900	8	3	1	1,936	11	3	1	12,448	20	6	1	12,448	16	5
Value added (real)	254	132,026,320	403,983	84,794	99	327,708,576	740,225	51,865	375	565,572,864	720,838	143,519	99	565,572,864	613,960	115,814
Capital (real)	13	1,104,034,176	500,919	24,008	19	2,396,316,416	2,909,459	26,143	1	1,447,295,360	769,084	25,337	1	2,396,316,416	757,501	24,871
Labor costs (real)	26	53,476,432	179,551	31,468	4	63,504,840	192,305	14,922	4,376	124,939,888	268,132	47,606	4	124,939,888	235,236	40,250
Fixed assets (nominal)	29	1,489,453,184	906,524	35,340	17	2,832,126,720	3,344,534	24,873	1	1,610,169,344	632,402	24,813	1	2,832,126,720	826,200	27,989
Sales (nominal)	0	642,218,368	1,442,235	204,388	1,517,922	233,755,056	117,625,649	117,603,968	6	1,689,164,032	2,224,878	254,339	0	1,689,164,032	1,954,623	235,236
Firm age	1	119	13	12	1	30	15	14	2	32	14	12	1	119	14	12

	Estonia															
	Micro (0-9)				Small (10-49)				Medium (50-249)				Large (250+)			
	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median
Number of firms	17,226				2,768				364				1,059			
Number of employees	1	9	3	2	10	49	19	16	50	249	97	81	256	2,900	665	427
Value added (real)	690	10,225,642	120,926	68,509	6,013	20,921,492	842,611	563,400	66,088	98,424,600	4,733,914	3,558,014	254	132,026,320	2,373,500	32,958
Capital (real)	13	10,560,667	89,071	18,293	337	59,193,528	721,221	148,537	1,012	1,004,110,464	6,352,005	1,453,743	63	1,104,034,176	4,613,206	15,753
Labor costs (real)	26	1,046,157	44,229	24,928	2,869	2,626,634	408,670	305,372	19,185	12,112,608	2,370,713	1,932,500	41	53,476,432	1,028,722	4,831
Fixed assets (nominal)	29	53,988,468	172,825	26,288	405	238,168,720	1,114,198	222,688	1,214	1,205,130,496	9,679,733	2,134,857	76	1,489,453,184	9,282,728	26,432
Sales (nominal)	0	29,685,102	376,552	161,514	0	124,736,952	2,888,221	1,415,897	199,780	354,669,728	17,514,255	9,969,563	0	642,218,368	9,484,331	76,251
Firm age	1	88	13	11	1	108	17	17	2	119	22	22	1	114	14	11

	Latvia															
	Micro (0-9)				Small (10-49)				Medium (50-249)				Large (250+)			
	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median
Number of firms	1,991				268				33				50			
Number of employees	1	9	3	2	10	49	18	15	50	228	81	75	252	1,936	689	515
Value added (real)	99	3,660,516	91,696	40,305	9,690	13,043,975	677,123	315,358	673,998	45,235,436	5,281,787	2,719,094	2,970	327,708,576	23,905,438	83,884
Capital (real)	19	7,757,013	206,843	19,407	345	84,149,280	1,178,316	139,153	41,775	33,417,588	4,834,881	1,023,621	274	2,396,316,416	118,535,771	288,132
Labor costs (real)	4	470,312	20,814	12,550	6,344	1,539,835	202,044	130,432	479,024	6,702,701	1,569,422	1,092,468	7	63,504,840	6,059,975	1,570
Fixed assets (nominal)	17	7,011,798	190,692	18,312	312	83,820,152	1,180,991	131,048	37,762	30,207,168	5,313,280	1,070,523	248	2,832,126,720	139,227,736	260,451
Sales (nominal)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	117,603,968	233,755,056	175,679,512	175,679,512
Firm age	1	30	15	13	1	30	17	18	5	30	23	27	1	30	22	27

	Lithuania															
	Micro (0-9)				Small (10-49)				Medium (50-249)				Large (250+)			
	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum	Mean	Median
Number of firms	26,539				10,255				2,122				394			
Number of employees	1	9	4	4	10	49	20	17	50	249	100	82	251	12,448	647	418
Value added (real)	375	12,691,636	143,095	82,749	1,465	27,186,946	732,172	468,166	44,542	147,294,064	3,709,423	2,532,105	934,978	565,572,864	23,245,504	12,774,640
Capital (real)	1	172,109,664	189,669	13,281	1	309,000,032	596,794	78,964	141	547,576,384	3,433,666	772,911	1,679	1,447,295,360	29,930,667	5,644,685
Labor costs (real)	4,376	866,721	39,039	27,653	5,117	4,387,157	254,796	181,048	132,242	9,346,648	1,515,251	1,188,186	739,215	124,939,888	9,329,737	6,257,431
Fixed assets (nominal)	1	195,852,560	159,020	13,286	1	352,456,608	446,453	74,436	2	615,999,808	2,849,067	629,228	911	1,610,169,344	25,419,793	4,026,424
Sales (nominal)	6	75,239,544	415,943	136,432	84	441,529,696	2,204,196	814,597	55,857	479,098,592	11,255,161	5,535,391	1,091,714	1,689,164,032	75,974,045	29,706,402
Firm age	2	32	13	11	3	32	16	15	4	32	15	13	3	30	22	28

Sources: Orbis; Statistics Lithuania; and IMF staff calculations.

Note: For Estonia and Latvia, the data source is Orbis which reports financial variables in USD. For Lithuania, the data source is Statistics Lithuania which reports financial variables in EUR.

Table 4.2. Number of Observations

	Estonia	Latvia	Lithuania	*Total*
1997	2,088	0	0	*2,088*
1998	3,223	0	0	*3,223*
1999	4,695	0	0	*4,695*
2000	5,394	0	15,015	*20,409*
2001	5,926	0	12,061	*17,987*
2002	8,649	0	16,530	*25,179*
2003	9,421	0	16,906	*26,327*
2004	10,352	0	18,486	*28,838*
2005	11,103	0	20,605	*31,708*
2006	12,401	0	23,235	*35,636*
2007	13,873	0	26,487	*40,360*
2008	14,453	0	28,135	*42,588*
2009	13,876	0	25,751	*39,627*
2010	15,836	1,438	25,372	*42,646*
2011	17,869	1,567	27,027	*46,463*
2012	19,094	1,689	28,815	*49,598*
2013	20,108	1,796	30,749	*52,653*
2014	23,286	1,831	32,084	*57,201*
2015	24,544	2,370	33,767	*60,681*
2016	22,998	2,467	35,174	*60,639*
2017	22,903	2,406	36,243	*61,552*
2018	23,621	2,381	37,345	*63,347*
2019	23,999	2,373	39,029	*65,401*
2020	21,417	2,342	39,310	*63,069*
Total	*351,129*	*22,660*	*568,126*	*941,915*

Sources: Orbis, Statistics Lithuania; and IMF staff calculations.

5. Conclusions

Russia’s war in Ukraine has triggered supply-side disruptions and inflationary pressures that have affected competitiveness and productivity across Estonia, Latvia, and Lithuania, amplifying pre-existing challenges in the region. While inflation has eased, persistent increases in prices, wages, and input costs have weakened the region's competitive position relative to the euro area. The ability of each country to absorb these common shocks has varied significantly, with Estonia experiencing a prolonged recession and more pronounced decline in competitiveness, particularly in export markets. This contrasts with the shallower slowdown and more modest competitiveness losses seen in Latvia and Lithuania, which have been better able to shield their export shares.

This paper has reviewed a range of structural factors—declining productivity growth, real exchange rate appreciation, differences in production structure and export composition, corporate balance sheet strength, and allocative efficiency—that could explain these divergent outcomes.

Using multivariate filtering techniques, the paper has assessed the alignment of the real effective exchange rate with an equilibrium value consistent with historical productivity trends, as suggested by the Balassa-Samuelson hypothesis.

The findings highlight that differences in long-term productivity growth, especially related to TFP dynamics, have had significant implications for external competitiveness in the region. Estonia's post-GFC slowdown in TFP growth, alongside real exchange rate appreciation, has eroded its competitive edge, contributing to its current economic struggles. In contrast, Latvia and Lithuania have shown greater resilience, benefiting from less severe declines in productivity, a more balanced REER entering the crisis, and, in the case of Lithuania, stronger corporate balance sheets.

Looking into the root causes of these developments, a micro-econometric analysis using firm-level data points to resource misallocation as a key factor behind declining productivity in all three countries, with the services sector being particularly affected.

Addressing these structural challenges will require targeted reforms in product, capital, and labor markets to improve allocative efficiency and, in turn, support productivity growth and restore competitiveness. Future research, particularly using firm-level data, could provide deeper insights into the drivers of declining productivity in the Baltics and inform policies aimed at reversing these trends.

Annex I. The Constant Share Analysis Decomposition

To illustrate the constant share analysis decomposition, let us consider the special case of an economy, *r*, that exports one product to one partner economy, *p*. Let total exports of the economy be X_r and total world exports be X_W. Then the economy's share of world exports is X_r/X_W. Letting X_{Wp} be world exports to country *p*, *r*'s export market share can be rewritten as:

$$\frac{X_r}{X_W} = \frac{X_r}{X_{Wp}} \frac{X_{Wp}}{X_W}$$

This formula implies that the country's export share can be expressed as the product of the country's share of world exports to country *p* multiplied by the share of *p* in world exports.

Now, let: $\theta_r = X_r/X_W$, $\theta_{rp} = X_r/X_{Wp}$, and $\delta_p = X_{Wp}/X_W$.

Then, substituting, the expression becomes: $\theta_r = \theta_{rp} \times \delta_p$.

Let the change between any two periods be denoted by Δ, so $\Delta\theta_r$ is the change in the export share, and so on. Then, it must be the case that:[a]

$$\Delta\theta_r = \Delta\theta_{rp}\delta_p^0 + \Delta\delta_p\theta_{rp}^0 + \Delta\theta_{rp}\Delta\delta_p$$

where the shares δ and θ are evaluated at their initial values. This is the simplest version of the export market share growth decomposition.

The economy in this simple example can increase its export market share by getting a larger share of its partner market, by having the partner market grow overall, or both. The decomposition allows us to disentangle these effects.

The expression shows that it is possible to decompose the change in the export market share into three components:

- the first term is the effect on the share of expanding into in the partner market, holding the size of the partner constant. This intensive margin, or competitiveness effect, measures the portion of the change of *r*'s export share that is attributable to a higher penetration of *r*'s exports in the destination market, holding the size of the destination market constant; that is, it approximates the gains in r's export share that are attributable to competitiveness gains;

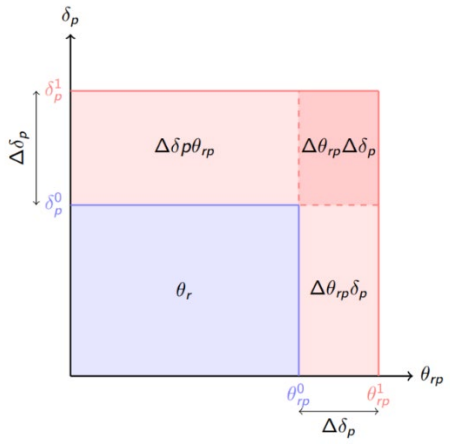
[a] To show this, let $z = xy$, then: $\Delta z = xy - x_0y_0$. Adding and subtracting xy_0: $\Delta z = xy + xy_0 - xy_0 - x_0y_0 = x\Delta y + y_0\Delta x$. Further adding and subtracting $x_0\Delta y$ yields: $\Delta z = x\Delta y + x_0\Delta y - x_0\Delta y + y_0\Delta x$. Factoring and rearranging yields: $\Delta z = x_0\Delta y + y_0\Delta x + \Delta x\Delta y$.

- the second term is the effect of the growth in the size of the export partner, holding relative penetration constant. This extensive margin, or composition effect, measures the portion of the change of r's export share that is attributable to the change in the size of the destination market. By weighting the change in the size of an export destination market in world trade by the average share of r's exports to that particular export destination, we are able to approximate what would have happened to the overall share if r's share had remained constant and only the size of the export market had changed;
- the third term is the interaction of the two effects above.

Gilbert (2017) provides an intuitive geometric exposition of the CSA breakdown (Figure AI.1). A detailed description of the methodology and an example of how it is applied to measuring competitiveness is provided in di Mauro et al. (2005). Although the methodology is beset by several well-documented theoretical problems, it remains informative for our purposes.[b]

The formula can be generalized to more than a single export destination. It can also be extended to a detailed breakdown of export categories and goods. As we are mainly interested in the geographical dimension, in this paper we consider the CSA decomposition for Estonia, Latvia, and Lithuania exports as a whole by destination country, using detailed IMF Direction of Trace statistics.

Figure AI.1. CSA Decomposition



[b] Among the limitations, CSA assumes that the market structure remains unchanged over the analyzed period, ignoring the effects of technological advancements, changes in consumer preferences, and regulatory changes. It focuses on changes in market share attributable to internal factors such as price competitiveness and product quality, but it does not account for external factors, such as global economic conditions, exchange rate changes, and competitor actions. It assumes that products within the market are homogeneous, ignoring product differentiation, which can impact market share independently of price or volume changes. Finally, CSA provides information on changes in market share but does not offer insights into the underlying causes of those changes. Disentangling the effects of different factors influencing market dynamics requires additional analytical techniques or qualitative research. For a comprehensive discussion of these, and other, limitations of CSA, see Richardson, J.D. (1971), Constant-Market-Shares Analysis of Export Growth, *Journal of International Economics* 1, no. 2 (May), pp. 227-39.

Annex II. Additional Estimation Material

Table 1. Johansen Cointegration Tests

Rank selection by Test and Deterministic Case

Country	Sample	No. of Observations	Endogenous Variables	Test Type	Deterministic Case - No. of Cointegrating Vectors						
					Case 1	Case 2	Case 3 JHJ	Case 4 JHJ	Case 4	Case 5 JHJ	Case 5
Estonia	1995Q4-2023Q2	111	ln (TFP)	Trace	1	1	1	1	1	2	2
			ln (REER)	Max-Eigen	1	1	1	1	1	2	2
Latvia	2002Q4-2023Q2	83	ln (TFP)	Trace	1	1	1	1	1	2	2
			ln (REER-HP)	Max-Eigen	1	1	1	1	1	2	2
Lithuania	1999Q2-2023Q2	97	ln (TFP)	Trace	2	1	1	2	2	2	2
			ln (REER)	Max-Eigen	2	1	1	2	2	0	0

Note: Rank selected at 0.05 level using critical values from MacKinnon-Haug-Michelis (1999)

Remarks: *Case 1*: No deterministic terms; *Case 2*: Cointegrating relationship includes a constant; *Case 3* (Johansen-Hendry-Juselius): Cointegrating relationship includes a constant. Short-run dynamics include a constant; *Case 3*: Short-run dynamics include a constant; *Case 4* (Johansen-Hendry-Juselius): Cointegrating relationship includes a constant and trend. Short-run dynamics include a constant; *Case 4:* Cointegrating relationship includes a trend. Short-run dynamics include a constant; *Case 5* (Johansen-Hendry-Juselius): Both the cointegrating relationship and short-run dynamics include a constant and trend; *Case 5*: Short-run dynamics include a constant and trend.

Source: IMF staff estimates

Table AII.2. Cointegration Between REER and TFP

	Estonia	Latvia	Lithuania
Dependent variable	Ln (REER)	Ln (REER)	Ln (REER)
Method	DOLS	DOLS	DOLS
Sample (adjusted)	1996Q4-2023Q2	2002Q2-2023Q2	1998Q4-2023Q2
Observations (adjusted)	107	85	99
Cointegrating equation deterministic factors	C, @TREND	C	C, @TREND, Ln (REER-1)
Automatic Leads	0	11	0
Automatic Lags	6	1	0
Criterion	SIC	SIC	SIC
Variables			
Ln (TFP)			
Coefficient	0.47	0.30	0.03
Std. Error	0.10	0.07	0.01
t-Statistic	4.77	4.46	2.49
Prob.	0.00	0.00	0.01
C			
Coefficient	117.87	-30.85	-4.93
Std. Error	29.79	6.56	1.49
t-Statistic	3.96	-4.70	-3.31
Prob.	0.00	0.00	0.00
@ TREND			
Coefficient	0.32		0.05
Std. Error	0.02		0.02
t-Statistic	18.80		2.87
Prob.	0.00		0.01
Ln (REER-1)			0.88
Coefficient			0.05
Std. Error			18.55
t-Statistic			0.00
Prob.			
R-squared	0.96	0.48	0.98
Adjusted R-squared	0.96	0.47	0.98
S.E. of regression	2.48	6.04	1.59
Long-run variance	18.70	136.26	2.69
Mean dependent var	-3.06	-1.97	-0.87
S.D. dependent var	12.45	8.30	10.37
Sum squared resid	595.72	2989.53	236.88

Source: IMF staff estimates.

Table AII.3. Estonia: Decomposition of GDP Growth
(Percentage points)

	1995-2008			2009-2019			2020-2023Q2		
	Total	Structural	Cyclical	Total	Structural	Cyclical	Total	Structural	Cyclical
TFP	30.7	32.2	-1.6	1.4	-3.6	5.0	-10.5	-1.6	-9.0
Capital	57.6	60.2	-2.6	23.5	23.1	0.4	10.4	7.0	3.3
Capital accumulation	47.9	47.9	n.a	20.8	20.8	n.a	8.4	8.4	n.a
Capacity utiization	9.7	12.3	-2.6	2.7	2.3	0.4	2.0	-1.4	3.3
Labor	-3.1	-5.2	2.1	-2.0	-0.1	-1.8	3.9	3.1	0.8
Labor force	-0.3	-1.6	1.2	0.3	1.6	-1.4	2.8	2.2	0.6
(-) Unemployment	0.8	0.2	0.6	1.6	1.5	0.1	-1.0	-0.3	-0.7
Hours-worked	-3.6	-3.8	0.2	-3.9	-3.3	-0.6	2.1	1.2	0.8
Δ Labor Share	-14.2	-14.2	0.0	3.5	3.4	0.1	-1.1	-1.1	0.0
GDP	70.9	73.0	-2.1	26.4	22.7	3.6	2.7	7.5	-4.8
Average Annual Growth									
GDP	5.1	5.2	-0.1	2.4	2.1	0.3	0.8	2.2	-1.4
TFP	2.2	2.3	-0.1	0.1	-0.3	0.5	-3.0	-0.4	-2.6
Gross TFP (= TFP + Δα)	1.2	1.3	-0.1	0.4	0.0	0.5	-3.3	-0.7	-2.6
Capital	4.1	4.3	-0.2	2.1	2.1	0.0	3.0	2.0	1.0
Labor	-0.2	-0.4	0.1	-0.2	0.0	-0.2	1.1	0.9	0.2
Δ Labor Share	-1.0	-1.0	0.0	0.3	0.3	0.0	-0.3	-0.3	0.0

Source: IMF staff estimates
Note: growth rates calculated as difference in natural logarithms of original series.

Table AII.4. Latvia: Decomposition of GDP Growth
(Percentage points)

	1998Q3-2008			2009-2019			2020-2023Q2		
	Total	Structural	Cyclical	Total	Structural	Cyclical	Total	Structural	Cyclical
TFP	3.5	4.0	-0.5	37.9	36.6	1.3	8.8	6.6	2.2
Capital	46.8	51.3	-4.5	6.6	3.6	3.0	0.7	1.0	-0.3
Capital accumulation	52.2	52.2	n.a	-4.0	-4.0	n.a	1.5	1.5	n.a
Capacity utiization	-5.4	-0.9	-4.5	10.6	7.6	3.0	-0.7	-0.4	-0.3
Labor	6.6	0.2	6.4	-14.1	-7.0	-7.1	4.4	3.3	1.1
Labor force	1.3	-0.2	1.5	-6.9	-5.1	-1.8	-1.2	-0.5	-0.7
(-) Unemployment	1.3	0.5	0.7	2.0	1.8	0.2	0.0	0.6	-0.6
Hours-worked	4.1	-0.1	4.2	-9.2	-3.7	-5.5	5.6	3.1	2.5
Net L/K Share Shift	-18.0	-18.2	0.2	-19.2	-19.4	0.3	-7.2	-7.2	0.0
GDP	38.9	37.2	1.7	11.3	13.9	-2.6	6.7	3.7	3.0
Average Annual Growth	6.0	5.7	0.3	1.0	1.3	-0.2	1.9	1.0	0.9
TFP	0.5	0.6	-0.1	3.4	3.3	0.1	2.5	1.9	0.6
Gross TFP (= TFP + Δα)	-2.2	-2.2	0.0	1.7	1.6	0.1	0.5	-0.2	0.6
Capital	7.2	7.9	-0.7	0.6	0.3	0.3	0.2	0.3	-0.1
Labor	1.0	0.0	1.0	-1.3	-0.6	-0.6	1.2	0.9	0.3
Δ Labor Share	-2.8	-2.8	0.0	-1.7	-1.8	0.0	-2.1	-2.1	0.0

Source: IMF staff estimates
Note: growth rates calculated as difference in natural logarithms of original series.

Table AII.5. Lithuania: Decomposition of GDP Growth
(Percentage points)

	1998Q3-2008			2009-2019			2020-2023Q2		
	Total	Structural	Cyclical	Total	Structural	Cyclical	Total	Structural	Cyclical
TFP	-48.5	-49.0	0.6	10.4	11.1	-0.7	14.7	13.7	1.1
Capital	115.0	114.0	1.0	39.2	39.5	-0.3	6.1	8.9	-2.8
Capital accumulation	97.3	97.3	n.a	33.5	33.5	n.a	11.0	11.0	n.a
Capacity utiization	17.7	16.6	1.0	5.7	6.0	-0.3	-4.9	-2.1	-2.8
Labor	2.0	2.2	-0.2	-4.6	-1.4	-3.2	-1.0	0.4	-1.4
Labor force	-5.0	-5.6	0.6	-1.5	-0.4	-1.1	1.9	1.3	0.6
(-) Unemployment	1.9	2.1	-0.2	0.6	0.9	-0.3	0.0	-0.4	0.4
Hours-worked	5.1	5.7	-0.6	-3.7	-2.0	-1.8	-3.0	-0.5	-2.4
Net L/K Share Shift	-12.5	-12.5	0.0	-22.4	-22.5	0.1	-12.3	-12.3	0.0
GDP	56.1	54.6	1.5	22.6	26.6	-4.1	7.5	10.7	-3.2
Average Annual Growth	5.2	5.1	0.1	2.1	2.4	-0.4	2.1	3.0	-0.9
TFP	-4.5	-4.6	0.1	0.9	1.0	-0.1	4.2	3.9	0.3
Gross TFP (= TFP + Δα)	-5.7	-5.7	0.1	-1.1	-1.0	0.0	0.7	0.4	0.3
Capital	10.7	10.6	0.1	3.6	3.6	0.0	1.8	2.5	-0.8
Labor	0.2	0.2	0.0	-0.4	-0.1	-0.3	-0.3	0.1	-0.4
Δ Labor Share	-1.2	-1.2	0.0	-2.0	-2.0	0.0	-3.5	-3.5	0.0

Source: IMF staff estimates
Note: growth rates calculated as difference in natural logarithms of original series.

Annex III. How We Derive Allocative Efficiency

We calculate a measure of allocative efficiency using firm-level data. Following Hsieh and Klenow (2009) and IMF (2024), we introduce the following assumptions:

- A Cobb-Douglas production function at the firm level, where α_{cs} represents the country-sector specific capital share. Y_{csit}, A_{csit}, K_{csit}, and L_{csit} represent output, technology, capital, and labor at the firm level. The subscripts *c, s, i,* and *t* represent country, sector, firm, and year, respectively.

$$Y_{csit} = A_{csit} K_{csit}^{\alpha_{cs}} L_{csit}^{1-\alpha_{cs}} \tag{1}$$

- Aggregation with constant elasticity of substitution, where σ_c represents the elasticity of substitution. Lower case *i* indicates sector *i*.

$$Y_{cst} = \left(\sum_{i=1}^{I_{cst}} Y_{csit}^{\frac{\sigma_c - 1}{\sigma_c}} \right)^{\frac{\sigma_c}{\sigma_c - 1}} \tag{2}$$

- Distortions on output, capital, and labor markets. The distortions on capital and labor markets increase the effective cost of capital and labor by τ_K and τ_L, respectively. τ_Y represents a tax on output. τ_{csit} is defined as a function of the distortions on capital, labor, and output markets.

$$\tau_{csit} \equiv (1 + \tau_{Kcsit})^{\alpha_{cs}} (1 + \tau_{Lcsit})^{1-\alpha_{cs}} / (1 - \tau_{Ycsit}) \tag{3}$$

- Firms maximize profits under monopolistic competition, by choosing the optimal amount of capital (*K*) and labor (*L*) such that the marginal revenue product of each input factor is equal to its marginal cost, as described by Equations (4) and (5). r_{cst} and w_{cst} are the cost of capital and labor, respectively, at the sector level. Profit maximization is such that the firm's output price is a fixed markup over its marginal cost.

$$K_{cst} = \frac{\alpha_{cs}}{r_{cst}} \frac{\sigma_c - 1}{\sigma_c} \sum_{i=1}^{I_{cst}} \frac{(1 - \tau_{Ycsit}) P_{csit} Y_{csit}}{1 + \tau_{Kcsit}}, \tag{4}$$

$$L_{cst} = \frac{1 - \alpha_{cs}}{w_{cst}} \frac{\sigma_c - 1}{\sigma_c} \sum_{i=1}^{I_{cst}} \frac{(1 - \tau_{Ycsit}) P_{csit} Y_{csit}}{1 + \tau_{Lcsit}}, \tag{5}$$

- Equation (6) gives the output in the equilibrium. As illustrated by equation (7), the marginal revenue product of capital and labor, will not be equalized due to the distortions.

$$Y_{cst} = \frac{\left(\frac{A_{csit}}{\tau_{csit}}\right)^{\sigma_c} K_{cst}^{\alpha_{cs}} L_{cst}^{1-\alpha_{cs}}}{\left[\sum_{i=1}^{I_{cst}} \left(\frac{A_{csit}}{\tau_{csit}}\right)^{\sigma_c - 1} \frac{1 - \tau_{Ycsit}}{1 + \tau_{Kcsit}}\right]^{\alpha_{cs}} \left[\sum_{i=1}^{I_{cst}} \left(\frac{A_{csit}}{\tau_{csit}}\right)^{\sigma_c - 1} \frac{1 - \tau_{Ycsit}}{1 + \tau_{Lcsit}}\right]^{1-\alpha_{cs}}} \tag{6}$$

$$\frac{MRPK_{csit}}{r_{cst}} = \frac{1 + \tau_{Kcsit}}{1 - \tau_{Ycsit}}, \qquad \frac{MRPL_{csit}}{w_{cst}} = \frac{1 + \tau_{Lcsit}}{1 - \tau_{Ycsit}} \tag{7}$$

- Equations (8) and (9) illustrate the fact that in an ideal world without distortions, total factor productivity at the sector level is an aggregation of the technology component of the firm-level productivity *A*, since the

distortion parameters τ_{csit} and τ_{cst} both equal 1 in that case. With distortions on factor and output markets, total factor productivity becomes lower than that in the ideal-case scenario. This wedge is represented by the term AE in Equation (10). For each unit decline in allocative efficiency, there will be a one-percentage point decline in TFP growth.

$$TFP_{cst} \equiv \left[\sum_{i=1}^{I_{cst}} A_{csit}^{\sigma_c - 1} \left(\frac{\tau_{csit}}{\tau_{cst}}\right)^{1-\sigma_c}\right]^{\frac{1}{\sigma_c - 1}} \tag{8}$$

$$Y_{cst} = TFP_{cst} K_{cst}^{\alpha_s} L_{cst}^{1-\alpha_s}$$

$$\ln TFP_{ct} = \sum_{s=1}^{S} \theta_{cst} \ln \left[k_{cst}^{\alpha_{cs}} l_{cst}^{1-\alpha_{cs}} \underbrace{\left(\sum_{i=1}^{I_{cst}} A_{csit}^{\sigma_c - 1}\right)^{\frac{1}{\sigma_c - 1}}}_{\equiv A_{cst}^{*}}\right] \tag{9}$$

$$+ \sum_{s=1}^{S} \theta_{cst} \ln \underbrace{\left[\sum_{i=1}^{I_{cst}} \frac{A_{csit}^{\sigma_c - 1}}{\sum_{i=1}^{I_{cst}} A_{csit}^{\sigma_c - 1}} \left(\frac{\tau_{csit}}{\tau_{cst}}\right)^{1-\sigma_c}\right]^{\frac{1}{\sigma_c - 1}}}_{AE_{cst}} \tag{10}$$

- We first aggregate the calculated allocative efficiency up to the sector level, and then aggregate it to the country level using sectoral value added shares based on the EUKLEMS database. Then, we calculate annual TFP growth using the country-level TFP index from the AMECO database (the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs). Afterwards, we decompose TFP growth into the innovation and allocative efficiency components using the aggregated allocative efficiency based on firm-level data. The two components are captured by the two terms on the right-hand side of Equation (11).

$$\Delta lnTFP_{ct} = \Delta \ln IN_{ct} + \Delta lnAE_{ct} \tag{11}$$

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