INTERNATIONAL MONETARY FUND

IMF Country Report No. 15/337

REPUBLIC OF ESTONIA

SELECTED ISSUES

December 2015

This paper on Republic of Estonia was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on November 30, 2015.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: http://www.imf.org
Price: $18.00 per printed copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

REPUBLIC OF ESTONIA

SELECTED ISSUES

November 30, 2015

Approved By
European Department

Prepared By Ramdane Abdoun, Seung Mo Choi, Pragyan Deb, and Christoph Klingen

CONTENTS

TABLES

APPENDICES

REFERENCES

ESTONIA: INCOME CONVERGENCE AND MEDIUM-TERM GROWTH POTENTIAL

Since the mid-1990s, Estonia has had an overall stellar growth performance, greatly narrowing the gap in living standards with Western Europe. Although its short modern economic history as an independent country with only one pronounced business cycle makes it difficult to uncover underlying trend growth, there is a clear sense that it has slowed considerably of late. More formal analysis puts it at 2¼ percent currently. Challenging demographics, less scope for brisk capital accumulation, and slowing productivity growth as income convergence advances, all weigh on the outlook. A comparison with other successful economies would suggest that Estonia generally got its policy settings right and therefore stands a good chance to escape the "middle income trap" of stalled income convergence if existing policy plans are implemented with determination. On this basis, potential growth is projected to average some 3 percent over the next five years and 2¾ percent over the next two decades, implying continued income convergence with EU levels, albeit at only half its historical pace. A number of policy enhancements could lift growth above this central projection. Those include a greater operational policy focus on raising productivity growth, scaling up a number of envisaged pro-growth programs, supporting the upgrading of traditional industries as a second leg of innovation policy, and fully restoring Estonia's high investment

A. Introduction

1. **Since the mid-1990s, the Estonian economy has made great strides in closing the income gap with Western Europe.** Between 1995 and 2014 it expanded by 4.4 percent per year on average, the fastest rate in Europe together with Lithuania. As a result, per capita income advanced from 10 percent to 47 percent of the Western European average, and from 30 percent to 67 percent when adjusted for differences in purchasing power.[1]

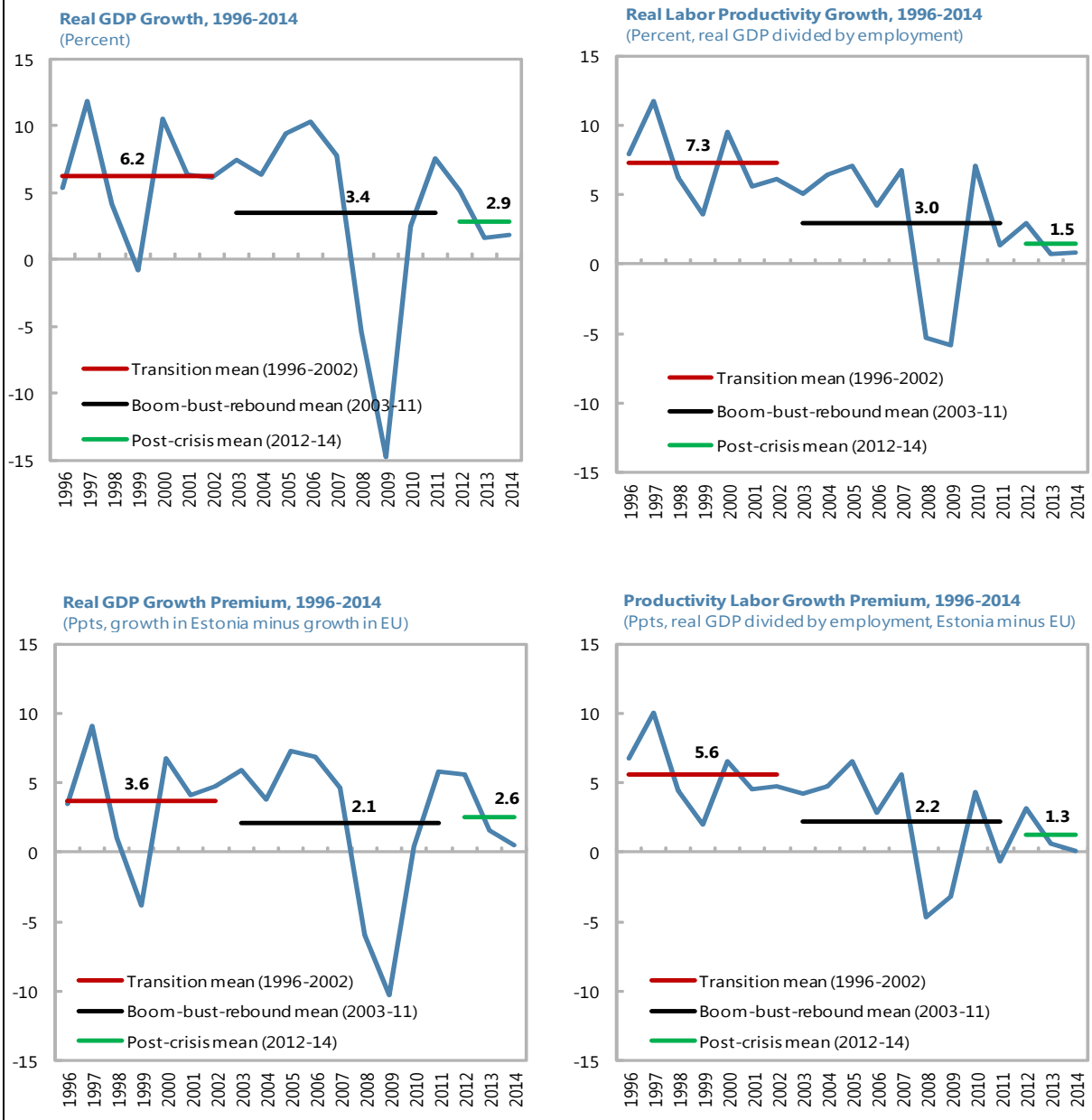
2. **But the growth record has been uneven over time, complicating the identification of underlying trends.** Estonia's recent economic history can be broken down into three distinct periods: (i) the transition period of 1995–2002 characterized by very strong growth, despite the fallout from the 1999 Russia crisis; (ii) a boom-bust-rebound period during 2003 to mid-2012 with lower but still solid average growth when EU accession and a foreign-financed credit boom eventually overheated the economy, followed by a collapse triggered by the global financial crisis of 2008/09 and a subsequent partial rebound; and (iii) the post-crisis period with more moderate growth (Bakker and Klingen, 2012). With essentially only one large business cycle, it is hard to ascertain underlying growth trends.

[1] Western Europe is defined as "EU-15," comprising Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

3. **Nonetheless there is a sense that growth has slowed over time, raising questions about prospects going forward and the economy possibly getting stuck in a "middle income trap."** The post-crisis growth slowdown may have been exacerbated by a weak global environment, but one cannot help noticing the successive decline in GDP and labor-productivity growth in absolute terms, as well as in terms of their premiums over growth rates in the EU, over the three periods (Figure 1). From a theoretical point of view, one would also expect a slowdown of convergence as the gap in living standards with Western Europe shrinks and the low-hanging fruit from economic reform is increasingly depleted. Few countries have managed to maintain income convergence with the advanced economies once they attained middle-income status—a phenomenon called middle income trap. In Estonia the challenge is compounded by investment that has yet to regain its traditional strength and intensifying adverse demographics.

4. **This paper seeks to give a better sense about the medium-term growth outlook for Estonia and suggest ways to improve it, drawing on international experience.** To this end, section B sets out the main growth drivers of the past and their likely future developments. Section C tries to formally purge growth and its drivers from cyclical influences to uncover underlying potential growth. Section D compiles international evidence on what it takes to overcome the middle income trap and how conditions and policies in Estonia compare. With these findings in mind, section E projects potential growth forward. Section F concludes with policy implications for Estonia.

Figure 1. Estonia: GDP and Productivity Growth, 1996–2014



Sources: Eurostat; Statistics Estonia; WEO, IMF; and IMF staff estimates.

B. Salient Features of Estonia's Growth Record

5. **Estonia's growth has been heavily capital driven, but capital intensity remains much below that of Western Europe.** Growth accounting shows that about half of the GDP expansion during 1995–2014 was due to capital accumulation, compared with a little over one third in the rest of CEE or Western Europe. While capital stock numbers are subject to considerable uncertainty, more reliable figures for investment confirm the finding: Estonia's investment ratios averaged 29 percent of GDP, some 8 ppts above the EU average. But investment ratios have come down after the crisis of 2008/09 and currently hover around 25 percent of GDP, even though Estonia's capital-to-labor ratios are still much below those of Western Europe, indicating considerable remaining scope for catching up in terms of capital intensity. The composition of investment is similar to elsewhere in Europe with the exception that intellectual property investment is unusually low and investment in non-residential buildings is unusually high, potentially holding back productivity growth (Box 1).

6. **Employment has been a slight drag on growth in the past, but will substantially intensify going forward.** During 1995–2014, employment contracted at an annual average rate of 0.1 percent, thereby making a small negative growth contribution. The population decline was much larger at 0.5 percent per year, but a smaller decline in the working age population, rising participation rates, and a fall in unemployment contained the impact on employment. The population decline is set to continue at about the same rate over the next two decades, reflecting the sharp fall in fertility since the 1990s and net emigration. This demographic outlook is similar to that of CEE as a whole, which is the most demographically challenged region in the world. In contrast to the past however, Estonia's population decline could have a much larger impact on employment because the decline of the working age population is expected to triple. There may also be less room for already fairly high participation rates to rise further and now considerably lower unemployment to fall much more (Box 2).

7. **Productivity growth contributed to GDP growth to a similar extent as elsewhere in CEE, but maintaining high rates will likely be an uphill battle.** Total factor productivity (TFP) growth has been the most important growth driver since 1995. It averaged 2.4 percent per year—similar to the 2.2 percent for the CEE average and much better than the 0.7 percent achieved in Western Europe. Nonetheless, the gap in TFP levels with Western Europe remains large at almost 50 percent, with the deficit particularly large in the manufacturing sector. Catching-up with Western Europe through adaptation and knowledge spillovers might well slow down as the income gap narrows. Accordingly, other drivers of TFP growth, such as more effective R&D, better skill matching in the labor market, and more productive investment will assume heightened importance in the decades ahead (Box 3).

8. **Rapidly developing exports have been one of the hallmarks of Estonia's growth performance** (IMF, 2014). Estonia is one of the most open economies in Europe, with exports coming close to 90 percent of GDP in gross terms and some 50 percent of GDP in domestic value-added terms, i.e., when the value of imported inputs embedded in exports is stripped out. Export market shares have generally been on a rising trend, though quality improvements of export goods,

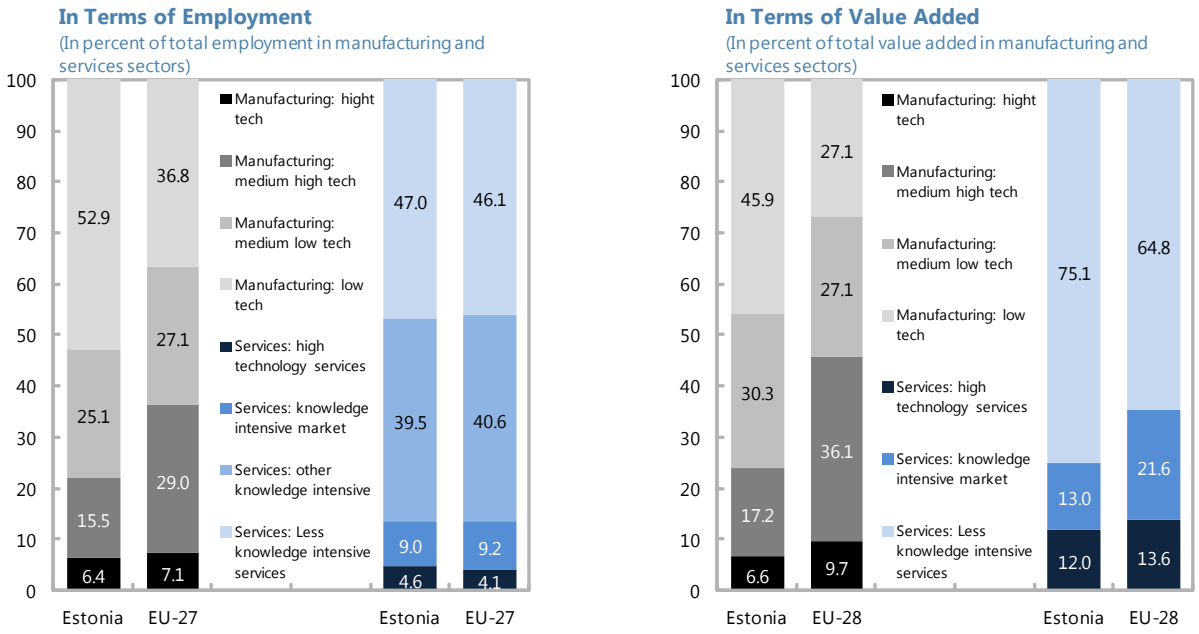
measured by the price increases they manage to fetch in global markets, seem to have slowed down in recent years.

9. **Estonia has put a major emphasis on ICT from early on to spur productivity and innovation.** As early as 1998, nearly all school classrooms were already connected to the internet and Estonia is a leader in e-government. It adopted a smart specialization strategy long before it became mandatory with the EU's Multiannual Financial Framework 2014–20 (OECD, 2015a, Box 1.1). The national reform program "Estonia 2020" sets out the broad objective of reaching by 2020: (i) 80 percent of the EU average productivity per worker; (ii) R&D expenditure of 3 percent of GDP; and (iii) a 0.11 percent share of Estonian exports in world trade. The Research, Development, and Innovation (RDI) Strategy "Knowledge-based Estonia" by the Ministry of Education and Research and the "Entrepreneurship Growth Strategy" by the Ministry of Economic Affairs and Communications elaborate further in the ministries' respective areas of responsibility. The current smart specialization strategy sets out priority areas for innovation: (i) ICT horizontally through other sectors; (ii) health technologies and services; and (iii) more effective use of resources.

10. **High-tech activities have gained a clear foothold in Estonia, but more traditional sectors still dominate the economy.** Estonia is home to a number prominent software startups, such a Skype, GrabCAD, or Kazaa, and is also a leading innovator in oil shale (EBRD, 2014 and Crouch, 2015). Swedish communications-maker Ericsson produces telecommunication equipment in Estonia, which accounts for some 20 percent of exports. Yet, large parts of the economy are still dominated by more traditional sectors and activities. Agriculture, industry, and construction still account for about one-third of employment and gross value added, compared with a quarter for the EU average. And within manufacturing, the wood, furniture, and textile sectors make up 40 percent of employment and 27 percent of gross value added, against 17 and 10 percent, respectively, for the EU average. A classification of sectors by product sophistication according to Eurostat shows a deficit vis-à-vis the EU average in the mid-high-tech manufacturing sectors in terms of employment, and in knowledge-intensive market services in terms of value added (Figure 2). Estonia's export structure paints a similar picture. The sophistication of its good exports has not yet advanced to the level reached by countries that subsequently successfully transitioned to high-income economies (Figure 3). Estonia's revealed comparative advantage remains mainly in labor-intensive goods and services, although knowledge-intensive services have begun to carve out a small revealed comparative advantage in recent years.[2] Sophisticated service exports, proxied as "IT and communication services" and "other business services," account for about 7 percent of total exports, not far behind the share of the Nordic countries and more than double the CEE average.

[2] A country is said to have revealed comparative advantage (disadvantage) in a product if its exports account for a larger (smaller) share in its total exports than global exports of this product in total global exports.

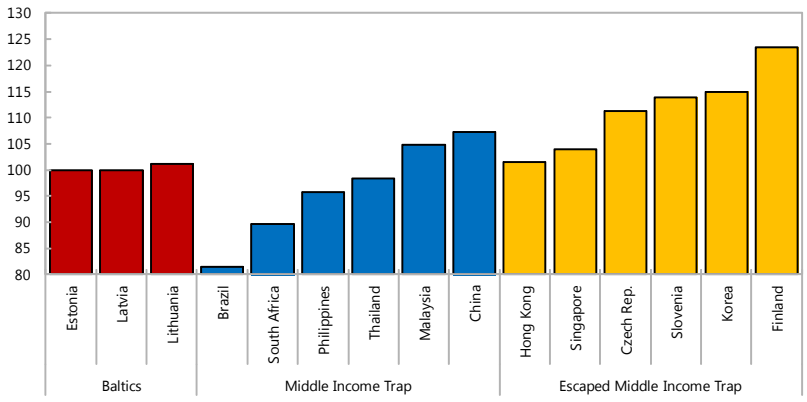
Figure 2. Estonia and EU: Shares of Sectors by Sophistication, 2013*



* 2012 for shares in terms of value added.
Sources: Eurostat; and IMF staff calculations.

Figure 3. Estonia: Export Sophistication Index*

(Index, Estonia, 2014=100)



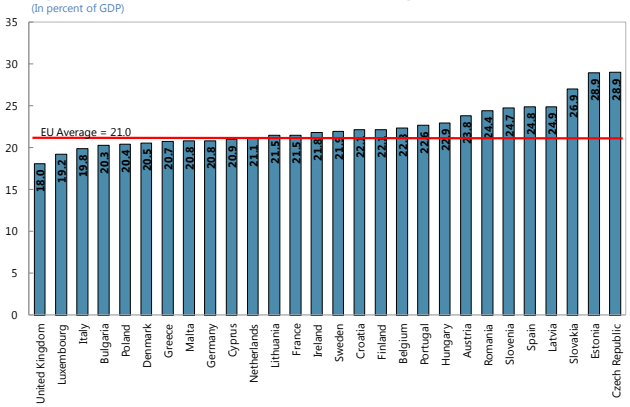
Sources: WITS Trade Outcomes Database; and IMF staff calculations.
*Export sophistication is an outcome based measure: if a product is mostly produced by rich countries, then it is revealed to be sophisticated. Estonia's export sophistication is compared with the other Baltics and countries considered to be currently in the Middle Income Trap (MIT) (2014 data), and with countries that escaped the MIT when their per-capital GDP (in constant 2005 PPP) was compareable to that of Estonia.

Box 1. Estonia's Investment and Capital Stock in International Perspective

Since 1995, Estonia has consistently set aside more resources for investment than other European countries. This boosted capital intensity, which remains, however, only a fraction of Western European levels. As the rest of Central and Eastern Europe (CEE), residential construction plays a lesser role and corporate investment a larger role in overall investment in Estonia than in Western Europe. Overall strong investment in Estonia translates into high "productive" investment, but within this category intellectual property investment is much weaker than in both CEE and Western Europe.

Estonia boasts one of the highest investment ratios in Europe. It averaged 29 percent of GDP during 1995–2014—some 8 ppts above the EU average and second only to the Czech Republic (Figure 1.1). Investment activity closely followed the business cycle, with investment ratios steadily rising during the boom years to peak at 35 percent of GDP in 2007. A sharp decline followed when the boom turned to bust, but it has since recovered to some 25 percent of GDP. Throughout the cycle investment ratios remained substantially above those for the EU as a whole (Figure 1.2).

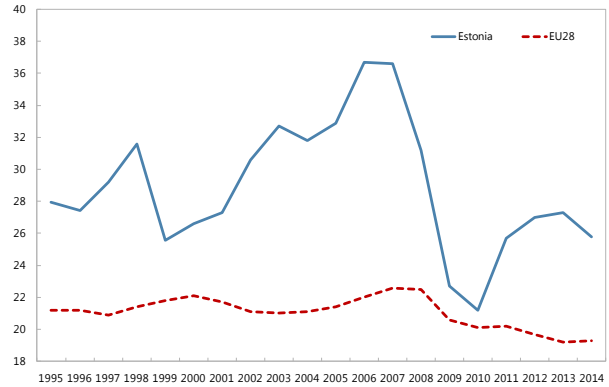
Figure 1.1. Gross Fixed Capital Formation, average 1995-2014
(In percent of GDP)



Sources: Eurostat; and IMF staff calculations.

The allocation of Estonia's investment across sectors is typical of economies throughout CEE. About two thirds of investment is carried out by non-financial corporations, compared to around one half in Western Europe. On the flipside, a smaller share of investment comes from households, which account for a third of the total in Western Europe but only a sixth in Estonia and CEE more generally. This reflects the relatively smaller role of residential construction in CEE. The share of government investment is about the same in CEE, Estonia, and Western Europe.

Figure 1.2. Estonia: Investment Ratio, 1995–2014
(In percent of GDP)



Sources: Eurostat; and IMF staff estimates.

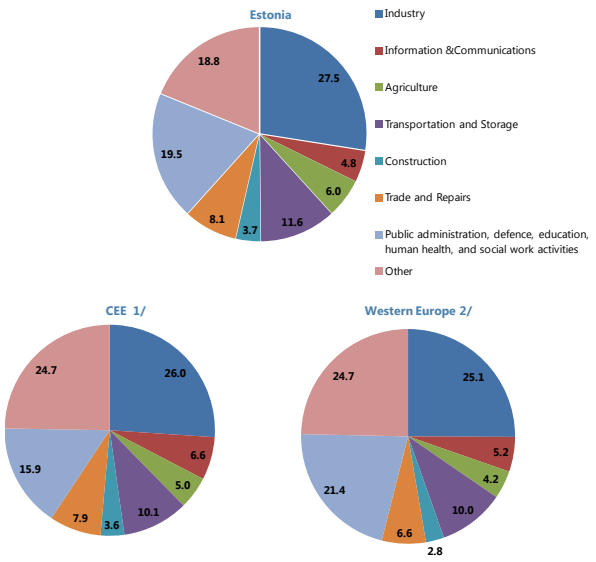
The allocation of investment across activities in Estonia was broadly similar to that elsewhere in Europe (Figure 1.3). Industry accounted for 27.5 percent of total investment, marginally above the 25.1 and 26.0 percent observed for CEE and Western Europe, respectively. Investment of the information and communications sector was lower in Estonia than in CEE—4.8 against 6.6 percent of the total—while public administration, defense, education, health, and social work activities accounted for a somewhat higher share in Estonia than in CEE, although it remained below the share observed in Western Europe.

The allocation of investment across assets shows a relative deficit of Estonia in the intellectual property category while the share of "productive investment" overall was in line with European standards (Figure 1.4). Productive investment, defined as all investment except that into dwelling and other buildings, accounted for 47 percent of the total, the same as in Western Europe, compared with 54 percent in CEE. Because of Estonia's higher investment ratio, productive investment as a percent of GDP was substantially higher than in Western Europe—13½ against 10 percent of GDP—and about the same as in CEE. However, Estonia sticks out

Box 1. Estonia's Investment and Capital Stock in International Perspective (continued)

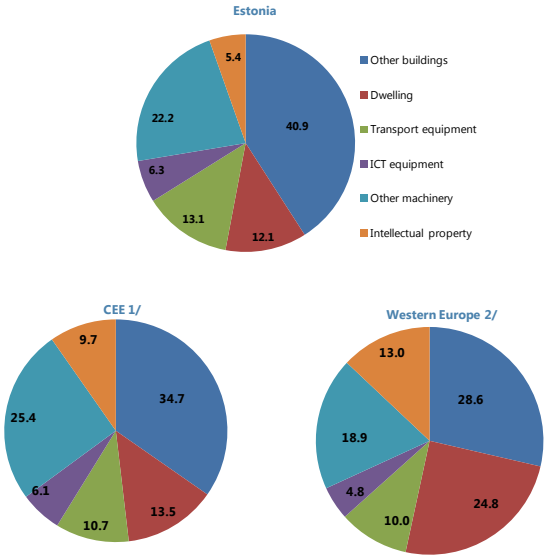
with a relatively low share of investment devoted to intellectual property. It accounts for just 5.4 percent of the total, compared with 9.7 percent in CEE and 13.0 percent in Western Europe. Intellectual property investment

Figure 1.3. Investment by Activity, 1995-2013
(In percent of total)



Sources: Eurostat; and IMF staff calculations.
1/ Simple average of the Czech Republic, Hungary, Latvia, Lithuania, and Slovakia.
2/ Simple average of Austria, Cyprus, Denmark, France, Germany, Greece, Italy, and the Netherlands.

Figure 1.4. Investment by Asset, 1995-2013
(In percent of total)



Sources:Eurostat; and IMF staff calculations.
1/ Simple average of the Czech Republic, Hungary, Latvia, Lithuania, Romania, Slovenia, and Slovakia.
2/ Simple average of Austria, Belgium, Cyprus, Denmark, Germany, Greece, France, Italy, Luxembourg, Malta, the

comprises additions to the stock of knowledge from R&D, mineral exploration, computer software and data base investment, as well as entertainment, literary, and artistic originals.* Furthermore, there is some evidence that corporate sector investment in Estonia, as well as CEE in general, may be more skewed toward buildings than in Western Europe.**

Estonia's high propensity to invest led to a rapid increase of the economy's capital intensity, but in absolute terms capital intensity remains much lower than in Western Europe. The capital to labor ratio increased steadily over the past two decades with a brief pause only in the recovery phase after the 2008/09 crisis when rehiring outstripped capital accumulation. Since 1995, the capital stock per worker has more than tripled, making Estonia one of the most capital intensive countries in CEE (Figure 1.5). However, the gap with Western Europe remains very large—Western Europe employs three times more capital per worker.

Estonia's low capital intensity relative to Western Europe pervades all economic activities (Figure 1.6). Capital intensity grew the fastest in Estonia's tradable sector, especially agriculture, while it did not advance much in the nontradables sector. Nonetheless, the shortfall in the capital to labor ratio vis-à-vis Western Europe remains particularly large in agriculture and manufacturing. It is relatively small in trade, restaurants, and hotels. Interestingly, the gap with Western Europe is also very large in construction activities.

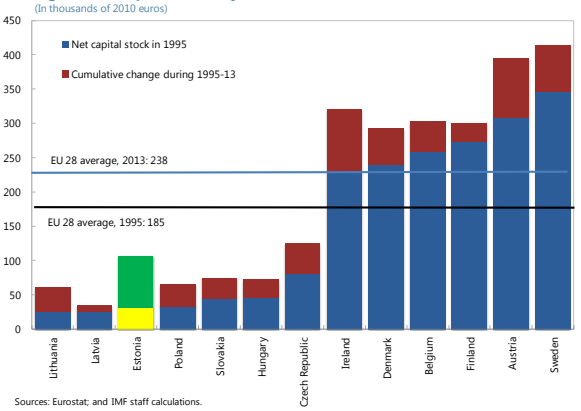
---

* R&D investment under intellectual property does not need to match R&D expenditure: the former (i) excludes software related R&D which is reported separately; (ii) it also excludes R&D that is exported and includes R&D that is imported; and (iii) is partially valued at the market prices for the associated results rather than exclusively on a cost basis.

** A breakdown of sectoral investment by type of asset is not available, but household investment can be proxied by investment in dwellings and the split of government investment between buildings and the rest is probably similar in Estonia, CEE, and Western Europe.

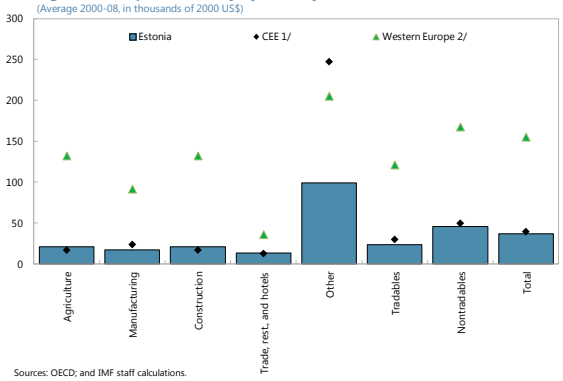
Box 1. Estonia's Investment and Capital Stock in International Perspective (concluded)

Figure 1.5. Capital Intensity
(In thousands of 2010 euros)



Sources: Eurostat; and IMF staff calculations.

Figure 1.6. Capital Intensity by Activity
(Average 2000-08, in thousands of 2000 US$)

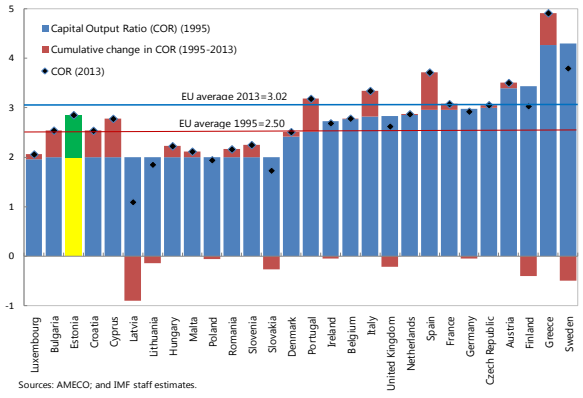


Sources: OECD; and IMF staff calculations.
1/ Simple average of the Czech Republic and Poland.
2/ Simple average of Denmark, Finland, France, Germany, Italy, Norway, Netherlands, Spain, Sweden, and the UK.

Estonia's capital-output ratio has increased only moderately since 1995 and at just under 300 percent is similar to that of Western Europe (Figure 1.7). For most of the period the capital-output ratio remained close to the initial level of 200 percent, with the impacts of growing capital intensity and productivity gains largely offsetting each other. But in the wake of the 2008/09 crisis, productivity suffered a setback while capital intensity did not decline, lifting the capital-output ratio to 290 percent in 2013. This leaves it close to the average for Western Europe, with lower capital intensity counterbalanced by lower productivity.

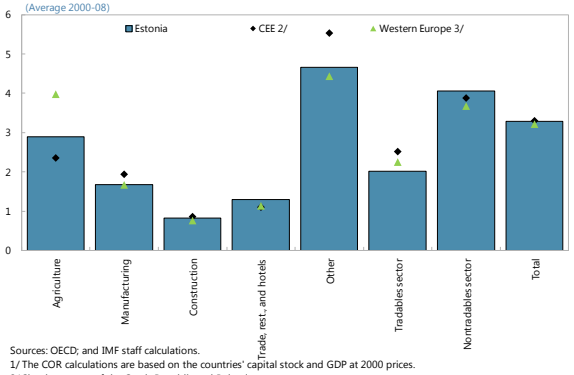
A capital-output ratio similar to that of Western Europe broadly applies to all economic activities (Figure 1.8). According to OECD capital stock data by activity for 2000–08, almost all activities exhibit similar capital-output ratios to those in Western Europe. However, it is notably lower in the category "other" due to utilities, reflecting particularly low capital intensity relative to Western Europe. In agriculture it is also lower, reflecting a relatively less pronounced productivity deficit vis-à-vis Western Europe.

Figure 1.7. Capital Output Ratio: 1995 and Change in 1995-2013



Sources: AMECO; and IMF staff estimates.

Figure 1.8. Capital Output Ratios by Activity 1/
(Average 2000-08)



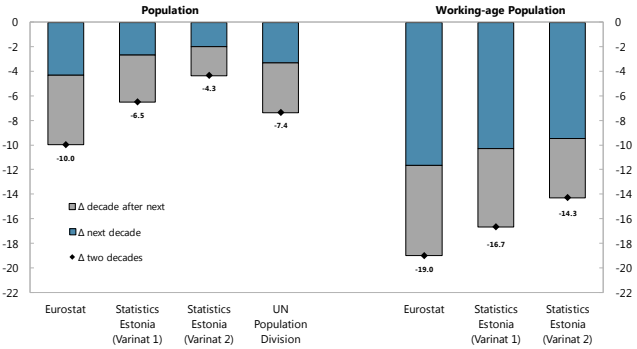
Sources: OECD; and IMF staff calculations.
1/ The COR calculations are based on the countries' capital stock and GDP at 2000 prices.
2/ Simple average of the Czech Republic and Poland.
3/Simple average of Denmark, Finland, France, Germany, Italy, Norway, the Netherlands, Spain, Sweden, and the UK.

Box 2. Estonia's Demographic Challenge in International Perspective

Estonia's population will likely continue to decline at about the same rate as in the past, but the fall in the working age population will triple to 1 percent a year. Few other regions except for the rest of Central and Eastern Europe (CEE) face such challenging demographics. They will tend not only to slow down headline GDP growth, but rising old-age dependency ratios will also be a drag on per-capita GDP growth and put pressure on social security systems.

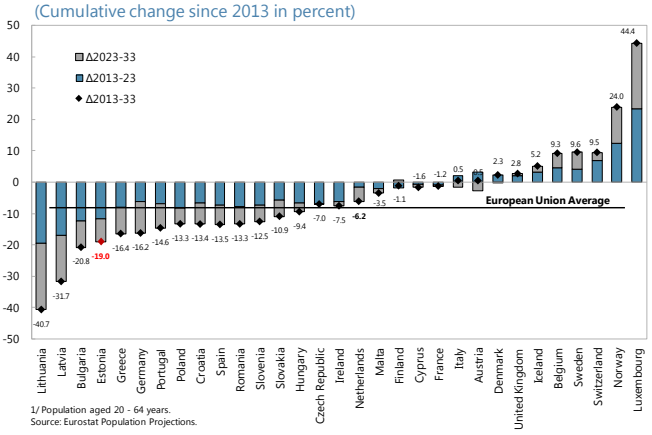
Estonia's demographic outlook is challenging, demographers agree. Statistics Estonia (SE), the European Commission (EC), and the UN all concur that Estonia's population will continue to decline over the next two decades (Figure 2.1). The EC projects the largest shrinkage of 10 percent cumulatively, or 0.5 percent per year on average. This rate of decline would closely match Estonia's historical experience since the mid-1990s. Net emigration rates are assumed to remain broadly unchanged from the past, accounting for about half of the projected population decline. But more importantly, the decline of the working age population would pick up sharply from 0.3 percent in the past to over 1 percent per year on average going forward, leading to a cumulative decline of 19 percent over two decades. ES's projections are somewhat less pessimistic but also see a large decline in the working age population of between 14 and 17 percent cumulatively, or 0.8 and 0.9 percent per year on average.

Figure 2.1.Estonia: Population Projections Over Two Decades
(Cumulative changes in percent)



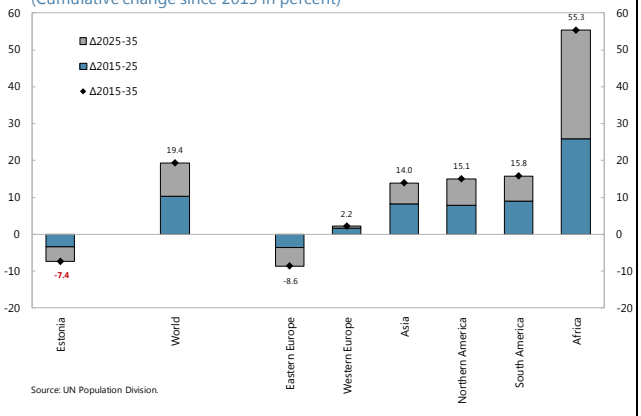
Sources: Eurostat, Statistics Estonia, and UN Population Division.

Figure 2.2. European Countries: Working-Age Population, 2013-33[1/]
(Cumulative change since 2013 in percent)



1/ Population aged 20 - 64 years.
Source: Eurostat Population Projections.

Figure 2.3. Selected Regions: Population Projections, 2015-35
(Cumulative change since 2015 in percent)



Source: UN Population Division.

The decline in the working age population of Estonia is more severe than in Europe as a whole (Figure 2.2). The EC sees the working age population declining in most European countries, but the (un-weighted) average of -7½ percent is less than Estonia's -19 percent. Most CEE countries also face steep declines, with prospects for Bulgaria, Latvia, and Lithuania even more difficult than for Estonia.

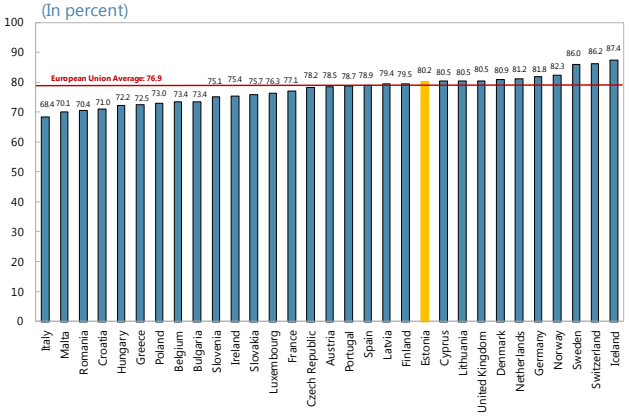
The projected population decline in Estonia is similar to that for Eastern Europe as a whole, the demographically most challenged region in the world (Figure 2.3). According to UN projections, the global population is set to continue expanding, with Africa the most dynamic region and only subdued, but still positive, population growth in Western Europe. Eastern Europe is the only region with a projected population decline and Estonia's demographic outlook is close to this region's

Box 2. Estonia's Demographic Challenge in International Perspective (concluded)

average. Notwithstanding a growing global population, its median age is projected to increase because of rising longevity. The global increase by four years is close to what is expected for Estonia, but with a median age of 45.3 years by 2035 Estonia will come close to Western Europe's median age of 46.2 years according to UN projections. SE's projections put Estonia's medium age at 46.1 years by 2035.

In the past, rising labor force participation and falling unemployment have mostly offset the effect of Estonia's shrinking working age population on employment, but scope for further mitigation will become harder to find. Since 1995, employment has declined by only 1.3 percent cumulatively, because the participation rate rose by 4 ppts and the unemployment rate fell from around 10 percent to just over seven percent. Gains in the participation rate come from the older age brackets of 55–64 years and 65–74 years (Table 2.1). However, with unemployment now already close to its structural rate and the participation rate exceeding the EU average, it will become increasingly difficult to counterbalance the effects from the rapidly shrinking working age population (Figure 2.4).

Figure 2.4.European Countries: Participation rate, 2014
(In percent)



Source: Eurostat.

Demographic developments will also push up the number of older people relative to the working age population. In the EC's projections, the old-age dependency ratio would rise from 29.3 to 45.0 percent over the next twenty years (Figure 2.5). In this regard, developments in Estonia will closely mirror developments across CEE and Western Europe, which all will have to grapple with the following two main economic consequences:

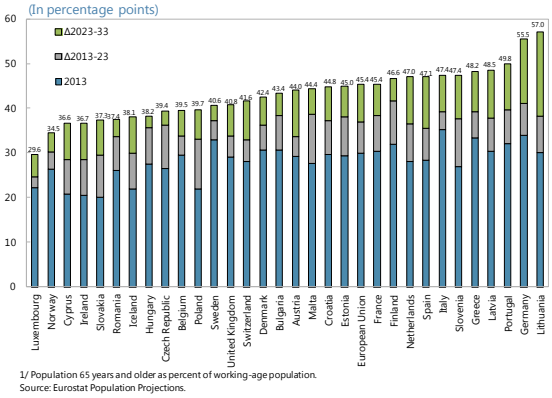
Table 2.1. Participation Rates by Broad Age-groups, 1994 and 2014

	15-19	20-24	25-54	55-64	65-74
Females					
1994	28.5	60.5	86.9	33.6	8.0
2014	9.9	59.0	82.1	66.3	18.6
Males					
1994	35.8	83.9	94.9	60.9	17.1
2014	9.6	63.9	91.8	68.6	23.9

Sources: Statistics Estonia; and IMF staff calculations.

- Pay-as-you-go pension systems will come under pressure as an ever smaller number of workers will have to support an ever larger number of pensioners. Efforts to restore balance in pension systems through large benefit cuts or hikes in social security contributions would be socially problematic or significantly weaken work incentives, respectively.
- Everything else equal, rising old-age dependency ratios would lower per-capita GDP growth. Assuming no changes to labor productivity growth and participation rates, the increase of the dependency ratio projected by the EC would reduce per-capita GDP growth by 0.6 ppts annually over the next two decades.

Figure 2.5. European Countries: Dependency Ratios, 2013-33[1/]
(In percentage points)



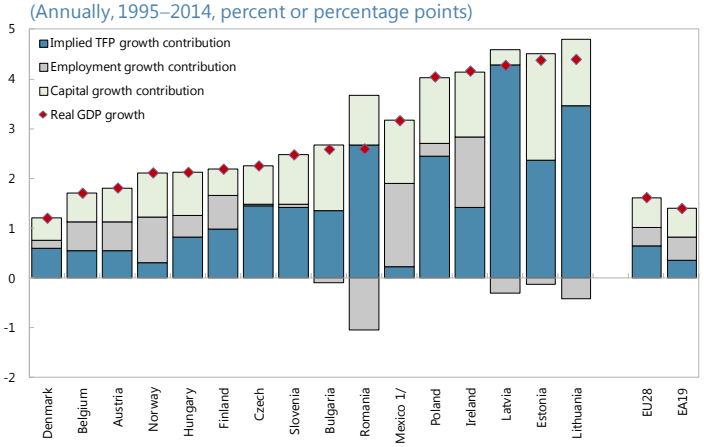
1/ Population 65 years and older as percent of working-age population.
Source: Eurostat Population Projections.

Box 3. What Drives Productivity Growth?

Fostering total factor productivity (TFP) is central to maintain high economic growth. Estonia's TFP growth over the past two decades was similar to that in the rest of Central and Eastern Europe (CEE)—it was relatively high investment ratios that made Estonia one of the best performers in terms of overall economic growth. TFP levels now stand at only 50–60 percent of those for Europe as a whole, with the deficit particularly pronounced in manufacturing. TFP growth is set to decline as income convergence advances or if productive investment falters, unless RDI is better absorbed by industry and labor skills better matched to job market needs.

Estonia's overall growth performance has been amongst the best in the EU, but this reflects high investment rather than superior TFP growth (Figure 3.1). Economic growth since 1995 has averaged 4.4 percent per year, second only to Lithuania in the EU. Simple growth accounting shows that Estonia's TFP growth at 2.4 percent was similar to the CEE average but it accounted for less of total growth than in the rest of CEE—roughly half compared to two thirds. Instead, it was comparatively fast capital accumulation that made Estonia a top performer in terms of overall economic growth (Box 2). TFP growth varied widely within CEE. Latvia and Lithuania achieved the highest rates. Had Estonia matched their TFP growth and combined it with its own high rate of capital accumulation, its PPP per-capita GDP would now stand at 90 percent of the EU average instead of about 70 percent.

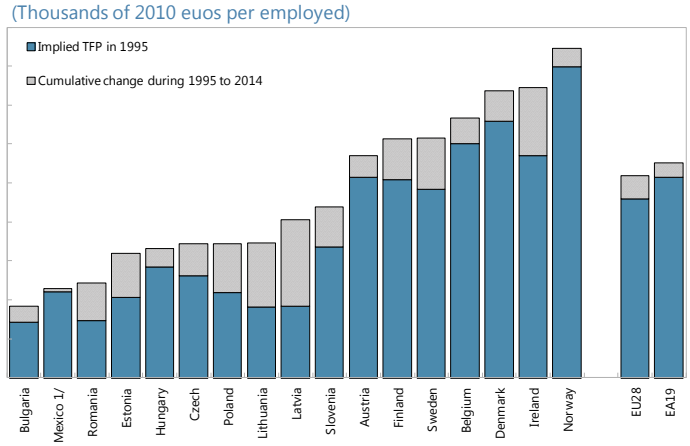
Figure 3.1. Selected Countries: GDP Growth and Factor Contributions
(Annually, 1995–2014, percent or percentage points)



Sources: European Commission, AMECO data base: and IMF staff calcualtions.
Assumes labor share of income of 2/3 for all countries. No adjustment for cyclical position. 1/ Refers to 1995–2012.

Estonia's TFP level is similar to that in CEE and remains substantially below Western European levels (Figure 3.2). Although TFP growth has been substantially higher in CEE than in Western Europe, productivity levels as measured by TFP per employed person remains much lower. Estonia's TFP is slightly below the CEE average. It comes to 62 percent of the EU average and 56 percent of the level in Western European economies. A variant of the growth accounting exercise (using countries' actual labor shares rather than a standardized share of two thirds for all countries) puts Estonia's TFP level even lower at only about 50 percent of the EU average. This large productivity gap underscores still vast potential for catching-up but also the magnitude of the task.

Figure 3.2. Selected Countries: Implied Total Factor Productivity
(Thousands of 2010 euos per employed)

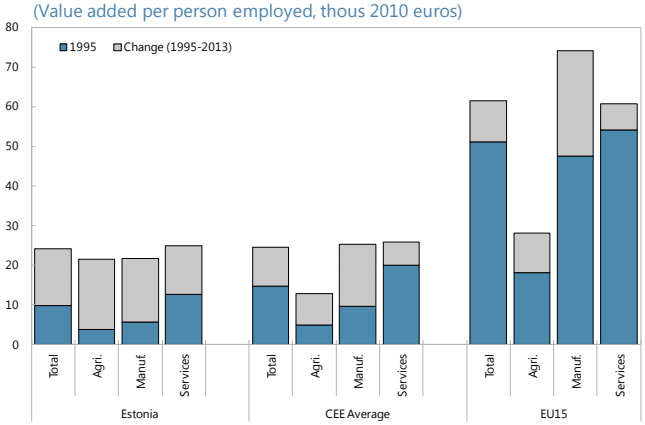


Sources: European Commission, AMECO data base: and IMF staff calcualtions.
Assumes labor share of income of 2/3 for all countries. No adjustment for cyclical position. 1/ Refers to 1995–2012.

Box 3. What Drives Productivity Growth? (continued)

Estonia's productivity gap with Western Europe is most pronounced in the manufacturing sector (Figure 3.3). Comprehensive data to calculate sectoral TFP levels are not available, but value-added per worker, i.e., labor productivity, can be used as a proxy. These calculations confirm that productivity levels in Western Europe are higher than those in Estonia in all sectors. Interestingly, in Western Europe manufacturing is more productive than the services sector, while it is the other way around in Estonia. The rest of CEE shares this feature, but it is more pronounced in Estonia. This suggests that matching Western European productivity levels seems particularly challenging in manufacturing, possibly because of insufficent intellectual property investment in the maufacturing sector or weak linkages between the R&D in universities and research institutions and the private sector. Data are available for a smaller set of countries for 2000–07 to calculate sectoral TFP. They point to an even larger productivity deficit in manufacturing than the labor productivity data.

Figure 3.3. Selected Countries: Labour Productivity by Sectors
(Value added per person employed, thous 2010 euros)



Sources: Eurostat
Total is the average labour productivity of the Agriculture, Manufacturing and Services sector (excludes construction and other industry)

Going forward, several forces will influence TFP growth in Estonia.

- As income convergence advances, TFP growth is likely to slow. TFP growth is generally negatively correlated with initial income as a wide gap to the technological frontier offers ample scope for catching-up through spillovers (Romer, 1990). Data for Europe confirm this relationship (Figure 3.4). With Estonia's PPP per-capita income now at some 70 percent of the EU average as opposed to less than 50 percent back in 1995, TFP growth could decline by around 1 percentage point.
- A decline in productive investment would likely be a further drag on TFP growth (Figure 3.5). The growth literature generally treats TFP growth and investment as separate drivers of economic growth, but in the data for European countries TFP growth is positively associated with productive investment, proxied as investment in machinery and equipment (Stiroh, 2001). This may reflect that technical progress is to some extent embodied in capital, although establishing causality is tricky as productive investment and TFP could be jointly driven by third factors, such as institutional quality. A letting up of Estonia's high level of productive investment could weight on TFP growth, in addition to reducing growth through a lower rate of capital accumulation.
- Population aging appears not to have any appreciable effect on TFP growth. No association between different aging indictors and TFP growth in the data for the sample of European countries is discernible. This echoes the literature, which fails to find strong evidence for population aging hurting productivity (Burtless, 2013). Studies on the relationship between age and productivity using firm-level data are also inconclusive about the existence of a productivity-pay gap for older workers. Most likely the positive productivity effects from experience (Disney, 1996) counterbalance the potentially negative effetcs from outdated skills (OECD, 1998) associated with an older work force.

Box 3. What Drives Productivity Growth? (concluded)

1996) counterbalance the potentially negative effetcs from outdated skills (OECD, 1998) associated with an older work force.

Figure 3.4. TFP Growth vs Initial PPP per-capital GDP
(Annual TFP growth between 1995-2014 and thousands of PPP GDP in 1995 relative to EU28)

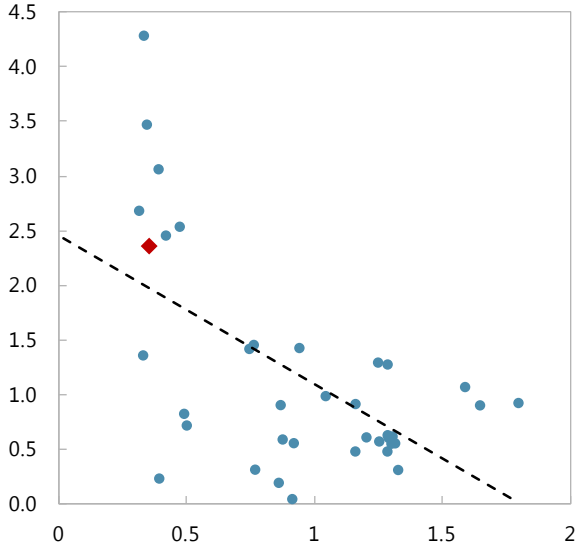
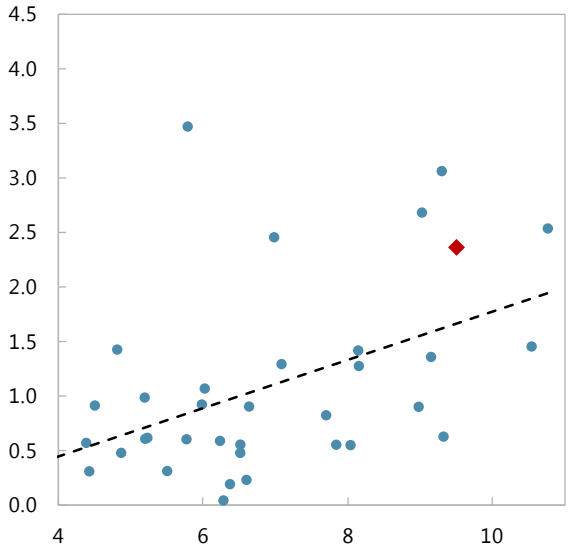


Figure 3.5. TFP Growth vs Productive Investment
(Annual TFP growth and share of GFCF in equipment to GDP between 1995-2014)



Sources: European Commission, AMECO data base; and IMF staff calcualtions.
Note: Calculations assume labor shares of income of 2/3 for all countries and make no adjustment for cyclical positions. Similar results hold in a cross-sectional regression of TFP growth on initial income and productive investment, with significant and economically meaningful coefficients. Overall investment is not significant. Also, variables capturing demographic characteristics such as population (overall and working age) growth, median age, dependency ratio, share of over 65, etc. are not significant.

- **Addressing skill mismatches in the labor market offers a way to lift TFP growth.** Estonia's skill mismatch, measured as the share of over-qualified and under-qualified workers, stands at about 37 percent of employees in the 25–64 age group.* This is not much higher than the average for the EU at 34 percent, but the best European performers, the Czech Republic and Slovakia, reach mismatch ratios below 20 percent. Many empirical studies have highlighted that a persistent technology-skill mismatch partly explains TFP differences across countries (Klenow and Rodriguez, 1997).

- **More RDI and better linkages between research institutions and the private sector could also help boost TFP growth.** Estonia's innovation system earns praise, but it is rather science driven and detached from the Estonian economy, which remains dominated by traditional sectors. Moreover, private firms' RDI investment has so far remained limited.

* Over-qualified (or under-qualified) workers are those whose highest level of qualification attained is greater than (or lower than) the qualification requirement of their occupation. The modal qualification in each occupational group at the two-digit level is used to measure qualification requirements.

C. Estimating Estonia's Historical Potential Growth

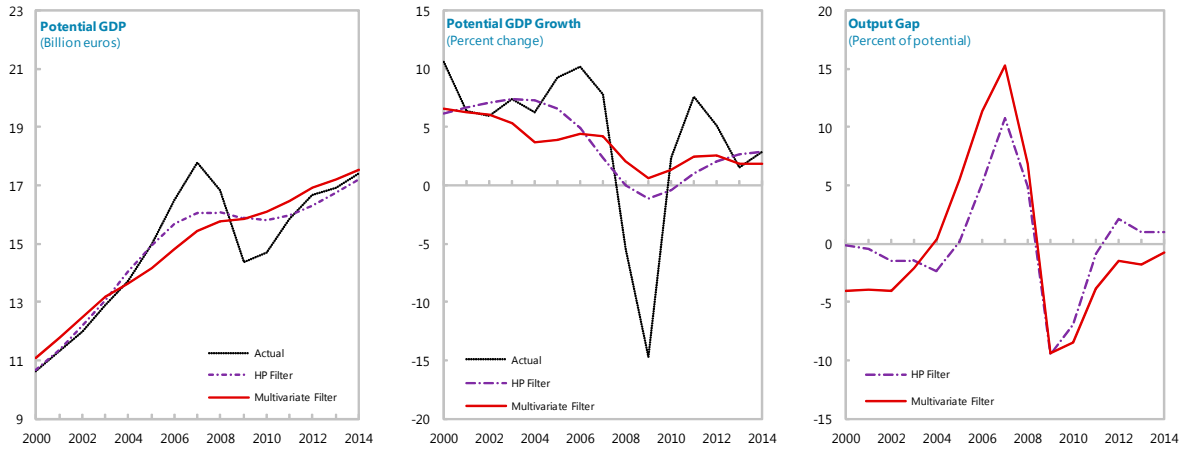
11. **This paper employs a multivariate Kalman filter to strip out the cyclical effects from GDP growth and uncover underlying potential growth.** The evolution of real GDP over time is clearly influenced by cyclical factors, such as demand shocks to a country's exports or credit booms or busts. The underlying potential growth of an economy moves more smoothly. One way to uncover it is to apply a Hodrick-Prescott (HP) filter to the real GDP series. But this is subject to two major drawbacks: as a purely statistical approach it neglects the information about the cyclical position of the economy contained in other variables such as inflation, unemployment, or credit growth, and it implicitly assumes that output gaps—the difference between real and potential GDP—are serially uncorrelated, although from an economic perspective one would expect that they are not. A superior approach can be a multivariate Kalman filter that conditions on a set of variables that capture the economic cycle and allows for serial correlation of output gaps (Borio et al., 2014, and Appendix 1).

12. **The best results in the case of Estonia are obtained by conditioning on four variables**: real credit growth and its change to capture the financial cycle; inflation to capture demand shocks; and trading-partner import growth to capture external conditions. Just as the HP filter, running multivariate filters requires setting a smoothing parameter. The conventional choice for the HP filter is a value of 1,600 for quarterly data (Raven and Uhlig, 2002), corresponding a business-cycle length of 10 years (Maravall and Rio, 2001). An equivalent degree of smoothing is chosen for the multivariate filter.

13. **Application of the multivariate filter puts Estonia's potential output growth at 2.2 percent during 2011–14 and the output gap in 2014 at -0.7 percent** (Figure 4 and Table 1). Potential output estimates based on the multivariate filter move more steadily than those based on the HP filter, presumably because the HP filter does not account for the prominent role of credit in Estonia's boom-bust cycle. Accordingly, output gaps are larger, reaching an astounding 15 percent of GDP at the peak of the boom in early 2007. The multivariate filter also avoids the counterintuitive dip of potential growth into negative territory in the crisis of 2008/09. Output gaps diminish quickly in the recovery phase but remain negative, ending at -0.7 percent of GDP in 2014. Potential growth from 2011 onward is quite steady and moderate, averaging 2.2 percent a year compared to 4.3 percent in the strong years 2003–07.

14. **The multivariate filter can also be applied to subcomponents of GDP to get a sense how their growth potential and cyclicality compare to economy-wide economic activity.** The tradable sector exhibits higher potential growth, underscoring the importance of exports as a driver of growth. Likewise, potential growth is higher over the whole 2001–14 period when the real estate sector is excluded.

Figure 4. Estonia: Potential Output, Potential Growth, and Output Gap, 2000–15



Source: IMF staff calculations.

* Data up to 2015:Q2. Thereafter, IMF World Economic Outlook projections for GDP, CPI and trading partner import growth; and 2015:Q2 figures for credit growth and its change. The variance ratio (corresponding to the smoothing parameter in the HP filter) set to 1,600. The conditioning variables are credit growth, the change in credit growth, CPI inflation, and trading partner import growth. Conditioning variables are de-trended with a smoothing parameter of 8,500.

Table 1. Estonia: Actual and Potential Output Growth

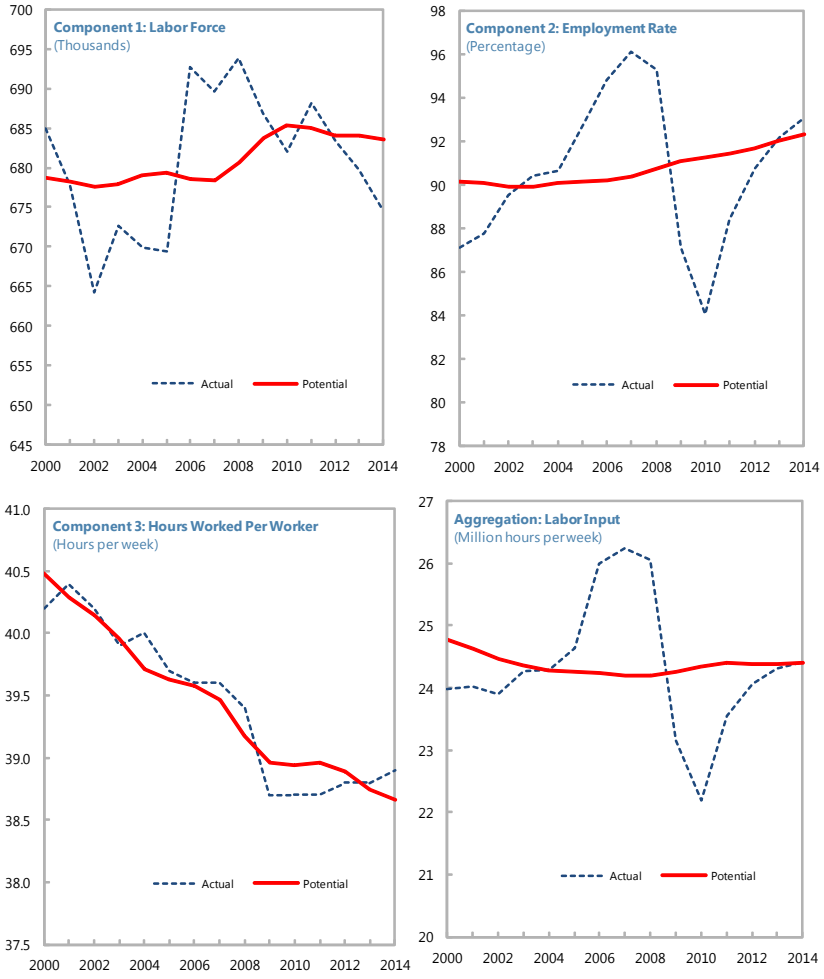
	2001-14		Strong Years 2003-07		Post Boom-Bust-Recovery 2011-14	
	Data	Potential	Data	Potential	Data	Potential
GDP	3.6	3.3	8.2	4.3	4.3	2.2
Tradable Sector Output Only	4.3	4.2	8.5	4.7	4.8	2.6
Output Excluding Real Estate Activities	3.9	3.6	8.7	3.7	4.7	2.7

Source: IMF staff calculations.

15. **A next step decomposes potential growth into factor contributions in a growth accounting exercise.** It assumes that output is generated according to a standard constant-returns-to-scale Cobb-Douglas production function from capital, labor, and TFP. Labor and capital shares of income are set to the customary two-thirds and one-third, respectively. Factor inputs at potential output are derived as follows:

- The actual **capital stock** reflects the maximum capital available in the economy and is therefore equal to capital input at potential output. The data on net capital stocks are taken from the European Commission's AMECO database.[1]

Figure 5. Estonia: Labor Input and Its Components, 2000–15



[1] There is considerable uncertainty in measuring the initial capital stock in 1996. In the AMECO database it is set to 200 percent of GDP for Estonia, as well as most other CEE countries. Had it been larger, for example because the GDP collapse in the early transition period pushed up the ratio, capital accumulation would have played a smaller role in explaining growth and the contribution from TFP would have been correspondingly higher. Alternatively, one may assume a year in the middle of dataset was on a steady state in which capital-output ratio does not change. This constant ratio can be obtained by applying GDP growth and the investment ratio (both on average across years) to the law of motion of capital. The resulting capital stock grows more slowly than the one provided by AMECO. In yet another approach, Kattai (2010) documents that Estonia's capital stock was similar to the GDP in 1996, judging from the asset value of companies. Applying the perpetual method based on this assumption provides the capital stock estimates growing faster than the ones provided by AMECO.

- **TFP** is obtained as the residual from deducting capital and labor contributions at potential from potential output growth.

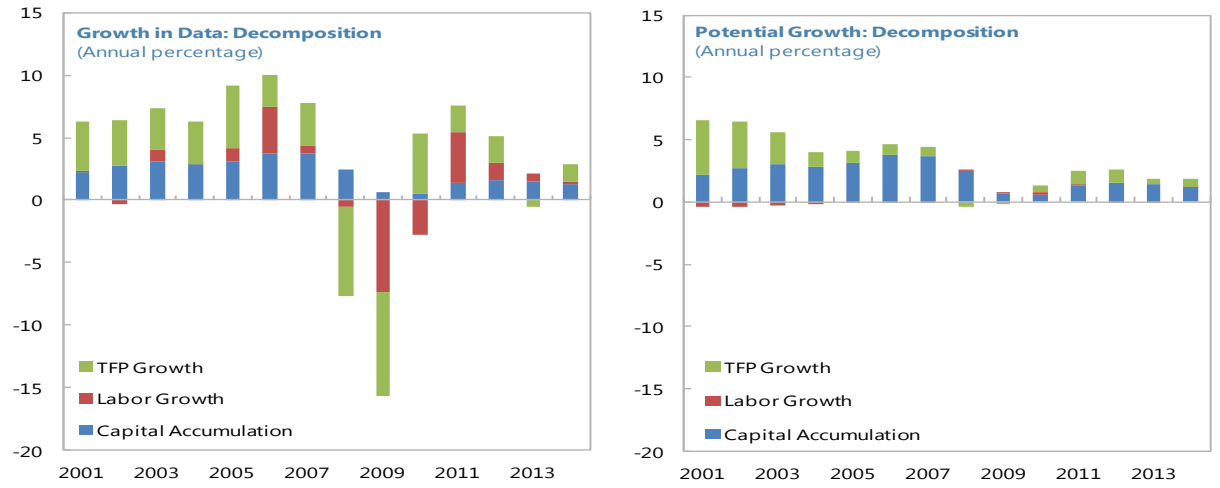
16. **The growth decomposition exercise confirms the key role of capital accumulation for Estonia's growth performance and the slowdown of TFP growth in the post boom-bust-rebound period** (Table 2 and Figure 6). For the entire period 2001–14, capital contributed 2.2 percentage points to potential GDP growth, 1.2 percentage points came from TFP, and labor input did not play much of a role. In the strong years 2003–07, capital and TFP contributions both rose significantly, but fell back to 1.4 and 0.8 percentage points during 2011–14. It should be noted that this decomposition does not make any allowance for improvements in human capital. Precise quantification is difficult, but one exercise suggests that it may have contributed 0.5 percentage points during 2001–14 and 0.7 percent during 2011–14 (Annex 2). This suggests that labor's growth contribution could have been higher by these amounts and TFP growth commensurately lower.

Table 2. Estonia: Growth Decomposition
(Percent)

	2001–14		Strong Years 2003–07		Post Boom-Bust-Recovery 2011–14	
	Actual	Potential	Actual	Potential	Actual	Potential
GDP Growth	**3.6**	**3.3**	**8.2**	**4.3**	**4.3**	**2.2**
Contribution from Capital	**2.2**	**2.2**	**3.3**	**3.3**	**1.4**	**1.4**
Contribution from Labor (excl. Human Capital)	**0.1**	**-0.1**	**1.3**	**-0.1**	**1.6**	**0.0**
Growth in Labor Force	-0.1	0.0	0.5	0.0	-0.2	0.0
Change in Employment Rate	0.3	0.1	1.0	0.1	1.7	0.2
Growth in Hours Worked per Worker	-0.2	-0.2	-0.2	-0.2	0.1	-0.1
Contribution from TFP	**1.3**	**1.2**	**3.6**	**1.3**	**1.2**	**0.8**
Memo item: Human capital contribution	0.4	0.5	0.2	0.7	0.4	0.7

Source: IMF staff calculations.

Figure 6. Estonia: Growth Decomposition, 2001–14



Source: IMF staff calculations

D. International Evidence on Overcoming the Middle-income Trap

17. **The middle-income trap is defined as the growth slowdown that tends to afflict countries when they reach middle-income levels.** Economies tend to start stagnating or at least stop making significant progress in closing the income gap with advanced economies, thus remaining stuck at middle-income levels (Im and Rosenblatt, 2013). Countries are typically considered middle income when their per-capita GDP is in the range of US$2,000 to US$15,000 in 2005 purchasing power terms (Aiyar et al., 2013). While Estonia, at around US$20,000 is technically outside this range, the gap to Germany or Sweden of some 40 percent remains large and growth has significantly slowed in the post boom-bust-recovery period. Is Estonia at risk of falling into the middle-income trap? What did it take in other countries to escape it?

18. **Standard growth models predict income convergence at a diminishing speed as countries grow richer.** Conditional on macroeconomic stability and getting basic policy settings right, the intersectoral transfer of labor from agriculture to more productive sectors such as manufacturing, higher investment, higher labor-force participation rates, and better educational standards, are initially strong drivers of growth. But once achieved, rapid growth tapers off as countries become more prosperous and get closer to the frontier. Continued growth requires structural transformation to keep convergence going by graduating from low-skilled labor-intensive activities and pushing the frontier further (Young, 1995). But many countries fail to develop the national innovation systems required to compete with high-income countries in more sophisticated products (Gill and Kharas, 2007, Yusuf and Nabeshima, 2009, and Woo, 2009). Empirically, up to 85 percent of the growth slowdown can be attributed to diminishing TFP growth rather than a drop off in the rate of factor accumulation (Eichengreen, Park, and Shin, 2011).

19. **The structural transformation to escape the middle income trap is a gradual process, requiring focus on high connectivity sectors and an emphasis on diversified and sophisticated exports** (Jankowska et al., 2012). In the successful Asian economies, new production was sequentially developed in industries (e.g., iron, steel, and electronics) using skills and capabilities transferable with relative ease from existing industries (Lin, 2009). Countries such as Korea recognized the importance to strategically foster high "connectivity" sectors—sectors that are closely linked to other sectors in the economy such that capabilities and knowhow can be easily redeployed. In contrast, Latin America countries have tended to specialize in industries that are relatively far from high-value-added products and less connected. Reliance on a diversified, sophisticated, and non-standard export basket also improves the odds of achieving structural transformation and overcoming the middle income trap (Felipe et al., 2012). For example, Korea was able to gain comparative advantage in a significant number of sophisticated products and was well connected, whereas less successful Malaysia and the Philippines managed to gain comparative advantage in electronics only (Ohno, 2009 and Studwell, 2013).

20. **Empirical studies confirm that escaping the middle-income trap is difficult.** Out of 101 middle-income economies in 1960, only 13 had become high-income economies by 2008, including Equatorial Guinea, Hong Kong (China), Ireland, Israel, Puerto Rico, Korea, Singapore, and Taiwan Province of China (World Bank, 2012). Other studies, also include the Czech Republic, Malta, Slovenia, and Slovakia in the list (Foxley and Sossdorf, 2011 and Cherif and Hasanov, 2015). Even within this successful group, only some made the transition entirely on account of their autonomous efforts, primarily in Asia (Agénor, Canuto, and Jelenic, 2012). Others benefitted from the discovery of natural resources, such as Equatorial Guinea, or integration with high-income economies, such as Puerto Rico and a number of catching-up European economies. This highlights the scale of the challenge for Estonia, but also the opportunities associated with European economic integration.

The Role of Innovation, R&D, and Investment

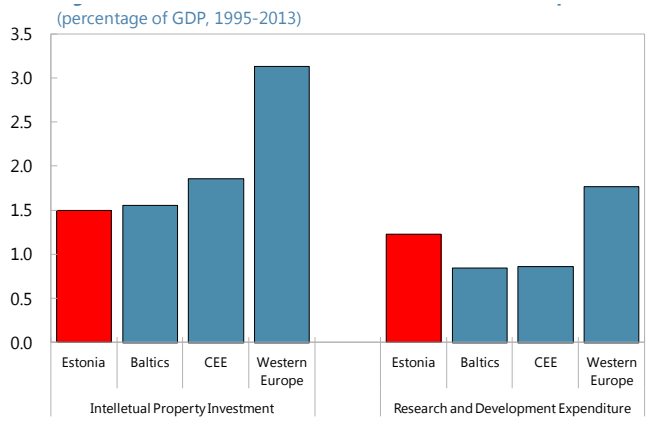
21. **Economies may fail to achieve the needed structural transformation if they do not switch from an investment-based strategy to an innovation-based strategy** (Acemoglu, Aghion, and Zilibotti, 2006). While public support for investment and the adoption of existing technologies remains important, the key to catching up with the technology frontier lies in innovation. In support, governments should move to an innovation-based growth strategy, encompassing financial support and guidance for RDI, incentives for private RDI, especially SMEs and startups, facilitating collaboration, fostering networks, and strengthening competition policies to ease the entry and exit of firms and keep managers on their toes.

22. **Experience from countries that escaped the middle income trap suggests that focused RDI incentives, assistance to SMEs, and improving the relationship between government, business, and academia in building R&D clusters are key.** For example, incentives for collaborative research between industry and universities through tax incentives, support for access to professional services, and the fostering of social networks, were a central plank of the Korean development strategy. They were supported by government tax incentives for R&D, including schemes specifically targeted at SMEs, the importation of foreign technology, and pressure on large

parts of university research to connect with the private sector and produce practical results. Over time, governments typically aim for a gradual shift of R&D funding from the public to the private sector. In Korea the government made most of the outlays initially, but the private sector increasingly took over, eventually accounting for 80 percent of total R&D expenditure (Kim, 1997 and Park, 2000). Korean firms aggressively obtained technologies from abroad, paying significant royalties and buying turnkey factories. They also routinely sent researchers to US firms to absorb advanced technology (Sohn and Kenney, 2007).

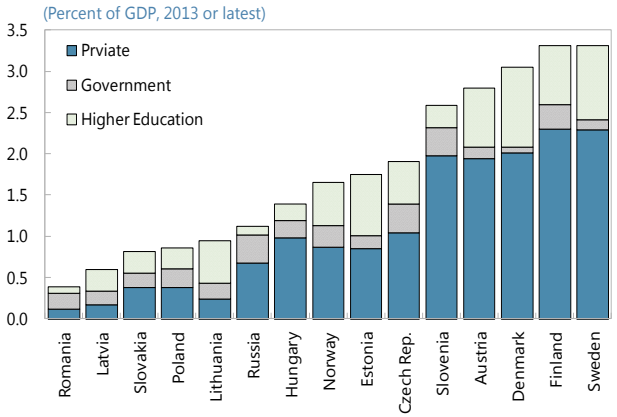
23. **Innovation and SME development are strategic goals for Estonia.** High level targets are set out in the competitiveness strategy "Estonia 2020," notably raising R&D expenditure to 3 percent of GDP and labor productivity to 80 percent of the EU average. A number of other strategic documents elaborate further, including identification of priority sectors for development under the "Smart Specialization Strategy." Implementation programs are also articulated, although only two out of seven programs of the 2007–13 innovation strategy fully so (Expert Group, 2012). R&D spending has picked up in recent years, and at about 1¾ percent of GDP currently is closing in on the EU average (Figure 7). But it relies heavily on EU-funds, which account for two thirds of the public R&D spending. Only 40 percent of R&D expenditure is financed by the private sector, compared to about 60 percent for the Czech Republic, Slovenia, and Austria and closer to 70 percent in most of the Nordics (Figure 8). That Estonia is one of the few countries that does not provide tax incentives for R&D investments may be partly responsible. Moreover, investment in intellectual property, which is a broader concept than R&D expenditure because it also includes intellectual property imports, remains well below the EU average. Support for SMEs specifically in the area of innovation is difficult to judge, but it appears that micro, small, and medium-sized companies received a considerable share of EU funds.

Figure 7. Selected Countries: IP Investment and R&D Expenditure



Sources: Eurostat; and IMF staff calculations.

Figure 8. Selected Countries: Research and Development Expenditures



Sources: Eurostat; and IMF staff calculations.

24. **Implementation agencies have a range of instruments at their disposal.** Under the 2014–20 planning period, the Ministry of Economy and Communication (MoEC) and the Ministry of Education and Research (MoER) are allocated roughly equal amounts of EU funds for their "Entrepreneurship Growth Strategy" and "Knowledge-based Estonia Strategy," respectively, of around 1.3 percent of GDP annually.

- Most MoEC programs are designed to directly benefit the private sector. About 40 percent go toward venture capital funds and are leveraged with private equity. The remaining 60 percent finance various programs implemented by Enterprise Estonia. The largest is the "Company Development Program," which targets 300-400 promising companies that have a track record of presence in export markets or sales growth. The second largest program supports "Competence Centers," which provides practical advice to companies in six scientific areas. There also are an "Innovation Voucher" program and support for creative industries and clusters.

- The bulk of MoER programs support research and higher education at universities. University transfer offices, where businesses can benefit from the scientific knowledge of academia, are also promoted. Under the "Applied Research Program," it is private companies that set research projects' objectives when working with universities and they are freed from the administrative burden of project management in exchange for co-financing of at least 35 percent of the projects' costs.

The Role of Infrastructure and Industrial Clusters

25. **Investment in advanced infrastructure can increase productivity and wages, inducing labor to invest in needed skills.** Productivity gains from learning-by-doing and knowledge network effects can help economies move to a high-growth equilibrium. One way to achieve this is through support and development of clusters connected to the already existing industrial base.

26. **In Korea, economic transformation was facilitated by significant government investment in the creation of industrial cities, technology, and science parks with cutting edge infrastructure.** A national R&D program was launched along with initiatives aimed at helping private companies develop high technologies. The industrial clusters evolved around four strategically important industries in each region and regional innovation councils were used to help facilitate their development (Mazzarol, 2012).

27. **The promotion of clusters is also a feature of Estonia's innovation policies, but they have not taken off in a big way.** The cluster development program in Estonia is co-financed by Enterprise Estonia with EU funds and aims to promote cooperation between companies with similar interests and between companies and research institutions in order to improve international competitiveness. Applications are bottom up and finance for RDI work is granted based on international peer review. In practice however, these clusters mostly focus on coordination of marketing activities and staff training—the number of clusters has declined from 17 to 13 and they comprise 20–30 companies each. Industrial parks are separate entities and are loosely defined to include areas with basic infrastructure and local government support. But the cross-border Tallinn-Helsinki cluster has produced tangible positive results in terms of enhancing the productivity, innovation, competitiveness, and export capacity of SMEs. Similar cross-border cluster collaboration projects with Latvia are envisaged, such as a cluster for niche food producing companies and a regional business incubator cooperation network for boosting export capacity of start-ups. Cross-border clusters are particularly suitable for small states, such as Estonia, where they can help realize economies of scale and scope (see Box 4).

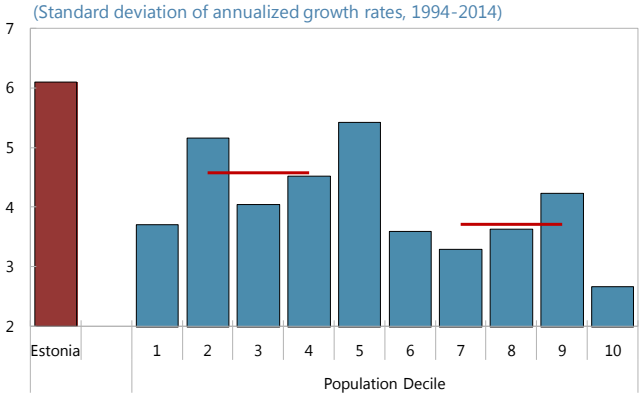
Box 4. Is Small Size an Obstacle to Growth?

Small states do not appear to be disadvantaged in achieving strong economic growth, though growth tends to be more volatile. They face a number of offsetting advantages and disadvantages. Closer integration can help alleviate a key drawback of small states related to lumpy investment and economies of scale in infrastructure.

Investment lumpiness and scale economies can constrain small states, but these can be mitigated through closer integration and cooperation. In principle, increasing returns to scale may be difficult to realize in small states (Romer, 1986; Barro and Sala-i-Martin, 1995; Aghion and Howitt, 1998). But through European Union membership and close cooperation with the other Baltic and Nordic states, Estonia has the opportunity to become part of regional operations that have sufficient scale. Prominent examples include infrastructure projects in the energy sector, such as the EstLink 2 between Estonia and Finland and the 3rd Estonia-Latvia electricity interconnection, proposals for the Baltic-connector and the associated liquefied natural gas terminal between Estonia and Finland, and the Baltic rail project that would improve connectivity between Estonia with the rest of Europe. In the private sector, participation in cross-border value chains can help alleviate constraints where domestic size is lacking.

Small economies are highly open to external trade, exposing them to the vagaries of export markets (Figure 4.1). Openness to trade increases productivity growth via trade-related technology diffusion (Coe and Helpman, 1995, Engelbrecht, 1997, Falvey et al., 2002, and Schiff and Wang, 2006), and this increase is substantially larger for small states than for large ones (Schiff and Wang, 2008). However, small size also leads to concentration of economic activities and limits diversification. This makes small states more vulnerable to terms of trade shocks (Commonwealth Consultative Group, 1997, Briguglio, 1995, and Armstrong and Read, 1998). Empirical studies have documented higher growth volatility in small economies due to external shocks (Easterly and Kraay, 2000), which could adversely affect average growth (Ramey and Ramey, 1995).

Figure 4.1. Growth Volatility by Size*
(Standard deviation of annualized growth rates, 1994-2014)



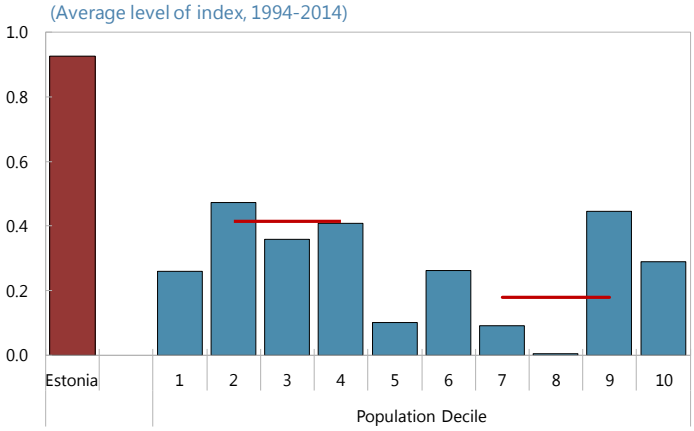
Sources: World Economic Outlook.
*Size declie based on population. Estonia belongs to the 3rd decile.

Small states typically exhibit higher levels of brain drain, in part due to limited opportunity to use specialized expertise (Docquier, Lohest, and Marfouk, 2007), but emigration from Estonia seems not skewed toward the highly skilled. The negative impact of the brain drain is larger in small than in large states both because TFP growth is more sensitive to the brain drain and because the brain drain is substantially larger (Schiff and Wang, 2008). In the case of Estonia, net migration averaged at -3.1 per thousand inhabitants during 1995–2013 (compared with the EU28 average of +2.1). While high, this was much lower than the -6.7 in Latvia and -8.3 in Lithuania. In addition, according to Estonia's National Audit Office, "people who emigrate from Estonia tend to be young, low paid, and without a permanent job, and there is no extensive emigration of people with higher education."

Box 4. Is Small Size an Obstacle to Growth? (concluded)

Theories of economic growth suggest that the provision of public services is subject to indivisibilities and therefore exhibit increasing returns to scale that are hard to realize for small states (Alesina and Spoalare, 1997). This is particularly true for fiscal institutions (Easterly and Rebelo, 1993) and defense (Harden, 1985). It is also suggested that public officials in small states are more likely to be subjected to conflicting pressures (Farrugia, 1993), and it may be difficult to recruit a high-quality civil service given the limited pool of candidates in small states (Streeten, 1993). On the flip side, Kuznets (1960) notes that small states tend to have more cohesive populations, which may make it easier to forge the political consensus required to adjust to a changing environment. Easterly and Levine (1997) and Alesina, Baqir, and Easterly (1999) find that measures of ethnic fractionalization are associated with a lower level of public goods provision and lower growth. Indeed, small states score better in terms of government effectiveness (Figure 4.2).

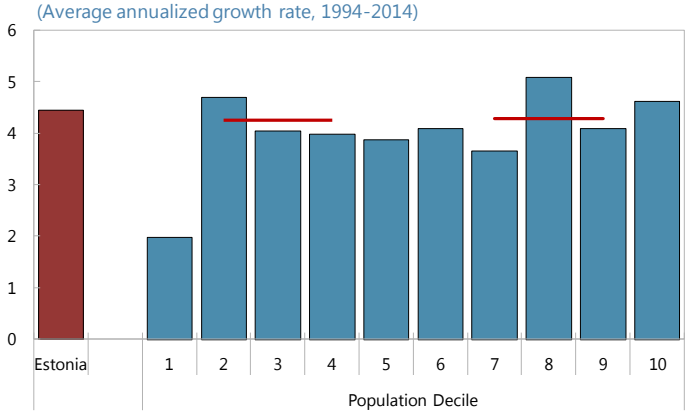
Figure 4.2. Government Effectiveness*
(Average level of index, 1994-2014)



Sources: World Governance Indicators.
*Size declie based on population. Estonia belongs to the 3rd decile.

The overall impact of size on economic growth and catching-up potential is ambiguous. The empirical evidence is mixed, with some studies suggesting that small states have a productivity advantage (Easterly and Kraay, 2000). Armstrong, de Kervenoael, Li, and Read (1998) use cross-sectional regressions covering a large number of small states and independent regions and argue that population size does not significantly affect growth, if initial income and regional effects are controlled for. Likewise, Milner and Westaway (1993) also cannot find evidence that the effect of key growth determinants varies with country size.

Figure 4.3.Real GDP Growth by Size*
(Average annualized growth rate, 1994-2014)



Sources: World Economic Outlook.
*Size declie based on population. Estonia belongs to the 3rd decile.

The Role of FDI and Multinational Firms

28. **FDI and the presence of multinational firms can boost technology diffusion, but views about the magnitude of the benefits are mixed.** Some studies stress the benefits from knowledge transfer of multinational firms not only to their foreign affiliates, but also to their local suppliers, spillovers to other local firms through demonstration effects, increased competition, worker mobility, and information sharing about export markets (Javorcik, 2010). Others caution that multinational firms' interest in providing knowledge and training is limited, the absorption capacities of domestic firms may be low, weaknesses in the relations to domestic suppliers reduce spillover effects, and competition may actually suffer when multinational firms come to dominate domestic markets (Hayakawa, Kimura, and Machikita, 2010). Accordingly, a comprehensive literature review concludes that evidence about the strength of productivity spillovers is rather mixed (Smeets, 2008).

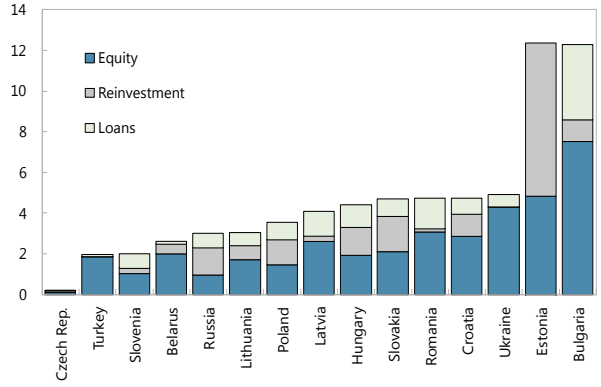
29. **The cases of Malaysia and Thailand illustrate the potentially limited benefits from the presence of multinational firms.** Both countries relied to a great extent on multinational firms for technological upgrading rather than development of autonomous systems. But multinational firms turned out not to be much of a conduit for technology diffusion to local firms. They preferred their own suppliers, relied primarily on in-house production or imported inputs, and repatriated most of their profits. Local value added increased but technology diffusion did not improve (Felker, 2001). Korea deliberately forewent FDI and focused instead on reverse engineering, original equipment manufacturing, licensing, and the purchase of turnkey factories (Chung, 2007).

30. **In Ireland on the other hand, FDI was instrumental for the transformation of the economy.** The focus on export-oriented FDI in manufacturing led to extensive development of green-field state-of-the-art factories. A key part of the Irish success was expanding backward linkages from these export-oriented firms to the domestic economy. Many of the new firms started out with few initial linkages, but developed them over time (Görg and Ruane, 2001, and Kennedy, 1999). This underscores the importance of fostering the local connectivity of multinational firms and attracting multinational firms with high spillover potential.

31. **Estonia attracted considerable FDI and many multinational firms, improving living standards but generating limited spillovers.** FDI inflows over the last decade were the second highest in the region and the FDI stock is second to none of Estonia's peers (Figures 9 and 10). Foreign-owned firms provide one third of all jobs in Estonia, pay higher wages, and are more active in export markets, thus helping underpin Estonia's living standards. Foreign firms tend to locally reinvest their profits, which account for over 60 percent of total FDI inflows. However, the sectoral mix of FDI suggests limited spillover to the rest of the economy. Close to two-thirds is invested in the finance and real estate sectors and only 16 percent went into the manufacturing sector.

Figure 9. Selected Countries: FDI Inflows

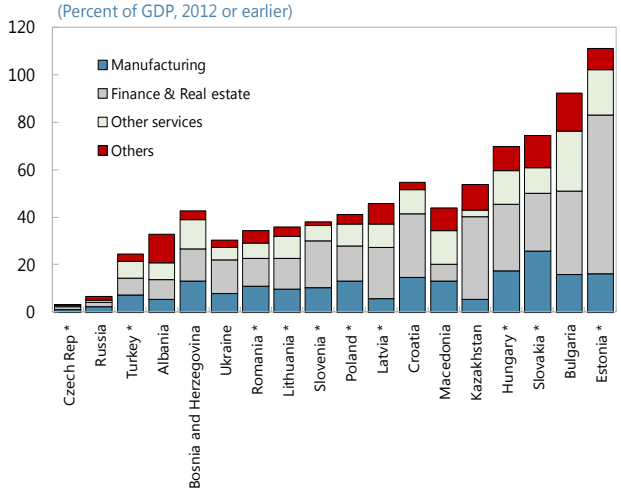
(Percent of GDP, 2003-12 average)



Sources: WIIW; and IMF staff calculations.

Figure 10. Selected Countries: Stock of FDI by Activity

(Percent of GDP, 2012 or earlier)



Sources: WIIW; and IMF Staff calculations.
*Denotes countries without 2012 data; Latvia (2011); Hungary, Lithuania, Slovakia (2010); Czech Republic, Poland, Estonia (2009); Romania (2008) and Slovenia (2007)

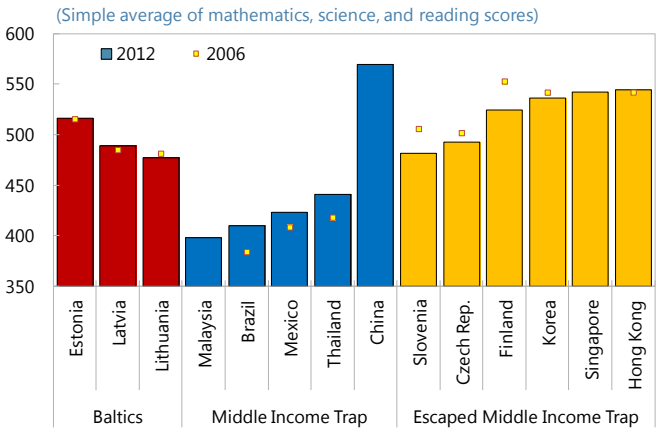
The Role of Education and Labor Resources

32. **High educational standards and efficient use of labor resources are critical for achieving the structural transformation to high-income status of an economy.** Empirical studies demonstrate that countries with a high share of the population that has completed secondary and tertiary education are less likely to experience growth slowdowns (Eichengreen, Park, and Shin, 2013). The earlier middle-income countries increase public and private resources to improve the quality of education, the greater the chances for a rapid transformation to advanced economy status, a lesson clearly borne out by the experiences of Finland, Korea, and Ireland (Foxley and Sossdorf, 2011). At the same time, it is critical that labor resources are used efficiently: fields of study need to accord with labor market needs; skills need to be maintained throughout work life supported by life-long learning and active labor market policies; and high labor force participation needs to be achieved, including through adequate retirement ages, avoiding disincentives for women to join the labor force, and controlling the takeup of disability pensions.

33. **Finland and Korea are examples of countries that were successful in making the transformation and implemented major education reform.** Finland introduced nine years of mandatory primary education, divided secondary education into a vocational and technical track on the one hand and an academic secondary school track on the other hand, and set up polytechnics in tertiary education catering to regional and business needs for human capital. Similarly, Korea introduced six years of mandatory elementary school education in 1954 and, in the 1970s, reformed vocational and technical secondary education, with a view to providing skilled workers to high growth sectors such as chemicals and heavy industries. Interestingly, the upgrading of educational standards in Korea tended to be one step ahead of the upgrading of the economy.

34. **Estonia scores well in headline indicators for educational attainment.** At close to 6 percent of GDP, Estonia's public expenditure on education is above the EU average. The tertiary educational attainment rate for the 30–34 year olds is also higher at 44 percent. Almost all classrooms were connected to the internet as far back as 1998 and pupil's PISA scores for reading and numeracy skills exceed the OECD average (Figure 11). There have been several rounds of education reform, including the abolition of tuition in tertiary education and the introduction of targeted study allowances and scholarships with the 2013 amendments to the Higher Education Act to boost the number of graduates in key fields of specialization. Enrollment in life-long learning and female labor force participation are also more favorable than in the EU, although not as good as in the Nordics. Relatively low pensions that discourage early retirement and keep many pensioners in the labor force tend to push up participation rates, but generous parental leave of 18 months at full pay may have the opposite effect. Recourse to the disability system is high, with around 10 percent of the working age population receiving pensions. "Work Capacity Reform" legislation has recently been adopted and will be implemented from mid-2016. It seeks to put more disabled pensioners to work and reforms the verification system for eligibility.

Figure 11. Selected Countries: 2006 and 2012 PISA Scores



Sources: OECD; and IMF staff calculations.

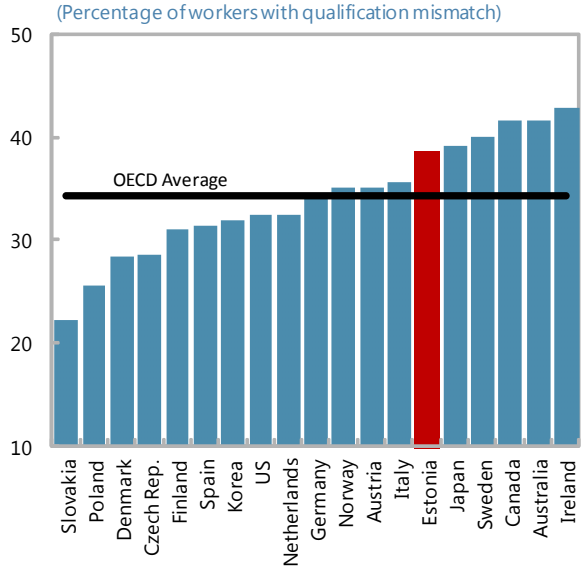
35. **Nonetheless, some deficiencies lurk behind the favorable readings of the headline indicators.** That about a third of Estonia's labor force does not hold a professional education is perhaps the biggest blemish, especially considering that the deficit among the 25–34 year olds is just as large. Aptitude tests under the OECD's Programme for the Assessment of Adult Competencies (PIAAC) find deficits in problem solving skills in a technology-rich environment and large differences in the performance between Estonian and non-Estonian residents. PIAAC data also reveal skill mismatches, with many workers having higher skill levels than needed in their jobs and some workers having lower skills than required. Such mismatches are typically attributed to insufficient mobility of workers between firms related to barriers to residential mobility, not enough competition between firms, overly stringent bankruptcy laws, low managerial quality, and inadequate life-long learning (OECD 2015b and 2015c). Qualification mismatches, which measure inadequacies in the level of formal levels of education, are high in the case of Estonia. OECD quantifications suggest that reducing skill and qualification mismatches to best-country practice could boost productivity by 5–10 percent.

36. **Universities may not provide graduates with the optimal specializations and vocational and apprenticeship programs are not yet fully developed.** Anecdotal evidence points to mismatches between students' chosen field of study and the needs of the private sector, with an oversupply in arts and behavioral sciences and a shortage of ICT specialists, engineering, and

science graduates. The quality of university studies may also suffer because students spend a lot of time working for pay—some 27 hours per week, the highest in the EU together with Latvia (Staehr, 2015). Enrollment rates in vocational training are a third below the EU average, partly reflecting the high value attached to higher education compared to vocational qualifications and the salary advantage of university graduates over and above the contribution to workplace skills (Estonian Ministry of Education and Research, 2015). Dropout rates are high at close to one-third. With businesses considering the provision of labor skills mainly the responsibility of the government, apprenticeship programs are underdeveloped at a participation rate of only 2 percent.

Figure 12. Selected Countries: Qualification Mismatch

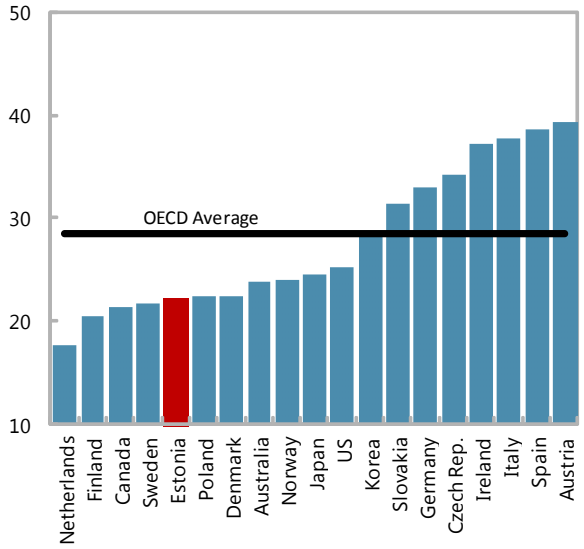
(Percentage of workers with qualification mismatch)



Sources: OECD; and IMF staff calculations.

Figure 13. Selected Countries: Skill Mismatch

(Percentage of workers with skill mismatch)



Sources: OECD; and IMF staff calculations.

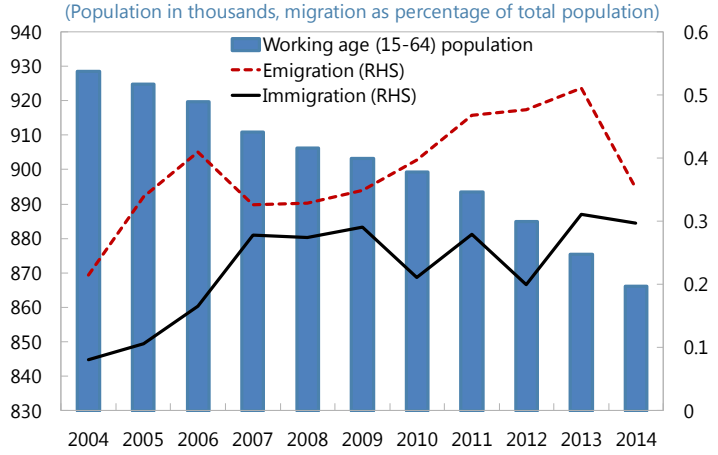
The Role of Expats and Foreign Brains

37. **If labor market needs cannot be fully met by local talent, foreign-educated residents or immigration can provide a way out.** For example, in Taiwan Province of China and Korea, returnees who had gained relevant experience and built networks abroad played a key role in the government's efforts to create innovative firms. The large number of highly skilled workers from Taiwan Province of China and Korea who were employed in Silicon Valley in the 1980s brought back their accumulated technical experience in industry and informal relationships. Returnees played an important role in the successful establishment of IT and other high-technology industries in Taiwan Province of China's Silicon Valley, Hsinchu City, in the late 1980s. Postgraduate returnees in Hsinchu City accounted for about 78 percent of its labor force. Many highly educated returnees were also attracted to the local aerospace sector and other industries (Stalker, 2000).

38. **The government of Taiwan Province of China implemented a series of policies specifically designed to encourage the return of highly educated former emigrants** (Iredale and Guo, 2011). These included the provision of travel subsidies for returnees and their families, job search assistance, business investment assistance, facilitation of visits by academics and experts, and the establishment of recruitment programs that offered competitive salaries and improved working conditions (Tsay and Lin, 2000).

Figure 14. Estonia: Population and Migration Trends

(Population in thousands, migration as percentage of total population)



Sources: Statistics Estonia; and IMF staff calculations.

39. **Estonia is battling significant net emigration, but its large expatriate population and room for immigration are also opportunities** (Figure 14). Estonia's history has been marked by several waves of emigration that gave rise to an expatriate community an estimated 200,000 people strong, compared to a resident population of 1.3 million. During 1995–2013 net migration averaged -3.1 per thousand inhabitants, compared to +2.1 per thousand inhabitants for the EU28 average. In CEE, only Latvia and Lithunia saw more people leaving with rates of -6.7 and -8.3, respectively. But it was not primarily the highly skilled that left Estonia: a study by Estonia's National Audit Office concludes that people who emigrate from Estonia tend to be young, low paid and without a permanent job, and there is no extensive emigration of people with higher education. Immigration to Estonia from outside the EU has been moderate and is restricted by the Aliens Act, which currently sets an annual cap on the number of migrants at 0.1 percent—up from 0.05 percent earlier—of Estonia's permanent population. The quota does not apply to the citizens of the United States and Japan, as well as students and researchers. With the 2013 amendments to the Law on Foreigners, foreign students are allowed to stay in Estonia after finishing their studies provided they find local employment.

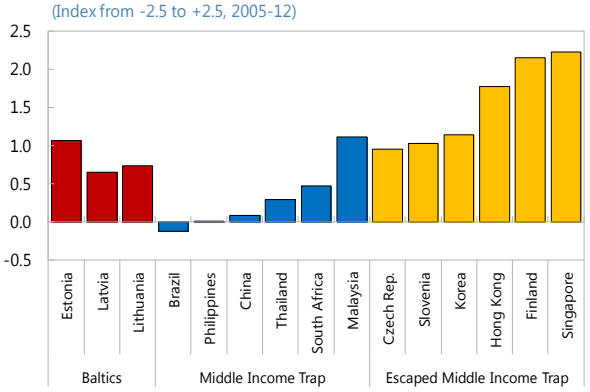
The Role of Macroeconomic Stability and Institutional Quality

40. **Macroeconomic stability and institutional quality have long been recognized as key perquisites for strong and sustainable growth.** Inflation above a certain threshold and macroeconomic volatility has been shown to be detrimental to growth (Ghosh, 2000 and Montiel, 2004). Argentina and Turkey in the 1980s and 1990s are cases in point. Large cross-country models that seek to identify the fundamental drivers of growth typically find a positive impact from indices of institutional quality or the business climate and a negative impact from indicators of government size, along with a significant role for economic openness, initial income levels, and education levels (e.g., Schadler et al., 2006). Other studies link good economic institutions, such as property rights,

judicial independence, labor market flexibility, and business environment reform, directly to the likelihood of overcoming the middle income trap (Hartwell, 2013).

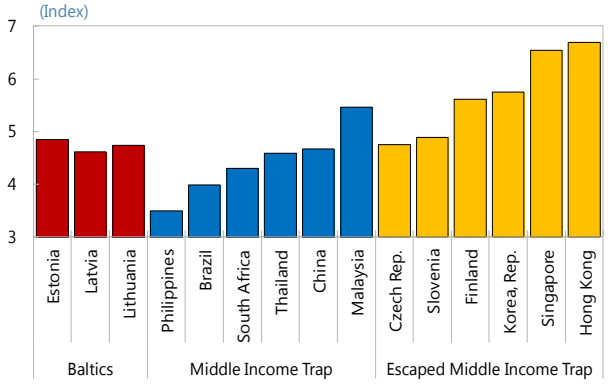
41. **In Estonia, macroeconomic stability is in place and institutional quality is high.** With the boom-bust-recovery cycle now below its belt, Estonia has achieved internal and external balance. Inflation is low, unemployment is close to its structural level, and the current account is roughly balanced. Estonia earns high marks for its business climate, with the World Bank's "Ease of Doing Business" assessment ranking Estonia 17 out of 189 countries and ahead of all other CEE and the World Economic Forum's "Global Competitiveness Report" ranking Estonia 29 out of 144 countries, again ahead of all other CEE countries. Estonia also has the second fewest regulated professions in the EU, after Lithuania, according to the European Commission. Government effectiveness is ranked rather high and so is the quality of infrastructure (Figures 15 and 16). Further state reforms are on the agenda to consolidate the large number of local governments, merge central government agencies, further enhance e-governance, and reduce government employment in line with the shrinking working age population.

Figure 15. Selected Countries: Government Effectiveness



Sources: World Governance Indicators; and IMF staff calculations.

Figure 16. Selected Countries: Infrastructure Quality



Sources: World Economic Forum; and IMF staff calculations.

E. Projecting Estonia's Future Potential Growth

42. **Projections of Estonia's future potential growth are based on historical trends in the evolution of factor inputs, population projections, and the effects from known policy changes.** Projections derive potential growth as the sum of the contributions from the factors of production at their potential level: labor, capital, and TFP. As in the decomposition of historical potential growth, they assume a standard constant-returns-to-scale Cobb-Douglas production function with labor and capital shares of two-thirds and one-third, respectively.

43. **Out of the three production factors, labor input can be projected most reliably.** Labor input derives as the product of the constituent elements: working age population, labor-force participation rates, employment rates, and hours worked per employed person.

- **Population projections** are the ones by Statistics Estonia under variant 1. They foresee an annual average decline during 2014–33 by 0.3 percent for total population, 0.6 percent for the population aged 15–74 years, and 0.9 percent for the population aged 20–64 years. For the economically most active age group of 20–64 years, the decline is about three times as high as in the past and picks up during the projection period.

- **Projections of labor-force participation rates** follow the "cohort approach," which calculates them from recent and cyclically adjusted labor force entry and exit rates for each cohort as it ages (Burniaux et al., 2004 and Joansson et al., 2013). This takes better account of recent trends in labor force participation, compared with simply applying historical participation rates for each age group. Because demographics will shift the age distribution within the working age population toward older age groups with lower participation rates, the overall participation rate tends to fall. But this is offset by the effects of rising retirement ages to 65 years for men and women through 2026 and the assumption that the trend rise in female labor force participation will continue at a moderate pace, bridging over the projection period 60 percent of the gap with Sweden, the best performer in the EU. The 2015 reform of Estonia's disability system will also significantly raise participation rates, but the effect on employment will likely be more limited as many of those with partial work capacity either already work or will have trouble finding jobs, pushing up structural unemployment (Bank of Estonia, 2015a, Box 4). The overall cumulative effect on employment is an estimated 2.7 percent. All said, the labor-force participation rate, excluding the effect from the disability reform, is likely to remain roughly constant over the next twenty years, compared with a rise by 6.5 ppts for the 15–74 year olds since 1999.

- Recent developments suggest that **structural unemployment** in Estonia has declined—backward looking studies find rates close to the double digits, but actual unemployment is currently significantly lower without signs of economic overheating (IMF, 2014). This may reflect employers becoming more tolerant of skill mismatches as they seek to fill existing positions with fewer people entering the labor force. Skill mismatches may also decline as people with education acquired before the re-establishment of independence in 1991 are starting to exit the labor force. The projections assume structural unemployment to further decline to 5 percent by 2033, excluding the effect of the disability reform.

- **Hours worked per employed person** have long been on a declining trend, falling from 40.5 to 38.7 hours per week between 2000 and 2014. However, with labor becoming scarcer the trend is assumed to peter out and reverse a bit, with average weekly hours worked reaching 40 again in 2025 and remaining constant thereafter.

These assumptions imply broadly unchanged labor input over the next twenty years on average, with positive rates in the first decade offset by negative ones in the second decade. Overall, this outlook is similar to developments from 2000 to now when labor input growth was close to zero.

44. **Projected capital accumulation will contribute much less to potential GDP growth than in the past.** Estonia has a history of high investment. The investment ratio climbed above 35 percent

of GDP at the height of the boom but has retracted to around 25 percent of GDP in the post boom-bust-recovery period. The projections assume a gradual increase to 30 percent of GDP, considering Estonia's conducive business environment, the need to substitute capital for increasingly scarce labor, and exposure to competition that mandates investing in the upgrading of equipment and knowledge. The depreciation rate is kept at its historical average of around 5 percent. While this leaves the investment ratio above its historical average, the rate of capital accumulation—and therefore the capital contribution to growth—will be significantly lower than in the past. With the capital stock in relation to GDP higher than in the past and rising further, a given investment ratio translates into smaller and smaller rates of capital accumulation and hence a smaller contribution to potential GDP growth. In addition, rising depreciation reduces net investment.

- **TFP growth could match its historical performance.** TFP is the growth factor most difficult to project. Overall it has been on a declining trend averaging only 0.8 percent in the post boom-bust-recovery period, well below its 2001–14 annual average of 1.3 percent. Projections involve weighing factors that put downward pressure on TFP growth, such as the reduced catching-up potential and the depletion of relatively easy options for further economic reforms, against positive factors, such as Estonia's strong economic institutions, high educational standards, and determined efforts to boost innovation. Gradual rising TFP growth to 1.5 percent a year seems to strike a reasonable balance. It is also in line with what Johansson et al. (2013) suggests for the average of OECD countries.

45. **Combining the projections for the three factors of production in a central scenario puts Estonia's annual potential GDP growth at around 3.0 percent for the next five years** (Figure 17). The average for the full projection period through 2033 is somewhat lower at 2.7 percent, primarily because the labor contribution turns negative in the second half as the demographic deterioration accelerates and gains from rising participation rates, longer working hours, and falling unemployment have run their course. Projected average annual growth is lower than during 2001–14, when it reached 3.4 percent. The decline of growth in per-capita terms is similar, because the pace of population decline does not change significantly from the past. But growth per worker declines by less—from 3.1 to 2.9 percent—as the decline in the number of workers is higher in the projection period than in the past.

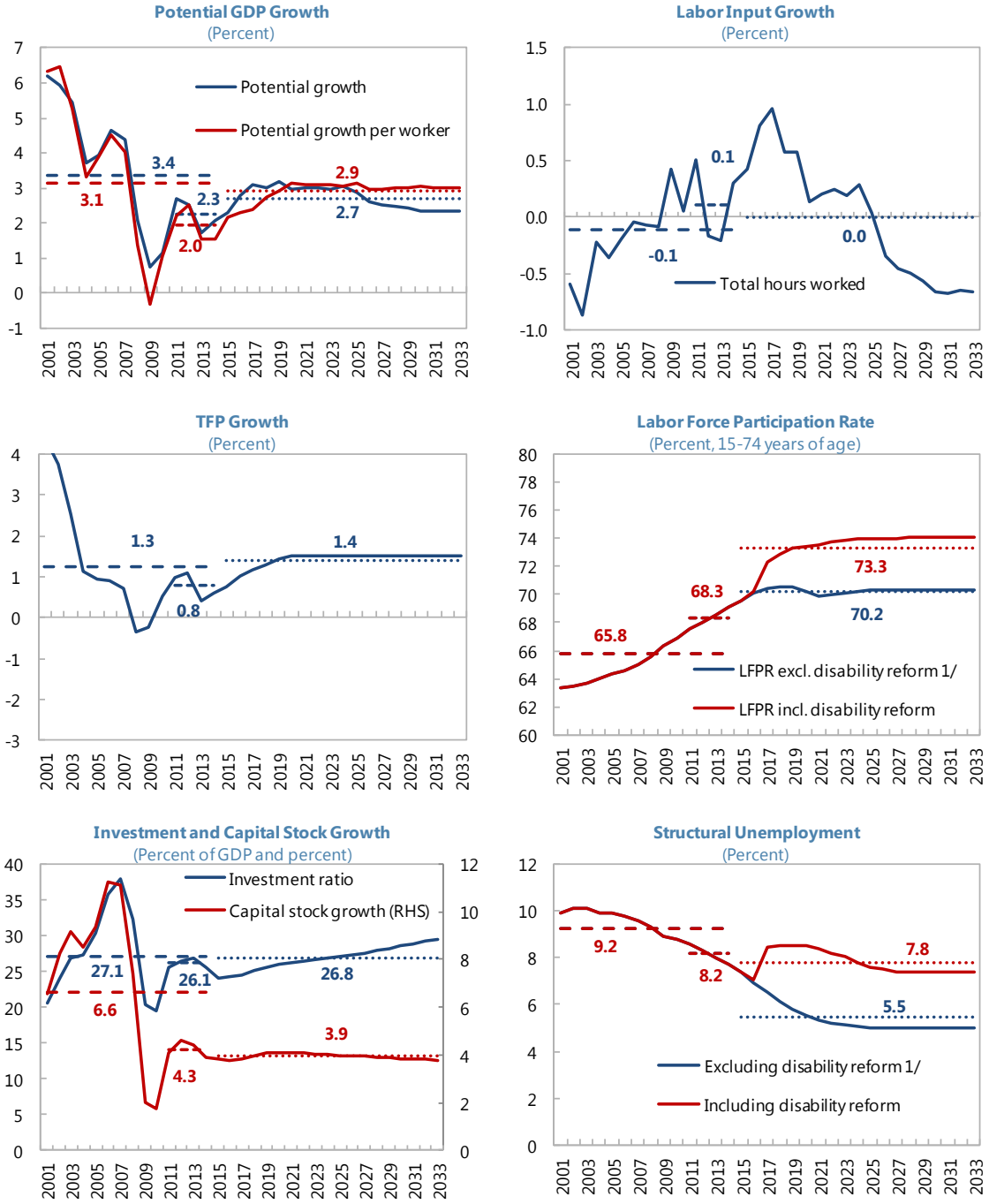
46. **A number of variations to the central scenario give a sense of what it would take to lift future potential growth by one percentage point and the risks that it falls short.**

- A **stretch scenario** considers several enhancements over the central scenario. TFP growth reaches 1.8 instead of 1.4 percent, the investment ratio rises to 35 instead of 30 percent of GDP, and labor force participation rates increases to the high Swedish levels, averaging 74 instead of 70 percent for the 15–74 year olds, excluding the effect of the disability reform. Under these circumstances, projected potential GDP growth would reach 3.7 percent (Figure 18). Higher TFP growth and more investment contribute 0.4 ppts each; higher labor force participation rates add the remaining 0.2 ppts. It should be noted that rising participation rates cannot be a permanent source of growth because they are subject to natural upper limits. Investment can make a contribution for longer but

very much runs into diminishing returns as the capital-to-output ratio rises. It is only TFP that can underwrite sustained high growth.

- In a more **pessimistic scenario** efforts to boost TFP growth are assumed to be less successful with an average projected rate of 1.1 instead of 1.4 percent. In addition, the investment ratio would only rise to 25 instead of 30 percent of GDP. As a result, potential GDP growth would average 2.2 percent over 2015–33 instead of 2.7 percent (Figure 19).

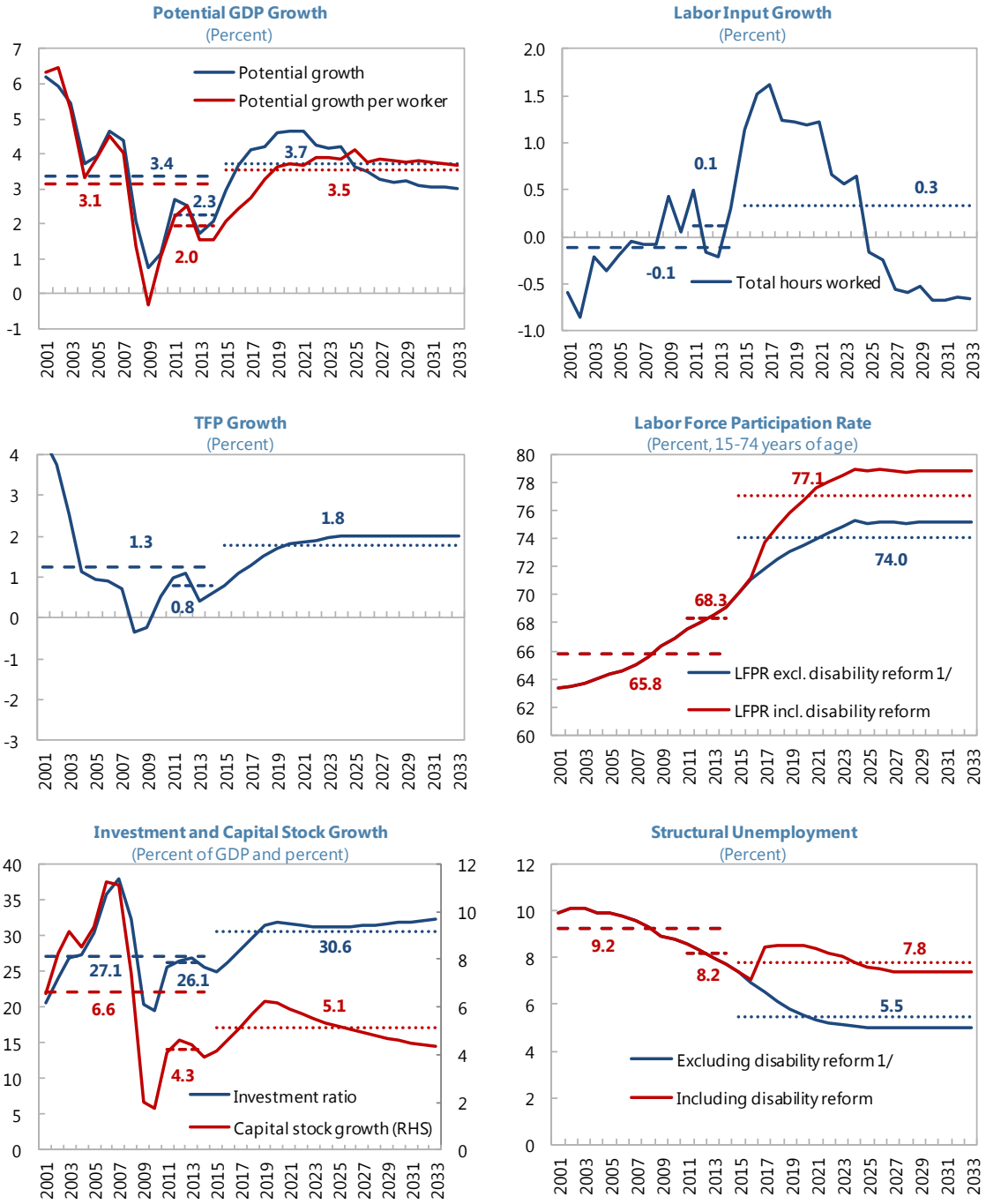
Figure 17. Estonia: Central Scenario for Potential Growth, 2001–33



1/ The disability reform is expected to add significantly more people to the labor force, but the effect on employment will be limited as many will likely be unable to find a matching job, which will push up the structural unemployment rate. The evolution of labor force participation and structural unemployment rates is shown only to ease comparability with historical data and is not factored into labor input or potential growth calculations.

Source: IMF staff calculations.

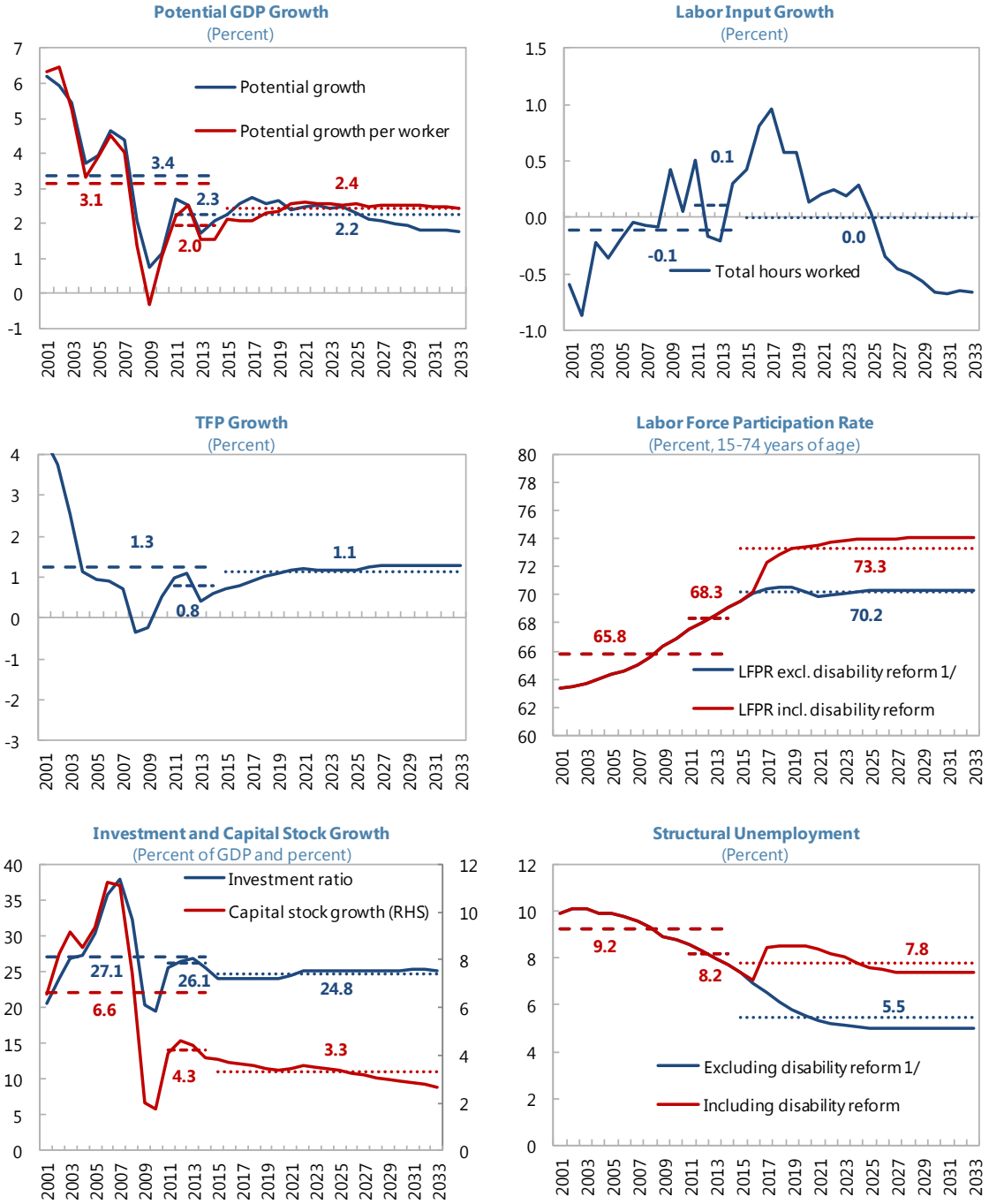
Figure 18. Estonia: Stretch Scenario for Potential Growth, 2001–33



1/ The disability reform is expected to add significantly more people to the labor force, but the effect on employment will be limited as many will likely be unable to find a matching job, which will push up the structural unemployment rate. The evolution of labor force participation and structural unemployment rates is shown only to ease comparability with historical data and is not factored into labor input or potential growth calculations.

Source: IMF staff calculations.

Figure 19. Estonia: Pessimistic Scenario for Potential Growth, 2001–33



1/ The disability reform is expected to add significantly more people to the labor force, but the effect on employment will be limited as many will likely be unable to find a matching job, which will push up the structural unemployment rate. The evolution of labor force participation and structural unemployment rates is shown only to ease comparability with historical data and is not factored into labor input or potential growth calculations.

Source: IMF staff calculations.

F. Policy Implications for Estonia

47. **Overall, Estonia is well positioned to realize the 2.7 percent medium-term growth rate of the central scenario.** The scenario is predicated on a pickup in TFP growth, which should be achievable considering Estonia's generally conducive business environment, good educational standards, and improvements of innovation policies that should pay off over time. It is also predicated on containing the adverse effects from demographics. Policies to this effect are in place, such as raising the retirement age and reforming the disability pension system. Favorable trends in female labor force participation and declining structural unemployment will also lend support.

48. **Estonia would stay away from the middle income trap, but income convergence with the EU average would slow to half its historical pace.** According to the IMF's October 2015 World Economic Outlook projections, real per-capita GDP growth in Estonia was 2.1 ppts higher than in the EU during 2001–14, but this premium would come down to 1 ppt during 2015–20 under the central scenario. The premium is likely to decline further after 2020 because of the increasing demographic headwinds in Estonia. The challenge to keep up income convergence is by no means unique to Estonia and applies to CEE at large if not to emerging market economies generally. Estonia is arguably better equipped to meet this challenge than most of its peers.

49. **What then can be done to achieve higher potential growth and faster income convergence for Estonia?** Since Estonia already gets all of the major policy settings right, no radical departure from the current approach is called for. It will be important though to fully implement the many pro-growth policy initiatives that are in the pipeline and make them a success. Over and above that, a more focused policy approach, enhancements in innovation and SME support policies, better mobilization of labor and human capital, and structural reform could help lifting Estonia's potential growth toward the rates of the stretch scenario.

Enhancing Policy Focus and Implementation

50. **Raising productivity should be squarely put on the top of the economic policy agenda.** While it already is a key goal under the "Estonia 2020" strategy, the plethora of objectives and policies laid out in ministerial strategies and programs risk losing focus, pose coordination challenges, and could lead to conflicting goals. A transparently laid out hierarchy of goals and objectives with raising productivity at the top would provide the needed clarity and focus.

51. **Establishing a strong productivity unit in the Prime Minister's office to drive the agenda should be considered.** Several ministries are involved in efforts to raise productivity growth, implementing a multitude of programs. But there is no overall accounting of government spending for productivity promotion, no evaluation of the relative merits of the different initiatives, no centralized mechanism to boost successful programs and redesign or terminate poorly performing ones, and implementation had sometimes been poor in the past. A productivity unit in the Prime Minister's Office with a strong mandate to address these issues and that plays a much more pivotal role than the existing Strategy Unit would be an important step forward. It could be

supported by a productivity commission, which for example Australia has chosen to establish (OECD, 2015d).

Enhancing Innovation Policy

52. **Policies should foster innovation in a broad sense.** Innovation is not only about grand scientific breakthroughs, but also about adopting existing technologies, the introduction of new products, making major upgrades to production processes or management methods, etc. While innovation may be broadly defined at the strategic level, in practice Estonia follows a science-driven approach that is "quite detached from the vast part of its economy" (Expert Group, 2012, p. 22). Estonia should continue fostering science to close in on the global frontier of knowledge and innovation, but a second leg to innovation policies is needed that upgrades Estonia's traditional industries, which still account for the bulk of employment and value-added creation. In this context, the Company Development Program could be scaled up and also cover firms that are not already quite successful. Indeed in economies like Estonia's, it is this type of innovation that promises the highest returns (EBRD, 2014).

53. **Innovation could rely more on imported knowledge and intellectual property.** Estonia's investment into intellectual property is low relative to its R&D spending, implying that it relies less than other countries on imported knowhow. Yet, imports might be the most efficient avenue to innovate and lift productivity in many instances—they have for instance played a key role in Korea's economic transformation. Estonia should review its innovation promotion programs and instruments to identify and reduce any biases that unduly favor own-account productivity enhancements over foreign acquired ones.

54. **Less reliance on EU funds would make innovation support more flexible and effective.** EU funds come with many strings attached that may not fully meet national requirements. For example, the amount of support that an enterprise can receive under certain programs is capped and cross board activities may be constrained, especially if they involve non-EU countries. In the past they are found to have also imparted a bias toward investment into R&D infrastructure. Going forward, more budgetary resources will need to be mobilized in any event, as Estonia's eligibility for EU funds may decline under the EU's next Multiannual Financial Framework for 2020–26 or thereafter.

Enhancing Labor Mobilization and Human Capital

55. **The key remaining issue on the education front is the large number of young people without professional education.** Considering the scale of Estonia's demographic challenge, it is imperative to make the most of available labor resources. The envisaged strengthening of vocational training by raising its profile, providing more apprenticeship slots, and giving it public financial support more commensurate with tertiary education could incentivize young people to enroll. In higher education, the match between skills taught at universities and labor market needs could be further improved by better information about job market prospects in different fields, more private sector involvement in curriculum development and in the running of universities, and stronger

incentives for students to choose fields of study that are in high demand in the labor market. Close attention will also need to be paid to managing the adjustment of the educational system to the declining number of students.

56. **More reliance on foreign labor resources could be considered.** Relaxing the still tight immigration quotas for non-EU citizens, especially for professionals that are in short supply in Estonia, has strong economic appeal for a country with a rapidly shrinking population. In addition, a larger effort could be made to draw on the large expatriate Estonian community. Promotion and incentives to return could be stepped up. A program to promote short-term work stays in Estonia could reacquaint expatriates to their country and also help transfer valuable knowledge to domestic companies.

57. **A further increase of the retirement age should be put on the agenda, together with a boost to life-long learning.** The retirement age of 65 years for both men and women will be fully phased in by 2026, but further hikes are needed to curb sharply rising dependency ratios. The majority of European countries have already legislated retirement ages above 65 years, even though most of them face less unfavorable demographics than Estonia (European Commission, 2015a, p. 65). To keep the aging workforce productive, it will be important to make significant investments into life-long learning. The envisaged resource envelop should be scaled up significantly. The development of digital skills for all age groups will help address the existing deficiencies in adult skills and raise the effective retirement age.

58. **Successful implementation of the disability reform, together with more generally stepped-up Active Labor Market Programs (AMLP) could make a difference.** The reform could expand the labor force by around 5 percent, but these new entrants will need substantial support to reach their full productive potential. ALMP will need to be strongly stepped up and this should not come at the expense of existing ALMPs that serve the rest of the unemployed. Spending on ALMPs is already much below the European average and a boost over and above what is required to integrate the former disability-pension recipients would be desirable. In particular, expanding the training mandate of the Unemployment Insurance Fund beyond the unemployed and those at imminent risk of losing their job could pay high dividends and is rightly under consideration.

59. **Raising female labor force participation is a further avenue for mobilizing additional labor resources.** It is already high by European standards, but the example of the Nordic countries shows that still more is possible. To achieve this, good and affordable availability of child care facilities has been shown to be effective, more so than family allowances. Steps to reduce Estonia's large gender gap in remuneration would also strengthen incentives for women to take up formal employment.

Enhancing Other Structural Aspects

60. **Fully restoring Estonia's traditionally high public investment could help underpin fast growth.** Estonia's public investment is one of the highest in the EU relative to national income, but the capital stock is still far lower than in Western Europe. Infrastructure gaps continue to exist,

notably in intermodal and international transport connections, cross-border energy links, and regional development (European Commission, 2015b). The efficiency of network industries could be boosted by further investing into regional integration (IMF, 2014). The economy's energy intensity remains very high at 3½ times the EU average. The reliance of indigenous oil shale as the key primary energy source is responsible to a considerable extent, but there are also important inefficiencies in the insulation of buildings, in the transport sector, and in energy transmission.

61. **There also is room for further structural reform** (OECD, 2015d). Exclusive rights in number of professional services, such as engineers, architects, accountants, and lawyers may unduly restrict competition. Entry barriers for foreign providers in maritime services are also high. Insolvency procedures tend to be long and recovery rates low, possibly inhibiting the access to financing for more risk undertakings.

62. **Finally, more FDI would be beneficial, especially if linkages to the domestic economy are systematically developed.** Estonia should aim to further improve its attractiveness for high connectivity FDI and multinational firms, as well as broadening its SME support policies. In particular, removing the licensing requirements that remain in public utilities, transportation and telecommunications, could attract FDI in the infrastructure sector, foster linkages between inward investors and the domestic economy, and improve the country's international integration and attractiveness for multinational firms. As regards SME support, the focus is currently on already quite successful firms or startups, while other enterprises with adequate potential may also need assistance to successfully navigate the intricacies of international markets, modern technology, and today's business practices.

References

Acemoglu, Daron, Philippe Aghion, and Fabrizio Zilibotti, 2006, "Distance to Frontier, Selection, and Economic Growth," *Journal of the European Economic Association*, Vol. 4, No. 1, pp. 37–74.

Agénor, P.-R., O. Canuto, and M. Jelenic, 2012, "Avoiding Middle-Income Growth Traps", Economic Premise No.98 (Washington: World Bank).

Aghion, P., and P. Howitt, 1998, "Market Structure and the Growth Process," *Review of Economic Dynamics*, Vol. 1, No. 1, 276-305 (Philadelphia: Elsevier B.V.).

Aiyar, S., R. Duval, D. Puy, Y. Wu, and L. Zhang, 2013, "Growth Slowdowns and the Middle Income Trap," IMF Working Paper 13/71 (Washington: International Monetary Fund).

Alesina, A., and E. Spoalare, 1997, "On the Number and Size of Nations," *Quarterly Journal of Economics*, Vol. 112, No. 4, pp. 1027–1056.

Alesina, A., R. Baqir, and W. Easterly, 1999, "Public Goods and Ethnic Divisions," *Quarterly Journal of Economics,* Vol. 114, No. 4, pp. 1243–1284.

Armstrong, H. W., and R. Read, 1998, "Trade and Growth in Small States: the Impact of Global Trade Liberalization," *World Economy,* Vol. 21, No. 4, pp 563–585.

Armstrong, H, et al., 1998, "A Comparison of the Economic Performance of Different Microstates and Between Microstates and Larger Countries," *World Development*, Vol. 26, No.4, pp. 639–656 (Philadelphia: Elsevier B.V.).

Bakker, Bas, and Christoph Klingen (eds.), 2012, *How Emerging Europe Came Through the 2008/09 Crisis: An Account by the Staff of the IMF's European Department* (Washington: International Monetary Fund).

Barro, Robert J., and Xavier Sala-i-Martin, 2012, *Economic Growth* (New York: McGraw Hill, 2nd ed.).

Bank of Estonia, 2015a, Estonian Economy and Monetary Policy, 1/2015.

———, 2015b, Labor Market Review, 1/2015.

Borio, Claudio, P. Disyatat, and J. M. Juselius, 2014, "A Parsimonious Approach to Incorporating Economic Information in Measures of Potential Output," BIS Working Paper, 442 (Basel: Bank of International Settlement).

Briguglio, Lino, 1995, "Small Island Developing States and their Economic Vulnerabilities," *World Development*, Vol. 23, No. 9, pp. 1615–1632 (Philadelphia: Elsevier B.V.).

Burniaux, J., R. Duval, and F. Jaumotte, 2004, "Coping with Ageing: A Dynamic Approach to Quantify the Impact of Alternative Policy Options on Future Labour Supply in OECD Countries," OECD

Economics Department Working Papers, No. 371 (Paris: Organization for Economic Co-operation and Development).

Burtless, Gary, 2013, "The Impact of Population Aging and Delayed Retirement on Workforce Productivity," Center for Retirement Research at Boston College.

Coe, David T., and Elhanan Helpman, 1995, "International R&D Spillovers," *European Economic Review*, Vol. 39, No. 5, pp. 859-887 (Philadelphia: Elsevier B.V.).

Commonwealth Consultative Group, 1997, *A Future for Small States: Overcoming Vulnerability* (London: Commonwealth Secretariat).

Cherif, R., and F. Hasanov, 2015, "The Leap of the Tiger: How Malaysia Can Escape the Middle-Income Trap," IMF Working Paper WP/15/131 (Washington: International Monetary Fund).

Chung, Sungchul, 2007, "Excelsior: The Korean Innovation Story," *Issues in Science and Technology*, Vol. XXIV, No. 1.

Crouch, David, 2015, "Estonia Sees Bright Future for Its Power Industry," *Financial Times*, June, pp. 2.

Disney, R., 1996, "Ageing and Saving," *Fiscal Studies*, Vol. 17, No. 2, Institute for Fiscal Studies.

Docquier, F., Olivier Lohest, and Abdeslam Marfouk, 2007, "Brain Drain in Developing Countries?" *World Bank Economic Review,* Vol. 21, Issue 2, pp. 193–218.

Easterly, William, and Aart Kraay, 2000, "Small states, small problems? Income, Growth, and Volatility in Small States," *World Development*, Vol. 28, No.11, pp. 2013–2027.

Easterly, W., and S. Rebelo, 1993, "Fiscal Policy and Economic Growth: an Empirical Investigation," *Journal of Monetary Economics*, Vol. 32, pp. 417–458 (Philadelphia: Elsevier B.V.).

Easterly, W., and R. Levine, 1997, "Africa's Growth Tragedy: Policies and Ethnic Divisions," *Quarterly Journal of Economics*, Vol. 112, No. 4, pp. 1203–1250 (Cambridge: MIT Press).

Disney, R., 1996, "Ageing and Saving," *Fiscal Studies*, Vol. 17, No. 2, Institute for Fiscal Studies.

EBRD, 2014, "Innovation in Transition," *Transition Report*, (London: European Bank for Reconstruction and Development).

Eichengreen, B., D. Park, and K. Shin, 2011, "When Fast Growing Economies Slow Down: International Evidence and Implications for China," NBER Working Paper No. 16919 (Cambridge, MA: National Bureau of Economic Research).

Engelbrecht, Hans-Jürgen, 1997, "International R&D Spillovers, Human Capital and Productivity in OECD Economies: An Empirical Investigation," *European Economic Review*, Vol. 41, No. 8, pp. 1479–1488 (Philadelphia: Elsevier B.V.).

Estonian Ministry of Education and Research, 2015, "Adult Skills: Their Use and Usefulness in Estonia," (Tartu: Ministry of Education and Research, Republic of Estonia).

European Commission, 2014, "ERAWATCH Country Reports 2013: Estonia," *JRC Science and Policy Reports* (Seville).

European Commission, 2015a, "The 2015 Aging Report: Economic and Budgetary Projections for the 28 EU Member States," European Economy 3/2015.

European Commission, 2015b, "Country Report Estonia 2015" (Brussels: European Commission).

Expert Group, 2012, "Peer-Review of the Estonian Research and Innovation System: Steady Progress towards Knowledge Society," report prepared for the European Research Area Committee (Brussels: European Commission).

Falvey, Rod, Neil Foster, and David Greenaway, 2002, "North-South Trade, Knowledge Spillovers and Growth" *Journal of Economic Integration*, April, pp. 650–670.

Farrugia, C., 1993, "The Special Working Environment of Senior Administrators in Small States," *World Development*, Vol. 21, No. 2, pp. 221–226 (Philadelphia: Elsevier B.V.).

Felipe, J., A. Abdon, and U. Kumar, 2012, "Tracking the Middle-income Trap: What is It, Who Is in It, and Why?" Levy Economics Institute Working Paper No. 715 (Hudson, NY: Bard College).

Felker, Greg, 2001, "Industrial Policy and Industrialization in Malaysia and Thailand," in *Southeast Asia's Industrialization: Industrial Policy, Capabilities and Sustainability* (Houndmills: Palgrave).

Foxley, A., and F. Sossdorf, 2011, "Making the transition: From Middle-Income to Advanced Economies," The Carnegie Papers (September).

Gill, I., and H. Kharas, 2007, *An East Asian Renaissance: Ideas for Economic Growth* (Washington: World Bank).

Ghosh, Atish R., 2000, "Inflation and Growth," *IMF Research Bulletin*, Vol. 1 (June).

Görg, H., and F. Ruane, 2001, "Multinational Companies and Linkages: Panel-data Evidence For the Irish Electronics Sector," *International Journal of the Economics of Business*, Vol. 8, No. 1, pp. 1–18.

Harden, S., 1985, *Small Is Dangerous: Micro States in a Macro World* (London: Frances Pinter).

Hartwell, Christopher, 2013, "The Growth Elixir: Escaping the Middle-Income Trap in Emerging Markets," IEMS Emerging Market Brief, Vol. 13–08.

IEMS Emerging Market Brief, Vol. 13–08 (November).

Hayakawa, Kazunobu, Fukunari Kimura, and Tomohiro Machikita, 2010, "Firm-level Analysis of Globalization: A Survey of the Eight Literatures." ERIA-DP-2010-05. Jakarta: ERIA.

Hodrick, Robert J., and Edward C. Prescott, 1997, "Postwar U.S. Business Cycles: An Empirical Investigation," *Journal of Money, Credit and Banking*, Vol. 29, No.1, pp. 1–16.

Im, F. G., and D. Rosenblatt, 2013, "Middle-Income Traps: A Conceptual and Empirical Survey," World Bank Policy Research Working Paper No. 6594 (Washington: World Bank).

IMF, 2014, "Baltic Cluster Report," IMF County Report No. 14/117 (Washington).

Iredale, R., and F. Guo, 2001, "The Transforming Role of Skilled and Business Returnees: Taiwan, China and Bangladesh," Centre for Asia Pacific Social Transformation Studies, University of Wollongong, (Wollongong).

Jankowska, A., A. Nagengast, and J.R. Perea, 2012, "The Product Space and the Middle-Income Trap: Comparing Asian and Latin American Experiences," OECD Development Centre Working Paper No. 311 (Paris: Organization of Economic Cooperation and Development).

Javorcik, B., 2010, "Foreign Direct Investment and International Technology Transfer," *Encyclopedia of Financial Globalization*.

Johansson, A., et al., 2013, "Long-term Growth Scenarios," OECD Economics Department Working Papers, No. 1000 (Paris: Organization of Economic Cooperation and Development).

Kattai, Rasmus, 2010, "Potential Output and the Output Gap in Estonia: A Macro Model Based Evaluation," Eesti Pank Working Paper 3/2010 (Tallinn: Bank of Estonia).

Kennedy, Kieran A., 1991, "Linkages and Overseas Industry," edited by Foley, A. and D. McAleese, *Overseas Industry in Ireland,* pp. 82–105 (Dublin: Gill and Macmillan).

Kim, L., 1997, *Imitation to Innovation: the Dynamics of Korea's Technological Learning* (Cambridge, MA: Harvard Business School Press).

Klenow, P., and A. Rodriguez, 1997, "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" *NBER Macroeconomics Annual 1997*, Volume 12.

Kuznets, S., 1960, *The Economic Consequences of the Size of Nations* Economic Growth of Small Nations, Proceedings of a Conference held by the International Economic Associations, Hague, ed. E. A. G. Robinson (Toronto: Palgrave MacMillan).

Lin, Justin Yifu, 2009, *Economic Development and Transition: Thought, Strategy, and Viability* (New York: Cambridge University Press).

Lin, J. Y., and D. Rosenblatt, 2012, "Shifting Patterns of Economic Growth and Rethinking Development," Policy Research Working Paper No. 6040 (Washington: The World Bank).

Maravall, Agustín, and Ana del Río, 2001, "Time Aggregation and the Hodrick-Prescott Filter," Banco de España Working Paper 108 (Madrid).

Mazzarol, Tim .W., 2012, "Building a National Innovation System: What can we learn from Korea?", *The Conversation*, (September 9)

Milner, C., and Westaway, T., 1993, "Country Size and the Medium-Term Growth Process: Some Cross-country Evidence," *World Development*, Vol. 21, No. 2, pp. 203–211

Montiel, Peter, and Luis Servén, 2004, "Macroeconomic Stability in Developing Countries: How Much Is Enough?" World Bank Policy Research Working Paper 3456 (Washington).

OECD, 1998, "Work-force Ageing in OECD Countries," Employment Outlook 1998, (Paris: Organization of Economic Cooperation and Development).

———, 2015a, "*OECD Economic Surveys: Estonia,"* (Paris: Organization of Economic Cooperation and Development).

———, 2015b, "*Labour Market Mismatches and Labour Productivity: Evidence from PIAAC Data,"* (Paris: Organization of Economic Cooperation and Development).

———, 2015c, "*Skill Mismat and Public Policy in OECD Countries,"* (Paris: Organization of Economic Cooperation and Development).

———, 2015d, "Estonia and Finland: Fostering Strategic Capacity Across Governments and Digital Services Across Boarders," OECD Public Governance Review (Paris: Organization of Economic Cooperation and Development).

Ohno, K., 2009, "Avoiding the Middle-Income Trap: Renovating Industrial Policy Formulation in Vietnam," ASEAN Economic Bulletin, Vol. 26, No. 1, pp. 25–43.

Park, S. O., 2000, "Innovation Systems, Networks, and the Knowledge-based Economy in Korea," edited by J. H. Dunning, *Regions, Globalization, and Knowledge-based Economy*, pp. 328–348 (Oxford: Oxford University Press).

Ramey, G., & Ramey, V. A., 1995, "Cross-country Evidence on the Link Between Volatility and Growth," *American Economic Review*, Vol. 85, No.5, pp. 1138–1151.

Ravn, Morten Overgaard, and Harald Uhlig, 2002, "On Adjusting the Hodrick-Prescott Filter for the Frequency of Observations," *Review of Economics and Statistics*, Vol. 84, No. 2, pp. 371–375.

Romer, Paul , 1986, "Increasing Returns and Long-run Growth." *The Journal of Political Economy,* Vol. 94, No. 5, pp. 1002–1037.

———, 1990, "Endogenous Technological Change," *The Journal of Political Economy*, Vol. 98, No. 5, pp S71-S102.

Schadler, Susan, et al., 2006, "Growth in the Central and Eastern European Countries of the European Union," IMF Occasional Paper 252 (Washington: International Monetary Fund).

Schiff, Maurice, and Yanling Wang, 2006, "On the Quantity and Quality of Knowledge: the Impact of Openness and Foreign R&D on North-North and North-South Technology Spillovers," *Global Integration and Technology Transfer*, (New York: Palgrave Macmillan and The World Bank).

Schiff, Maurice, and Yanling Wang, 2008, "North-South and South-South Trade-related Technology Diffusion: How Important Are They in Improving TFP Growth?" *The Journal of Development Studies* 44.1, pp. 49-59.

Schiff, Maurice, and Yanling Wang, 2006, "On the Quantity and Quality of Knowledge: The Impact of Openness and Foreign R&D on North-North and North-South Technology Spillovers," Chapter 5 in *Global Integration and Technology Transfer*. (New York: Palgrave Macmillan and World Bank).

Schiff, Maurice, and Yanling Wang, 2008, "North-South and South-South Trade-Related Technology Diffusion: How Important Are They in Improving TFP Growth?" *The Journal of Development Studies* Vol. 44, Issue 1, pp 49-59.

Smeets, Roger, 2008, "Collecting the Pieces of the FDI Knowledge Spillovers Puzzle," *The World Bank Research Observer*, Vol. 23, No. 2, pp. 107-138.

Sohn, D. W., and M Kenney, 2007, "Universities, Clusters, and Innovation Systems: the Case of Seoul, Korea," *World Development*, Vol. 35, No. 6, pp. 991–1004 (Amsterdam: Elsevier B.V.).

Staehr, Karsten, 2015, "Economic Growth and Convergence in the Baltic States: Caught in a Middle Income Trap?" Paper prepared for the DG ECFIN Seminar on "Joining the Euro and Then? How to Ensure Economic Success after Entering the Common Currency," Vilnius, June 16.

Stalker, P., 2000, *Workers Without Frontiers: the Impacts of Globalization on International Migration* (Boulder, CO: Lynne Rienner Publishers).

Stiroh, Kevin J., 2001, "What Drives Productivity Growth?" Federal Reserve Bank of New York; *Economic Policy Review*, Vol. 7, No. 1, March.

Streeten, Paul, 1993, "The Special Problems of Small Countries," *World Development*, Vol. 21, No. 2, pp. 197–202.

Studwell, J., 2013, *How Asia Works: Success and Failure in the World's Most Dynamic Region* (London, Profile Books).

Tsay, C., and J. Lin, 2000, "Return Migration and Reversal of Brain Drain in Taiwan: an Analysis of the 1990 Census," The Institute of Economics, Academia Sinica, Taipei (unpublished paper).

Woo, W.T., 2009, "Getting Malaysia Out of the Middle-Income Trap" (Mimeo, University of California Davis).

World Bank, 2012, *China 2030: Building a Modern, Harmonious, and Creative High-Income Society* (Washington: The World Bank).

Young, A., 1995, "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *Quarterly Journal of Economics*, Vol. 110, pp. 641–80.

Yusuf, S., and K. Nabeshima, 2009, "Can Malaysia Escape the Middle-Income Trap? A Strategy for Penang," World Bank Policy Research Working Paper 4971 (Washington).

Appendix 1. Technical Description of the Filters

The HP filter can be understood as a special case of the multivariate filter:

$$y_t = y_t^* + c_t, \quad \text{(observation equation)} \tag{1}$$

$$\Delta^2 y_t^* = \varepsilon_t^*, \quad \text{(state equation)} \tag{2}$$

$$\lambda \equiv \frac{\mathrm{Var}\left(y_t - y_t^*\right)}{\mathrm{Var}\left(\varepsilon_t^*\right)}, \tag{3}$$

where y_t and y_t^* are the GDP and potential output. Here, c_t (output gap) and ε_t^* are error terms uncorrelated with each other. Each of these error terms is independent and identically distributed with normal distributions with mean zero. In (3), λ represents the degree of smoothing (or a variance ratio). For annual frequency, λ=6.25 (Ravn and Uhlig, 2002) and λ=100 (Hodrick and Prescott, 1997) are often used. These correspond to λ=1,600 and λ=25,600 in quarterly frequency, which capture approximately 10-year and 20-year cycles, respectively, according to Maravall and del Río (2001).

The multivariate filter considered here replaces (1) by

$$y_t = y_t^* + \rho\left(y_{t-1} - y_{t-1}^*\right) + x_t\beta + \varepsilon_t, \quad \text{(observation equation with exogenous variables)} \tag{4}$$

where ρ is a measure of (conditional) serial correlation of the output gap, x_t is a set of conditioning variables which can be correlated with the business cycle, and ε_t is an error term following a normal distribution, which has mean zero and is uncorrelated with c_t. A special case of (4) without conditioning variables, called dynamic HP filter, controls for the serial correlation of output gaps.[1]

The data for GDP, credit and CPI (all seasonally adjusted) are from Haver Analytics. The data for trading partners' import growth are obtained from the IMF World Economic Outlook database and seasonally adjusted. The data are up to the second quarter of 2015.[2] In order to eliminate potential longer-term trends, conditioning variables are de-trended by applying the HP filter with λ = 8,500 (which captures an approximately 15-year cycle according to Maravall and del Río, 2001). Without this de-trending, a trend of financial deepening in the early 2000s in Estonia would be misread as cyclical.

[1] Unlike Borio et al. (2014), this paper applies a maximum likelihood estimator to derive parameters, rather than using a Baysian approach. Hence, the selection of priors is avoided.

[2] To mitigate the end-point problem, the data are extended using the forecasts up to the fourth quarter of 2017. We use the IMF's WEO forecasts for the real GDP, CPI, and partners' import growth. For credit growth and the change in credit growth, we use the last year's observations as forecasts for future years.

Appendix 2. Labor Components Potential Output

(a) Labor force: Labor force is the population multiplied by labor participation rate. To obtain its level at potential output, cohorts of genders (male and female) and age groups (15–19, 20–24, …, and 70–74) are considered separately. The population is not affected by the business cycle, but participation rates are.

For each cohort, this paper applies a logit function for labor participation rate to ensure that the fitted level of labor participation rate is between zero and one. The resulting value is regressed on a linear time trend and its square root (to capture potentially non-linear time trends), potential growth (to capture the long-term evolution of the component), and output gap (to capture cyclical effects). Specifically:

$$\text{logit (labor participation rate)}_{g,a,t} = \text{constant}_{g,a} + a_{g,a} \times (\text{linear time trend})_{g,a,t} + b_{g,a} \times (\text{linear time trend})_{g,a,t}^{1/2} + c_{g,a} \times (\text{potential growth})_{g,a,t} + d_{g,a} \times (\text{output gap})_{g,a,t} + (\text{error term})_{g,a,t},$$

where subscripts g, a, and t represent gender, age, and time (year). The potential level of the labor participation rate (for each age-gender cohort) is obtained as the level predicted by this regression with the output gap closed. Specifically,

$$\text{logit (labor participation rate at full employment)}_{g,a,t} = \text{constant}_{g,a} + a_{g,a} \times (\text{linear time trend})_{g,a,t} + b_{g,a} \times (\text{linear time trend})_{g,a,t}^{1/2} + c_{g,a} \times (\text{potential growth})_{g,a,t}.$$

Finally, the labor force at potential, for each cohort, is obtained by multiplying the population by the labor participation rate at full employment. The total labor force at potential is the sum of all cohorts.

(b) Unemployment rate: Data for unemployment rates are available on a quarterly basis. Starting July 1, 2014, the legislation required that employers register all employees. The Ministry of Finance estimates that, due to this new legislation, roughly 5,000 employees were additionally captured in statistics, which lowers the unemployment rate by 0.74 percentage points.[1] This paper adjusts all unemployment rates before the third quarter of 2014 by subtracting 0.74 percentage points to avoid a break in the series.

The unemployment rate is regressed on a linear time trend, its square root, potential growth, and output gap. The structural unemployment rate (i.e., the unemployment rate at potential) is the level predicted by this regression assuming that the output gap is closed.

(c) Hours worked per employee: To obtain its potential level, the number of hours worked per employee is regressed here on a linear time trend, its square root, potential growth, and output

[1] Bank of Estonia (2015b) documents that roughly 9,000 employees had been added to the employment register in 2014 but not all of them are due to the new registration (p. 14).

gaps. The hours worked at full employment are the level predicted by this regression with the output gap closed.

(d) Human capital per worker (included in TFP and shown as memo item only): Human capital per worker is measured by the hourly wage rate of an average worker relative to the hourly wage rate of a worker with occupations at the lowest skill category (which can be viewed as "raw labor"). Occupations are grouped into four skill categories according to the International Standard Classification of Occupation. For example, occupations are assigned to the lowest skill category when they require an education level below an upper secondary school degree. Wage data from Statistics Estonia are applied to compute the relative hourly wage rate of each skill category, taken as average over time. These relative hourly wage rates are applied to the composition of skill levels in each year to compute the human capital per worker. I.e., a worker that makes twice the wage of a worker in the lowest category is assumed to have twice the human capital. For the decomposition of actual GDP human capital per worker is used. The decomposition of potential GDP cleanses human capital of cyclical influences, which can arise because workers with low human capital are more likely to lose their jobs in recessions, by using human capital per participant in the labor force instead.