



# SLOVAK REPUBLIC

## SELECTED ISSUES

July 2018

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# SLOVAK REPUBLIC

June 13, 2018

## SELECTED ISSUES

Approved By  
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# CREDIT GROWTH AND MACROPRUDENTIAL POLICIES IN THE SLOVAK REPUBLIC<sup>1</sup>

*Strong private sector credit growth has persisted for over a decade and resulted in household debt that is high relative to peers. Credit is now growing in riskier segments. Housing prices have also started to reflect pressures from strong credit growth. This paper assesses Slovakia's household and private sector indebtedness against macroeconomic fundamentals, identifies key vulnerabilities from rapid household credit growth, assesses policy responses to date, and presents further policy options.*

## A. Background

**1. Strong private sector credit growth has persisted in the Slovak Republic** (Figure 1). In the aftermath of the global financial crisis, both mortgage and consumer loans to households have experienced double-digit growth. Household debt as a share of net disposable income is now higher than in most Central European (CE) countries. Leverage, as measured by household financial liabilities in percent of financial assets, has also soared past peers. While episodes of rapid credit growth may indeed imply increased access to credit and enable greater investment and economic growth (Levine, 2005), these episodes can also lead to vulnerabilities due to buildups of excessive leverage and asset price bubbles (IMF, 2012). Large buildups of household leverage have been shown to precede sharp drops in consumption, output, and employment during the subsequent deleveraging episodes (Mian and Sufi (2008), among others).

**2. Credit growth in the Slovak Republic has been driven by both demand- and supply-side factors.** On the demand side, Slovak households have historically been among the least indebted within the EU. Consequently, rapid lending growth could be viewed as a catch-up effect. Nevertheless, a sharp drop in lending rates, strong labor market dynamics, and a recovery in property prices also contributed to demand (Figure 1). On the supply side, two factors played a significant role. First, an extended period of accommodative monetary policy reduced net interest income and increased competition among banks in the Slovak market, putting pressures on banks to increase lending volume in an effort to stabilize profits. Second, favorable economic conditions underwrote continued improvement in the quality of the retail loan portfolio, affecting banks' perceptions of credit risk. In the years following the crisis, a significant portion of new lending to households consisted of refinancing at lower interest rates thus limiting the pass-through to housing prices. More recently, housing prices, both existing and new dwellings, have crept upwards.

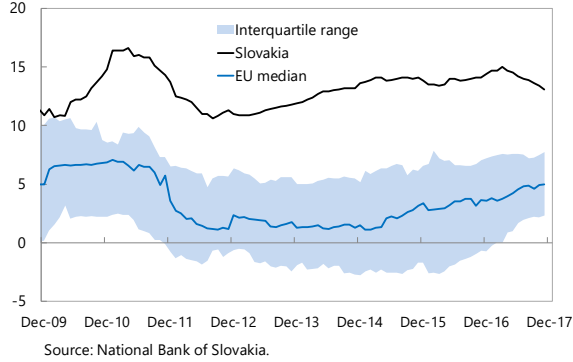
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<sup>1</sup> Prepared by Olamide Harrison, Pavol Jurca, Štefan Rychtárik, and Irene Yackovlev.

**Figure 1. Slovak Republic: Recent Developments in Credit and Housing Markets**

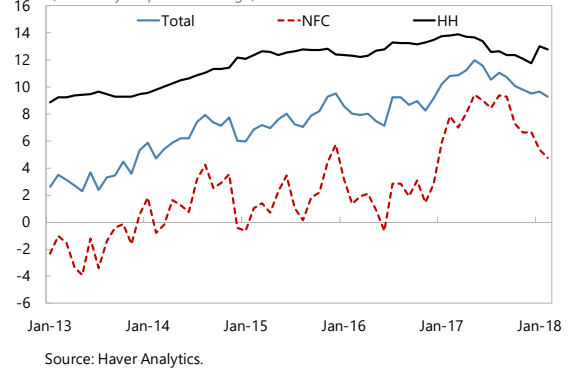
Private sector credit in Slovakia has consistently grown faster than in other EU countries...

**Private Sector Credit Growth**  
(Percent)



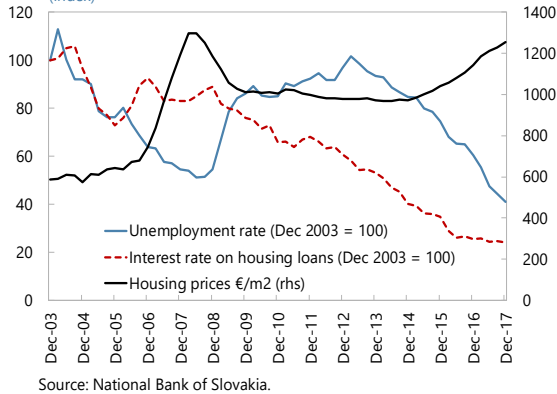
...driven primarily by growth in lending to households.

**Lending Growth**  
(Year-on-year percent change)



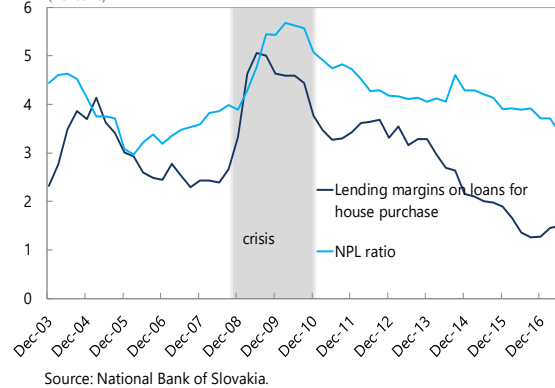
Declining interest rates, a tight labor market, and rising house prices have supported credit demand growth

**Household Credit Demand Drivers**  
(Index)



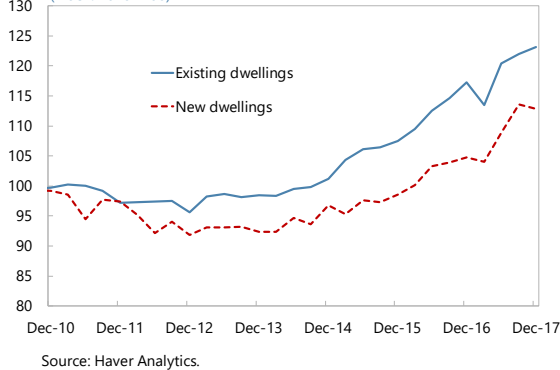
Declining lending margins and credit risk indicators have supported the supply of credit

**Household Credit Supply Drivers**  
(Percent)



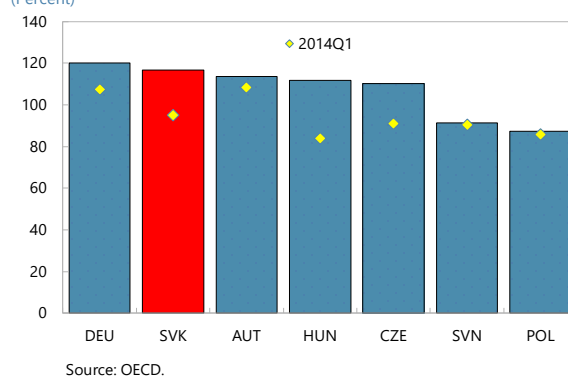
House prices are rising in both primary and secondary markets...

**Housing Price Indices**  
(Index: 2010=100)



...and yields on housing have increased, but are broadly in line with peers.

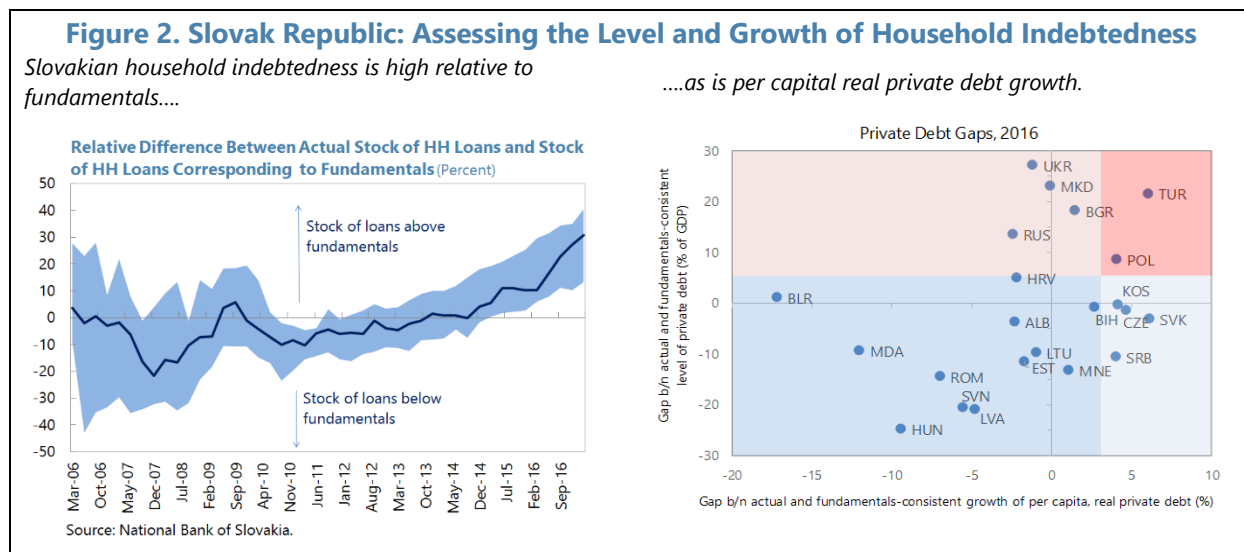
**Price to Rent Ratios, 2017Q3 or Latest**  
(Percent)



**3. The rest of the paper is organized as follows.** Section B describes assessments of household and private sector debt levels relative to fundamentals. Section C discusses vulnerabilities to households that result from the buildup of indebtedness. Section D describes the policy response to date and Section E assesses its effectiveness. Finally, Section F presents further policy options and concludes.

## B. Household Indebtedness in the Slovak Republic: Excessive or Fundamentals-Driven?

**4. Econometric analysis suggests that household indebtedness is growing at a faster pace than implied by economic fundamentals.** We used a panel cointegration technique to identify any long-run relationship between the volume of retail loans and selected macroeconomic and financial variables, including interest rates and per capita income, for a set of 11 central and eastern European countries.<sup>2</sup> If robustness tests did not reject the existence of such a relationship, regression analysis (fully modified and dynamic OLS) was used to estimate the long-run relationship between identified macroeconomic and financial variables and the stock of household loans. Estimates suggest that in Slovakia the stock of household loans is now above the level implied by economic fundamentals, with Slovakia showing the largest deviation among 11 countries in the sample. However, this approach has limitations given the small sample size.

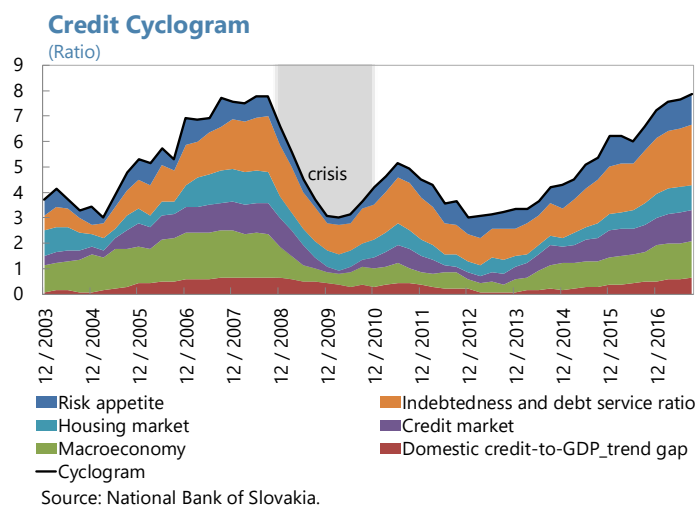


<sup>2</sup> More countries could not be included due to lack of disaggregated data on household debt, see Annex I for details.

**5. To complement this analysis, we also assess overall private sector indebtedness against economic fundamentals.** We use an autoregressive-distributed lag (ADL) model for a set of 36 European countries to establish a time-varying norm derived from an estimated long-term relationship between overall private sector debt (See Annex II for details). Estimates of the gap in real per capita private debt suggest that the current pace of credit growth is higher than the fundamentals-consistent growth, while the current level of real per capita private debt is lower than the fundamentals-consistent level. Results for Slovakia also reflect a significant degree of financial deepening since EU accession. An important caveat is that most countries in the sample have lower income levels than the Slovak Republic, and that interest rates may be depressed by the current ECB monetary policy stance, both factors could result in a somewhat elevated norm. Applying the standard Hodrick-Prescott (HP) filter to credit-to-GDP ratios suggests only a slight deviation from the long run trend. This exercise is subject to several limitations beyond the well-known shortcomings of the HP filter which constrain its direct use in data evaluation and policy prescription. For instance, it could lead to procyclical prudential policies because periods with large declines in GDP would suggest the presence of 'excessive credit' and would call for a tightening of lending standards and increases in capital requirements.

**6. The credit cycle seems to have reached its post-crisis high.** The credit cyclogram,

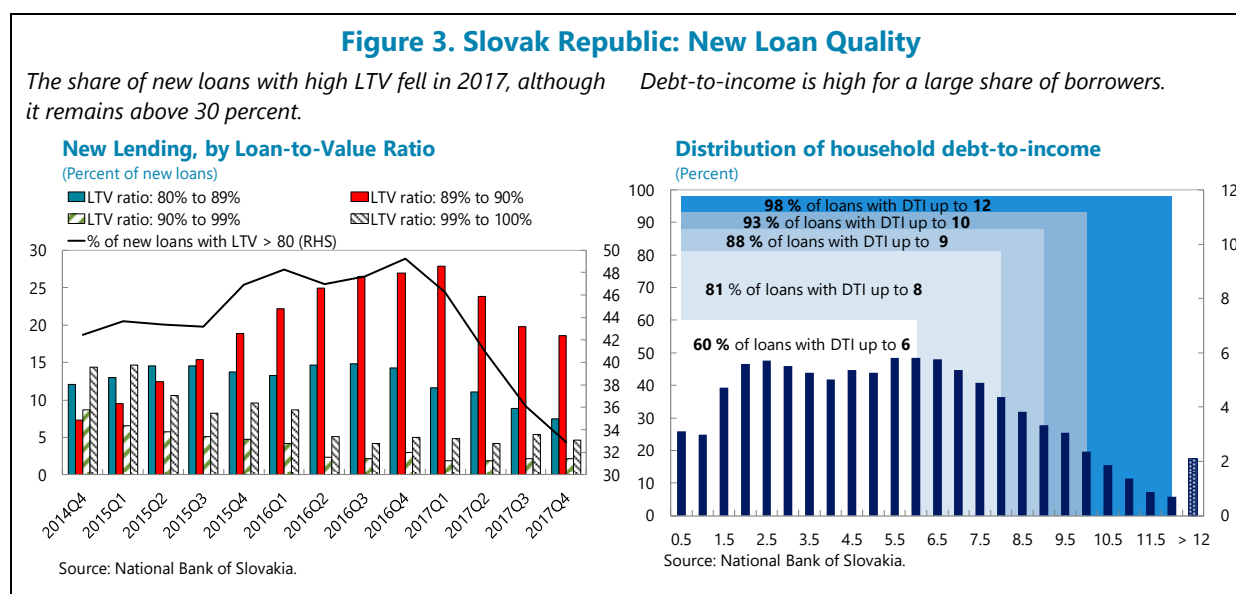
compiled by the National Bank of Slovakia, is an aggregation of a set of core and supplementary variables evaluated against distributions of their own historical values to disentangle factors cyclical credit growth. According to this analysis, household indebtedness seems to be the strongest contributing factor. Growing household indebtedness increases the sensitivity of households to adverse macroeconomic shocks. The next section explores these vulnerabilities and some mitigating factors.<sup>3</sup>



<sup>3</sup> Private sector credit growth in the Slovak Republic has been high and sustained, but lower than seen in previous credit boom episodes. Deviations from a backward-looking rolling cubic trend and ad-hoc thresholds suggest that the current episode of private sector credit growth does not meet all the technical criteria to be classified as a credit boom. As defined in the IMF's 2012 Staff Discussion Note on Credit Booms (SDN/12/06), an episode of credit growth is defined as a boom if the deviation of credit-to-GDP from the estimated trend is greater than 1.5 times its standard deviation and the growth rate of credit-to-GDP exceeds 10 percent; or the growth rate exceeds 20 percent.

## C. Vulnerabilities from Rapid Household Credit Growth and High Indebtedness

**7. In addition to sustained strong growth, new lending has shifted toward riskier segments of household borrowers.** The share of new loans with a loan-to-value (LTV) ratio higher than 80 percent rose from 42 percent at end-2014 to 49 percent at end-2016. During this period, and partly in response to the introduction of a binding limit on LTVs over 90 percent, the share of new loans with LTV ratios between 89 percent and 90 percent grew from 7 percent at end-2014 to 28 percent by end-March 2017. At the same time, four out of five new loans were granted to households with high debt-to-income ratios (8 and above).



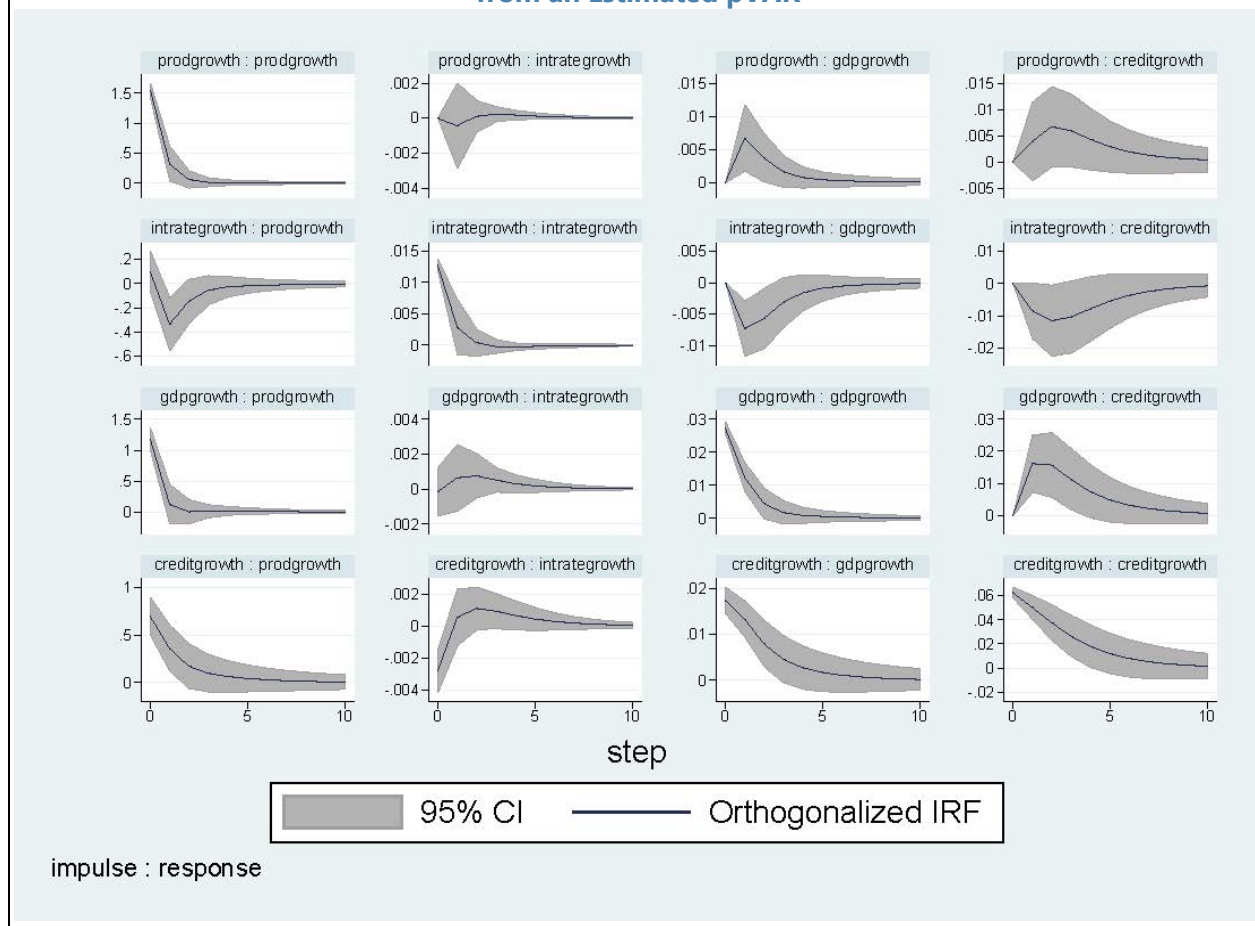
**8. Households have sought to lengthen mortgage maturities and lock-in historically low long-term interest rates to reduce their vulnerability to shocks.** Since the crisis, the average period of interest rate fixation on mortgages has increased and the share of short-term mortgages has declined considerably. This should thus act as a buffer in the face of adverse shocks. Nevertheless, it is worth noting that though the average maturity for households has increased (26 years for new loans), the marginal distribution of interest-rate fixation period of borrowers is important for assessing vulnerabilities. A higher mass of borrowers at the margin of exposure to this shock could negatively affect bank portfolio quality and asset prices and thus affect both financial and real sectors.

**9. A rise in the interest rate could lead to tighter credit conditions for firms and negatively affect labor productivity.** This is illustrated with impulse response functions from a panel VAR estimation of a sample of EU countries (Figure 4). A Cholesky decomposition with the following ordering is used: interest rate shock -> credit growth -> labor productivity growth -> GDP growth. The results show that a shock to the effective interest rate would lead to a persistent decline in GDP growth through its effects on credit and labor productivity growth. Specifically, a



1.25 percentage point increase in effective interest rates could cause a 0.75 percentage point drop in GDP growth after one year. Simulations imply that the shock would take roughly 5 years to dissipate. Notably, labor productivity rises on impact—reduced lending and higher financing costs cause firms to shed workers and increase capacity utilization—before falling sharply during the adjustment. Credit growth also remains negative throughout the projection period which would imply private sector deleveraging.

**Figure 4. Slovak Republic: Impulse Response Functions to Macroeconomic Shocks from an Estimated pVAR**

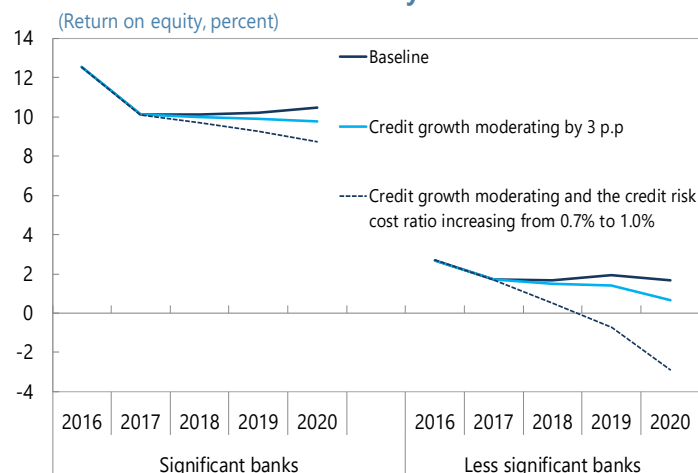


**10. Bank profitability has been supported by strong credit growth, but at the cost of rising sensitivity to adverse shocks.** The business model of the Slovak banking sector is largely dependent on generating net interest income from loans to residents. Half of net interest income is in turn generated from lending to the household sector. To maintain profitability, banks have increased the volume of lending to households to offset the negative effect of decreasing interest margins. Banks' reliance on continued growth in the volume of loans to households to generate profitability for shareholders is increasing banks' sensitivity to macroeconomic shocks, specifically to shocks that either reduce demand for new loans or increase credit risk.

### 11. A simulation of the potential impact of macroeconomic shocks on banks' profitability shows that interest rate and credit risks represent the largest source of risk in bank portfolios.<sup>4</sup>

The simulation uses a balance sheet approach to show that significant banks' sensitivities to factors such as credit and interest rate risks may increase by as much as 50 percent over a three-year horizon if credit growth continues unabated. For example, a fall of the average significant bank's net interest margin by 0.1 percentage points in 2017 could cause net profit to drop by 9 percent; whereas the bank's net profit could decrease by as much as 13 percent if the same change in net interest margin occurs in 2020 and credit growth continues apace. Similarly, an increase in the credit risk to cost ratio would imply markedly higher losses in 2020 than in 2017 under the same conditions for less significant banks. The interest rate risk on household loans is mitigated by the short average duration of interest rate fixation (3 to 5 years). Continued vigilance and extensive supervisory stress testing, as conducted by the SSM in 2017, are nevertheless warranted.

#### Simulation of Banks' Profits by Bank Size



Source: National Bank of Slovakia.

## D. Policy Response to Date

**12. The NBS introduced borrower-based measures in 2014,<sup>5</sup> prompted by a growing unease about risks and imbalances in the household credit market.** There were three main imbalances that motivated the decision: (i) one in four new loans being granted had a high LTV (at the level or close to 100 percent); (ii) the prevalence of borrowers taking advantage of the low interest rate environment to increase their loan value rather than to decrease their debt service payments, often without proper income and credit verification; and (iii) lack of verification of borrowers' ability to repay their mortgages in the event of an interest rate rise. These core measures were complemented by maturity limits, interest rate sensitivity tests, and a mandatory amortization schedule for annuities. In addition, standards for real estate appraisal, income verification, and lending via financial intermediaries were introduced or tightened. By 2016, imbalances in the housing sector and vulnerabilities among mortgage lenders were mounting. A cap on pre-payment penalties (1 percent as of March 2016) further exacerbated the pressure (Figure 5). At the same time, the stock of high LTV loans at or near the regulatory boundary value (90 percent) was rising.

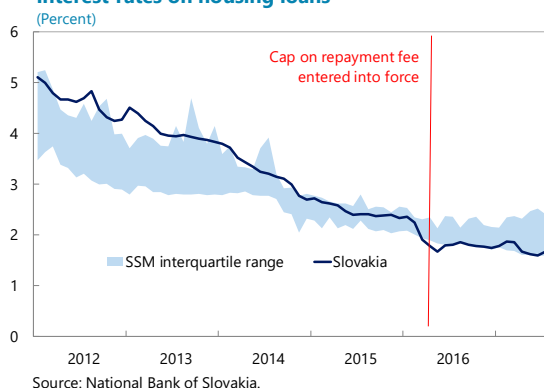
<sup>4</sup> The analysis is described in detail in FSR 11/2017 (p. 32-35).

<sup>5</sup> Recommendation No 1/2014 of NBS of 7 October 2014 in the area of macroprudential policy on risks related to market developments in retail lending: [full text](#) and [comprehensive summary](#).

**Figure 5. Slovak Republic: Housing Market Developments, 2016–17**

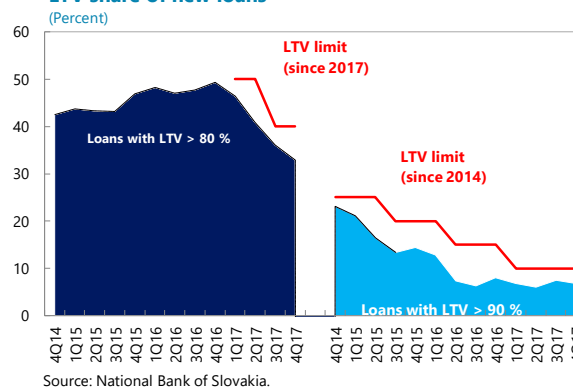
Interest rates on housing loans fell further after the cap on repayment penalties came into force in March 2016.

#### Interest rates on housing loans



The share of high LTV loans continued to climb in each instance until limits were imposed.

#### LTV share of new loans



**13. These developments prompted the NBS to embark on a first revision of macroprudential policy measures in 2016–17 (Table 1).**<sup>6</sup> The objective was to promote sound and sustainable credit growth, and address risks related to vulnerabilities in the residential real estate market. Measures were transposed into binding decrees for housing loans<sup>7</sup> as well as consumer loans.<sup>8</sup> The scope of application was extended to all lenders (not only banks). The debt-service-to-income ratio (DSTI) became binding, albeit at a lower level (80 percent). The share of loans with an LTV of 80 to 90 percent was restricted to 40 percent of the loan book.

**14. The risks from rising household indebtedness triggered a second round of revisions to macroprudential policies in 2018.** As mentioned in the previous section, Slovakia currently has the highest level of household indebtedness among peer countries in the CEE region. Moreover, the current distribution of DTI indicates that a relatively large proportion of new loans exceed debt-to-income limits set in EU members such as Ireland, the United Kingdom, and Norway. The two proposed measures—the debt-to-income (DTI) limit of 8 and the limit of 20 percent on the share of loans with loan-to-value ratios exceeding 80—aim to bring Slovakia’s regulatory framework in line with that of peers, and reduce the risk of household indebtedness.

<sup>6</sup> The revision of the measures is explained in FSR 05/2017 (p. 44-45; for housing loans) and FSR 11/2017 (p. 45-46; for consumer loans).

<sup>7</sup> Decree No 10/2016 of Národná banka Slovenska of 13 December 2016 laying down detailed provisions on the assessment of borrowers' ability to repay housing loans: [full text](#) and [comprehensive summary](#). The revision of the housing loan measures is explained in FSR 05/2017 (p. 44-45).

<sup>8</sup> Decree No 10/2017 of Národná banka Slovenska of 14 November 2017 laying down detailed provisions on the assessment of borrowers' ability to repay consumer loans: [full text](#) (in SK only) and [comprehensive summary](#). The revision of the consumer loan measures is explained in FSR 11/2017 (p. 45-46).

**Table 1. Slovak Republic: Overview of Macroprudential Policy Measures**

	Introduction of measures (2014–2015) (non-binding)	1 <sup>st</sup> revision (2016–2017) (binding)	2 <sup>nd</sup> revision (2018, forthcoming) (binding)
<b>LTV limit</b>	90 % Share of 90+: 10 % (phase-in applied)	Additional limit for 80+: 40 % (phase-in applied)	80 % Share of 80+: 20 % (phase-in applies)
<b>DSTI limit</b>	100 %	80 % (phase-in applies)	No change
<b>Interest rate sensitivity test</b>	Applies to new loans only	Applies to all customer's loans with variable interest rates	No change
<b>Maturity limit</b>	RRE-secured loans: 30Y (excep. 10 %) Unsecured loans: 8Y (phase-in applied)	No change	No change
<b>Amortization rule</b>	Mandatory amortization with annuity	No change	No change
<b>DTI</b>	Not set	Not set	Limit proposed at the level of 8 (exception: 5, phase-in applies)

Source: National Bank of Slovakia.

**15. The role of the countercyclical capital buffer as a policy instrument is conceptually different from that of borrowed-based measures.** First, they serve two different objectives. Borrowed-based measures only apply to new business and target actual lending practices (e.g. DSTI or LTV). In contrast, the countercyclical capital buffer builds general banking sector resilience during good times to ensure adequate loss-absorbing capacity in bad times. Second, they differ in their scope and degree of cyclicity. The countercyclical capital buffer has a broad scope because it covers all private debt, including households and non-financial corporations, and a cyclical component because the expectation is that it will be reduced in downturns to absorb credit losses. For these reasons, capital and borrower-based measures are not substitutes; and are considered complementary parts of a wider policy mix.

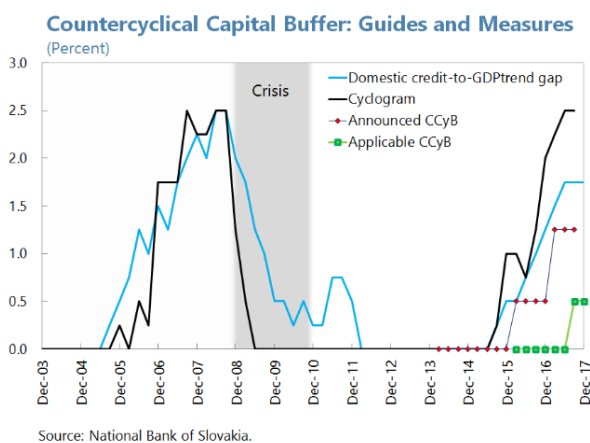
**16. NBS decisions on the countercyclical capital buffer rate are guided by three leading indicators:**

- *Private sector credit growth.* A simple annual rate of private credit growth as a baseline indicator for discussions on excessive credit growth. Notwithstanding its simplicity, its clear advantage is the ease of interpretation, comparability, and widespread international use.
- *The credit gap.* The NBS uses a national credit gap indicator based on the GDP trend. Its most important advantage compared to the standardized Basel formula is use of the GDP trend making the denominator more stable in both good times and bad times. Similarly, the buffer guide is calibrated based on the experience with excessive credit losses incurred by Slovak banking sector in 2009–10. Therefore, the coefficients in the buffer guide are modified as follows:

$$rate_t = (0.475 \times gap_t - 0.95)$$

- *A composite indicator of financial cycle, the Cyclogram.* It comprises several variables capturing not only trends and dynamics, but also stocks and levels to address the emerging character of domestic lending market (Rychtarik, 2014).

**17. The NBS increased the countercyclical capital buffer rate to 0.5 percent for domestic exposures in July 2016.** The countercyclical capital buffer was further increased to 1.25 percent in July 2017. While indicators of national credit gap indicator and Cyclogram provided strong quantitative guidance for these decisions, the NBS also considered the following elements: the growing level of private sector indebtedness, the loosening of lending standards, changes in average risk weights, the banking sector profitability outlook, and the general monetary policy environment. Both increases in the countercyclical capital buffer were widely anticipated by market participants following the issuance of forward guidance two quarters in advance. In both cases the decisions came into force 12 months after the decision was published in the NBS Official Journal. The total delay from trigger to implementation is close to 6 quarters, considering the lag resulting from data availability and the time necessary for legal procedures.



## E. Effectiveness of the Policy Response

**18. In practice, the ongoing evaluation of the effectiveness of macro-prudential policy is mainly based on detailed monitoring of a standard set of indicators of credit standards** (LTV, DSTI, DTI, maturity). Other indicators such as rate of growth of housing or consumer loans, indicators related to the residential real estate market, or indicators of changes in credit quality in the retail loan portfolio of banks are closely monitored as well, although they are not direct policy objectives.

**19. We conduct an event study to assess the impact of macroprudential measures.** The event study follows the approach of Kuttner and Shim (2013). It shows that, for the most part, the impact of macroprudential policy measures was short-lived in both Slovakia and selected peer countries (Netherlands, Czech Republic, and Poland) following the global financial crisis. In Slovakia, for example, the impact tended to dissipate in the third quarter after the macroprudential measure came into effect. In Poland, the impact dissipated after one quarter. The event study highlights the shortcomings of the initial rounds of tightening of macro-prudential policy measures in Slovakia, given that the framework for borrower-based measures had to be built from the ground up and that macroprudential policy operated with a lag between 4–6 quarters in Slovakia (Figure 6). This meant that the reaction time in the years following the crisis was slower than desired because of macroprudential limits, in many cases, started from market averages and were slowly phased-in.<sup>9</sup>

<sup>9</sup> It is possible that other factors –such as frontloading before implementation, legislative changes, and decreasing interest rates –also had a dampening effect yet are not captured by the event study methodology.

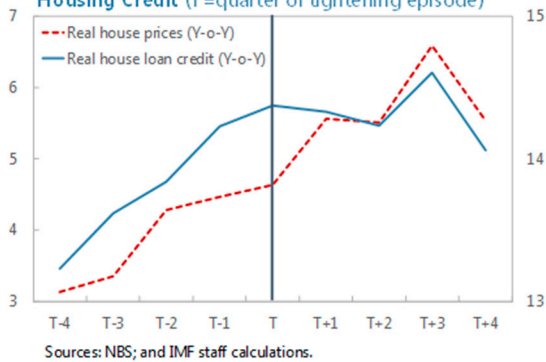
**Figure 6. Slovak Republic: Event Study of Housing Prices and Housing Credit**

(T= Quarter of Tightening Episode)

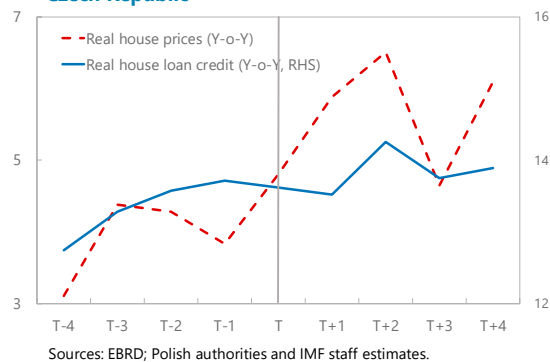
*Episodes of macroprudential policy tightening in Slovakia were effective in slowing growth in both house prices and credit, but the effect dissipated within 3 quarters.*

*In Czech Republic, Macroprudential policy tightening appears to have had some impact on growth in house loan credit, but not on prices.*

**Slovakia: Event Study of Housing Prices and Housing Credit (T=quarter of tightening episode)**



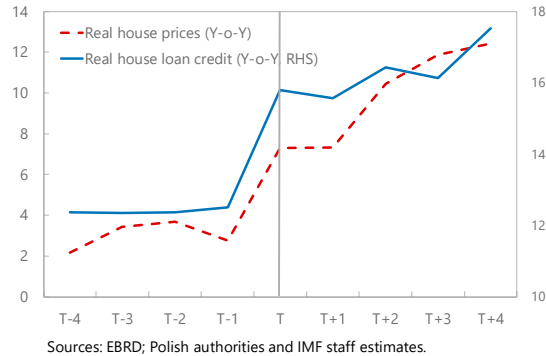
**Czech Republic**



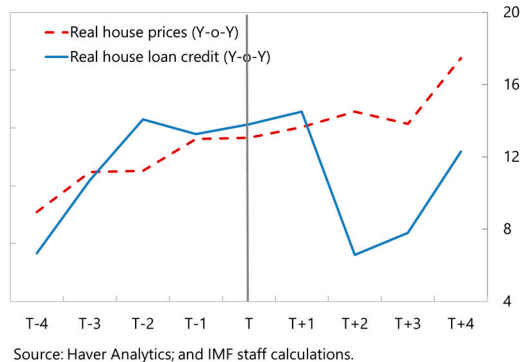
*In Poland, macroprudential policy tightening generally followed sharp increases in house prices or loans; after one quarter growth typically resumed.*

*Macroprudential policy tightening typically had a more lasting effect in the Netherlands [chart to be inserted].*

**Poland**



**Netherlands**



**20. We also conduct an empirical analysis broadening our comparator set of countries.**

Several new datasets—including Kuttner and Shim (2016) and Cerutti et al (2015)—eased the data constraint on analyzing the impact of non-interest rate policies on housing cycles and provided new insights into the most impactful policy levers for stabilizing housing markets. In addition, several studies underscored the impact of LTV ratios identified by Crowe et al (2011) and Cerutti et al (2015), both of which highlighted the key role of loan to value limits in curbing real estate booms. Kuttner and Shim (2016) also stress the importance of debt service to income ratios; they estimate that a policy action to reduce the maximum debt-service-to-income ratio could reduce real credit growth by as much as 4–7 percentage points over the subsequent 4 quarters. Interestingly, Kuttner and Shim (2016) find a significant, cumulative effect of housing-related taxation on housing prices when they limit their dataset to the 18 countries that they define as active users of macroprudential policies.

**21. Our empirical analysis assesses the relationship between housing prices and mortgage credit growth, and non-interest rate policy instruments (Annex III).** We extend Kuttner and Shim's (2016)'s panel data set of 57 emerging and advanced economies from 1980: Q1 through 2016: Q4. The data on non-interest rate policy instruments includes both reserve requirements and macroprudential policy instruments. As control variables we use structural features of the mortgage industry (type of interest rate, term to maturity), and macroeconomic variables (real GDP growth, CPI growth and the policy interest rate). The results are discussed below (Table 2).

<b>Table 2. Slovak Republic: Impact of Non-Interest Rate Policies on Housing Prices and Housing Credit Growth<sup>1</sup></b>		
<b>Dependent Variable<sup>2</sup></b>	<b>Housing Prices</b>	<b>Housing Credit Growth</b>
Interest rate	-0.22*	-0.23**
Policy rate	-0.19**	-0.19**
Inflation	-0.04***	0.68
Real GDP growth	-0.87	-0.11
<b>LTV (limit)</b>	-1.05*	-0.05***
<b>DSTI (limit)</b>	-0.32	-2.65**
<b>Risk weights (max)</b>	-0.35	-0.35
<b>Provisioning (max)</b>	1.58	2.64
<b>Exposure limits</b>	-2.56*	-1.62
<b>Housing related taxation</b>	-1.36	-6.04
Observations	3,480	4,683
Adjusted R-squared	0.26	0.42

<sup>1</sup>A \*\*\* next to a coefficient signifies significance at the 1 percent level; \*\* at the 5 percent level; and \* at the 10 percent level. See Annex III for regression specification and definitions.  
<sup>2</sup>See Annex III for variable definitions and discussion of robustness tests.

- *Non-interest rate policies and housing prices.* Among macroprudential instruments, the maximum loan-to-value ratios and limits on exposure to residential real estate have a statistically significant impact on housing price appreciation. DSTI ratios, risk weights, and provisioning do not have a statistically significant effect on prices. We also find the effect of housing-related taxation to be statistically insignificant in our augmented dataset, even when the sample size is restricted to the 18 countries defined as active users of macroeconomic policy by Kuttner and Shim (2016).
- *Non-interest rate policies and mortgage credit growth.* Of the set of non-interest rate policies evaluated, caps on debt-service-to-income ratios appear to be the most effective policy tool for curbing mortgage credit growth. DSTI ratios are unchanged by housing price increases, which means that their effect is undiluted by housing price appreciation during real estate booms. As is the case with housing prices, our findings are consistent with previous studies that find changes in the maximum LTV ratio and limits on exposures also have a negative impact on housing credit



growth. However, changes in reserve requirements have no statistically significant impact on housing credit growth since they do not affect borrowers directly.

**22. We also undertake an impact analysis of the recently approved revisions to macroprudential policy.** Using detailed household data from EU SILC (2016) for a sample of 5,738 representative households, we estimate the maximum potential household indebtedness based on both demand and supply factors. The simulation suggests that after tightening DSTI and LTV limits, households' maximum indebtedness would still increase with further growth in household income or declines in interest rates, but the rate of growth will converge to the rate of growth in household income over the long-term. In addition, while the DSTI limit in Slovakia (80 percent) is higher than the average among peer countries such as Estonia, Latvia, Hungary and Slovenia (50 percent), our calculations reveal that the calibration applied in Slovakia is at least as strict as in other countries for households earning median income, and even stricter for those with lower incomes but less binding for households with higher incomes. Therefore, the proposed debt-to-income limit (DTI) would be complementary since it would mainly curb the risk of high indebtedness among higher income households.

<b>Table 3. Slovak Republic: Impact on the Change in the Maximum Potential Household Indebtedness</b>		
	<b>Current level of income and interest rates</b>	<b>Increase in income by 15 % and decline in interest rates</b>
<b>Without additional measures</b>	Baseline scenario	+ 22%
<b>Tightening limits on DTI and LTV</b>	- 6%	+ 14%

Sources: National Bank of Slovakia; EU SILC; and Household Finance and Consumption Survey.

**23. The results suggest that these borrower-based measures do not represent a significant one-off impact on the market and that, in the medium-term, the accumulation of other risks would be significantly reduced.** Indeed, the importance of the DTI limit for the mitigation of the risk of household credit growth is mainly applicable in a scenario where interest rates fall even lower and income growth is linked to the rising risk of overheating in the labor market and the economy. Under such a scenario, the implicit DTI limit will be less binding for an increasing number of households.

**24. Our impact analysis also shows that the pace of credit growth gradually decreases with the implementation of measures.** We assume that the majority of loans affected by the tightened limits would still be granted, albeit at a lower volume. The tightening of both the DTI and LTV limits might cause a drop household credit growth of about 0.5–1.4 p.p., and a decrease in the volume of new loans approximately by 8 percent each. This estimation however depends on some assumption, notably (i) the overlap between groups of clients affected by these limits, (ii) the proportion of clients that will give up the loan application if full requested amount cannot be granted and (iii) the proportion of clients who will partially replace the reduced loan volume due to the tightening of the



LTV limits by consumer credit financing. Under current regulations, approximately a third of the debt subject to the stricter LTV limits can instead be financed through consumer credit, while maintaining the level of monthly repayments.

**25. As the preceding analysis shows, the authorities' current and planned macro-prudential measures are slowing down household credit growth at the margin, and supporting the aim of keeping household debt in line with incomes and debt servicing capacity.**

- The event study highlights the need to take a longer-term view to assess the full impact of measures, but also underscores the potential for impacts to dissipate thus necessitating ongoing vigilance.
- The empirical analysis shows that in Slovakia, the DSTI measure is appropriately calibrated for median households. However, the proposed DTI limit would complement the existing macroprudential framework by discouraging high indebtedness among higher income households for whom the DSTI limit is less binding.
- While the share of loans with high LTV ratio is declining, the impact analysis makes a case that further tightening of both LTV and DTI limits would be effective in mitigating the build-up of imbalances with no significant downside in terms of credit market development.

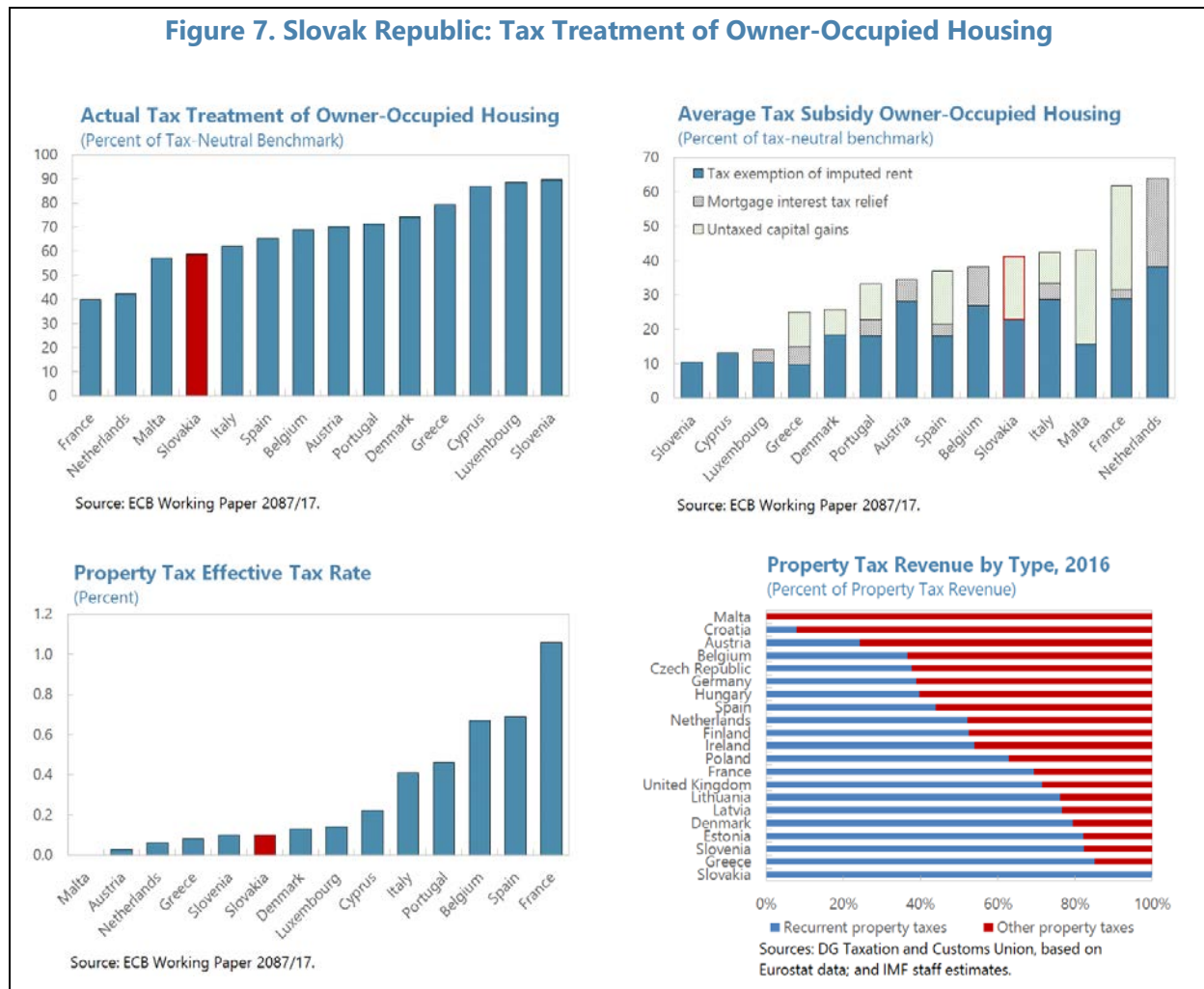
The analysis underscores the importance of proceeding with the second revision of macroprudential policies as planned. While merited, the proposed introduction of LTV and DTI limits might not be enough to avoid an unsustainable run-up in household credit. Therefore, the NBS has communicated the possibility of further tightening of macroeconomic policy, if warranted. However, it is also important to consider what more can be done beyond tightening macroprudential policy.

## F. What More Can Be Done?

**26. Fiscal policies could perhaps play a complementary role in amplifying the effects of macroprudential policies on housing price and mortgage credit growth.** Several studies suggest that property taxes can be used as an effective tool to dampen house price volatility and to curb excessive mortgage credit growth. Wolswijk (2005) noted that greater fiscal subsidization was associated with higher mortgage credit to GDP ratios in EU countries. Using data on effective property tax rates in the United States, Poghosyan (2016) finds that an increase of 0.5 percent in property tax rates can reduce housing price volatility by 0.5–5.5 percent. These findings suggest that increasing recurrent property taxation and reducing mortgage interest deductibility could mitigate incentives for debt-financed home ownership. Most recently, Fatica and Prammer (2017) find that tax benefits in European Union countries reduce the cost to homeowners of housing capital by nearly 40 percent on average compared to the efficient level under neutral taxation.

**27. Compared to peers, the role of housing-related taxation in curbing housing prices and mortgage credit growth in Slovakia could be significantly expanded.** Property taxes in Slovakia are among the lowest in the European Union; property taxes account for 1.4 percent of total tax revenue compared to 6.8 percent on average in the EU. As a percentage of GDP, property taxes are the lowest of any EU country. The effective tax rate is just 0.10 percent, among the lowest in the EU, one-third of the EU average and one-tenth that of France.

**Figure 7. Slovak Republic: Tax Treatment of Owner-Occupied Housing**



**28. The tax treatment of owner-occupied housing in Slovakia distorts the incentives of home ownership.** Compared to the tax-neutral benchmark, in Slovakia the tax on owner-occupied housing is just 58 percent of what the tax-neutral benchmark would suggest. In other words, the favorable tax treatment of owner-occupied housing in Slovakia reduces the user cost of housing capital by one percent of the house value per year, on average, compared to the tax-neutral treatment. Poterba (1995) suggests that to achieve real estate market equilibrium the cost of owning and maintaining your own house should be equal to the cost of renting a comparable property. A tax treatment substantially below the tax-neutral benchmark—such as the one in Slovakia—acts as a subsidy distorts the market by pushing the cost of owner-occupied housing below its equilibrium

level. In Slovakia, the average tax subsidy is comprised of a tax exemption of imputed rent (23 percent of the tax-neutral benchmark) and untaxed capital gains (18 percent of the tax-neutral benchmark) (Figure 7). Since January 1, 2018 young borrowers also benefit from a mortgage interest deduction, not yet reflected in the data.<sup>10</sup>

**29. Increasing housing-related taxes could help dampen demand for household credit and provide additional revenue for the budget.** As a first step, the average subsidy on untaxed capital gains could be reduced by about one-third or 6 percent of the tax-neutral benchmark, to bring it in line with the EU average. Slovakia's tax rate on capital gains is currently 19 percent, compared to the EU top rate of 35 percent (for Malta), and main residences are exempt from capital gains after tenure exceeds 2 years. As a second step, reducing the tax exemption on imputed rent would likely require a significant increase in the effective tax rate on property over the long-run. This would require a combination of phased-in increases in recurrent property tax rates as well as enhanced tax administration efforts. Increasing property tax revenue to the EU average could yield up to 1.2 percent of GDP annually—and would represent an important contribution to the budget.

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<sup>10</sup> Since January 1, 2018, young borrowers up to 35 years of age with incomes below 1.3 times the average can deduct up to 50 percent of their mortgage-related interest expenses from their tax liability for the first five years after purchasing their home. The deduction is capped at €400 per year, and the mortgage volume is capped at €50,000. This replaced a previous interest rate subsidy for young borrowers.

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## Annex I. Estimation of the Retail Credit Level Consistent with Fundamentals<sup>1</sup>

**1. The relationship between retail debt and macroeconomic fundamentals is estimated using panel cointegration model.** The model has the following form:

$$\ln L_{it} = \alpha_i + \sum_j \beta_j X_{ijt} + \epsilon_{it} \quad (1)$$

$L_{it}$  : stock of retail loans,

$X_{ijt}$  : macro-financial variables,

$i$  : country index,  $t$  – time index,  $j$  – index of variable.

The vector of macro-financial variables includes a combination of the following variables:

- the volume of GDP (in natural logarithms),
- income (in natural logarithms),
- retail interest margin,
- employment rate,
- unemployment rate,
- net effective exchange rate,
- property price index (in natural logarithms).

The analysis was performed on eleven countries: Slovakia, the Czech Republic, Poland, Hungary, Slovenia, Croatia, Estonia, Latvia, Lithuania, Romania and Bulgaria. The analysis used nominal variables, since it was their impact on the nominal stock of loans which was examined. The time series (with quarterly frequency) were adjusted for seasonal variations.

**2. Respective equations including different combinations of the macro-financial variables were estimated fully modified ordinary least squares (FMOLS) method and the dynamic ordinary least squares (DOLS) method.** Based on the estimation, six specifications of cointegrating equations are selected, using the following combination of explanatory variables:

- income, interest margin and unemployment rate;
- GDP, income and unemployment;
- GDP, interest margin and unemployment;
- property prices, GDP and employment rate;
- property prices, GDP, income and unemployment rate;
- property prices, income, interest margin and unemployment.

All specifications were first tested using panel cointegration tests to confirm that a long-run relationship indeed exists between lending volumes and a possible combination of explanatory variables. As all equations are estimated using both the method (DOLS and FMOLS), it gives in total 12 possible cointegrating equations.

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<sup>1</sup> The authors are thankful to Ján Klacso who has done this part of econometric analysis.

## Annex II. Estimation of the Private Sector Debt Level Consistent with Fundamentals

**1. The relationship between private sector debt and its main determinants is estimated using an Arellano-Bond specification on a panel dataset.** The specification was chosen to address endogeneity issues in the dynamic panel structure which render fixed effects estimators inconsistent. A broad sample of 36 European countries during 1995–2016 is used under the admittedly strong assumption that all countries share the same long-term elasticities with respect to fundamentals.

**2. The relationship between private sector debt and its main determinants is cast as a single equation, autoregressive-distributed lag (ADL) model.** The latter can be interpreted as a stylized, reduced-form, demand and supply system expressed in semi-loglinear form:

$$\ln \frac{D_{it}}{P_{it}} = \alpha_i + \sum_{j=1}^2 \beta_j \ln \frac{D_{it-j}}{P_{it-j}} + \sum_{j=0}^1 \gamma_j \ln \frac{Y_{it-j}}{P_{it-j}} + \sum_{j=0}^1 \delta_j R_{it-j} + \epsilon_{i,t} \quad (2)$$

$\frac{D_t}{P_t}$  : Per capita private sector debt stock in thousands of 2005 purchasing-power-parity

U.S. dollars (see note to Figure 7 for details);

$\frac{Y_t}{P_t}$  : Per capita GDP in thousands of 2005 purchasing-power-parity U.S. dollars (source:

IMF's World Economic Outlook database), used as a measure of debt-servicing capacity that affects positively (+) both the demand and supply of credit;

$R_t$  : nominal interest rate on private sector debt (fraction)<sup>1</sup>, which has opposite effects on demand (-) and supply (+);

$i$  : country index,  $t$  – time index.

The demand-side effect of changes in interest rates is expected to dominate the supply-side impact in the reduced-form equation, in line with the findings in the existing literature (Cottarelli, Dell'Ariccia, and Vladkova-Hollar, 2003; Schadler and others, 2005; Iossifov and Khamis, 2009). Lack of data on private sector net worth for CESEE countries outside the EU prevents us from including that variable in the regional regressions.

<sup>1</sup> For EU countries, the implicit interest rate is calculated using sectoral accounts data as the ratio of interest payments (including financial intermediation services indirectly measured) over the average of the beginning and end-period combined stock of debt of firms and households. For other countries, data are mostly for the lending rate, published in the IMF's International Financial Statistics database, with gaps in country coverage filled with data for the short-term interest rate published in the OECD's Economic Outlook database and from national data sources.

**3. The long-run relationship between private sector debt and its main determinants is then given by the long-run solution of the ADL model,** under the stability condition

( $0 < \sum_{j=1}^2 \beta_j < 1$ ):

$$d_{it}^* = \frac{\alpha}{1 - \sum_{j=1}^2 \beta_j} + \frac{\sum_{j=0}^1 \gamma_j}{1 - \sum_{j=1}^2 \beta_j} y_{it}^* + \frac{\sum_{j=0}^1 \delta_j}{1 - \sum_{j=1}^2 \beta_j} R_{it}^*, \text{ where} \quad (3)$$

lowercase variables are expressed in natural logarithm of per capita quantities in thousands of 2005 purchasing power parity U.S. dollars; asterisk indicates long-run value;

All variables entering equation (2) are assumed to be either (trend) stationary or integrated of order one and cointegrated (that is, there is a linear combination of the variables in levels that is stationary). In the latter case, the long-run coefficients inferred from the short-run regression specification lie in the cointegration space of the dependent and explanatory variables (Hendry, 1995).

The equilibrium-correction (EC) model isomorphic to the reduced-form demand and supply system (1) is then given by:

$$\Delta d_{it} = \gamma_0 \Delta y_{it} + \delta_0 \Delta R_{it} - (1 - \sum_{j=1}^2 \beta_j) (d_{t-1} - d_{it-1}^*) \quad (4)$$

## Annex III. Estimation of the Impact of Non-Interest Rate Policies on Housing Prices and Housing Credit Growth

**1. To estimate the relationship between non-interest rate policies and housing prices or housing credit growth, we use simple ordinary least squares with fixed effects and robust standard errors.** We estimate two equations, one for each dependent variable, that take the following forms:

$$\ln P_{it} = \alpha_i + \beta_1 \ln P_{it-1} + \sum_j \beta_j M_{ijt} + \sum_j \beta_j X_{ijt} + \sum_j \beta_j X_{ijt-1} + \epsilon_{it} \quad (5)$$

$P_{it}$  : housing prices,

$M_{it}$  : non-interest rate macroprudential policies,

$X_{it}$  : macro-financial variables,

$i$  : country index;  $t$  : time index;  $j$  : variable index.

$$\ln C_{it} = \alpha_i + \beta_1 \ln C_{it-1} + \sum_j \beta_j M_{ijt} + \sum_j \beta_j X_{ijt} + \sum_j \beta_j X_{ijt-1} + \epsilon_{it} \quad (6)$$

$C_{it}$  : housing credit growth,

$M_{it}$  : non-interest rate macroprudential policies,

$X_{it}$  : macro-financial variables,

$i$  : country index;  $t$  : time index;  $j$  : variable index.

The panel dataset includes observations for 57 emerging and advanced economies spanning the period from the first quarter of 1980 through the fourth quarter of 2014. The set of macro-financial control variables is derived from the literature and comprises:

- Interest type on mortgage loans
- Policy rate
- Harmonized CPI
- Real GDP growth

The independent variables capture non-interest rate macroprudential policies compiled from a variety of sources, notably ESRB and BIS databases, and databases from IMF working papers:

- LTV ratio
- DSTI ratio
- Risk-weights
- Provisioning
- Exposure limits

As a robustness check, we ran a Hausman test to determine whether the fixed effects specification was appropriate. We compare random and fixed effects models and test whether the unique errors (ui) are correlated with the regressors, the null hypothesis is they are not. The p-value was significant (0.032) so fixed effects was deemed the appropriate model in this case. To address possible issues of non-stationary time series data, we take the first differences of those variables (see Table 1).



**Table 1. Variable Definitions and Sources**

	<b>Definition</b>	<b>Source</b>
<b>Household Credit Growth</b>	Year on Year Real Household Credit Growth (Percent)	BIS Credit to Households and NPISHs; deflated by yearly CPI growth from World Bank WDI
<b>Housing Prices</b>	Year on Year Real House Price Growth (Percent)	IMF Global Housing Watch, and Federal Reserve St. Louis Housing Database
<b>Inflation</b>	Year on Year Change in Consumer Price Index (Percent)	IMF, World Economic Outlook
<b>Real GDP growth</b>	Year on Year Real GDP Growth (Percent)	IMF, World Economic Outlook
<b>Policy Rate</b>	Monetary Policy Rate (Percent)	Cerrutti, et. Al. compiled from IFS Central Bank Policy Rate when available, otherwise Discount Rate of Deposit Facility Rate for Euro Area countries.
<b>DSTI ratio</b>	Ceiling on debt service to income ratio (Percent))	Kuttner and Shim (2016)
<b>Risk weights</b>	Ratio of Risk Weights to Mortgage Loans (Percent)	Kuttner and Shim (2016)
<b>Provisioning</b>	Required provisioning to loan loss ratio (Percent)	Kuttner and Shim (2016)
<b>Exposure limits</b>	Limit on exposure to housing sector (Percent)	Kuttner and Shim (2016)
<b>Housing related taxation</b>	Property tax effective tax rate (Percent)	Ernst and Young Global Tax Guide, and ECB

# SKILLS MISMATCH AND PRODUCTIVITY<sup>1</sup>

*A sharp increase in labor shortage, including for skilled labor, in recent years has placed Slovakia among the EU countries facing acute labor shortages. Productivity growth, which has already slowed down considerably since the Global Financial Crisis, faces further headwinds from high skill mismatch and shortage. Policies should focus on improving the functioning of the labor market, enhancing the quality of the education system, increasing labor supply including through strengthening the current framework to employ foreign workers. In addition, our estimates show that addressing the long-standing institutional weaknesses would provide a strong boost to productivity.*

## A. Introduction

**1. The Slovak Republic faces significant skills mismatch and labor shortage, particularly for skilled labor, similar to peers in central Europe.** The share of firms that report labor shortages as an obstacle for production expansion has tripled during the last two years and wage growth has surpassed productivity growth for the last 3 years. While skills and qualification mismatches are slightly below the Euro Area (EA) average, they exceed considerably the levels of Central European peers, namely Czech Republic, Hungary and Poland

**2. Skills mismatch and labor shortage carry a significant productivity cost both at the individual and aggregate levels.** For example, the lack of appropriate skills could limit technology absorption and investments in tangible and intangible assets at a firm level and if persists would increase skills mismatch. While individual firms could benefit from employing overqualified staff, it could have a negative impact on aggregate economy through inefficient allocation of resources (McGowan and Andrews, 2015).

**3. This paper aims to analyze potential implications of skills mismatch and shortage on Slovakia's productivity.** Cross-country panel analysis techniques are used to identify the link between productivity and various measures of skills mismatch/shortage for European economies controlling for other productivity determinants such as labor and product market regulation, human capital, governance, and R&D spending. The paper also relies on cross-country experience to draw recommendations for labor market, education, and immigration policies that can address skill mismatch and shortage in the short-to-medium term.

**4. The paper is structured as follows.** Section B provides a summary of the literature, Section C discusses data and measurement issues, Section D demonstrates some stylized facts, Section E presents empirical results, and Section F concludes.

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<sup>1</sup> Prepared by Ara Stepanyan.

## B. Literature Review

**5. The literature traditionally estimates the impact of skills mismatch on productivity indirectly.** The impact is usually inferred through the bearing of skills mismatch on wages, job satisfaction, turnover costs, etc. (Hartog, 2000; Quintini, 2011). The findings show that an overqualified worker will earn less than a worker with a similar qualification in a well-matched job. Previous studies also highlight that over-skilled workers experience lower job satisfaction since their skills are not fully in use (Allen and van der Velder, 2001). Verhaest and Omey (2006) argue that over-qualified workers tend to participate less in training compared with well-matched workers, which hinders accumulation of firm-specific knowledge. Forth and Mason (2006) demonstrate that skill shortages negatively affect technology adoption and investments in tangible and intangible assets.

**6. Recent literature attempts to estimate directly the impact of skills mismatch on productivity.** Kampelmann and Rycx (2012), using employer–employee panel data for Belgium, showed that under-education is detrimental to firm productivity. McGowan and Andrews (2015) identified a strong negative association between skills and qualification mismatch and labor productivity. They also argue that the negative association between over-qualification and productivity is working through a less efficient allocation of resources, while that between under-qualification and productivity works through lower allocative efficiency and within-firm productivity.

## C. Data and Measures of Skills Mismatch and Skills Shortage

**7. Measures of skills mismatch or shortage are limited and not perfect** (Box 1). We have used several sources of skills mismatch and shortage indicators to complement each other. We used survey based indicators from European Commission’s (EC) business and Consumer survey and OECD’s survey of Adult Skills. In addition, we used several indicators calculated using data on labor force by education attainment and employment by education.

- **Skills mismatch and shortage:** Following Estevão and Tsounta (2011), we constructed an aggregate index of skills mismatch that is based on Eurostat data on employment and labor force by education attainment (see Annex A for more details). This indicator shows whether there is a discrepancy between skills demand and supply. Using similar logic, we constructed a skills shortage index that shows the difference between the share of employed with tertiary education and the share of labor force with tertiary education. However, the differences in education quality, both overtime and across countries, would have a significant influence on skill supply. Therefore, labor force with tertiary education is adjusted for the quality of education (see Annex A for more details). Data on education quality are from the World Economic Forum.
- **Labor shortage:** We used the share of respondents from the EC’s Business and Consumer survey that indicated labor being a factor limiting production expansion.

- **Qualification and field-of-study mismatch:** OECD's Skills for Jobs Database provides data on qualification mismatch and field-of-study mismatch, which is calculated using European Union Labor Force Survey.
- **Skill gaps:** OECD's survey of Adult Skills measures three distinct categories of skill gaps: knowledge, which refers to an organized body of information usually acquired during education or training; skills (in a narrower sense) refers to the qualities needed for an individual to make the knowledge productive on the job, which is usually acquired through experience and training; and ability that refers to the ability to perform an activity, which does not necessarily link to a job or task, but a skill such as an ability to plan or organize work (see OECD 2017).

### Box 1. Slovak Republic: Skills Mismatch and Shortage Indicators and Definitions

**Imbalances in the labor market can manifest themselves in different forms.** Skill shortage and mismatch are some of these forms. Skills mismatch and skills shortage are distinct concepts as one can exist in the absence of the other. However, there is a link between skills mismatch and skill shortage as employers unable to find the skills they need may choose to hire under-skilled workers (OECD, 2016). All these measures of skills mismatch and shortage have some weaknesses, and therefore, are complementary to each other.

**Skill shortage:** Skill shortage characterizes a situation when employers are unable to hire employees with the required skills at the market rate due to a lack of supply of the adequate skill in the labor market. Skill shortage is measured directly and indirectly. Employee's surveys are used to measure labor shortage directly. An example of such a survey is EC's Business and consumer surveys that contains a question on whether the labor is a factor that limits production. Measures such as employment growth, wage growth, incidents of overtime are used to extract indirect signals about labor shortages.

**Skills mismatch:** Mismatch describes a situation when a worker's skills differ from the requirements to perform her/his job. Mismatch can be measured relative to the qualification level, field of study, or skills.

- Qualification mismatch captures the difference between worker's qualification and the required qualification for the job (overqualification or underqualification). Qualification mismatch is usually measured using data on education attainment of workers and the required level of education for their jobs.
- Field-of-study mismatch characterizes a situation where workers are employed in a field different from their specialization. In general, occupations are linked to fields of study based on what educational specialization is assumed to be appropriate for jobs in that occupation (Montt, 2015).

In case of skill mismatch, workers' skills exceed or fall short of the skills required to perform their jobs. While qualification and field-of-study mismatches could be calculated from labor force surveys, skill mismatch requires an assessment of skills possessed by individual workers, which goes beyond formal education, and require specific skills to perform their jobs. OECD's survey of Adult skills provides useful information to calculate skill mismatch indicators (see OECD 2017).

## D. Stylized Facts

**8. The Slovak Republic has skills and qualification mismatches that are slightly below the EA average, but exceeds considerably the levels of Central European peers** (Figure 1).

OECD's measure of qualification mismatch for 2015 implies quite low level of mismatch compared with the EA average (Figure 1). This is driven by the Slovak Republic's very low level of underqualification. However, in terms of qualification mismatch among young people, the Slovak Republic has one of the highest level among OECD countries. In addition, the Slovak Republic has one of the highest level of field-of-study mismatch among EA countries (Figure 1).

**9. Labor shortages, including for skilled labor, are more severe in the Slovak Republic compared with the EA average.**

The Slovak Republic's labor shortage in industry and services skyrocketed since 2013 (Figures 1). The share of survey respondents in industry that report labor shortages increased from 6 percent in 2013: Q4 to 33 percent in 2017: Q4. Similarly, the share of respondents in services sector increased from 4 percent in 2013: Q4 to 16 percent in 2017: Q4. This placed the Slovak Republic among EA countries with above average labor shortages. Labor shortages are even more severe in the Czech Republic, Hungary, and Poland. However, in terms of skilled labor shortage, the Slovak Republic has higher shortage than the Czech Republic and Hungary.

**10. The Slovak Republic's high needs in the areas of knowledge, skills, and abilities are in line with needs faced by other EA countries.**

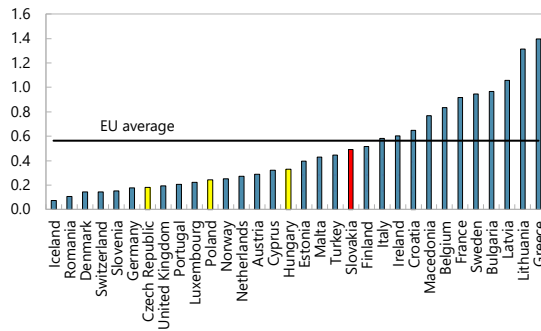
Almost all EA countries have excess demand for knowledge, skills, and abilities that are also in high demand in the Slovak Republic. However, the Slovak Republic's needs for quantitative abilities and knowledge on mathematics and science exceed the average needs for EA countries (Figure 2). The Czech Republic, Hungary, and sometimes Poland have much smaller needs in areas such as quantitative and reasoning abilities and engineering and technology compared with the Slovak Republic.

**11. However, in some areas that the Slovak Republic has shortages, other EA countries have excess supply.**

Knowledge for engineering and technology—one of the highly demanded knowledge in the Slovak Republic—is in excess supply in many EA countries (Figure 2). Similarly, many EA countries have excess supply of technical skills and knowledge on manufacturing and production, while the Slovak Republic experiences shortage.

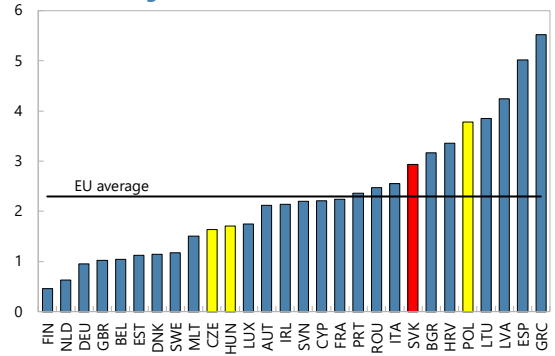
**Figure 1. Slovak Republic: Skills Mismatch Indicators**

**Skills mismatch Index, 2016**



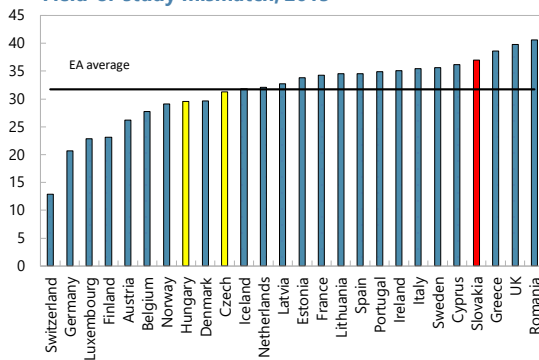
Sources: Eurostat; and IMF staff calculations.

**Skill Shortage Index, 2016**



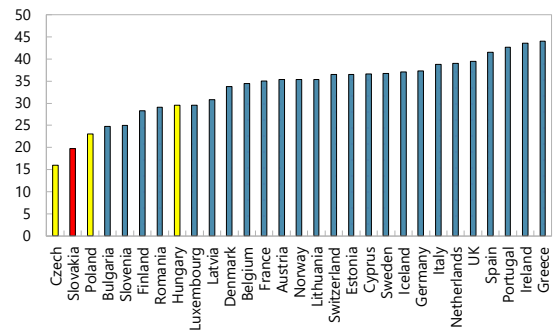
Sources: Eurostat; and IMF staff calculations.

**Field-of-study mismatch, 2015**



Sources: Segoe UI - Size 18

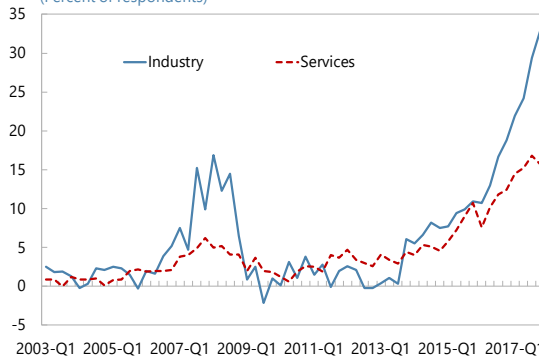
**Qualification mismatch, 2015**



Sources: Segoe UI - Size 18

**Labor Shortages**

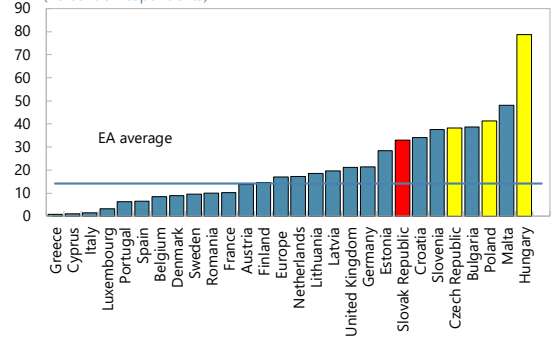
(Percent of respondents)



Sources: Eurostat; and IMF staff calculations.

**Labor Shortages in Industry, 2017Q4**

(Percent of respondents)



Sources: Segoe UI - Size 18

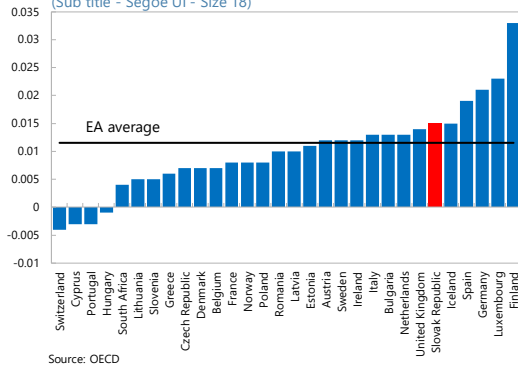
Sources: Eurostat, World Economic Forum, OECD, and IMF staff calculations.

**Figure 2. Slovak Republic: Skill, Knowledge, and Ability Gaps, 2013**

(Positive (negative) value means excess demand (supply))

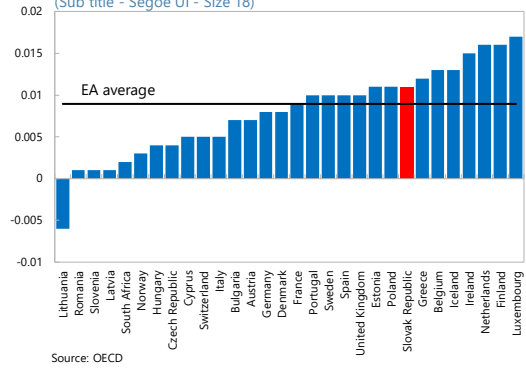
**Quantitative Abilities**

(Sub title - Segoe UI - Size 18)



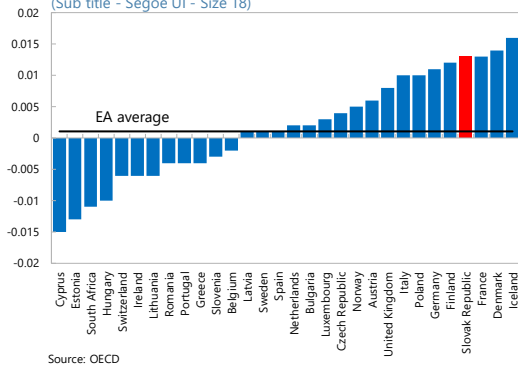
**Mathematics and Science**

(Sub title - Segoe UI - Size 18)



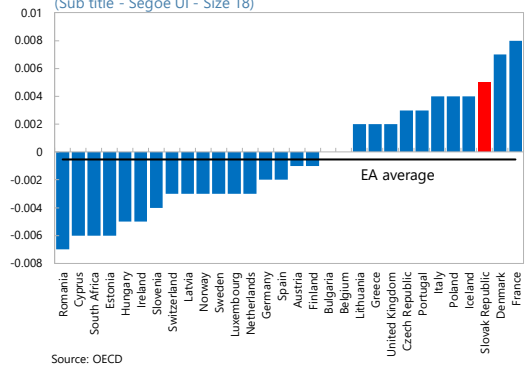
**Engineering and Technology**

(Sub title - Segoe UI - Size 18)



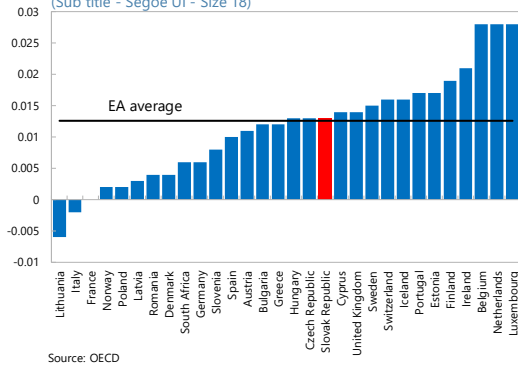
**Technical Skills**

(Sub title - Segoe UI - Size 18)



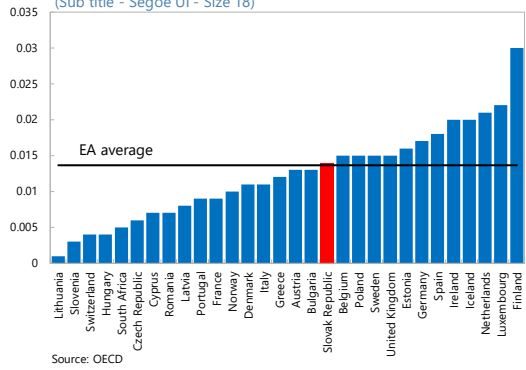
**Health Services**

(Sub title - Segoe UI - Size 18)



**Reasoning Abilities**

(Sub title - Segoe UI - Size 18)



Sources: OECD, Adults Skill Survey.

## E. Econometric Analysis

**12. We used panel regression analysis to identify links between productivity and skills mismatch and shortage.** We used total factor productivity (TFP) or labor productivity as the dependent variable and regressed it against skills mismatch or shortage indicators controlling for other determinants of productivity. Equations are estimated both on annual and non-overlapping five-year average data. The purpose of estimates using five-year averages is to eliminate cyclical variations and look at the long-run links. To mitigate the impact of potential feedback loops between productivity and its determinants, equations are estimated using lagged values for independent variables. Although we should acknowledge that persistent nature of some of the structural variables may reduce effectiveness of this approach, thus the results should be treated as associations not causations. This panel regression is estimated for 26 European countries over 1995–2016:

$$Productivity_{i,t} = \alpha S_{i,t} + \mu J_{i,t} + \beta X_{i,t} + \gamma_t + \theta_i + \varepsilon_{i,t}$$

where, in the main specification,  $Productivity_{i,t}$  is TFP;  $S_{i,t}$  a skills mismatch index;  $J_{i,t}$  is an index for control of corruption; and  $\gamma_t$  and  $\theta_i$  are time and country fixed effects respectively.  $X_{i,t}$  are controls for other policy factors. The specific set of indicators used in the regression are as follows:

- TFP is estimated based on the production function approach.
- Skills mismatch index is constructed following Estevao and Tsounta (2011), which uses data on employment and labor force by education level.
- Quality of public institutions is measured by the Worldwide Governance Indicator on control of corruption, which captures perceptions of the extent to which public power is exercised for private gains. As an alternative measure for quality of public institutions, we used judicial independence index from Fraser Institute Index of Economic Freedom, which measures the perception of judiciary independence from political influences of members of government, citizens, or firms. These indicators have an advantage of providing a consistent set of estimates for countries in our sample for a long period of time.
- Other control variables to capture the role of market friendliness, intensity of research and development, and human capital are mainly from the Fraser Institute, the World Development Indicators, and the World Economic Forum, some of which are survey based indicators.

**13. According to our results, countries with high skills mismatch tend to have lower productivity.** Skills mismatch index has a negative sign and is statistically significant across all specifications, whether we use annual data or five-year averages (Table 1 and Table 2). The coefficients for skills mismatch are also largely similar in all specifications, highlighting the robustness of this association. The negative association between skills mismatch and productivity remains statistically significant even after controlling for the level of human capital. This



underlines the importance of efficient resource allocation, since misallocation that generates skills mismatch reduces productivity gains from human capital. This is consistent with findings by McGowan and Andrews (2015) that assign important role for inefficient resource allocation for the impact of skills mismatch on productivity. Improving effectiveness of active market labor policies (ALMP) would help address skills mismatch. Spending on ALMP in the Slovak Republic is still one of the lowest among EU countries and largely focused on job creation, despite increasing job vacancies, rather than on employability (Figure 4).

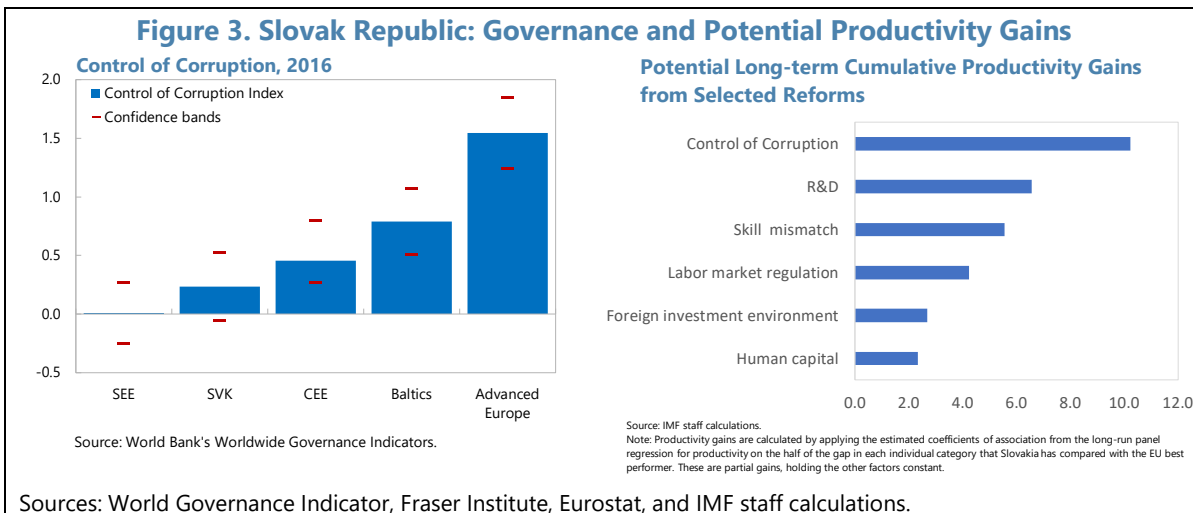
**14. However, labor shortage index, while having the expected sign, is not statistically significant in our analysis.** When we used labor shortage index instead of skills mismatch, it was not statistically insignificant in all specification. The impact of labor shortage could be indirect. Labor shortage could affect productivity through constraining spending on R&D because of a lack of required staff or generating skills mismatch (Mason, 2006; OECD, 2016), all of which are controlled for in our regressions. The recent amendment to the Employment Services Act in the Slovak Republic has simplified conditions for hiring non-EU nationals for occupations identified as experiencing labor shortages with company-level and regional restrictions. The authorities could use the experience of other countries to strengthen their framework for attracting foreign workers (Box 2). In addition, the Slovak Republic has considerable gender gap in labor force participation, which represents unutilized resources that could be used to meet increased demand for labor (Figure 4).

**15. Consistent with the empirical literature, our findings demonstrate that market friendliness of regulation is conducive for productivity.** The analysis suggests that productivity is positively correlated with restrictiveness of foreign investment environment and labor market regulation. While overall labor regulation in the Slovak Republic is not more restrictive than EA average, firing regulation and wage setting framework are more stringent in the Slovak Republic compared with EA average (Figure 4). In contrast with the literature, we were unable to identify statistically significant correlation between business regulation and productivity. This could reflect strong correlation between business regulation and other measures of market friendliness, such as environment for foreign investment.

**16. Improving the quality of public institutions could provide a significant boost to productivity.** The results suggest that countries with a better control of corruption tend to have higher productivity (Tables 1 and 2). Our robustness analysis using judicial independence index instead of control of corruption produced largely similar results (Tables 3 and 4). This is consistent with the literature that identified high corruption and low institutional quality as being detrimental for productivity and growth (see for example Mauro, 1995; Hall and Jones, 1999; Acemoğlu et al, 2001; and Banerjee and Iyer 2005). Various surveys point to a high level of perceived corruption in the Slovak Republic relative to other EU countries.<sup>2</sup> Lowering half of the gap between the Slovak Republic and the EU-15 best performer in perception of corruption has a

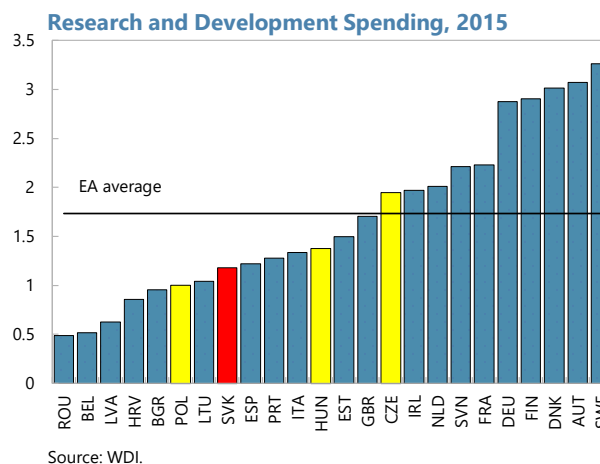
<sup>2</sup> Relative to peers, the Slovak Republic has relatively low scores on Transparency International's Corruption Perception Index, World Governance Indicator's Control of Corruption Index, and World Economic Forum's Judicial Independence index.

potential to increase the level of productivity by 10 percent in the long-run (Figure 3). However, these results should be interpreted with caution, given the possibility of feedback loops between productivity and its determinants and considerable confidence bands around these estimates. In addition, measures of institutional quality used in our analysis are perception-based and could be more subjective than standard macro variables.



**17. Human capital and spending on R&D are positively associated with productivity.**

Human capital index is statistically significant in all specifications, while spending on R&D in specifications with five-year averages but not always in regressions with annual data. While the Slovak Republic has relatively high share of the population with above primary education, the quality of Slovak education system is not high (Figure 4). The Slovak Republic spends less on R&D relative to EA average including the Czech Republic and Hungary. In addition, efficiency of R&D spending could benefit from better cooperation between the Slovak Academy of Science and businesses.



**Table 1. Slovak Republic: Summary of Empirical Analysis with Total Factor Productivity**

	TFP						
	Annual data				5 year averages		
	(1)	(2)	(3)	(4)	(5)	(6)	(-7) 1/
Labor market regulation	0.022* (0.01)		0.026** (0.01)		0.049** (0.02)	0.055*** (0.02)	0.31** (0.12)
Labor market regulation (one year lag)		0.022* (0.01)		0.027** (0.01)			
Environment for foreign direct investment	0.03** (0.01)		0.04*** (0.01)		0.056*** (0.01)	0.063*** (0.01)	0.281*** (0.07)
Environment for foreign direct investment (one year lag)		0.03** (0.01)		0.04*** (0.01)			
Spending on R&D	0.031 (0.02)		0.053** (0.03)		0.063* (0.03)	0.10*** (0.03)	0.18* (0.09)
Spending on R&D (one year lag)		0.03 (0.02)		0.06** (0.03)			
Control of corruption	0.094** (0.04)		0.12** (0.05)		0.10* (0.05)	0.16*** (0.05)	0.35* (0.17)
Control of corruption (one year lag)		0.095** (0.04)		0.116** (0.05)			
Skill mismatch	-0.026*** (0.01)				-0.026* (0.01)		-0.06* (0.03)
Skill mismatch (one year lag)		-0.024** (0.01)					
Business regulation	-0.004 (0.01)		-0.001 (0.02)		-0.029 (0.02)	-0.038 (0.03)	-0.17 (0.13)
Business regulation (one year lag)		0.007 (0.01)		0.001 (0.02)			
Life expectancy	0.01 (0.01)		0.002 (0.01)		0.014 (0.01)	0.014 (0.01)	0.2 (0.19)
Life expectancy (one year lag)		-0.003 (0.01)		-0.001 (0.01)			
Human capital index	1.12* (0.59)		1.17** (0.56)		1.28** (0.47)	1.43*** (0.45)	0.51** (0.19)
Human capital index (one year lag)		1.12* (0.59)		1.13* (0.56)			
Share of services sector in economy	0.007 (0.01)		0.003 (0.00)		0.009 (0.01)	0.004 (0.01)	0.35 (0.30)
Share of services sector in economy (one year lag)		0.008 (0.01)		0.004 (0.00)			
Labor shortages			-0.001 (0.00)			0.0004 (0.00)	
Labor shortages (one year lag)				0.00 (0.00)			
Constant	3.5*** (1.19)	3.8*** (1.20)	4.1*** (1.16)	4.3*** (1.17)	2.729* (1.41)	2.738* (1.33)	-0.05 (0.23)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	468	468	429	429	119	107	119
R-squared	0.68	0.63	0.70	0.67	0.78	0.78	0.78

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
1/ This column presents coefficients standardized with one standard deviation.

Table 2. Slovak Republic: Summary of Empirical Analysis with Labor Productivity

	Labor productivity					
	Annual data				5 year averages	
	(1)	(2)	(3)	(4)	(5)	(6)
Labor market regulation	0.02 (0.01)		0.018 (0.01)		0.041** (0.02)	0.039** (0.02)
Labor market regulation (one year lag)		0.018 (0.01)		0.017 (0.01)		
Environment for foreign direct investment	0.04*** (0.01)		0.041*** (0.01)		0.07*** (0.01)	0.063*** (0.01)
Environment for foreign direct investment (one year lag)		0.042*** (0.01)		0.043*** (0.01)		
Spending on R&D	0.046* (0.03)		0.05 (0.03)		0.092*** (0.03)	0.11*** (0.04)
Spending on R&D (one year lag)		0.05* (0.03)		0.057* (0.03)		
Control of corruption	0.14** (0.06)		0.19** (0.07)		0.14* (0.08)	0.24*** (0.08)
Control of corruption (one year lag)		0.14** (0.06)		0.18** (0.07)		
Skill mismatch	-0.035*** (0.01)				-0.03** (0.02)	
Skill mismatch (one year lag)		-0.033*** (0.01)				
Business regulation	-0.001 (0.02)		-0.005 (0.02)		-0.023 (0.03)	-0.044 (0.04)
Business regulation (one year lag)		0.029* (0.02)		-0.002 (0.02)		
Life expectancy	0.036** (0.02)		0.03 (0.02)		0.035 (0.02)	0.03 (0.02)
Life expectancy (one year lag)		-0.0007 (0.02)		0.02 (0.02)		
Human capital index	1.97*** (0.47)		2.1*** (0.50)		1.72*** (0.43)	2.13*** (0.48)
Human capital index (one year lag)		1.9*** (0.48)		2.03*** (0.50)		
Share of services sector in economy	0.017** (0.01)		0.012* (0.01)		0.022** (0.01)	0.017* (0.01)
Share of services sector in economy (one year lag)		0.017** (0.01)		0.013* (0.01)		
Labor shortages			-0.001 (0.00)			0.0003 (0.00)
Labor shortages (one year lag)				(0.00) (0.00)		
Constant	4.4*** (1.49)	5.0*** (1.35)	5.2*** (1.35)	5.8*** (1.22)	4.175** (1.81)	4.495** (1.61)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	468	468	429	429	119	107
R-squared	0.91	0.90	0.91	0.90	0.93	0.93
Robust standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

**Table 3. Slovak Republic: Summary of Alternative Analysis with Total Factor Productivity**

	TFP						
	Annual data				5 year averages		
	(1)	(2)	(3)	(4)	(5)	(6)	(-7) 1/
Labor market regulation	0.0226** (0.01)		0.0273** (0.01)		0.0552*** (0.02)	0.0665*** (0.02)	0.222*** (0.07)
Labor market regulation (one year lag)		0.0220** (0.01)		0.0268** (0.01)			
Environment for foreign direct investment	0.0219* (0.01)		0.0293** (0.01)		0.0585*** (0.02)	0.0727*** (0.01)	0.283*** (0.07)
Environment for foreign direct investment (one year lag)		0.0229* (0.01)		0.0307** (0.01)			
Spending on R&D	0.0257 (0.02)		0.0519* (0.03)		0.0691** (0.03)	0.116*** (0.03)	0.196** (0.09)
Spending on R&D (one year lag)		0.0262 (0.02)		0.0523* (0.03)			
Judicial independence	0.0133** (0.01)		0.0161** (0.01)		0.0146 (0.01)	0.0255** (0.01)	0.135 (0.10)
Judicial independence (one year lag)		0.0137** (0.01)		0.0164** (0.01)			
Skill mismatch	-0.0341*** (0.01)				-0.0367*** (0.01)		-0.0855*** (0.03)
Skill mismatch (one year lag)		-0.0326*** (0.01)					
Business regulation	0.0042 (0.02)		0.0157 (0.02)		-0.0184 (0.02)	-0.0277 (0.03)	-0.0637 (0.07)
Business regulation (one year lag)		0.00403 (0.02)		0.0152 (0.02)			
Life expectancy	0.0172 (0.01)		0.00695 (0.01)		0.0177 (0.01)	0.0204 (0.01)	0.243 (0.18)
Life expectancy (one year lag)		0.0136 (0.01)		0.00399 (0.01)			
Human capital index	1.142 (0.73)		1.354* (0.73)		1.261** (0.53)	1.376** (0.53)	0.500** (0.21)
Human capital index (one year lag)		1.056 (0.73)		1.269* (0.73)			
Share of services sector in economy	0.00897 (0.01)		0.00215 (0.01)		0.0104 (0.01)	0.00373 (0.01)	0.419 (0.32)
Share of services sector in economy (one year lag)		0.00958 (0.01)		0.00309 (0.01)			
Labor shortages			-0.00142 (0.00)			0.000641 (0.00)	
Labor shortages (one year lag)				(0.00) (0.00)			
Constant	2.894* (1.42)	3.238** (1.42)	3.597*** (1.23)	3.853*** (1.24)	2.287 (1.40)	2.089 (1.27)	0.12 (0.22)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	406	406	366	366	119	107	119
R-squared	0.556	0.89	0.56	0.54	0.77	0.76	0.77

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
1/ This column presents coefficients standardized with one standard deviation.

**Table 4. Slovak Republic: Summary of Alternative Analysis with Labor Productivity**

	Labor productivity					
	Annual data				5 year averages	
	(1)	(2)	(3)	(4)	(5)	(6)
Labor market regulation	0.0272** (0.01)		0.0267* (0.01)		0.0519*** (0.02)	0.0584*** (0.02)
Labor market regulation (one year lag)		0.0252** (0.01)		0.0254* (0.01)		
Environment for foreign direct investment	0.0315** (0.01)		0.0344** (0.01)		0.0740*** (0.01)	0.0777*** (0.02)
Environment for foreign direct investment (one year lag)		0.0335*** (0.01)		0.0335** (0.01)		
Spending on R&D	0.0629** (0.03)		0.0665* (0.04)		0.109*** (0.03)	0.144*** (0.04)
Spending on R&D (one year lag)		0.0650** (0.03)		0.0717** (0.03)		
Judicial independence	0.0248*** (0.01)		0.0280** (0.01)		0.0308* (0.02)	0.0450** (0.02)
Judicial independence (one year lag)		0.0256*** (0.01)		0.0290*** (0.01)		
Skill mismatch	-0.0443*** (0.02)				-0.0451*** (0.01)	
Skill mismatch (one year lag)		-0.0435** (0.02)				
Business regulation	0.00749 (0.03)		0.0145 (0.04)		-0.0133 (0.03)	-0.0337 (0.04)
Business regulation (one year lag)		0.00536 (0.03)		0.0121 (0.03)		
Life expectancy	0.0400** (0.02)		0.0286 (0.02)		0.0388** (0.02)	0.0396** (0.02)
Life expectancy (one year lag)		0.0318* (0.02)		0.0216 (0.02)		
Human capital index	2.076*** (0.67)		2.241*** (0.71)		1.870*** (0.53)	2.177*** (0.63)
Human capital index (one year lag)		1.908*** (0.67)		2.049** (0.73)		
Share of services sector in economy	0.0190* (0.01)		0.0112 (0.01)		0.0228** (0.01)	0.0158* (0.01)
Share of services sector in economy (one year lag)		0.0196* (0.01)		0.0122 (0.01)		
Labor shortages			-0.00113 (0.00)			0.000898 (0.00)
Labor shortages (one year lag)				(0.00) (0.00)		
Constant	3.719* (1.89)	4.515** (1.75)	4.844*** (1.61)	5.548*** (1.49)	3.464* (1.70)	3.386** (1.46)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	406	406	366	366	119	107
R-squared	0.58	0.886	0.88	0.875	0.933	0.923

Robust standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### Box 2. Slovak Republic: Hiring Foreign Workers: Country Examples<sup>1/</sup>

**To address labor shortage, the Slovak government has intended to ease the condition for employing foreign citizens.** The cabinet has recently approved a draft legislative amendment to the law on employment services in February 2018, which will become effective in May 2018. A few key components of the draft amendment include:

- *Simplifying the conditions of employment of non-EU nationals*, such as requiring the Labor Office to certify that a particular position cannot be filled by a Slovak citizen as well as an announcement of the vacant post. These conditions will be exempted for employment of non-EU nationals under the following conditions: (i) for selected jobs where there is a shortage of qualified workers; (ii) in districts where the average registered unemployment is below 5 percent; (iii) only to those employers who employ less than 30 percent of non-EU nationals from the total number of core full-time employees; and (iv) only to those employers who did not breach a ban on illegal employment. The initial list of occupations being in shortage will be published by June 30, 2018 and will be updated every year.
- *Shortening the period for publishing the job vacancy notice*. The period of publication of the announcement of the vacant post to find a suitable candidate for a suitable candidate for a vacant job position from the Slovak labor market is shortened from 30 to 20 working days.

**In terms of giving work permits to foreign nationals, experience could be drawn from other EU member countries.** In addition to the EU-wide work permit (known as the EU-blue card)<sup>2/</sup> granted to high-skilled non-EU citizens, EU member countries have their own criteria for national-specific work permits.<sup>3/</sup> Some of the main criteria are as follows:

- *Highly qualified workers in shortage occupations*. For example, in Austria, some categories of work permits (known as the Red-White-Red card) can be issued to employees who are highly qualified and/or have matched skills for shortage occupations. There is also a specific work permit category for those who are graduates from Austrian universities. In Germany, those—who do not have a university degree nor complete vocational training in the country—could still apply for work permits if they are a specialist in information and communication technologies.
- *Specific programs for certain nationalities*. For instance, the Czech government has continuously raised the number of Ukrainians allowed in as fast-track migrant workers (from 9,600 workers in 2017 to 19,600 workers in 2018). They also plan to apply similar schemes, to a smaller extent, to workers from Mongolia and the Philippines, and plan to explore opportunities for Serbia and Belarus. In Poland, non-EU nationals from six nationalities (Ukraine, Russia, Belarus, Georgia, Armenia, and Moldova) have exceptions and benefits from an easier access to the Polish labor market.

*Temporary employment without work permit*. In Poland, those six nationalities mentioned above can work without the need to obtain a work permit throughout the period of six months within the subsequent twelve months, provided that they have a written statement from an employer.

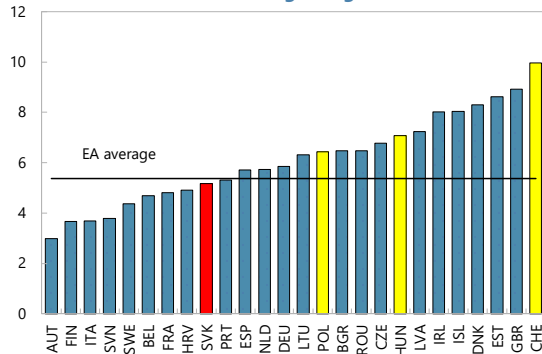
<sup>1/</sup> This Box was prepared by La-Bhus Fah Jirasavetakul.

<sup>2/</sup> More specifically, the EU-Blue card can be granted (initially for the duration of the working contract up to the maximum of four years) to high-skilled non-EU citizens with a university degree and a binding job offer with a salary of at least 1.5 times of the average gross annual salary paid in the EU member country. In some countries, the gross salary threshold could be lower for jobs where there is a shortage of applicants.

<sup>3/</sup> This refers only to work permits for non-EU nationals who move to an EU member country for job reasons, i.e. excluding those who are already in the country with other residential statuses.

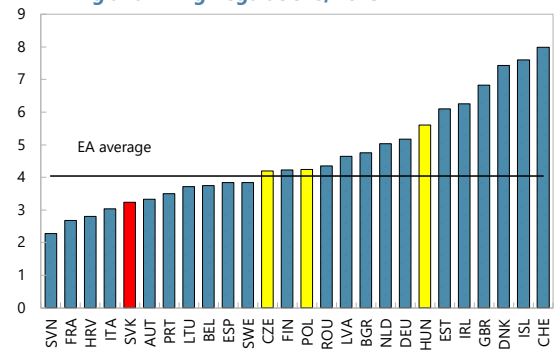
**Figure 4. Slovak Republic: Labor Market and Education**

**Centralized Collective Bargaining, 2015**



Source: Segoe UI - Size 18

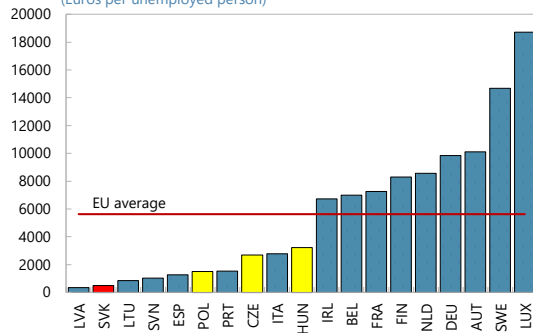
**Hiring and Firing Regulations, 2015**



Source: Segoe UI - Size 18

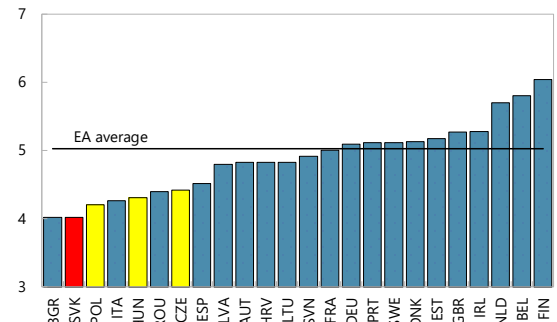
**Spending on Active Labor Market Policies, 2015**

(Euros per unemployed person)



Source: OECD.

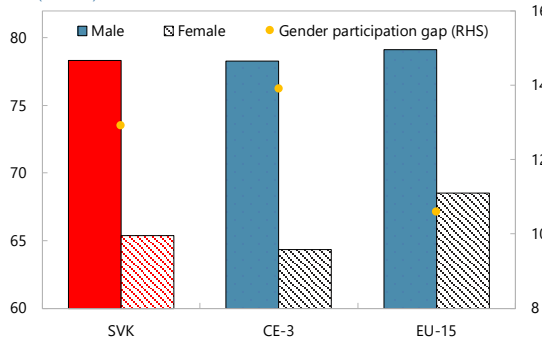
**Education Quality, 2014**



Source: World Economic Forum.

**Labor Force Participation Rate by Gender**

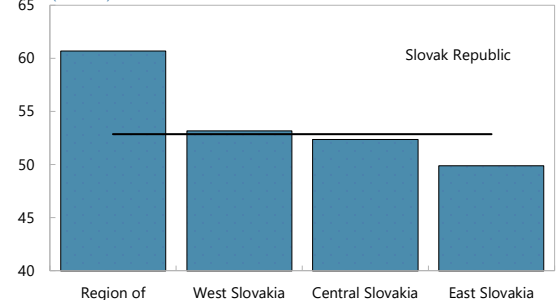
(Percent)



Sources: Eurostat; and IMF staff calculations.

**Female Participation Rate by Region**

(Percent)



Source: Eurostat.

Sources: Fraser Institute, World Economic Forum, Eurostat, and IMF staff calculations.



## F. Conclusions

**18. According to our analysis, the skills mismatch and labor shortages that the Slovak Republic is facing could hurt productivity.** Recent increases in labor shortages including for skilled labor, placed the Slovak Republic among EA countries with high shortage. Field-of-study mismatch in the Slovak Republic is also among the highest in EA. We have identified statistically significant negative association between productivity and skills mismatch. It seems that labor shortage affects productivity indirectly through limiting technology absorption and tangible and intangible investments and giving rise to higher skills mismatch if remained unaddressed.

**19. The Slovak Republic can use variety of policies to reduce skills mismatch and shortage and boost productivity:**

- Expanding labor force through strengthening framework for attracting foreign workers and increasing female labor force participation.
- Improving the quality of education and enhancing effectiveness of ALMPs to reducing skills mismatch.
- Strengthening governance, investing in R&D, and making regulations more market friendly to boost productivity.

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## Annex I. Skills Mismatch Index

**1. We constructed the index of skill mismatch using the framework presented in Estevao and Tsounta (2011).** The index measures the difference between skill supply and demand, where the supply is based on the education attainment of the labor force and the demand on the employment by education. Following Estevao and Tsounta (2011), the skills mismatch index for each country  $i$  at time  $t$  is constructed using the following equation:

$$\text{Skills mismatch index}_{i,t} = \sum_{j=1}^3 (S_{i,j,t} - M_{i,j,t})^2 \quad (1)$$

in which  $j$  is the skill level;  $S_{i,j,t}$  is the percentage of the population with skill level  $j$  at time  $t$  in country  $i$  (skill level supply), and  $M_{i,j,t}$  is the percentage of employees with skill level  $j$  at time  $t$  in country  $i$  (skill level demand).

- Educational attainment data from Eurostat are used to construct skill level supply using less than primary, primary and lower secondary education (as low skilled), upper secondary and post-secondary non-tertiary education (as semi-skilled), and tertiary education (as high skilled). Skill level demand is approximated by the percentage of employees with less than primary, primary and lower secondary education (to proxy low-skilled demand), with upper secondary and post-secondary non-tertiary education (for semi-skilled demand), and with tertiary education (for high-skilled demand).<sup>1</sup>

**2. One component of the skills mismatch index that measures the difference between the share of tertiary educated workers in employment and the share of tertiary educated people in the labor force could be treated as an index of skills shortage/excess.** However, skill supply would be significantly influenced by the changes in the education quality. To account for the differences in the education quality overtime and cross-country, we used education quality index from the World Economic Forum.

$$\text{High skill supply}_{t,i} = LF_{0,i}^h + \sum_{t=1}^N \Delta LF_{t,i}^h * EDQ_{t,i} \quad (2)$$

**3. Where,  $LF_{0,i}^h$  is initial level of the share of labor force with tertiary education for country  $i$ ,  $\Delta LF_{t,i}^h$  is the change in labor force with tertiary education at time  $t$  for country  $i$ , and  $EDQ_{t,i}$  is the index of education quality from World Economic Forum for country  $i$  at time  $t$ .** The index for education quality is normalized to the 90<sup>th</sup> percentile of the distribution data for all European countries, so that countries at 90<sup>th</sup> percentile have value 1.

**4. The new data from high skilled labor supply produced by the equation 2 is used to calculate difference in relative shares of high skill labor supply and demand as an index for skills shortage/excess index.**

<sup>1</sup> Although the Estevao and Tsounta (2011) method of estimating skill supply could be reasonably robust based on educational attainment, the measures of skill demand and skill intensity does have some weaknesses.