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Labor Tax Harmonization in a Multi-Country Model*

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Abstract

Labor tax rates are considerably heterogeneous across European countries. In this paper, we investigate the effects of a hypothetical policy experiment in which the tax rates levied on labor are harmonized in the member countries of the euro area. Using a four-country DSGE model, we find that shifts in domestic tax rates are the main driver of the total outcome of the policy change while spillover effects are rather limited in the long run. The short-run adjustment process is rather complicated: a country which gains in the long run may temporarily go through a period of dampened economic activity. In terms of volatility, the euro area with its homogenous labor tax system may be better prepared to face common area-wide shocks. On the other hand, shocks originating outside the euro area may increase volatility in the euro area.

1. Introduction

The economic integration of European countries has so far been achieved to a limited extent. Although a group of countries with a common monetary policy and currency has been established, the differences between these countries remain considerable. At the political level there are repeated calls for further integration, but these are always swiftly rejected. One of the bones of contention is the different tax structures in European countries. Countries with a higher tax burden call for higher tax rates in countries with lower tax rates, arguing that low-tax countries compete with their partners in the euro area. On the other hand, high-tax countries are not willing to lower their taxes because they need more financing for public services.

The objective of this paper is to quantitatively evaluate a hypothetical change in tax policy. We focus on just a small part of the issues that may be raised by different tax rates in a monetary union. We disregard issues such as uniformity of the tax base and corporate tax rates. Instead, we comprehensively study the effects of taxes levied on labor income and social security contributions paid by employees and employers.

To illustrate the differences within a group of euro area countries, *Table 1* shows effective personal tax rates taken from the OECD publication *Taxing Wages* (2010). The total tax wedge in a low-tax country is almost one-half of the tax wedge in the country with the highest taxes. Not only do the countries have different total tax wedges, they also have different tax structures. On one hand, there are countries in which the tax burden falls mainly on employers. In France and Spain, for example,

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Table 1 Tax Rates as a Percentage of Labor Costs in 2009

Country	Total tax wedge	Income tax	Social security contributions	
			Employee	Employer
Ireland	28.6	12.9	6.0	9.7
Luxembourg	33.9	12.7	10.9	10.3
Portugal	37.2	9.1	8.9	19.2
Slovak Republic	37.7	6.3	10.6	20.8
Netherlands	38.0	15.1	13.8	9.1
Spain	38.2	10.3	4.9	23.0
Greece	41.5	7.1	12.5	21.9
Finland	42.4	18.6	5.1	18.7
Italy	46.5	15.0	7.2	24.3
Austria	48.0	11.4	14.0	22.6
France	49.2	9.9	9.6	29.7
Germany	50.9	17.3	17.3	16.3
Belgium	55.1	21.1	10.7	23.3

Sources: Taxing Wages 2009; OECD 2010.

social security contributions paid by employers are considerably higher than the sum of income tax and social security contributions paid by employees. Conversely, the authorities in the Netherlands and Germany collect more taxes from employees than social security contributions from employers.

Literature on tax changes in a DSGE model environment is somewhat scarce. One example is Iwata (2009), who employs an extended Smets-Wouters (2003) model and introduces non-Ricardian households and three distortionary tax rules. Carton (2012) compares a closed economy with two countries in a currency union. He concludes that, in such a case, changes in domestic consumption tax policies spill over into the rest of the union; however, changes in labor tax rates have a relatively small effect on other countries in the union. Coenen, McAdam and Straub (2008) elaborate on a hypothesis suggested by Prescott (2004), who argues that in Europe taxes on labor income are the main disincentive to work and that consequently labor utilization in Europe is lower than in the United States. In a two-country DSGE model, the authors show that reducing tax rates to the level prevailing in the United States increases the number of hours worked and the total output of the economy. Given the considerable heterogeneity of tax rates across euro-area countries, it is not clear how such a policy would be implemented and whether different approaches would lead to the same outcome. Furthermore, it is questionable whether European countries would be willing to follow the United States and decrease the size of government in their economies. There are a number of papers that estimate the impact of a set of fiscal instruments on the real economy, for example Ambriško et. al. (2015), which, in principle, can be used to evaluate scenarios similar to ours. These papers, however, are mostly single-country models and are therefore unable to assess cross-border interactions.

In this paper, we quantitatively study the effects of a policy when all euro-area countries adjust their tax rates to the euro-area-wide average levels, which we call

the harmonized tax regime. We are interested in whether it matters to the euro area as a whole if individual countries tax labor differently. We evaluate the long-run effects of tax changes and describe transitional dynamics from the current situation to the new harmonized tax structure. The design of our experiment, in which we keep the tax rates at the area-wide level unchanged, allows us to evaluate the contribution of a uniform tax regime in terms of output volatility. Finally, we examine the extent to which low taxes levied on labor in some countries present an instrument for international competition.

To answer our research questions we employ a four-country DSGE model developed by Gomes, Jacquinot and Pisani (2012). In our setup, three countries belong to a monetary union and the fourth country represents the rest of the world. The tax rates and the steady state properties are such that one country resembles Germany, the second one Slovakia and the third the rest of the euro area. This rich multi-country structure allows us to study spillover effects in detail, as consumers are free to adjust their demand for imported goods when relative prices change due to shifts in tax rates.

Although the long-term results can be predicted quite easily, the course of adjustment in the short run is unclear. As a starting point we need to establish the new equilibrium when the countries adjust their tax rates to the euro-area average levels. Our primary focus is, however, the course of the adjustment process during the first few years after the change. Obviously, this depends on, among other things, the timing of the tax rate adjustment.

We find that Germany, a country that lowers its total tax wedge, boosts its economy when demand for its products increases both domestically and abroad. As a result, the country gains a bigger share in the world market. On the other hand, regions that increase their total tax wedge (Slovakia and the rest of the euro area) dampen domestic demand. Total consumption and investment decline, as does trade. Due to access to foreign markets, consumers in these countries mitigate the impact of the domestic tax hike by buying more imports. However, the spillover effects are limited compared to the effects caused by the changes in domestic taxes.

The economies may initially go through a volatile adjustment process due to the differing timing of the impacts of changes in different tax rates. In the short run, the spillover effects significantly contribute to volatility when investments, consumer inflation, exports and imports are particularly affected.

It also turns out that harmonized tax rates slightly increase the volatility of the output response to a foreign shock. On the other hand, when the euro area faces common area-wide shocks, the volatility of output is lower in the unified tax regime.

The model employed in this exercise does not fully capture all relevant channels of fiscal instrument transmission to the real economy. These are, for example, race-to-the bottom considerations, differences in preferences of different countries, capital mobility and political economy considerations. The more complex labor market block of the model should also increase the accuracy of the results. The implications of some of these features can be analyzed in future research.

The text is organized as follows: In Section 2, we briefly describe the model and its calibration. In Section 3, we introduce our scenarios and present the results of several exercises. Section 4 concludes the paper.

2. Model Structure and Calibration

The model we employ, EAGLE, is a four-country model developed by Gomes, Jacquinot and Pisani (2012) and is an extension of the New Area-Wide Model (Coenen, McAdam and Straub, 2008; Christoffel, Coenen and Warne, 2008). A comprehensive exposition of the model can be found in the above-mentioned references. Here we only briefly introduce the main features of the model and its calibration.

The world in the model comprises four regions that are symmetric in structure. Three regions form a monetary union with a common monetary policy and fixed exchange rate between the member regions. There are two types of agents populating each region—Ricardians and non-Ricardians. Furthermore, there are firms producing intermediate goods, firms producing final goods, the central bank and the government.

Households supply differentiated labor services to intermediate firms. Specialization gives households an opportunity to demand different wage levels for different labor types. We use a well-known Calvo mechanism (Calvo, 1983) to introduce rigidity in the labor market. Furthermore, households make decisions about how much to consume and how much to save. Regarding possibilities to save, the model contains two types of households. One type (non-Ricardians) can only smooth their consumption via changes in holdings of money while the other type (Ricardians) have access to domestic and international bond markets and can use bond holdings, in addition to money holdings, to insure themselves against shocks. The latter type of households own domestic firms and thus make decisions on how much capital to invest and how intensively the existing stock of capital should be used in production. They also receive all profits of these firms in dividend payments.

Intermediate-goods firms produce differentiated products and, like households, can influence the price of their products. We again use the Calvo mechanism to formalize the pricing behavior of firms. Firms produce output according to a Cobb-Douglas production function with labor and capital being the production inputs. There are two types of domestic intermediate products—tradable and non-tradable products. Non-tradable products can be consumed only domestically while tradable products can also be exported.

Final-goods firms operate in a perfectly competitive environment where they assemble domestic and foreign intermediate products to produce four types of final goods—private consumption goods, government consumption goods, investment goods and exports.

The monetary authority follows a Taylor rule in setting interest rates. More specifically, the central bank adjusts interest rates in response to the deviation of inflation and output growth from their target levels. In the monetary union, the monetary policy responds to union-wide deviations from policy targets.

The government purchases a composite of domestic non-tradable goods and makes transfers to households. On the income side, the government collects tax revenues, earns seigniorage on money holdings and issues bonds to finance its debt. Purchases of goods and transfers to households are exogenously given processes and their amount is a fixed fraction of the economy's output. The tax structure comprises a set of distortionary and lump-sum taxes. Lump-sum taxes follow a rule which

ensures stable public debt in equilibrium. The list of distortionary taxes includes consumption tax, labor income tax, dividend income tax, capital income tax and social security contributions paid by workers and firms.

Ricardian households can buy several types of bonds. Each such household can buy bonds issued by the domestic government. Bonds issued by the government in the rest of the world are traded internationally, so residents in the other three regions are allowed to buy these bonds. Moreover, the way the monetary union is set up in the model requires a bond that is traded in the monetary union. Similarly to the internationally traded bonds, bonds issued by one of the countries belonging to the union are available to residents of the other regions in the union. International transactions in bonds are subject to transaction costs in order to make the model stable, as suggested by Schmitt-Grohe and Uribe (2003).

In this paper, we extend the EAGLE model by including a new feature. In the original model, all imports are consumed domestically, unlike in reality, where the export sector utilizes a considerable proportion of all the country's imports, especially in the case of small economies. We therefore allow exporting firms to use imported products as an input in their production. This feature, which was originally incorporated into EAGLE by Brzoza-Brzezina, Jacquinot and Kolasa (2014), makes the countries more open in terms of the share of imports and exports in total output and may thus substantially alter the magnitude of spillover effects, which are an important subject of interest in this study.

The geography of the model world is as follows: three regions belong to the monetary union; the fourth region represents the rest of the world (labeled RW below). One of the monetary-union countries is small with a relatively low tax wedge (Slovakia, labeled SK), another country is large with a high tax wedge (Germany, labeled DE) and the third country represents the rest of the euro area (labeled REA). The parameterization of the rest of the euro area, Germany and the rest of the world are taken from the original model (for details, see Gomes, Jacquinot and Pisani, 2012). The parameters determining the dynamic properties are equal across countries, except for the parameters of price and wage Phillips curves. Those parameters for Slovakia are taken from Senaj, Výškrabka and Zeman (2012). The steady state values of GDP size, great ratios and international flows of goods are calculated from the data over the sample period 2002–2008. The details of calibration of the model can be found here in *Appendix 1* and in Senaj and Výškrabka (2011).

We calibrate the effective income tax rates and social security contributions in line with *Taxing Wages 2009–2010* (OECD, 2011). As the tax structure of the rest of the world is not our point of interest, we borrow these tax rates from Coenen, McAdam and Straub (2008). The tax rates in the rest of the euro area are calculated as a weighted average of national rates at PPP-based GDP weights.

3. Effects of the Tax Reform

In this section, we analyze the effects of distortionary tax changes. The setup of the scenario under review is introduced in the first part. We then look at the long-run effects of the reform. The third part deals with transitional paths towards the new steady state that the economies are likely to follow. The fourth part summarizes a few findings that relate to tax competition among European countries. Finally, we address

Table 2 Tax Rates

	Baseline scenario				Tax harmonization scenario
	DE	SK	REA	RW	Euro area
Effective income tax	17.3	6.3	12.6	13.4	13.9
Effective social contribution—employee	17.3	10.6	8.6	7.0	11.1
Effective social contribution—employer	16.3	20.8	23.4	9.0	21.2
Overall tax wedge	50.9	37.7	44.6	29.4	46.2

Note: All figures are expressed as percentage shares of labor costs.
Source: OECD 2010.

the important policy issue of whether the uniform labor tax structure helps the euro area deal with different types of shocks in terms of volatility of output.

3.1 Specification of the Scenario

Our working assumption is that explicit tax harmonization means the introduction of common tax rates in the member states of the monetary union. We define the euro-area-wide tax rates as a weighted average of individual tax rates, where the weights are the corresponding shares of GDP at model-consistent PPP units. In our experiment the governments neutralize the implied change in their revenues by appropriate adjustment in lump-sum transfers to households.

Table 2 contains full details on the tax rates used in our scenario. The total tax wedge in Germany is above the euro-area average, whereas the total tax wedges in the rest of the euro area and Slovakia are below the average. Looking at the composition of the tax rates reveals that in Germany and the rest of the euro area shifts in taxes on households go the opposite way to shifts in social security contribution paid by firms. In Germany, income tax rates are higher than the euro-area average and firms' social contributions are lower than the euro-area average. The opposite holds for the rest of the euro area. These differences have consequences for the total outcome of the simulations, as the different tax rates have different implications for the economy.[1]

3.2 Long-Run Effects

In the case of Germany, the total labor tax paid by employees decreases by 9.6 p.p. while the tax paid by firms increases by 4.9 p.p. The overall tax rate in the economy thus decreases by 4.5 p.p., which improves the budget of Ricardian consumers. It turns out that a drop in household taxes has a sizeable impact on the economy, while a hike in firms' taxes has only a moderate impact. The increase in firms' taxes leads mainly to a comparable decrease in real wages. The total change in real wages is indeed comparable to the change in firms' taxes, as they drop by about 4.6%. Lower wages compensate firms for higher taxes and help keep production prices low. In fact, the marginal costs of production decrease slightly and thus contribute to higher demand led by Ricardian agents. Non-Ricardian consumers cut their consumption as their financial situation deteriorates. Nevertheless, total consumption increases by 3.6%. As domestic production becomes relatively cheaper,

[1] Although the impacts are the same in the steady state, they might differ in the short-term horizon.

it replaces imported goods, although imports rise as well. Total imports rise by 1.1% while exports rise by 1.8%. The total output of the economy rises by 4.2%. Higher production accommodates increased labor supply of non-Ricardian consumers without putting pressure on real wages. At the same time, the improved financial situation of Ricardian agents allows them to invest more and to support higher production with a higher stock of capital. Investment rises by 3.7%.

The total tax imposed on labor in the rest of the euro area increases only slightly, by 1.6 p.p. In terms of individual components, households' labor income tax rate rises by 3.8 p.p., while the tax rate on firms' labor costs drops by 2.2 p.p. In qualitative terms, these changes are the precise opposite of those in Germany. We observe a 1.5% rise in real wages, as households gain almost the entire benefit of the decline in firms' labor costs. Although the wage rate increases mainly due to a decrease in firms' tax rates, households' higher labor tax is the main factor in the increased marginal costs of production and, consequently, prices. The negative effect on the budget of Ricardian agents outweighs the positive effect on the budget of non-Ricardian agents, and overall domestic demand falls—consumption declines by 1.2% and investment by 1.3%, as the capital stock required by the economy is not as high as it was in the original equilibrium. Consumers tend to switch from domestic goods to foreign goods. Total imports increase by 0.8% and exports increase by 0.4%. Altogether, output drops by 1.4%. Furthermore, the increased tax wedge generates mild negative spillover effects around the world. The impact is, of course, most pronounced in the rest of the euro area, whose share of world GDP shrinks by 0.1 p.p.

The most radical changes in the tax rates under review occur in Slovakia. Households' labor income tax rate rises by 8.1 p.p. and firms' labor cost tax rate increases by 0.4 p.p. In qualitative terms, the economy follows a similar process to that of the economy of the rest of the euro area. The improved financial situation of non-Ricardian rule-of-thumb consumers reduces incentives to work and the total number of hours worked decreases by a sizeable 4.3%. Such households also raise their wage demands, pushing overall wages in the economy up by 2.0%. This increases production costs and prices of domestic products. Nevertheless, final domestic demand falls due to lower disposable income and the negative wealth effect on Ricardian agents. Consumption and investment drop by 2.3% and 2.4%, respectively. Exports decrease only moderately, by almost 1.2%, and imports fall by 0.4%. As a result, total output decreases by 3.6%. However, the magnitudes are not as large as one would expect, considering the size of the tax changes. The reason is the share of Ricardian agents. In Slovakia, the share of those agents is set at 50%, which implies that the negative impulses from such agents are to some extent outweighed by the larger share of non-Ricardian consumers who benefit from increased taxes.[2] This observation is verified in the sensitivity analysis in *Appendix 2*.

A striking observation is that the total output of the euro area in purchasing power parity is lower than it was under the original tax structure. The euro area as a whole, however, gains marginally in terms of market share (increases by 0.02 p.p.) due to a slight appreciation in the real exchange rate. *Table 3* summarizes the long-run changes of selected variables.

[2] In the remaining three regions the size of Ricardian households is 0.75, in line with the original calibration of EAGLE. For Slovakia we set this figure at 0.50 in accordance with Zeman and Senaj (2009).

Table 3 Long-Run Changes

	Germany	Slovakia	Rest of euro area	Euro area
Output	4.18%	-3.60%	-1.41%	-0.35%
Output share	0.12	0.00	-0.10	0.02
Consumption	3.60%	-2.27%	-1.23%	
Investment	3.74%	-2.38%	-1.29%	
Real wages	-4.63%	1.45%	2.00%	
Hours worked	4.38%	-4.29%	-1.46%	
Export	1.83%	-1.15%	0.40%	0.87%
Import	1.13%	-0.42%	0.79%	0.71%
Terms of trade	0.57%	-0.72%	-0.20%	
Real exchange rate	1.27%	-1.15%	-0.46%	

Notes: All figures apart from output share represent a percentage deviation from the baseline steady state. Output share is expressed as a percentage point deviation from the baseline state.

3.3 Adjustment Processes

In this part, we study the transitional paths of the key variables after the implementation of common tax rates. First we examine the adjustment process in Germany. The situation in the rest of the euro area is to a large extent similar and we comment on it afterwards. After that, we discuss the main factors that drive the differences in the adjustment process of the Slovak economy. Finally, we present the transition process at the euro area level.

The first striking observation is that the transition processes are nontrivial. In particular, the real quantities start out in the opposite direction to their long term outcome. Consumer prices are also not heading monotonically toward the new equilibrium prices. The higher cost of production due to firms' higher taxes and higher demand due to households' lower taxes put upward pressure on inflation. When these effects fade away and the real wage settles at a lower level, domestic consumer inflation falls below the target for a protracted period of time.

The real wage settles at a lower level due to both types of tax rates. Firms' higher taxes force households to cut wages. Otherwise, firms would have to charge higher prices, which leads to lower demand for their products and subsequently to lower demand for labor. Consumers are better off when they absorb a part of the tax hike in their wages. On the other hand, a higher after-tax wage due to households' lower taxes makes leisure more expensive and consumers are willing to work more. The larger supply of labor puts downward pressure on wages. As a result, the real wage converges monotonically to its new equilibrium level.

The response of hours worked is not strong during the first phase of transition, as the positive impulse from households' lower taxes is mitigated by the effect of firms' higher taxes. The negative income effect on non-Ricardian agents who want to make up for the loss in income and work more is the main driver of the rise in total hours worked.

The dampening effect of firms' higher taxes on consumption interferes with the positive effect of households' lower taxes. The effect of the cut in households'

taxes, which is about twice as large as the increase in firms' taxes, dominates and total consumption immediately rises above the original equilibrium level and remains above it during the whole transition.

The development in consumption is in sharp contrast to the development in investments. Although the long-term equilibrium investment level is higher in the new tax regime, investment activity is restrained for a longer period. Higher inflation makes domestic products less favorable in both domestic and international markets and investors thus postpone expansion of capital stock. Moreover, the decreasing real wage due to households' lower taxes motivates firms to substitute labor for capital. Higher long-term output goes hand in hand with higher capital stock. Households start to build the stock of capital in the later phase of adjustment.

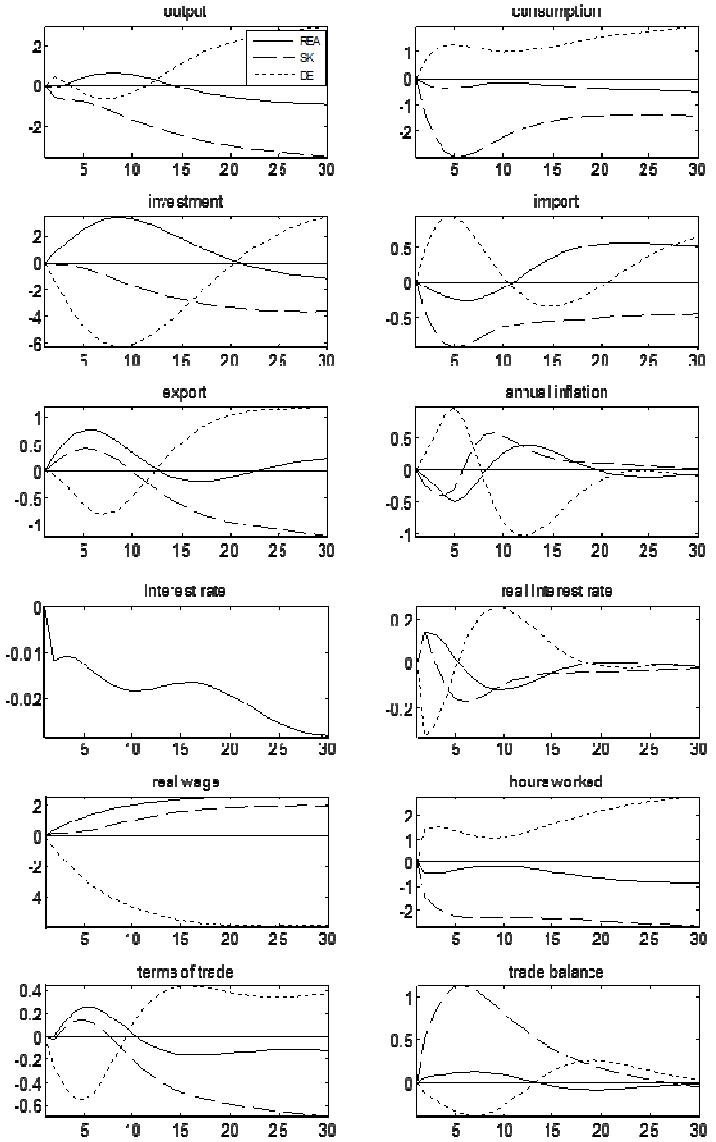
The initial developments in production costs make the country less favorable in the international market. Imports initially pick up, while exporters suffer as consumers tend to switch between domestic and foreign production in response to changes in relative prices. The hike in firms' taxes quickly feeds into demand for export goods and overall export performance declines. On the other hand, households' lower labor income tax only gradually brings benefits when exports pick up after about two years. Imports initially increase on the back of higher household demand. When the initial demand effect fades away, imports temporarily slow until demand in the export sector pulls the import sector up as well.

Total output also fluctuates around the original steady state for a few periods before it starts converging to the new equilibrium. Its volatility is not as high as the volatility of consumption and investment, since investment and net exports offset the influence of consumption.

The tax changes in the rest of the euro area go in the opposite direction compared with the changes in Germany. This results in opposite impulses for the adjustment of key economic variables. For example, the real wage in the rest of the euro area increases as both firms' lower taxes and households' higher taxes tend to increase the wage. Consumer inflation falls below the target for a few periods. After that it rises above the target in line with the higher price level in the new higher-tax regime. Consumption falls slightly while investments increase initially to support higher production. Higher domestic production is mostly exported. After a few periods of positive developments, the international relative prices hinder the export performance of the rest of the euro area, which leads to a slump in exports while imports pick up. Investment activity decreases and, together with lower consumption, leads output to a lower level compared to the original equilibrium. Hours worked fall as well in line with domestic production.

The adjustment process of real variables in Slovakia, which raises both households' and firms' taxes, is far smoother as the effects stemming from firms' higher taxes do not counteract the effects ensuing from households' higher taxes. The real wage is an exception, however. The impulse from households' taxes to increase the wage is mitigated by the impulse from firms' taxes to decrease the wage. As a result, the real wage increases slightly compared to the wage responses in the other two countries. Consequently, despite the large increase in the total tax wedge, the magnitude of the inflation response is comparable across countries. Consumption, investment, hours worked, imports and total output decrease immediately. Exports

Figure 1 Transition to the New Steady State

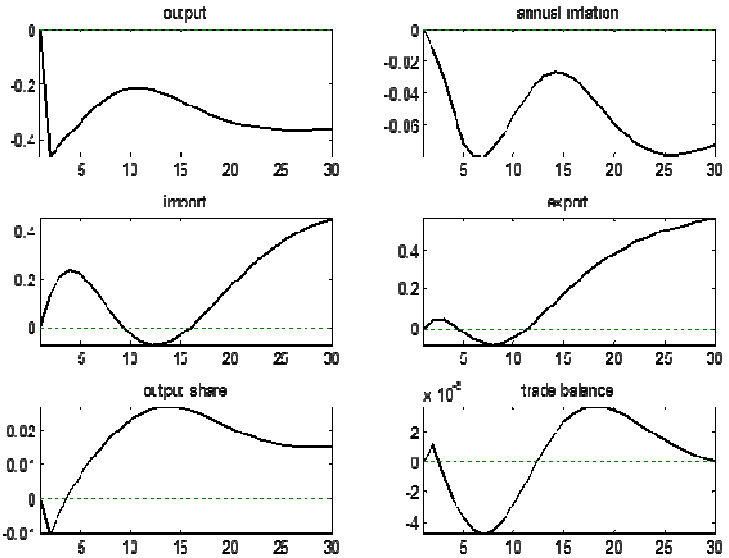


Notes: Each graph shows the trajectories of a single variable in terms of percentage deviations from the initial steady state (the deviation in inflation is given in percentage points) as observed in the three countries under review.

Source: Authors' calculations.

increase above their original level for a few periods due to higher foreign demand. Later they permanently fall below their original level. Nevertheless, given the large increase in the total tax wedge, the rather muted magnitude of responses may be surprising. The main reason is that in our baseline calibration we assume that the finan-

Figure 2 Transition to the New Steady State in the Euro Area



Source: Authors' calculations.

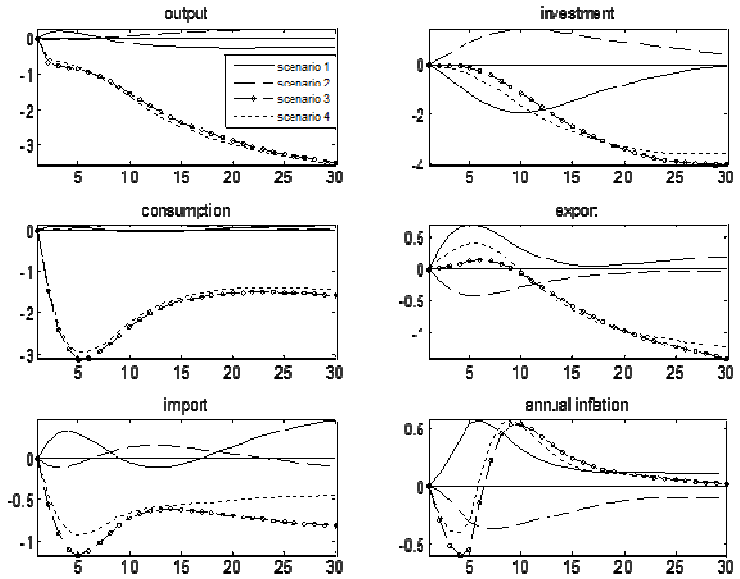
cial market in Slovakia is less developed and the share of Ricardian agents is lower than the share of Ricardian agents in Germany and the rest of euro area.[3] In *Figure 1* we present the transition paths of key macroeconomic variables. Similarly, in *Figure 2* we present the transition paths of a few macroeconomic variables of the whole euro area.

An interesting finding is that although the total tax wedge in the euro area remains unchanged, the total output at PPP weights declines slightly. Below we see that output drops instantly and that after a small correction it stabilizes at the new steady state. Despite lower total output, the share of the euro area in global output rises. As German exports replace domestic products around the world, the euro area begins almost immediately to increase its share in global output. As mentioned above, it takes time for exports and imports to adjust as the different paces of demand and supply effects unwind. Trade becomes volatile when imports of the euro area as a whole are more volatile than exports. The euro area's trade balance initially worsens in real terms, and after about ten periods it starts to improve in line with the long-term outcome.

We conclude that the composition of the tax structure plays a significant role and makes the patterns of the transition processes complicated. The economic impact of labor taxes levied on firms is different, especially in the short run, from that of taxes levied on households' labor income. Simultaneous change in both types of taxes implies different transition patterns due to differences in the timing and strength of initial demand and supply effects. From the euro-area perspective, monetary policy is neutral because the area-wide inflation and output do not deviate significantly from their targets.

[3] See the sensitivity analysis for further details.

Figure 3 Transition of the Slovak Economy to the New Steady State



Note: Each graph shows the paths of a single variable in terms of percentage deviations from the initial steady state (the deviation in inflation is given in percentage points) as a reaction to changes in domestic and foreign taxes.

Source: Authors' calculations.

3.4 Do Countries Compete with Each Other?

The aim of this part is to answer the question of whether countries compete with each other by means of tax systems or not. Hence in this exercise we quantify spillover effects from Germany and the rest of euro area to Slovakia. We chose a small open economy as a reference country because the spillover effects are not distorted by their impact on the other countries.

In *Figure 3* we present the transition processes of selected variables towards the new equilbria of the model in the following four scenarios: In scenario 1 Germany alone adjusts its tax rates to the average euro-area rates. In scenario 2 the rest of euro area alone adjusts its tax rates to the common average. In scenario 3 only Slovakia adjusts its tax rates to the average euro-area rates. Finally, in scenario 4 all three countries adjust their tax rates to the common rates.

Figure 3 reveals that in the long-run all variables, except for imports and exports, are determined mainly by the changes in the domestic tax rates. Long-run spillover effects are small compared to the effects caused by the change in the domestic tax structure. However, in the short-run investment, inflation and trade in particular respond to changes abroad quite strongly and may make the economy temporarily volatile in some respects. On the other hand, the results of scenarios 3 and 4 for consumption, the real wage, hours worked and total output are very similar, which indicates that adjustment in these variables is to a large extent driven by the effects stemming from changes in the domestic tax rates. It turns out that the labor tax reforms abroad do not affect the domestic economy significantly in the long run.

Table 4 Percentage Change in Volatility (in %)

	foreign shocks		common euro area shocks		country specific DE shocks		country specific REA shocks	
	pref. shock	prod. shock	mon. shock	prod. shock	pref. shock	prod. shock	pref. shock	prod. shock
Output								
Euro area	0.3	0.3	-0.4	-0.4	3.3	1.9	-1.9	-1.2
Slovakia	-3.3	-3.5	-3.4	-3.9	0.0	-1.1	-4.0	-2.9
Germany	3.2	3.5	4.3	4.1	6.1	4.0	2.6	3.2
Rest of euro area	-0.5	-0.7	-1.5	-1.3	2.1	0.6	-2.3	-1.2
Annual inflation								
Euro area	0.1	0.1	0.0	0.0	4.3	0.7	-1.7	-0.3
Slovakia	-0.5	-0.3	-0.7	0.3	3.9	1.8	-0.9	-0.2
Germany	-0.4	-0.5	0.5	0.0	4.2	0.4	-1.0	-0.1
Rest of euro area	0.6	0.6	-0.2	0.0	3.6	1.6	-2.1	-0.2

Notes: *pref. shock* = preference shock; *prod. shock* = produktiity shock; *mon. shock* = monetary shock; Percentage changes of standard deviations are reported. Positive numbers indicate an increase in volatility in the harmonized tax regime, whereas negative numbers denote a decrease in volatility.

Source: Authors' calculations.

Based on the model simulations, we can conclude that countries do not compete with each other through changes in their labor tax rates.

3.5 Volatility Analysis

Does a homogenous tax structure contribute to making the euro area more stable in the face of different shocks? To shed some light on this issue we compare volatility of output, consumption, inflation and interest rates in two different tax regimes. The first one represents the current heterogeneous state of the tax rates. The second assumes unified tax rates across the euro area. We are interested in volatility brought about by shocks originating either in the euro area or abroad. In particular, we study the behavior of the economies facing two foreign shocks (preference shock and productivity shock), two common euro-area shocks (monetary policy shock and productivity shock) and two country-specific shocks (preference shock and productivity shock) that originate separately in Germany and the rest of euro area.

For this purpose, we simulate the impact of a shock to the economy under both tax scenarios. We then compare the volatility of the selected variables before and after tax harmonization. In *Table 4* we report the percentage changes of standard deviations of output and annual inflation. Positive numbers indicate an increase in volatility in the harmonized tax regime, whereas negative numbers denote a decrease in volatility. Our findings are set out below.

First, focusing on the whole euro area, we find that tax harmonization causes only small changes to the volatility of euro-area output and inflation when foreign shocks hit the economy. Output is slightly more volatile in the homogenous tax regime while the impact on inflation is negligible. Our explanation is as follows: International trade is the channel through which foreign shocks enter the euro area,

which means that the more open the economy, the greater its exposure to foreign shocks. In our model, Germany is much more open than the rest of the euro area and, consequently, German influence dominates in the overall euro-area effects. In the unified tax regime, the German economy is more volatile, which makes the whole euro area more volatile.

The results are different when the common monetary and productivity shocks hit the economy. In this case the total output is less volatile, especially when the economies are affected by a productivity shock. Our conclusion is that the unified tax structure helps monetary policy to better stabilize the economy when euro-area shocks occur. The picture is quite different when country-specific shocks hit the economy. When the euro area faces preference or productivity shocks originating in Germany, output and inflation are more volatile under the scenario of homogenous tax rates. By contrast, if the shocks originate in a country which increases the total tax wedge, the euro economy is more stable. As we discuss in the next paragraph, a lower total tax wedge generates higher volatility in the economy and vice versa.

Second, we analyze volatility in a single country under the two tax systems. It turns out that the stability of the economy depends on the direction of the tax shift. In general, an increase in the total tax wedge results in less volatility in the real economy. This is because taxes act as automatic stabilizers: the higher the tax wedge, the lower the volatility of the real economy. As seen above, however, this happens at the expense of lower output. Unsurprisingly, volatility gains (losses) are higher when the shock originates in the domestic economy than they are in the case of foreign shocks. The inflation rate follows the pattern of real output in the case of common euro-area and country-specific shocks. When a shock hits a foreign economy, however, the volatility of German inflation declines while the volatility of inflation in the rest of euro area increases. For Slovakia, the country that raises all three tax rates, the situation is quite simple: the volatility of all variables is lower, except when the shocks originate in Germany.

4. Conclusions

In this paper, we look at the effects of hypothetical labor tax rate changes in the euro-area countries and, in particular, at what happens when the tax rates are adjusted to the average level in the euro area. For this, we employ a four-country DSGE model (EAGLE) in which three countries belong to the monetary union and the fourth one represents the rest of the world. The three countries that form the monetary union resemble Slovakia, Germany and the rest of euro area. The tax rates (which are considerably heterogeneous across European countries) and the long-term properties of the economies (such as GDP size, the ratios of investment, private and government consumption to GDP, and trade flows between the countries) make the model regions similar to the actual economies.

First, we calculate the long-run effects of these changes. Our main contribution is, however, the description of the process in the early stage of adjustment and analysis of the euro area's performance in terms of its stability with respect to different shocks.

When a country lowers its overall tax burden, we find that the long-run effects on consumption, investment, trade and hours worked are positive. When a country

increases its tax rates, the effects on overall economic performance are negative. The long-run changes largely reflect changes in the domestic tax rates, and the spill-over effects are rather limited. We find that even in a very open economy, the effect on private demand is moderate and the effect on domestic production is neutral. Lower prices abroad encourage consumers to shift away from domestic products, causing a drop in production of domestic tradable goods. As a result, this allows consumers to increase their demand for domestic non-tradable goods. Total demand rises slightly while domestic production remains basically unchanged. As the overall (*ex ante*) tax wedge in the euro area does not change, the total effect on the whole euro area is negligible. The euro area gains a little in terms of global market share when the country that decreases its tax rates (Germany) achieves the entire gain.

The adjustment process in the economies is complicated by the interaction of the opposing supply and demand effects. Consumption, real wages and, to some extent, hours worked converge monotonically to the new equilibrium. Investments, exports, imports and the inflation rate are volatile and oscillate around the original steady state for a protracted period of time before they converge to the new equilibrium. Although long-run spillover effects are muted, short-run effects may be sizeable. Changes in taxes abroad may cause volatility in a small economy, particularly in investments, trade and the inflation rate.

We find that the common tax rates slightly increase the volatility of the euro-area output response to foreign shocks. Conversely, when the euro area faces common area-wide shocks, output volatility is lower under the unified tax regime. There are no significant changes in the volatility of inflation.

Obviously, the findings here depend on the modeling framework adopted. Although our model simplifies the complexity of the studied problem in certain dimensions, its structure is rather rich and captures some important channels of transmission mechanisms. Certain features of the model are stylized[4] and for this reason we carry a sensitivity analysis and find that the conclusions are quite robust with respect to the values of arguably important parameters. We leave addressing these issues for future research.

[4] Values of some parameters among them.

APPENDIX 1

Model Calibration

In *Table 5* we report the steady state properties that distinguish the regions of the model world.

Table 5 Steady State Ratios

	SK	REA	DE	RW
Demand				
Private consumption/GDP	0.57	0.58	0.63	0.62
Private investment/GDP	0.26	0.22	0.19	0.22
Public expenditure/GDP	0.17	0.20	0.18	0.16
Net exports/GDP	0.00	0.00	0.00	0.00
Trade				
Imports total/GDP	0.93	0.21	0.42	0.03
Final cons. imports/GDP	0.25	0.07	0.16	0.01
Final inv. imports/GDP	0.13	0.03	0.05	0.01
Intermediate imports/GDP	0.55	0.11	0.20	0.01
Exports total/GDP	0.93	0.21	0.42	0.03
Share in world GDP	0.001	0.128	0.052	0.819

Note: All entries refer to ratios in real terms.
Source: Authors' calculations based on Eurostat data.

Table 6 International Trade

		SK		REA		DE		RW	
		Imp.	Exp.	Imp.	Exp.	Imp.	Exp.	Imp.	Exp.
C	from/to SK	-	-	0.002	0.0005	0.0025	0.001	0.0001	0.000
	from/to REA	0.063	0.203	-	-	0.095	0.079	0.005	0.006
	from/to DE	0.043	0.122	0.033	0.039	-	-	0.005	0.004
	from/to RW	0.146	0.080	0.038	0.034	0.068	0.078	-	-
I	from/to SK	-	-	0.0002	0.0003	0.0003	0.001	0.0001	0.000
	from/to REA	0.035	0.024	-	-	0.023	0.022	0.004	0.003
	from/to DE	0.040	0.012	0.009	0.009	-	-	0.004	0.002
	from/to RW	0.055	0.053	0.019	0.028	0.028	0.056	-	-
Im	from/to SK	-	-	0.001	0.002	0.002	0.004	0.0003	0.000
	from/to REA	0.191	0.145	-	-	0.115	0.069	0.007	0.012
	from/to DE	0.040	0.084	0.028	0.047	-	-	0.007	0.005
	from/to RW	0.322	0.212	0.076	0.046	0.084	0.107	-	-
C	total	0.252	0.405	0.072	0.073	0.165	0.158	0.010	0.010
I	total	0.131	0.089	0.028	0.038	0.051	0.079	0.008	0.005
Im	total	0.553	0.441	0.106	0.095	0.201	0.180	0.014	0.018
trade total		0.935	0.935	0.206	0.206	0.417	0.417	0.032	0.032
trade balance		0.000		0.000		0.000		0.000	

Notes: The figures shown in the table represent the international trade of the respective country as a percentage share in domestic real output. *Exp.* = exports; *Imp.* = imports.

Source: Authors' calculations.

Table 6 presents the international trade linkages between the countries. Here we split total imports and exports into imports and exports of final consumption goods (C), final investment goods (I) and intermediate imports (Im). All figures are expressed as a share in national GDP.

APPENDIX 2

Sensitivity Analysis

In order to assess the extent to which the results depend on some key parameters, we perform a sensitivity analysis in which we change the values of parameters that may play an important role in determining the results. First, we evaluate the impact of a new feature in the model—that the export sector assembles domestic and imported goods into export goods (column 1). Second, as our baseline implementation is based on the assumption that any government revenue change is offset by an appropriate change in transfers, we test the sensitivity of the results to the size of non-Ricardian households (column 2 and 3). Similarly, one of the most important assumptions behind the outcome of our simulations is that non-Ricardian households receive a greater portion of transfers (per capita) than do Ricardian households. The results when both types of households receive an equal proportion of transfers are presented in column 4. Finally, our baseline scenario assumes

an inverse value of Frisch elasticity equal to 2, which is standard in macroeconomics, however. Alternatively we set this value at 3 and find that the effects are roughly twice as big (column 5).

Table 7 Sensitivity Analysis

	Baseline calibration	No imports in exports	Size of Ricard. in DE and REA = 0.85	Size of Ricardians in SK = 0.7	Equal distribution of transfers	Frisch elasticity = 3
		(1)	(2)	(3)	(4)	(5)
Germany						
output	4.18%	4.04%	4.39%	4.18%	3.29%	7.13%
output share	0.12	0.14	0.12	0.12	0.10	0.19
hours worked	4.38%	4.32%	4.61%	4.38%	3.44%	7.49%
consumption	3.60%	3.46%	3.77%	3.60%	2.84%	6.11%
investment	3.74%	3.42%	3.92%	3.74%	2.95%	6.35%
real wages	-4.63%	-4.79%	-4.67%	-4.63%	-4.50%	-5.05%
export	1.83%	3.38%	1.91%	1.83%	1.45%	3.11%
import	1.13%	1.59%	1.17%	1.12%	0.89%	1.92%
Slovakia						
output	-3.60%	-3.25%	-3.61%	-4.22%	-3.19%	-6.29%
output share	0.00	0.00	0.00	0.00	0.00	0.00
hours worked	-4.29%	-3.79%	-4.28%	-5.00%	-3.79%	-7.45%
consumption	-2.27%	-2.61%	-2.27%	-2.70%	-2.02%	-4.00%
investment	-2.38%	-2.28%	-2.40%	-2.83%	-2.11%	-4.21%
real wages	1.45%	0.82%	1.45%	1.72%	1.23%	2.81%
export	-1.15%	-3.32%	-1.15%	-1.41%	-1.04%	-2.05%
import	-0.42%	-1.74%	-0.42%	-0.58%	-0.41%	-0.79%
Rest of the euro area						
output	-1.41%	-1.37%	-1.52%	-1.41%	-1.09%	-2.25%
output share	-0.10	-0.11	-0.11	-0.10	-0.08	-0.16
hours worked	-1.46%	-1.44%	-1.57%	-1.46%	-1.13%	-2.33%
consumption	-1.23%	-1.18%	-1.33%	-1.23%	-0.95%	-1.96%
investment	-1.29%	-1.20%	-1.39%	-1.29%	-1.00%	-2.06%
real wages	2.00%	2.07%	2.01%	2.00%	1.96%	2.11%
export	0.40%	-0.44%	0.39%	0.39%	0.32%	0.69%
import	0.79%	0.61%	0.81%	0.78%	0.63%	1.34%

Source: Authors' calculations.

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