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European Taxes in a Laboratory

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European Taxes in a Laboratory[1]

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Abstract

Labour tax rates are considerably heterogeneous across European countries. In this paper, we investigate the effects of a policy experiment in which the tax rates levied on labour are harmonised 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. Countries that decrease their total tax wedge boost their economies while countries that increase their tax wedge lose a proportion of output. The adjustment process is rather complicated: a country which gains in the long run may temporarily go through a period of dampened economic activity. The adjustment process is complicated somewhat by the fact that 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 labour tax system may be better prepared to face common area-wide shocks. On the other hand, shocks originating outside the euro area may increase the volatility of euro area output under the homogenous tax regime.

JEL codes: D58, H20
Key words: tax reform, DSGE model, euro area

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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. A prominent example is the issue of fiscal independence. 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 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, since comprehensive coverage would, of course, be beyond the scope of a single study. We disregard issues such as, for example, uniformity of the tax base and corporate tax rates. Instead, we comprehensively study the effects of personal taxes levied on labour 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* (2009). It is clear that personal tax rates differ significantly. 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 or Spain, for example, social security contributions paid by employers are considerably higher than the sum of income tax and social security contributions paid by employees. On the other hand, the authorities in the Netherlands or in Germany collect more taxes from employees (income tax plus social security contributions) than from employers and their social security contributions.

Heterogeneous tax rates are considered to be an instrument of tax competition. On one hand, countries compete with low taxes in order to attract more businesses. On the other hand, governments are pushed to collect enough receipts to cover spending commitments and to sustain living standards. Tax competition should pressure a government into managing its tax revenues effectively.

The 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. This model is estimated for the Japanese economy and it includes a crowding-in effect on consumption. Carton (2008) 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 labour tax rates have a relatively neutral 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 labour income are the main disincentive to work and that consequently labour utilisation in Europe is lower than in the United States. In a two country DSGE model, the authors show that reducing the tax

rates to the level prevailing in the United States increases the number of hours worked and the total output of the economy. Moreover, due to positive spillover effects, the output of the rest of the world rises as well. 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. What is more, it is questionable whether European countries would be willing to follow the United States and decrease the size of the government in their economies.

Table 1 Tax heterogeneity in 2009 (tax rates as a percentage of labour costs)

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

Source: Taxing Wages 2009, OECD 2010

In this paper, we quantitatively evaluate scenarios of tax changes in European countries. We test to what extent lower taxes in a euro area country have positive effects on partners inside the euro area compared to the effects on the rest of the world. After that, we evaluate the effects of a policy when all euro area countries adjust their tax rates to the euro area-wide average levels, which we call harmonised tax rates. In these scenarios, we are interested in whether it matters to the euro area as a whole if individual countries tax labour differently. We also examine how a small open economy inside the monetary union behaves in reaction to changes in both domestic taxes and taxes abroad. We evaluate the long-run effects of tax changes and describe transitional dynamics from the current situation to the new uniform tax structure. In addition, we present the welfare effects of our policy experiments. Finally, we focus on the contribution of a uniform tax regime in euro area countries in terms of the volatility of the main macro variables.

To answer our research questions we employ a four-country DSGE model developed by Gomes, Jacquinot and Pisani (2010). 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. We can evaluate to what extent the countries with lower taxes compete with those with higher taxes in the euro area.

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 both total domestic demand and production rise, 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 and trade worsens. As a result of their access to foreign markets, consumers in these countries mitigate the impact of the domestic tax hike. However, the spillover effects are limited compared to the effects caused by the changes in domestic taxes, even in a small open economy.

An economy 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, too, the spillover effects significantly contribute to volatility when investments, consumer inflation, exports and imports are particularly affected.

Changes in tax rates and the way the government finances these changes may strongly affect the welfare of households. In our simulation, the government compensates the changes in its tax revenues by adjusting transfer allowances to households. Households whose access to the financial markets is constrained rely more on government transfers than do households that can save. Consequently, changes in taxes and related necessary adjustments to transfer payments induce larger changes in the welfare of those households, mainly due to their sensitive supply of labour.

We also analyse changes in the volatility of output, inflation and interest rate between the current tax structure and the unified euro-area tax regime under review. It turns out that common tax rates slightly increase the volatility of the output response to a foreign shock. On the other hand, when the euro area faces area-wide shocks, the volatility of output is lower in the unified tax regime. There are no significant changes in volatility of inflation.

The text is organised as follows. In the following section, we briefly describe the model and its calibration. Then we introduce our scenarios and present the results. First, we discuss the long run effects and their robustness to alternative calibration of certain key parameters. After that we describe the transitional dynamics that the economies undergo when the tax structure changes. In the last part of this section, we comment on welfare effects of the policy change. Finally, in the last section we summarise a few findings that relate to a small open economy within the monetary union and the euro area as a whole.

1. MODEL STRUCTURE AND CALIBRATION

1.1. MODEL STRUCTURE

EAGLE, the model we employ here, is a four-country model developed by Gomes, Jacquinot and Pisani (2010) and is an extension of the New Area Wide Model ("NAWM") by Coenen, McAdam and Straub (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 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 – households that have access to financial markets and households that cannot insure themselves against idiosyncratic shocks on financial markets. Furthermore, there are firms producing intermediate goods, firms producing final goods, the central bank, and the government.

Households supply differentiated labour services to intermediate firms. Specialisation gives households an opportunity to demand different levels of wage for different labour types. We use a well-known Calvo mechanism (Calvo, 1983) to introduce rigidity in the labour 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 can only smooth their consumption via changes in holdings of money while the other type 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 physical 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 firms produce differentiated products and, like households, can influence the price of their products. We again use the Calvo mechanism to formalise the pricing behaviour of firms. Firms produce output according to a Cobb-Douglas production function with labour 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 abroad.

Final good 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 (consisting of domestic non-tradable goods only), investment goods and exports.

The monetary authority follows a Taylor rule in setting the 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 union-wide inflation rate and output growth rate are calculated as a weighted average of regional inflation and output growth rates with GDP size used as the weights.

The government purchases a composite of domestic non-tradable goods, makes transfers to households and issues bonds. 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 output. The tax structure is rich and comprises a set of distortionary taxes 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, labour income tax, dividend income tax, capital income tax, and social security contributions paid by workers and firms.

Those households that have access to bond markets can buy several types of bonds. Each such household can buy bonds issued by the domestic government. Bonds issued by a government in the rest of the world sector 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 countries belonging to 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 utilises 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, Kolasa (2010), 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.

Furthermore, the setup of the original model is such that two countries form the monetary union while the other two countries conduct their own independent monetary policy. In order to investigate the effects of heterogeneity in the euro area in greater detail, we change the structure of the model so that three countries belong to the monetary union and the fourth country represents the rest of the world.

In line with the above objective, the model must be recalibrated to a considerable degree. Regarding calibration of the monetary union regions, we stick to the original calibration, meaning that one country has the size and certain other characteristics of Germany and another represents the rest of the euro area. The new member country of the monetary union resembles a small country with a relatively low tax wedge – i.e. Slovakia. Finally, the fourth region aggregates all other countries outside the euro area.

1.2. MODEL CALIBRATION

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 (labelled RW below). One of the monetary union countries is small with a relatively low tax wedge (labelled SK), another country is large with a high tax wedge (labelled DE) and the third country represents the rest

of the euro area[4] (labelled REA). The parameters determining the dynamic properties are equal across countries, except for the parameters of price and wage Phillips curves (Calvo parameters). Thus a model country can be interpreted as a generic country. The parameterisation of the large country, the rest of the euro area, and the rest of the world are taken from the original model (for details, see Gomes, Jacquinot and Pisani (2010)).[5] The steady state values of the size and flows of goods are such that the large country in the monetary union resembles Germany and the small country resembles Slovakia. In Table 2 we report the steady state properties that distinguish the regions of the model world. Table 3 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.

Table 2: 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

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

[4] The rest of the euro area is assumed to comprise Austria, Belgium, Finland, France, Ireland, Italy, Luxemburg, the Netherlands, Portugal and Spain.
[5] For details of calibration see Table 11 in the Appendix.

Table 3: International trade

		SK		REA		DE		RW	
		Imports	**Exports**	**Imports**	**Exports**	**Imports**	**Exports**	**Imports**	**Exports**
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	

Source: Authors' calculations.
Notes: The figures shown in the table represent the international trade of the respective country as a percentage share in domestic real output

We calibrate the effective income tax rates and social security contributions in line with the OECD publication *Taxing Wages 2009-2010* (OECD, 2011b). The VAT tax rates are taken from *OECD Consumption Tax Trends 2010* (OECD, 2011a). However, the OECD does not report consumption tax rates in the US. 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. The following table summarises the tax rates employed in the baseline scenario of our model.

Table 4: Tax rates

	DE	SK	REA	RW
Consumption tax	19.0	19.0	19.2	7.7
Effective income tax	17.3	6.3	12.6	13.4
Effective social contribution - employee	17.3	10.6	8.6	7.0
Effective social contribution - employer	16.3	20.8	23.4	9.0
Overall tax wedge	69.9	56.6	63.7	37.1

Source: OECD (2011a), OECD (2011b), Coenen, McAdam and Straub (2008).
All figures are expressed as percentage shares of labour costs.

1.3. IMPULSE RESPONSE FUNCTIONS

In this section, we illustrate the model's performance using impulse response functions. In particular, we report responses to two temporary shocks: a shock to common monetary policy and a transfer shock. In each figure we report three responses. These responses correspond to three regions in the model that form the monetary union and each response corresponds to the shock originating in the same region (except for the monetary shock which is common to all regions).

1.3.1. MONETARY POLICY SHOCK

We simulate a one-off shock to the union's common monetary policy in a magnitude of 0.5 percentage point. The reaction of each of the three countries to this shock is similar. Output, consumption, investment and trade temporarily decline vis-à-vis their respective steady state levels. The effect on investment is about three times as large as the impact on consumption. Imports and exports decrease by about the same amount, although net exports initially worsen in all countries. The only exception is Slovakia, where imports suffer more than in the remaining two regions. This causes the trade balance to be positive for a few periods and consequently the decline in total output is less dramatic. Consumer prices are less sticky in Slovakia than in the other two regions, and therefore inflation in Slovakia declines more sharply.

1.3.2. TRANSFER SHOCK

The transfer shock is a temporary, yet persistent,[6] increase in transfer payments to households. The size of the shock is equal to one percent of output. In this case, too, the corresponding figures in the Appendix demonstrate how selected variables respond to the domestic transfer shock (the paths belonging to Germany's variables are responses to the shock originating in Germany). Like the previous shock, the transfer shock is also a demand shock, although in this case it originates in the private sector. Hence, demand for consumption goods increases along with domestic prices. The increased demand is driven by the rule-of-thumb consumers, who are the dominant recipients of the transfers. As increased transfers are financed by increased (lump-sum) taxes, optimising consumers suffer on net and decrease their consumption and investments. As a consequence, total consumption remains below its steady state level after the higher transfer payments vanish, and the economy gradually returns to the steady state. On the way investments need to catch up and prices need to return to their lower long-run value.

1.3.4. TECHNOLOGY SHOCK

Here we show how the selected variables respond to a technology shock common to all three euro area regions. This total factor productivity shock is temporary, although rather persistent.[7] Its size is such that total productivity improves by one percent.

Higher productivity of production inputs decreases production costs (and therefore prices) and stimulates demand. Consumption and investment immediately rise. Consumers tend to switch from foreign products to domestic products, which reduces imports and to a lesser

[6] The autoregressive coefficient of the transfer shock is equal to 0.9 in all three countries.
[7] The persistence parameter in the shock process is equal to 0.9.

extent exports as well. However, cheaper production and higher real wages allow consumers to consume more. Imports and exports follow aggregate consumption and temporarily increase above their steady state levels. Although the real wage rises and encourages households to work more, the number of hours worked initially declines when firms do not need as much labour as before. Our calibration indicates that the responses in Slovakia are somewhat faster that those in the other two regions. The difference in behaviour is due in large part to less rigid prices and wages in the calibration of the Slovak block.

2. EFFECTS OF TAX REFORMS

In this section, we analyse the effects of distortionary tax changes. The setup of the scenarios under review is introduced in the first part. We then look at the long-run effects of tax changes. The third part deals with transitional paths towards the new steady state that the economies are likely to follow. The fourth part addresses the important policy issue of whether a uniform labour tax structure helps the euro area deal with different types of shocks in terms of volatility of output and inflation. We then evaluate the impacts of tax reforms on households' welfare. The sixth part summarises a number of findings from the view of both a small economy inside the monetary union and the monetary union as a whole. Finally we present sensitivity analysis.

2.1. SPECIFICATION OF THE SCENARIOS

Before examining our three points of interest – the cost/benefit of tax harmonisation taxes, spillover effects, and the impact on a small open economy – we must introduce the complex scenario of tax-rate adjustment in a few steps. First, we need to understand the effects of national-level tax changes. After that we can study the impacts of the scenario in which all countries change their tax rates to the target values.

Our working assumption is that explicit tax harmonisation means the introduction of common tax rates in the member states of the monetary union. Since VAT rates are at comparable levels, we focus on labour taxes. In these exercises 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. The model weights imply that the euro area labour income tax rate is equal to 13.9%, the social security contribution paid by employees is equal to 11.1% and social security contribution paid by employers is equal to 21.2%.

Before considering any change in tax rates, we must first address the issue of an implied change in government revenues. In the present study we assume that any change in government revenues (either positive or negative) is fully compensated by a change in lump-sum transfers to households.

Turning to details of the scenarios, we study the effects of changes in three different labour tax rates. One of the taxes is paid by firms while the other two taxes are paid by households. We will see that the two sets of taxes differ in their impact on the country's economic performance.

Taxes paid by firms work through the labour market demand side. As Coenen, McAdam and Straub (2008) explain, taxes distort the optimal relation between labour costs and the marginal product of labour. In equilibrium, the real wage cost is equal to the marginal product of labour. Any change in the tax rate thus leads to a move in optimal labour demand. At the same time, changes in firms' taxes also directly affect the aggregate household budget through changes in transfer payments.

Taxes imposed on households' wage income operate through the labour market supply side. Changes in these tax rates affect the optimal labour/leisure choice. The two tax rates

imposed on households' labour income appear in the households' budget constraint additively, and thus have the same effect on optimal decisions.

Considering these differences, we simulate the impact of changes in household taxes separately from changes in firms' taxes. These simple simulations help us disentangle the basic mechanisms that drive the complicated overall adjustment process. We use these simulations in the section below devoted to transitional dynamics towards the new steady state. In line with the objectives of the paper, we focus mainly on more complicated scenarios as follows:

Scenario 1: tax change in Germany – tax rates in Germany are set at euro-area average levels while tax rates in the remaining two regions are kept at their original levels;

Scenario 2: tax change in the rest of the euro area – tax rates in the rest of the euro area are set at euro-area average levels while tax rates in the other two regions are kept at their original levels;

Scenario 3: tax change in Slovakia – tax rates in Slovakia are set at euro-area average values while tax rates in the remaining two regions are kept at their original levels;

Scenario 4: tax harmonisation – tax rates in all three regions are set at the same levels stated above.

Table 5 contains full details on the tax rates used in the scenarios. 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 euro area average. Looking at the composition of the tax rates reveals that in Germany and the rest of euro area shifts in taxes on households go the opposite way to shifts in taxes on firms. In Germany, households' 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 taxes have different implications for the economy.

Table 5: Tax reform scenarios

	Current situation	Tax change in Germany	Tax change in rest of the euro area	Tax change in Slovakia	Tax harmonisation
	baseline	**scenario 1**	**scenario 2**	**scenario 3**	**scenario 4**
Slovakia					
income tax	6.3	6.3	6.3	13.9	13.9
employee social contrib.	10.6	10.6	10.6	11.1	11.1
employer social contrib.	20.8	20.8	20.8	21.2	21.2
total tax wedge	37.6	37.6	37.6	46.2	46.2
total tax wedge difference		0	0	8.5	8.5
Germany					
income tax	17.3	13.9	17.3	17.3	13.9
employee social contrib.	17.3	11.1	17.3	17.3	11.1
employer social contrib.	16.3	21.2	16.3	16.3	21.2
total tax wedge	50.9	46.2	50.9	50.9	46.2
total tax wedge difference		-4.7	0	0	-4.7
Rest of the euro area					
income tax	12.6	12.6	13.9	12.6	13.9
employee social contrib.	8.6	8.6	11.1	8.6	11.1
employer social contrib.	23.4	23.4	21.2	23.4	21.2
total tax wedge	44.5	44.5	46.2	44.5	46.2
total tax wedge difference		0	1.6	0	1.6

Source: OECD (2011a), OECD (2011b), Coenen, McAdam and Straub (2007).
Note: All figures are expressed as percentage shares of labour costs. The total tax wedge difference is the difference between the original total tax wedge and its target value.

2.2. LONG RUN EFFECTS

In order to understand the results of the complex harmonisation scenario, we start with the simpler scenarios one to three above and then present the results of the complex scenario. Full details can be found in Table 6 below.

2.2.1. SCENARIO 1

In the case of Germany, the total labour tax paid by households 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%, which improves the budget of optimising consumers. It turns out that a drop in household taxes has a sizeable impact on the economy while a drop 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 it drops by about 4.5%. Lower wages compensate firms for higher taxes and help to keep production prices low. In fact, the marginal costs of production decrease slightly and thus contribute to higher demand led by optimising agents. Optimising agents benefit from their lower tax liabilities and increase demand for consumption goods. Rule-of-thumb consumers cut their consumption as their financial situation deteriorates. Nevertheless, total consumption increases by 3.7%. As domestic production becomes

relatively cheaper, it replaces imported goods, although imports rise as well. Total imports rise by 1.6% while exports rise by 2.2%. The total output of the economy goes up by 4.2%. Higher production accommodates increased labour supply of rule-of-thumb consumers without putting pressure on real wages. At the same time, the improved financial situation of optimising agents allows them to invest more and to support higher production with a higher stock of capital. Investment rises by 3.8%. The size of the country is large enough to generate visible spillover effects in the other countries. Consumption and investment rise in the other countries, driven mainly by imported products. Total production in those countries suffers slightly, however, as can be seen from the negative change in hours worked. All the countries record an increase in imports from the other countries, with Germany recording the largest share of the increased trade. As a result Germany's share in the world market rises by 0.12 percentage point.

2.2.2. SCENARIO 2

The total tax imposed on labour in the rest of the euro area increases only slightly, by 1.6 p.p. In terms of individual components, households' labour income tax rate rises by 3.8 p.p., while the tax rate on firms' labour costs drops by 2.2 p.p. In qualitative terms, these changes are the precise opposite of those in the previous scenario. At the same time, we observe a 1.9% rise in real wages, as households gain almost the entire benefit of the decline in firms' labour costs. Although the wage rate increases mainly due to a decrease in firms' tax rates, the higher households' labour tax is the main factor in the increased marginal costs of production and consequently prices. The negative effect on the budget of optimising agents outweighs the positive effect on the budget of rule-of-thumb agents, and overall domestic demand falls – consumption declines by 1.3% and investment by 1.4%, as the capital stock required by the economy is not as high as it was in the original equilibrium. Imports do not fall significantly as consumers tend to switch away from domestic goods to foreign goods. Total imports fall by 0.5% and exports fall by 0.6%. Altogether, output drops by 1.4%. Furthermore, the increased tax wedge generates mild negative spillover effects around the world. The impact of the tax changes is, of course, most pronounced in the rest of the euro area, whose share of world GDP shrinks by 0.1 p.p.

2.2.3. SCENARIO 3

The most radical changes in the tax rates under review occur in the small country, Slovakia. The households' labour income tax rate rises by 8.1 p.p., and firms' labour costs tax rate increases by 0.4 p.p., which means that the total labour tax rate increases by 8.5 percentage points. In qualitative terms, the economy follows a similar process to the economy of the rest of the euro area. The improved financial situation of rule-of-thumb consumers reduces incentives to work, and the total number of hours worked decreases by a sizeable 4.2%. Such households also raise their wage demands, pushing overall wages in the economy up by 1.2%. 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 optimising agents. Consumption and investment drop by 2.5% and 2.6%, respectively. Exports decrease only moderately, by 1.5%, and imports fall by 0.9%. 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 optimising agents. We have already seen above that the total outcome of the policy change depends on the

behaviour of the optimising agents. In Slovakia, the share of those agents is set at 50%,[8] which implies that the negative impulses from such agents are to some extent outweighed by the larger share of rule-of-thumb consumers who benefit from increased taxes. This observation is verified in the sensitivity analysis below.

2.2.4. SCENARIO 4

Having described what would happen if the countries changed the tax rates in isolation from other countries in the monetary union, we can now better understand the complex scenario of tax harmonisation. The individual tax changes are exactly the same as those implemented in the scenarios above. The differences between the outcome of this scenario and the previous ones stem from the interaction of the economies in the world market. We will see that the interaction of countries plays a rather limited role.

Interestingly, the outcome of the complex scenario is very similar to the outcomes of the tax changes made in each country in isolation. The key real variables differ only slightly from their counterparts in the simple scenarios. Consumption and investment in Germany are somewhat lower because rising taxes in two of their trading partners push prices up and further improve the relative prices of German goods. As a result, demand among German households for domestic production increases and their demand for foreign goods declines. Total German production of tradable goods thus rises above its level in scenario 2. An additional effect of the relative prices is that net exports improve slightly, although the total volume of trade drops. Overall demand for German tradable products rises at the expense of lower German non-tradable production. This change is, however, negligible. In terms of market size, Germany gains the largest proportion in the new equilibrium.

The consumers in the rest of the euro area benefit from developments in Germany. They consume more imported goods and less domestically-produced tradable goods. The overall negative effects of the domestic tax changes are to some extent mitigated by the international market. In fact the change in total imports turns from negative in scenario 3 to positive when tax rates are changed throughout the euro area. Total exports also increase but net exports worsen. Domestic production of tradable goods declines further when consumers are able to obtain cheaper goods abroad. This, however, has a positive effect on the domestic non-tradable sector, as consumers can afford more non-tradable goods.

The positive effect of lower German taxes outweigh the negative effect of higher taxes in the rest of the euro area, while in Slovakia the declines in total output, consumption and investment are lower compared with scenario 2. The differences are small, however. Slovak households replace domestic products mainly with German ones, and imports do not slump. Due to higher domestic prices, exports decline more markedly than imports and therefore net exports deteriorate. A cheaper mix of tradable products abroad increases Slovak demand for non-tradable goods and the relative size of the domestic tradable sector shrinks.

[8] 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 6: Long-run changes

	tax change in Germany	tax change in the rest of the euro area	tax change in Slovakia	tax harmonisation
	scenario 1	scenario 2	scenario 3	scenario 4
Germany				
output	4.18%	0.00%	0.00%	4.18%
output share	0.12	0	0	0.12
consumption	3.68%	-0.08%	-0.01%	3.60%
investment	3.80%	-0.05%	0.00%	3.74%
real wages	-4.54%	-0.08%	-0.01%	-4.63%
hours worked	4.35%	0.03%	0.00%	4.38%
export	2.18%	-0.31%	-0.03%	1.83%
import	1.58%	-0.41%	-0.03%	1.13%
terms of trade	0.57%	0.01%	0.00%	0.57%
real exchange rate	1.28%	0.00%	0.00%	1.27%
Slovakia				
output	0.05%	-0.01%	-3.64%	-3.60%
output share	0	0	0	0
consumption	0.39%	-0.15%	-2.51%	-2.27%
investment	0.39%	-0.13%	-2.64%	-2.38%
real wages	0.46%	-0.17%	1.16%	1.45%
hours worked	-0.14%	0.05%	-4.20%	-4.29%
export	0.65%	-0.27%	-1.52%	-1.15%
import	0.85%	-0.34%	-0.92%	-0.42%
terms of trade	-0.13%	0.02%	-0.60%	-0.72%
real exchange rate	0.01%	0.01%	-1.17%	-1.15%
Rest of the euro area				
output	-0.01%	-1.40%	0.00%	-1.41%
output share	-0.01	-0.10	0	-0.10
consumption	0.10%	-1.32%	0.00%	-1.23%
investment	0.06%	-1.35%	0.00%	-1.29%
real wages	0.11%	1.89%	0.00%	2.00%
hours worked	-0.04%	-1.42%	0.00%	-1.46%
export	1.04%	-0.61%	-0.03%	0.40%
import	1.28%	-0.45%	-0.04%	0.79%
terms of trade	-0.04%	-0.16%	0.00%	-0.20%
real exchange rate	-0.01%	-0.45%	0.00%	-0.46%
Euro area				
Output	0.76%	-1.09%	-0.01%	-0.35%
Rest of the world				
output	0.00%	0.00%	0.00%	0.00%
output share	-0.11	0.10	0	-0.02
export	1.10%	-0.35%	-0.04%	0.71%
import	1.35%	-0.43%	-0.05%	0.87%

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.

A comparison of the four scenarios reveals that when all three countries change their tax structure, the negative effects in Slovakia and the rest of the euro area are somewhat muted by positive spillover effects. At the same time, positive effects in Germany are dampened slightly by the negative developments in the other two countries, which causes higher

foreign demand. Moreover, domestic consumers rely more on domestic products and further increase demand for German products. As a result, consumers in Slovakia and the rest of the euro area are made somewhat better off by lower taxes in Germany, while consumers in Germany are to some extent worse off due to negative spillover effects. On the production side, the tradable sector in Slovakia and the rest of the euro area suffer more when consumers can buy cheaper German products. The non-tradable sectors in these two regions suffer less when Germany implements area-wide tax rates. Nevertheless, total production in the two regions is lower as Germany grasps the most.

All in all, the changes in the key macroeconomic variables are driven mainly by changes in domestic tax rates, while the extent of spillover effects is limited. 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 (which increases by 0.02 percentage points) due to a slight appreciation in the real exchange rate of its currency.

2.3. ADJUSTMENT PROCESSES

The steady state effects discussed above are in line with general intuition and the literature. However, the adjustment process that the economies undergo on the path towards the new steady state is unclear, since the changes are driven by multiple mechanisms. First of all, as explained above, firms' labour taxes operate through demand for labour while households' labour taxes operate through supply of labour; hence, the timing and volatility of adjustment depend on the relative strengths of the individual channels. In addition, international linkages and monetary policy contribute to the resulting patterns of convergence.

Implementation of the tax change is the same in all scenarios. It takes time to fully implement a new tax structure, and we assume, following Coenen, McAdam and Straub (2008), that the tax rate is adjusted in each period by a half of the difference between the previous period value and the target value. Essentially, this means that implementation of the full change takes about eight quarters.

The dynamic effects of simultaneous tax rate adjustment in the three countries are rather complicated, and so we proceed step by step starting with the simplest situation: where we separately adjust individual tax rates in a single country. We then comment on the situation where a single country completely adjusts its tax structure to the euro area average. Finally, we let the effects of changes in tax structures in all three countries interact and study the outcome of the complex scenario 4.

Below we present the paths of several key economic variables. Each graph shows the trajectories of a single variable in terms of percentage deviations from the initial steady state (the deviation in consumer inflation is given in percentage points) as observed in the three countries under review. As the first two subsections serve only to help understand the outcome of the complex scenario, we confine discussion to the results for Germany. The corresponding transition paths for the other two countries are reported in the Appendix.

2.3.1. INDIVIDUAL TAX RATES EFFECTS

Here we study the simplest situations where tax rates are separately adjusted to the euro area average level and in one country only. For the sake of exposition we present the results for Germany.

First we simulate the adjustment process in the economy when the firms' tax levied on labour cost is adjusted to the area-wide level – i.e., increased by 4.9 percentage points. The higher tax rate increases firms' labour costs and reduces their incentive to hire more labour. Capital becomes relatively less costly and therefore firms tend to substitute labour for capital. More expensive production forces firms to charge higher prices for their products. This in turn makes domestic products less favourable in the both domestic and international market, with the result that total production decreases. Lower production forces households to adjust the stock of capital and hence investment drops significantly.

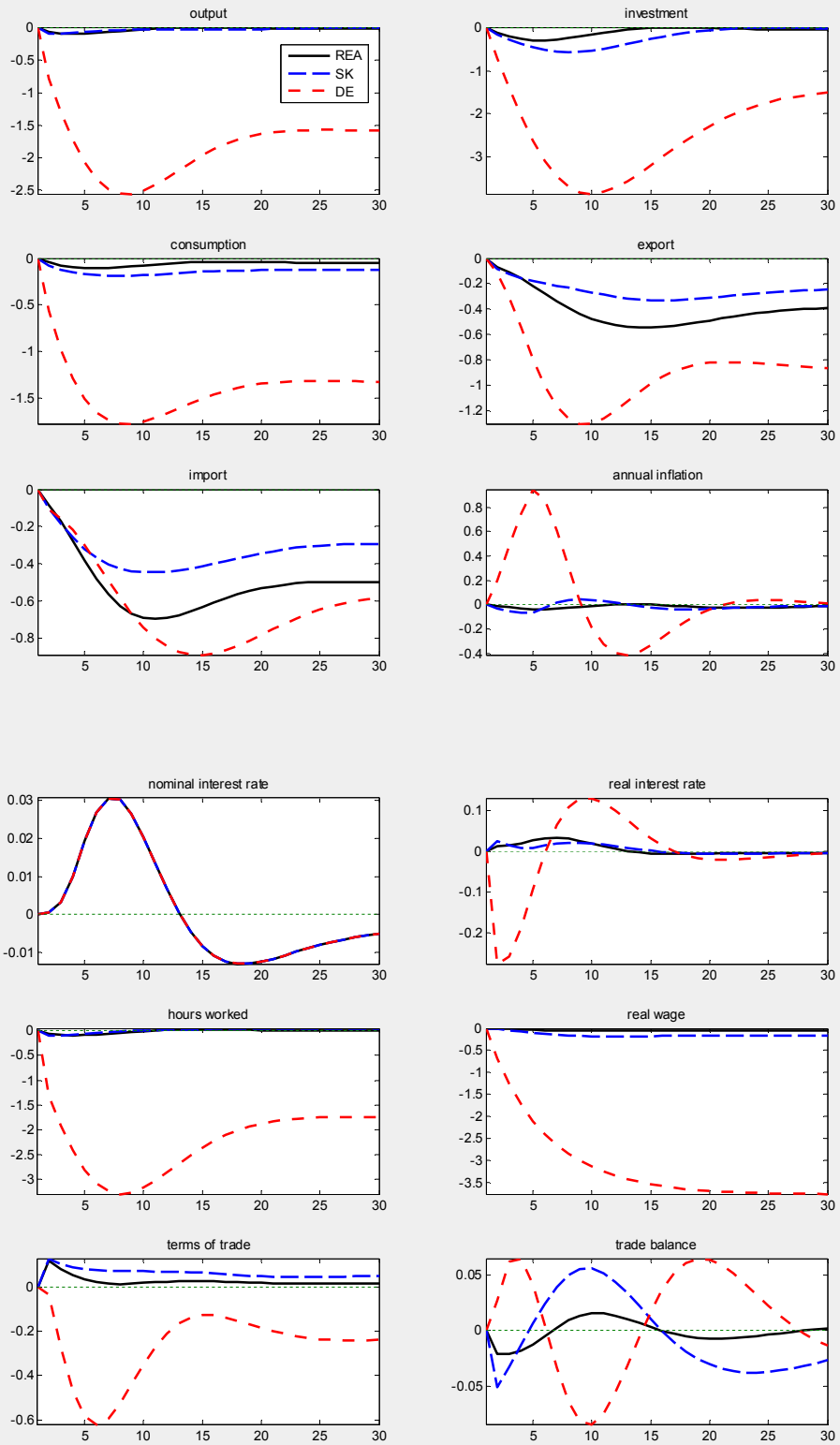
Higher tax revenues translate into higher transfers to both types of households, although non-Ricardian households benefit more as they receive a higher fraction of total transfers. The positive income effect makes households willing to consume more, and thus leisure becomes less expensive. Lower demand for labour therefore goes hand in hand with lower supply of labour. However, a drop in labour demand is significant and reduces households' labour income.

Negative demand impulses in the labour market put downward pressure on household wages, which mitigates the initial increase in firms' taxes. We find that the substantial part of the wage cost increase is offset by a decrease in the wages demanded by households. Lower real wages together with lower employment lead Ricardian households to lower their consumption. Non-Ricardian households also decrease their consumption initially. Higher income from government allowances and slower price growth after wage cost reductions allow these agents to expand their consumption, so that it is higher than it was under the former tax regime.

Total output drops immediately as a consequence of the decline in consumption and investment, while net export does not contribute significantly. Higher labour tax makes the economy less competitive on the international market and reduces exports more than imports. Moreover, switching from more expensive domestic products to foreign products sustain imports closer to their original steady state. The real exchange rate, however, evolves in such a way that the change in net export is negligible.

The central bank observes opposing developments in its twin objectives of stabilising inflation and output growth (inflation above the target and lower output growth) and its response is muted. Real interest rates thus mimic developments in the inflation rate, which is initially above the target level and then returns back to the target when the higher tax rate feeds into prices. In fact, the inflation rate declines below the target as dampened demand has a longer-lasting effect. Hence monetary policy does not initially stimulate spending so as to mitigate the drop in consumption. After the inflation rate falls below the target, the monetary policy helps consumption and investment converge to their steady states more rapidly.

Figure 1 Transition to the new steady state (firms' labour tax increase)



Source: Authors' calculations.

The effects of a reduction in households' labour income taxes (by 9.6 p.p.) vary widely. Since we neutralise the effects on the government budget through changes in transfers, and because transfers are unequally distributed across the two types of agents, the impact is radically different. Transfers financed by taxes levied on households' wage income can be understood as redistribution of income from one type of household to the other. Net income of rule-of-thumb consumers decreases when the labour income tax rate decreases (by 9.6 p.p.), whereas net income of optimising consumers improves. Rule-of-thumb consumers therefore reduce consumption and at the same time supply more labour and demand lower wages. Just the opposite reasoning holds for the optimising consumers.

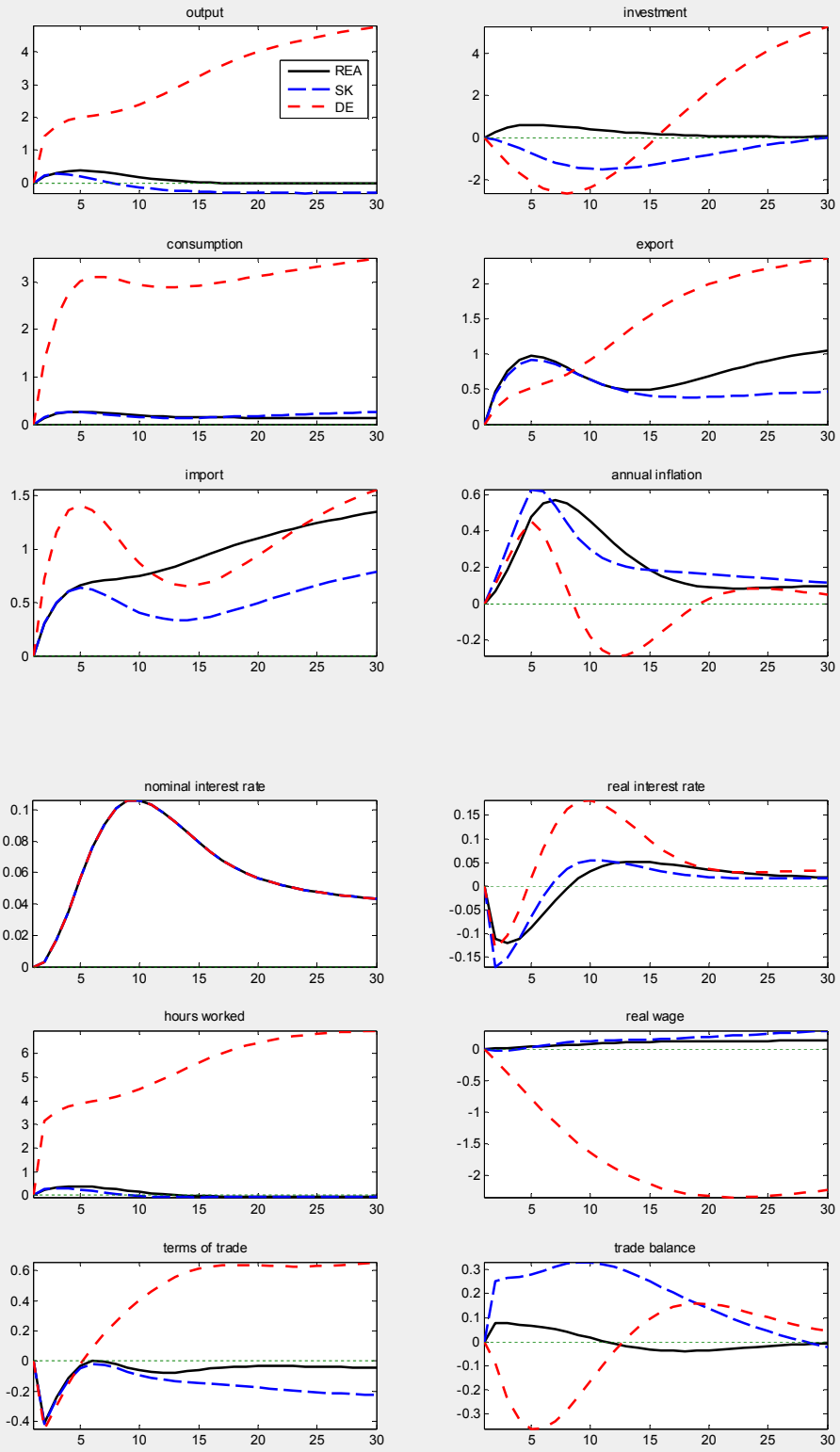
Furthermore, the lower tax burden increases the real after-tax wage and makes households willing to consume and work more. Both income and substitution effects make these households willing to supply more labour. However, the negative income effect in consumption decisions of non-Ricardian households prevails and steadily decreases their consumption. Just the opposite effects shape the Ricardian households' decisions. Income and substitution effects make these households willing to consume more. This positive effect outweighs the negative impact on non-Ricardian households, and aggregate consumption exceeds its pre-reform level. Overall higher demand temporarily increases both inflation and output growth, which is a signal for the central bank to smooth the transition to the new long-run equilibrium. Monetary policy is tightened for a protracted period of time although the real interest rate declines for a few periods.

The higher after-tax return on labour makes leisure more expensive, and households increase their supply of labour. This puts downward pressure on nominal wages. Both Ricardian and non-Ricardian households reduce wages; however, decreasing income from transfers forces non-Ricardian households to work longer hours and reduce their wages by a greater margin than Ricardian households do. The aggregate wage rate declines while total hours worked in the economy rises significantly.

Consumption is the only factor of higher output growth in the initial phase of the transition. Higher consumption is accompanied by higher imports, while export growth is subdued until the domestic demand effects fade away and the country gains long-lasting competitiveness resulting from the tax wedge reduction. Agents also cut investment – initially in favour of consumption – and labour is the production factor which delivers higher production. Although rule-of-thumb consumers are worse off in this scenario, the overall effect of the new tax structure is positive, as consumption, investment, net export and total output increase sharply from their initial steady-state levels.

These are the mechanisms that are at work when tax rates are changed. The resulting magnitudes of the simultaneous changes depend on the relative strengths of the respective effects. In the following section we look at the outcome of the scenarios when both tax rates are changed at the same time in a single country.

Figure 2 Transition to the new steady state (reduction in households' labour income taxes)



Source: Authors' calculations.

2.3.2. COUNTRY SPECIFIC EFFECTS

As we have seen above, the adjustment processes following the change in firms' taxes differ in both their qualitative and quantitative patterns from the adjustment processes following the change in households' taxes. When we simulate adjustment of the economies following the simultaneous change in firms' and households' taxes, we can expect rather complicated patterns.

In particular the real quantities follow a nontrivial adjustment process when they start out in the opposite direction to their long term outcome. Consumer prices are also not heading monotonically toward the new equilibrium prices.

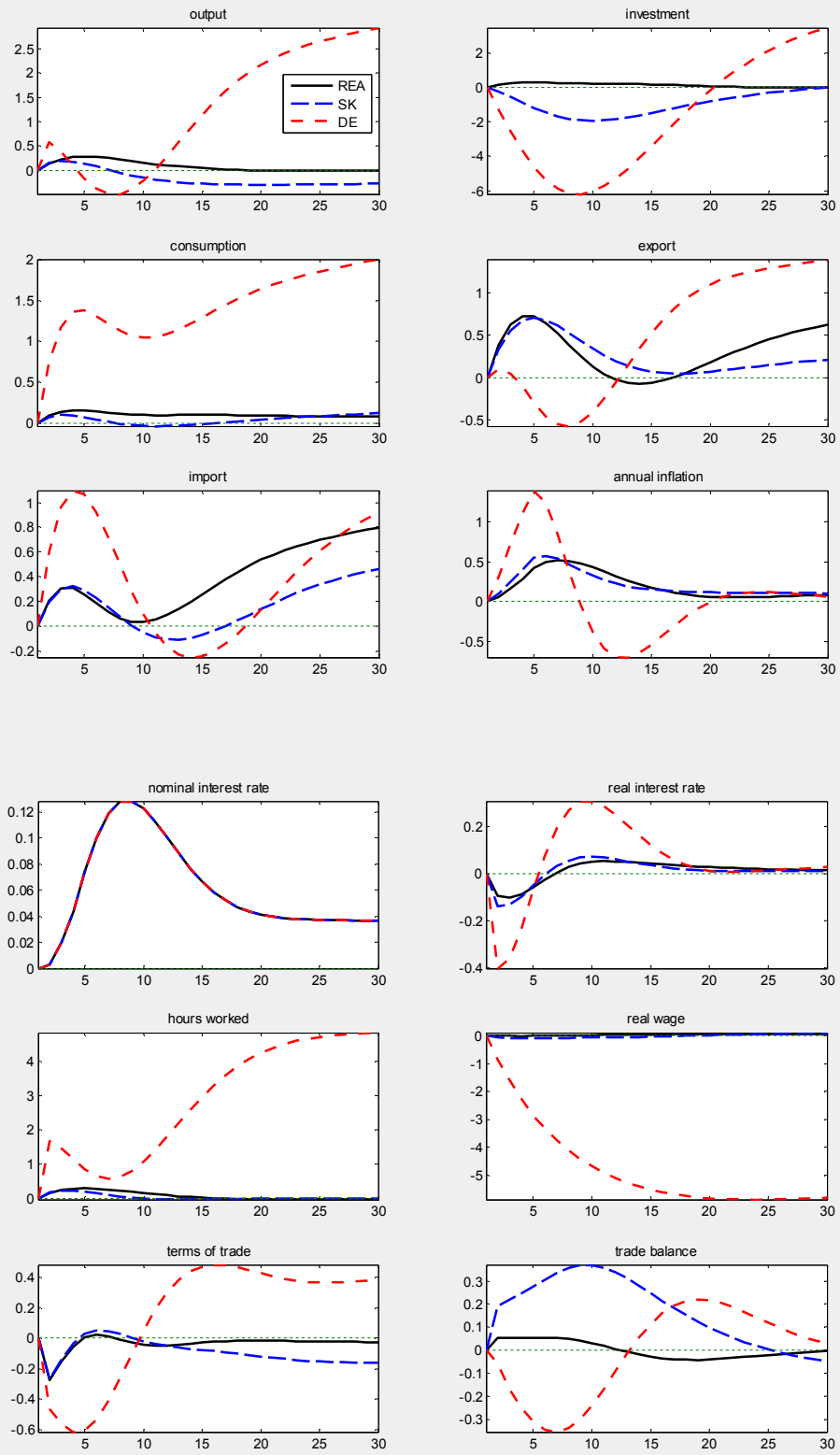
The increase in firms' taxes (and cost of production) and the initial demand effects of the same sign feed promptly into inflation. Higher inflation (at the area-wide level) drives down real interest rates and motivates households to spend more. The central bank tightens the monetary policy stance and to a limited extent dampens both demand and supply-driven increases in inflation. After these initial rapid impulses fade away, a longer lasting adjustment process begins, and the adjustment in real wages causes production costs, and consequently prices, to rise more slowly.

Initial developments in domestic prices make the country less favourable in the international market, as is apparent in the terms of trade. Imports initially pick up, while exporters suffer as consumers tend to switch between domestic and foreign production according to changing relative prices. As domestic inflation reverts, import and export developments revert as well and gradually reach their respective steady states.

Consumption is an exception among the real quantities, as it remains above the original steady state at all times. Both Ricardian and non-Ricardian households contribute to the rapid initial pick-up, when Ricardian households immediately recognise that they will be better off in the long run and have access to devices to smooth their consumption. Moreover, monetary policy does not tighten the nominal interest rate enough to slow the pick-up in inflation. On the other hand, non-Ricardian households can afford higher consumption as the labour supply expands immediately and government allowances decline only gradually. When the tax rates reach their new long-run level and transfers decrease, these agents adjust their consumption accordingly and cause a hump-shaped pattern in consumption.

As noted above, the change in either of tax rates initially drives investments down even though the level of production and capital return rise at the beginning of the transition process. Moreover, the magnitude of the change is large. The reason is that capital as a production input becomes more expensive relative to labour. Firms thus substitute capital for labour for a protracted period of time. When the return on labour settles at the new steady state, households start to invest more and the capital stock reaches its new steady state, which is lower than the initial equilibrium level. The negative impact on capital stock is mitigated by the higher steady state of production and accompanying higher need for production inputs.

Figure 3 Transition to the new steady state (tax changes in Germany)



Source: Authors' calculations.

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 large as the volatility of consumption and investment, since investment and net export offset the influence of consumption.

The trajectories of hours worked closely resemble the trajectories of consumption. After a rapid initial change, total hours worked return to the original level for a few periods and then move to the new equilibrium at a moderate pace. The labour supply of households that cannot intertemporally optimise on their consumption immediately starts moving towards the new equilibrium. The impact of such households dominates the impact of the other households. Households that are allowed to smooth their consumption through their access to the financial markets supply less labour for a short period of time. The new steady state is higher than the initial steady state and this change outweighs a drop in equilibrium capital stock.

Unlike in the case of hours worked, the opposing changes in the tax rates imply the same qualitative change in the real wage. We have already seen that the tax rate changes as implemented here have opposite effects on the supply of and demand for labour, and both move real wages in the same direction as the shift in tax rates. As a result, the real wage converges monotonically towards its new equilibrium level.

2.3.3. EURO AREA-WIDE EFFECTS

The main effects of the tax reform come from the domestic adjustment process described above, while the contribution of international linkages is rather limited. In addition, the impulse for the central bank is mixed. Here we present our final scenario – complex tax harmonisation – which takes into account international spillovers beyond the effects of domestic factors.

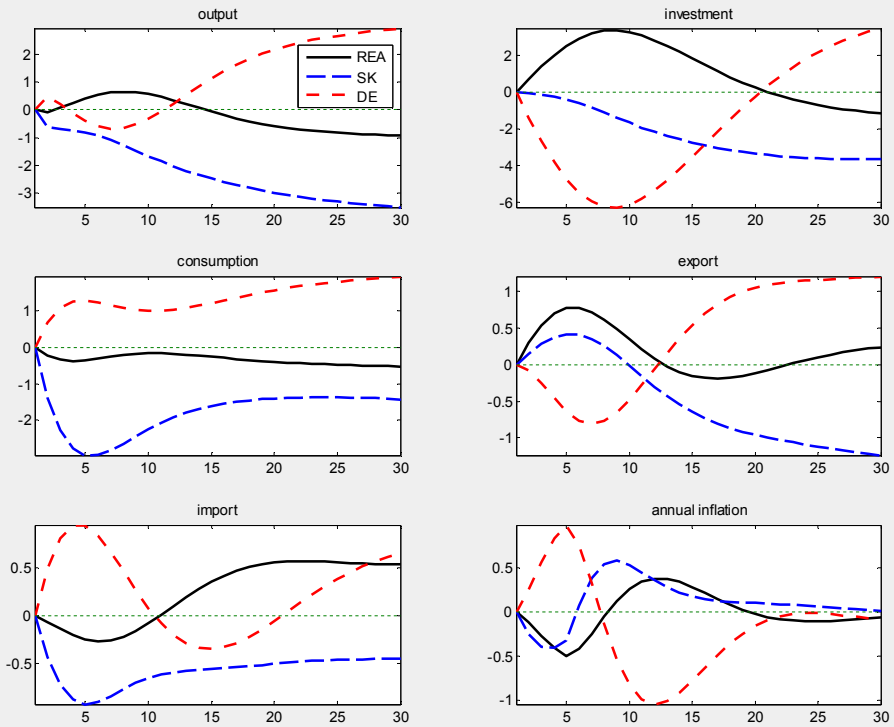
International trade is the channel that drives the differences between the scenarios in the preceding section and our complex scenario. We have seen that tax adjustments in either of the two large countries have sizeable effects on trade. The initial effect on relative prices is such that the country which lowers its overall tax wedge loses price competitiveness and its exports drop while imports boom. For countries inside the euro area, this results in an increase in exports, and the higher income of these countries is partly spent on foreign products, which increases their imports too. The opposite reasoning holds for a country which raises its total tax wedge.

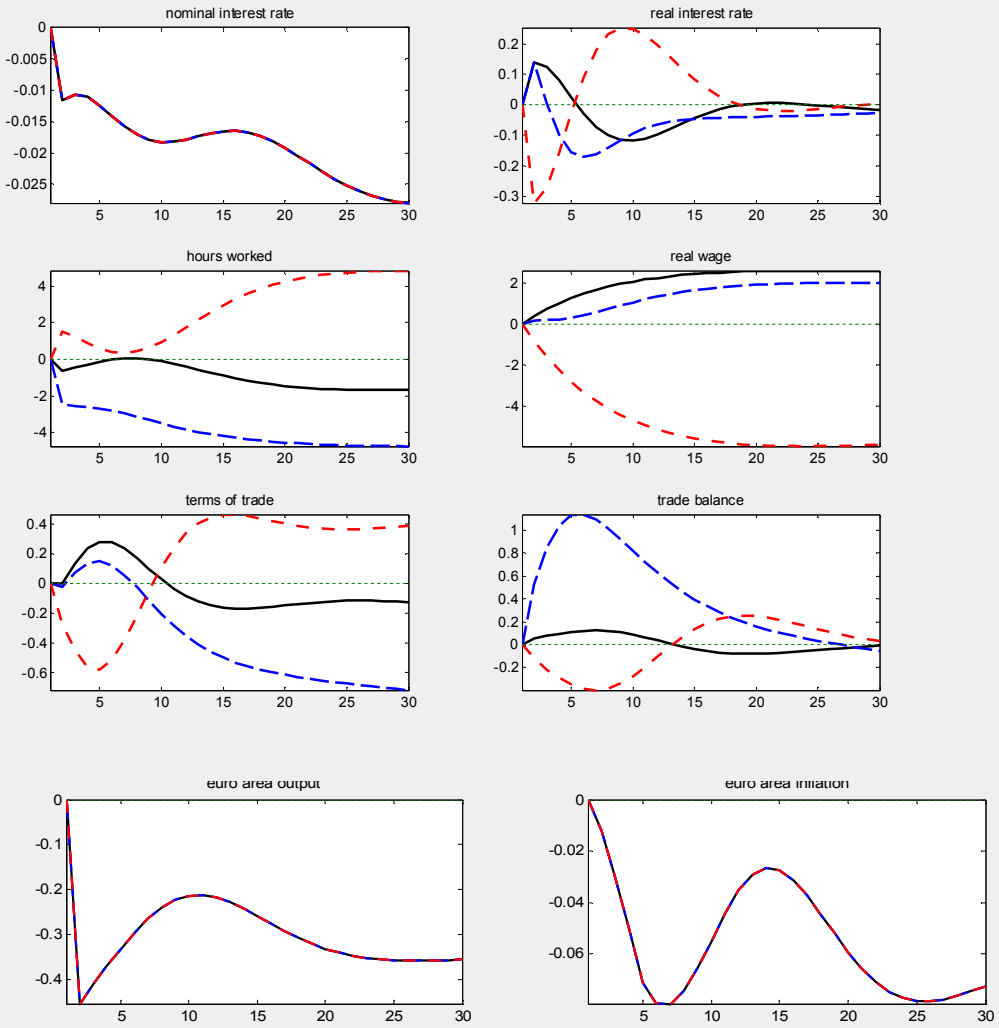
Bringing these arguments together, the implication is that the open economy dimension has a mixed impact on trade. In the early period of the transition, German exports suffer due to both a decrease in domestic taxes and an increase in foreign taxes. By contrast, German imports initially surge because of a decrease in the country's total tax wedge, while an increase in the tax wedge of the remaining regions causes a decline in German imports. Similarly, the positive effect on exports of a decrease in taxes in the rest of the euro area is reinforced by the effect of a decrease in German taxes. The effects on imports are mixed again.

We have seen above that tax changes in Germany and the rest of the euro area go in the opposite direction, resulting in opposite impulses for the adjustment of key economic

variables. This means that the early phase of convergence is rather complicated and that the economies diverge substantially from their long-term state. The adjustment process in Slovakia, which raises both households' and firms' taxes, is far smoother. Adjustment after a change in households' taxes takes longer than adjustment after a change in firms' taxes. When the initial demand and supply effects rebalance, the economies begin to converge towards the new steady state, in which the country with a lower total tax wedge gains in terms of output and market share while the countries with a higher tax wedge lose a degree of output and market share. Converging to the new steady state, however, takes time and depends on the timing of the policy change.

Figure 4 Transition to the new steady state (tax harmonisation in euro area)





Source: Authors' calculations.

All in all, the interaction between countries which simultaneously adjust their labour tax rates to the area-wide average does not change the transition processes significantly. Adjustment incurred by domestic factors is far more important. Furthermore, the patterns of the transition processes are rather complicated and may not be monotone, while the composition of the tax structure plays a significant role. The economic impact of taxes levied on firms is different, especially in the short run, from that of taxes levied on households. Simultaneous change in both types of taxes imply different transition patterns due to differences in the timing and strength of initial demand and supply effects; even if a country gains in terms of output in the new steady state, it may take about two years to reach a level of output higher than the initial level of output. The opposite argument holds for a country which loses output in the new steady state. Such a country may initially benefit from temporarily lower production prices and higher competitiveness on the international market. From the area-wide perspective, monetary policy is rather neutral. Therefore, real interest rates are determined by the national inflation rates.

2.4. VOLATILITY ANALYSIS

Having described the long-term changes to the economies and the transition paths towards the new steady state, we now turn to the following policy-relevant question: 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 behaviour of the economies facing two foreign shocks (preference shock and productivity shock), two common-area shocks (monetary policy shocks and productivity shock) and two country-specific shocks (preference shock and productivity shock) that originate separately in Germany and the rest of the 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 harmonisation. In Table 7 we report the percentage changes of standard deviations of output, consumption, annual inflation and the euro area nominal interest rate. Positive numbers indicate an increase in volatility in the harmonised tax regime whereas negative ones denote a decrease in volatility. Our findings are set out below.

Firstly, focusing on the whole euro area, we find that tax harmonisation causes only small changes to the volatility of euro area output and inflation when foreign shocks hit the economy. The output is slightly more volatile in the homogenous taxes 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 stabilise 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 originated in the 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.

Secondly, we analyse 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, we can say that an increase in the total tax wedge results in less volatility in the real economy. This is because taxes act as automatic stabilisers: 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. We also find that the change in the volatility of consumption caused by the implementation of common tax rates is much higher than the change in the volatility of output. The inflation rate follows the pattern of real output in the case of the common euro area and country-specific shocks. When the shock hits the foreign economy, however, the volatility of German inflation declines while the volatility of inflation in the rest of the 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.

Finally, we turn our attention to the stability of nominal interest rates. When the foreign or common euro area shocks hit the economy the euro area interest rate volatility is stable regardless of the tax rate scenario. The situation is again different when we simulate the effects of country-specific shocks. Under the common tax system, the interest rate is more volatile when the shocks occur in Germany. However, it is more stable when the shocks originate in the rest of the euro area.

Table 7 Percentage change in volatility

	foreign shocks		common euro area shocks		country specific DE shocks		country specific REA shocks	
	preference shock	productivity shock	monetary shock	productivity shock	preference shock	productivity shock	preference shock	productivity 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 the euro area	-0.5%	-0.7%	-1.5%	-1.3%	2.1%	0.6%	-2.3%	-1.2%
Consumption								
Slovakia	-8.7%	-6.1%	-4.3%	-4.3%	-6.5%	-5.3%	-11.0%	-5.3%
Germany	4.1%	4.2%	5.3%	4.4%	5.4%	4.8%	3.7%	3.9%
Rest of the euro area	-1.7%	-1.3%	-2.0%	-1.5%	1.4%	0.2%	-2.0%	-1.7%
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 the euro area	0.6%	0.6%	-0.2%	0.0%	3.6%	1.6%	-2.1%	-0.2%
Nominal interest rate								
Euro area	0.6%	0.0%	0.0%	0.0%	4.0%	0.6%	-1.6%	-0.2%

Source: Authors' calculations.
Note: Percentage changes of standard deviations are reported. Positive numbers indicate an increase in volatility in the harmonised tax regime whereas negative ones denote a decrease in volatility.

2.5. EFFECTS ON HOUSEHOLDS' WELFARE

We have seen that the tax rates in individual member countries compared to the average tax rates prevailing in the euro area are considerably heterogeneous in terms of both magnitudes and the sign of deviation from the average rates. We have also seen that the tax rate changes may differ in their impact on the two types of households, as government transfers to households offset changes in the government's income. In this section we therefore study the consequences of tax changes on the welfare of the two types of household. We employ a natural welfare metric defined as the life-time utility from consumption and leisure.

As the table below shows, tax changes have a more pronounced effect on the welfare of non-Ricardian households. More specifically, in tax-rate lowering countries the cost of the tax change to non-Ricardian households is greater than the benefit to Ricardian households. On the other hand, in tax-rate raising countries the benefit to non-Ricardian households is greater than the cost to Ricardian households. These findings are hidden when we study the long-term effects on the economies above. For instance, when a country with the German tax structure lowers its tax rates to the area-wide averages, it records increases in consumption, investment, net export and total output. This positive outcome of a policy change is induced mainly by Ricardian households, which, unlike the other type of households, benefit from the change. Just the opposite reasoning holds for the remaining two countries in our study. Non-Ricardian households gain more in terms of their utility than Ricardian households lose; nevertheless, the overall effects on the economy are negative.

Table 8: Welfare effects of the policy changes

	scenario 1	scenario 2	scenario 3	scenario 4
Ricardian households				
Germany	4.45%	-0.07%	-0.01%	4.37%
Slovakia	0.38%	-0.14%	-4.55%	-4.29%
Rest of the euro area	0.10%	-1.81%	0.00%	-1.71%
Rest of the world	0.02%	-0.01%	0.00%	0.01%
Non-Ricardian households				
Germany	-6.83%	-0.05%	0.00%	-6.88%
Slovakia	0.27%	-0.10%	5.41%	5.57%
Rest of the euro area	0.05%	2.67%	0.00%	2.72%
Rest of the world	0.01%	0.00%	0.00%	0.01%

Source: Authors' calculations.

These results are broken down further in Table 9, which shows changes in consumption and labour of the two types of households in the individual countries. The impact on consumption is roughly equal across the two types of households. The striking difference is in the effect on labour supply. While Ricardian households do not change their supply of labour to a significant extent when the tax rates are changed in their country, non-Ricardian households adjust their supply of labour dramatically. As explained above, tax levied on

households' labour income distorts the relation between consumption and labour supply decisions. Any change in tax rates thus leads to a change in the optimal level of consumption and labour supply. This distortionary effect is particularly strong in the case of non-Ricardian households, which do not have any device to reduce the volatility of their consumption. Optimising Ricardian households can insure themselves against negative effects when taxes increase, while they can gain more when taxes decrease. Altogether, the total effects on households' welfare are driven mainly by changes in labour supply decisions.

Interestingly, it seems that the only region where both types of households benefit from the changing tax policy in the union is the rest of the world, where they benefit from cheaper imports. By contrast, tax changes in the monetary union member countries have opposing effects on Ricardian and non-Ricardian households due to transfer changes.

Table 9 Consumption/labour effects of the policy changes

	scenario 1	scenario 2	scenario 3	scenario 4
Germany				
consumption Ricardian	5.48%	-0.08%	-0.01%	5.39%
consumption non-Ricardian	-4.71%	-0.06%	-0.01%	-4.77%
labour Ricardian	-0.29%	0.04%	0.00%	-0.25%
labour non-Ricardian	9.22%	0.02%	0.00%	9.24%
Slovakia				
consumption Ricardian	0.43%	-0.16%	-5.11%	-4.85%
consumption non-Ricardian	0.33%	-0.12%	2.88%	3.10%
labour Ricardian	-0.19%	0.07%	0.18%	0.05%
labour non-Ricardian	-0.11%	0.04%	-6.83%	-6.89%
Rest of the euro area				
consumption Ricardian	0.11%	-2.07%	0.00%	-1.97%
consumption non-Ricardian	0.07%	2.06%	0.00%	2.12%
labour Ricardian	-0.05%	0.35%	0.00%	0.30%
labour non-Ricardian	-0.02%	-3.29%	0.00%	-3.31%

Source: Authors' calculations.

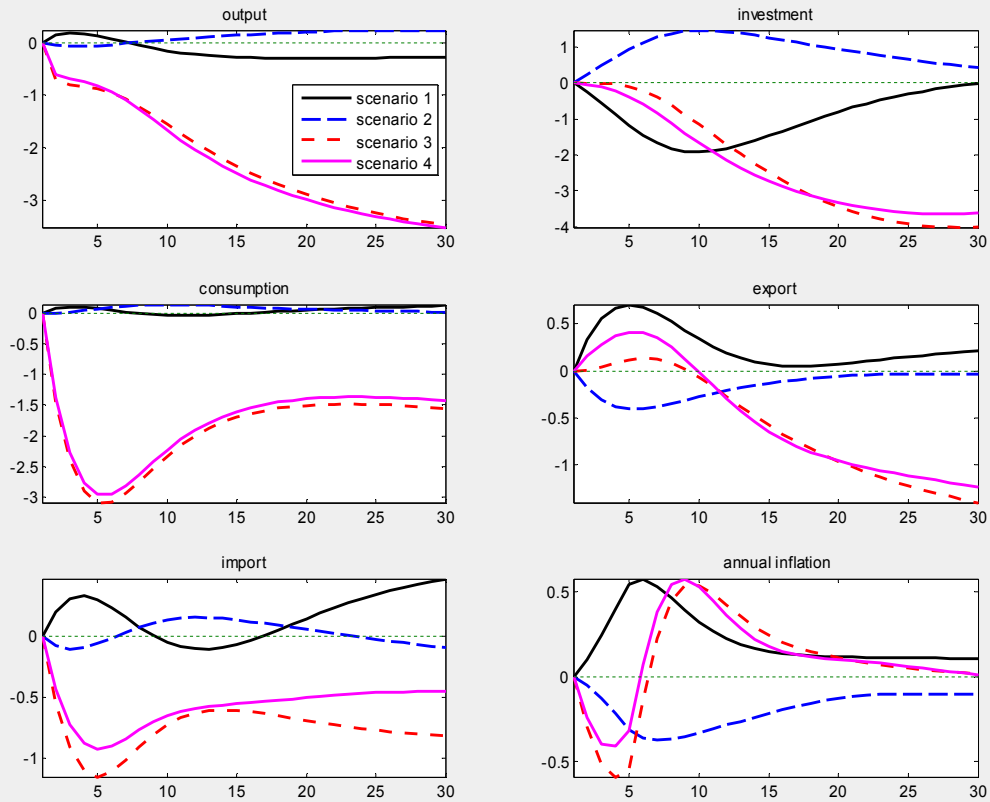
2.6. A FEW LESSONS FOR A SMALL COUNTRY AND THE EURO AREA

The aim of this section is to summarise a few findings that relate to a small country inside the monetary union, such as Slovakia, and we also comment on the impact on the euro area as a whole.

We have shown above that lowering taxes has positive effects on consumption, investment and trade. If the country is large enough, tax reductions also have positive spillover effects on its trading partners. Private consumption in those countries increases as consumers have access to cheaper products produced abroad. Domestic tradable production declines as a result, but since non-tradable production increases, the overall effect on domestic output is

roughly neutral. Long-run spillover effects are small compared to the effects caused by the change in the domestic tax structure. For a small country the short-run effects may, however, be of significant magnitude and make the economy temporarily volatile in some respects. In the figure below one can see that spillover effects on investments, consumer inflation and trade are likely to be sizeable. Since the rest of the euro area is Slovakia's more important partner in terms of volume of trade, the effects coming from this region are stronger. The magnitude of effects on investments and inflation during the first few periods is comparable with the magnitude when domestic taxes are changed. Export performance is even more volatile when taxes are changed abroad. By contrast, the responses of imports are benign. Similarly, consumption and total output are relatively stable.

Figure 5 Transition of the Slovak economy to the new steady state (all four scenarios)

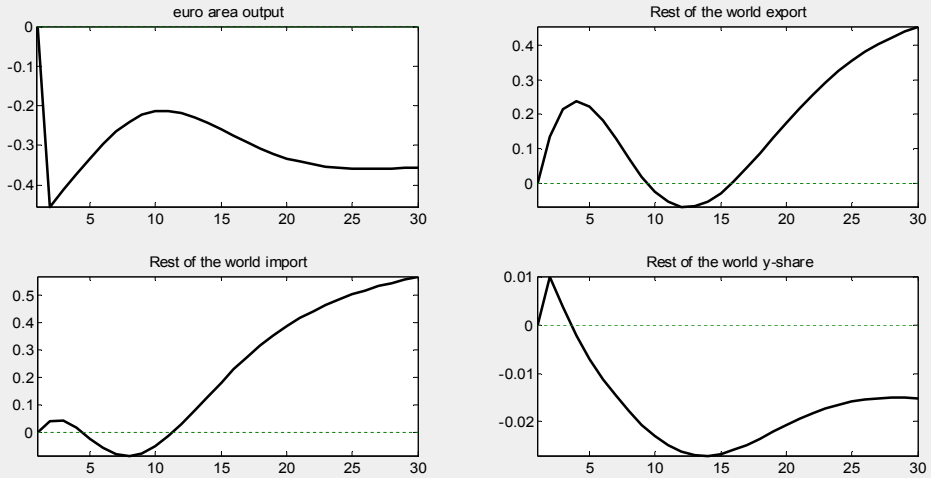


Source: Authors' calculations.
Note: We present Slovak variables from all four scenarios.

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 stabilises at the new steady state. Despite lower total output the share of the euro area in world output rises. As German exports replace domestic products around the world, the euro area begins almost immediately to increase its share in world output. Below we report the output share of the rest of the world, which is a

full complement to the output share of the euro area. As mentioned above, it takes time for exports and imports to adjust as the different pace of demand and supply effects unwind. Trade becomes volatile when imports of the euro area as a whole (exports of the rest of the world) are more volatile than exports. The trade balance of the euro area in real terms initially worsens, and after about ten periods it starts to improve in line with the long-term outcome.

Figure 6 Transition to the new steady state (tax harmonisation in the euro area)



Source: Authors' calculations.

2.7. SENSITIVITY ANALYSIS

In order to assess to what extent 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. 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 rule-of-thumb households. Similarly we also test the dependence of the results on the ratio of, on one hand, the size of transfers to the budget of rule-of-thumb consumers and, on the other hand, the size of transfers to Ricardian consumers.

The specialisation of economies has become a significant feature of economic development around the world, with export sectors tending to use increasingly larger volumes of imports as an input in production. As a consequence, the openness of economies around the world has risen steadily. Unlike in the original model, we incorporate the export intensity of imports as observed in the data, thus allowing us to capture the actual size of imports and exports in the economies. This new feature tends to mitigate the response of exports to changes in domestic labour costs/wage tax, since the production of export goods requires a combination of both domestic and imported goods with a certain degree of substitutability; this allows firms to adjust the composition of inputs reflecting changes in relative prices. However, in terms of consumption, investment, and, consequently, total output and hours worked, the changes are more pronounced when the export sector is allowed to use imported goods in production. The reason is twofold. First, if domestic production is cheaper, exports of all other countries are cheaper as well because a proportion of these contain cheaper goods originating in the country with lower production costs. The goods that circulate around the world are thus cheaper and more goods can be sold globally.

Quantitatively, the possibility to use imports in the production of export goods does not play a significant role in the adjustment of consumption, investment, total output, hours worked and real wages. It strongly affects net exports, as the amount of exports changes substantially while imports respond moderately.

Our baseline calibration assumes that there are two regions where the size of optimising agents is equal to 75% and one region where it is equal to 50%. In an alternative simulation, we evaluate the impact of an increase in size from 75% to 85%. We find that gains achieved in Germany are stronger, as the larger share of Ricardian households can take an advantage of lower overall tax burden. The effects are also more pronounced in the rest of the euro area, albeit with a negative sign. Quantitatively, in the case of Germany, the 10 percentage point increase in the share of optimising agents leads to a change of around 0.2 percentage point in the resulting magnitudes of output, consumption, investment and hours worked. In the case of the rest of the euro area, the difference in the magnitudes is lower and reaches around 0.1 percentage point. Real wages, exports and imports do not change significantly in either country. We separately conduct a similar simulation in which the share of Ricardian households in Slovakia is increased from 50% to 70%. In this case the differences are greater. Compared with the baseline scenario, total output drops by an additional 0.6 p.p., consumption and investment by an additional 0.4 p.p., and hours worked by an additional 0.7 p.p. These results suggest that in simulations such as those carried out here, the share of Ricardian households is an important characteristic of the economy and should be taken into account.

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. Unequal distribution of transfers leads to a different behaviour of both types of household when changes in government revenues are offset by changes in transfers. In the baseline simulation we assume that the amount of transfers received by non-Ricardian households is, in per capita terms, three times higher than that received by Ricardian households. We find that this assumption is quite important in determining the outcome. When we change the ratio of transfer payments to one to one, the changes in all variables are smaller. The reason is that net income (the difference between tax payments and

transfer allowances) of both types of household does not change significantly when every additional euro paid on tax is received via government transfers. The strong income effect is thus substantially eliminated. In Germany and the rest of the euro area the difference in the effects of the policy change are about 20% in most variables. In Slovakia the differences are somewhat muted by the larger share of the rule-of-thumb consumers. In this case the reduction in policy change effects is slightly higher than 10%.

As the labour market is crucial in these policy experiments, we also investigate the sensitivity of the results to Frisch elasticity, which drives labour supply when the real wage changes. Our baseline scenario assumes a rather low value equal to 0.5, which is however standard in macroeconomics. Alternatively we set this value at 3 and find that the effects are roughly twice as great. As expected, labour supply is the main factor behind the different behaviour in this situation. The response of real wages is not significantly different, but the households which are now more sensitive respond aggressively and total outcome is thus significantly different.

Table 10: 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
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.

3. CONCLUSIONS

In this paper, we have looked at the effects of labour tax rate changes in euro area countries and in particular at what happens when tax rates are adjusted to the average level in the euro area. For this, we employed 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 the 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.

We simulated two scenarios – where the countries adjust their labour taxes to the average area-wide values in isolation and where all countries make that adjustment at the same time – and investigate long-run as well as short-run effects. We also discussed the distributional effects of such changes.

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 spillover effects are rather limited. We find that even in a very open economy like Slovakia, the effect on private demand is moderate. The effect on domestic production is neutral. Lower prices abroad encourage Slovak consumers to switch away from domestic products, causing a drop in the production of domestic tradable goods. On the other hand, demand among Slovak consumers for non-tradable goods increases, and overall demand rise slightly while total 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 the 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. On the other hand, when the euro area faces the area-wide shocks, output volatility is lower under the unified tax regime. There are no significant changes in volatility of inflation.

In terms of welfare effects, it is very important to address the implied change in government tax revenues. When transfers to households are used to balance the government income-expenditure disparity, the welfare effect of tax changes on households that are net

contributors differs from that on households that are net receivers of transfers. Net receiver households are more sensitive to tax changes due to the higher sensitivity of their labour supply.

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5. APPENDIX

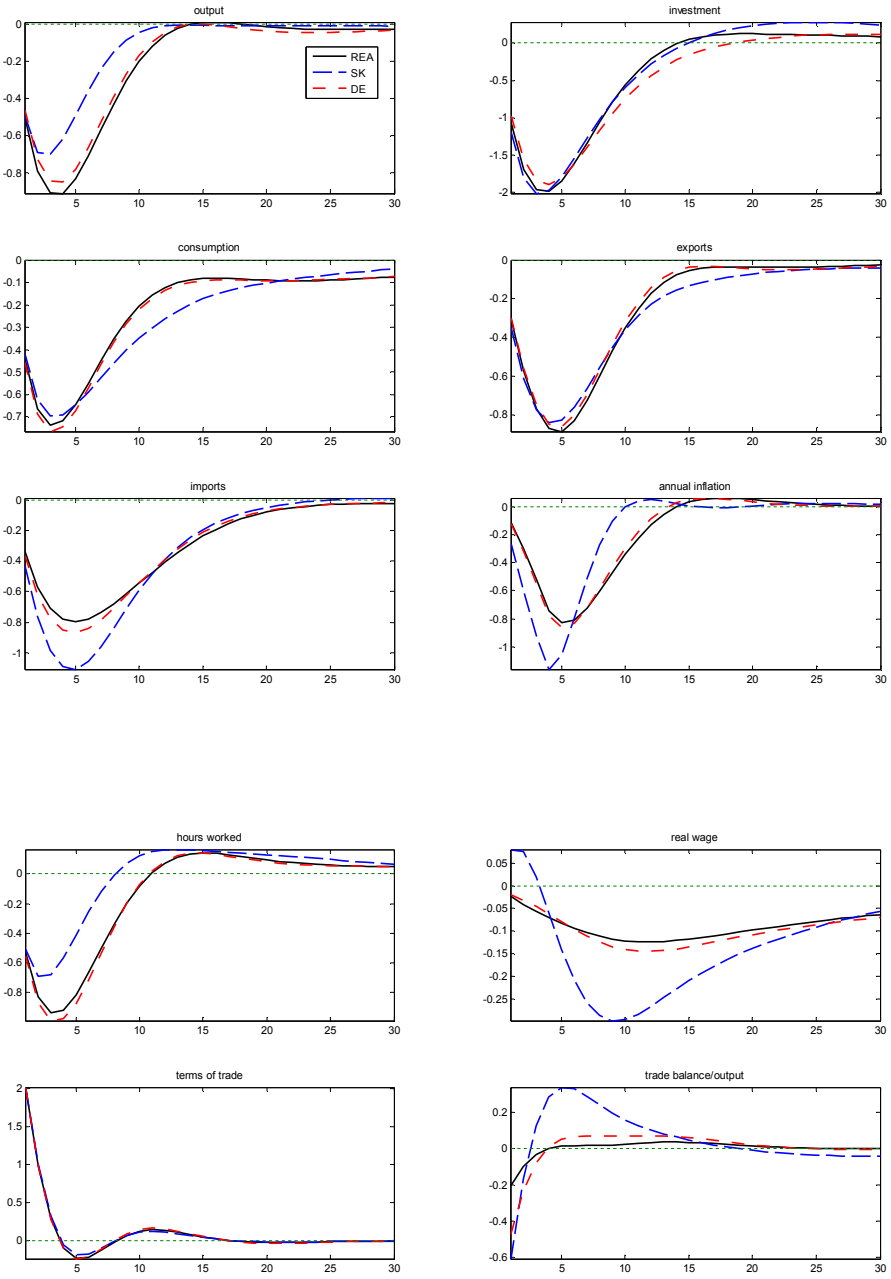
5.1. SELECTED PARAMETERS OF THE MODEL

Table 11 Selected parameters of the model calibration

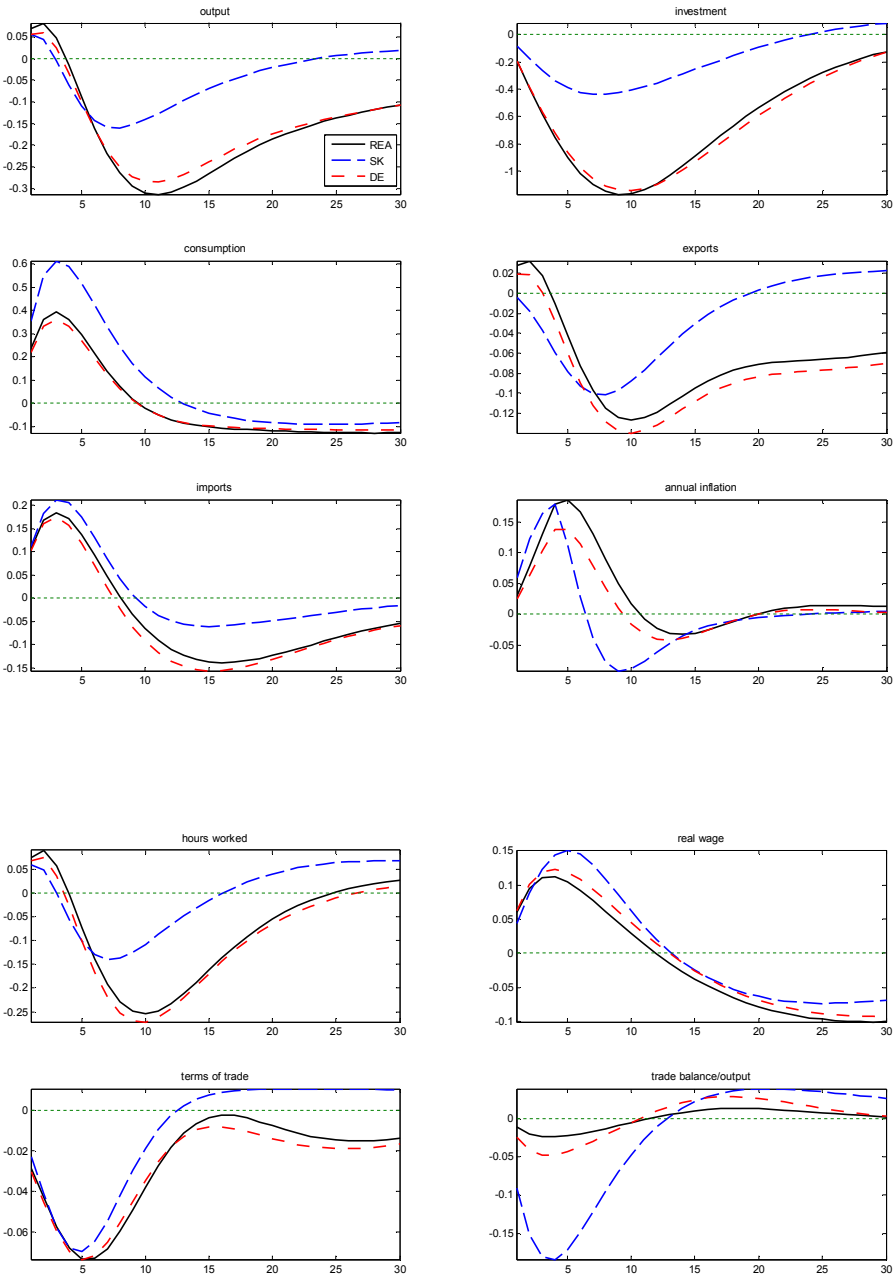
	Germany	Slovakia	Rest of the euro	Rest of the world
Labour share in non-tradable production function	0.3	0.35	0.3	0.3
Labour share in tradable production function	0.3	0.35	0.3	0.3
Discount factor	0.99	0.99	0.99	0.99
Depreciation rate of capital	0.025	0.025	0.025	0.025
Habit formation in consumption	0.7	0.7	0.7	0.7
Elasticity of substitution between tradable and non-tradable baskets in consumption goods	2.5	2.5	2.5	2.5
Elasticity of substitution between tradable and non-tradable baskets in investment goods	2.5	2.5	2.5	2.5
Elasticity of substitution between tradable and non-tradable baskets in export goods	2.5	2.5	2.5	2.5
Elasticity of substitution between home tradable and import baskets in consumption goods	2.5	2.5	2.5	2.5
Elasticity of substitution between home tradable and import baskets in investment goods	2.5	2.5	2.5	2.5
Inverse of the intertemporal elasticity of substitution in utility function	2	2	2	2
Inverse of Frisch elasticity	2	2	2	2
Weight of past inflation in indexation of non-tradable good price	0.79	0.5	0.79	0.79
Weight of past inflation in indexation of tradable good price	0.79	0.5	0.79	0.79
Weight of past inflation in indexation of wages of I-type household	0.78	0.75	0.78	0.78
Weight of past inflation in indexation of wages of J-type household	0.78	0.75	0.78	0.78
Weight of past inflation in indexation of export good price	0.75	0.75	0.75	0.75
Probability of no price change of non-tradable products	0.7	0.5	0.7	0.7
Probability of no price change of tradable products	0.7	0.5	0.7	0.7
Probability of no wage change of I-type households	0.75	0.75	0.75	0.75
Probability of no wage change of J-type households	0.75	0.75	0.75	0.75
Probability of no price change of export products	0.7	0.7	0.7	0.7
Intratemporal elasticity of substitution between I and J types of labour service	4.33	4.33	4.33	7.25
Intratemporal elasticity of substitution between different I types of labour	4.33	4.33	4.33	7.25
Intratemporal elasticity of substitution between different J types of labour	4.33	4.33	4.33	7.25

5.2. IMPULSE RESPONSE FUNCTIONS

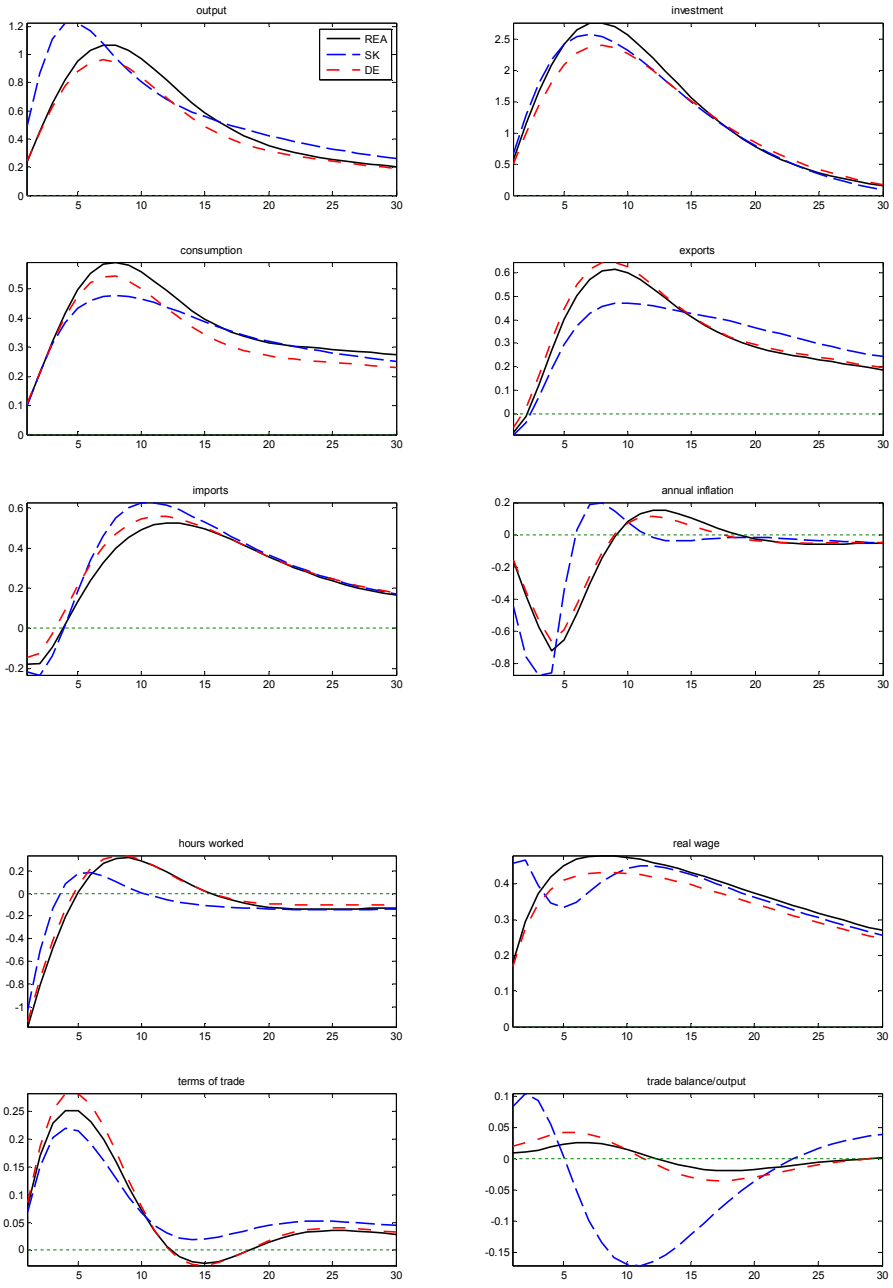
Monetary policy shock



Transfer shock



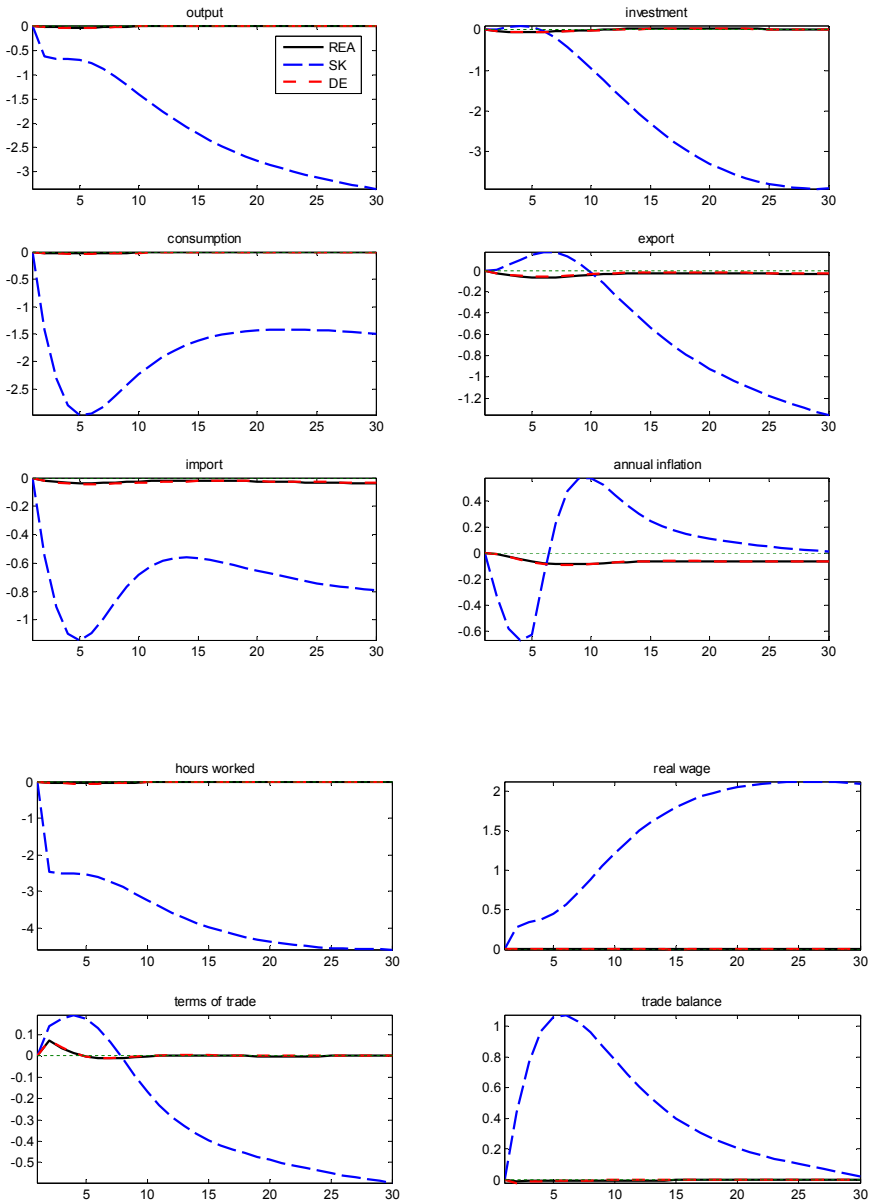
Technology shock



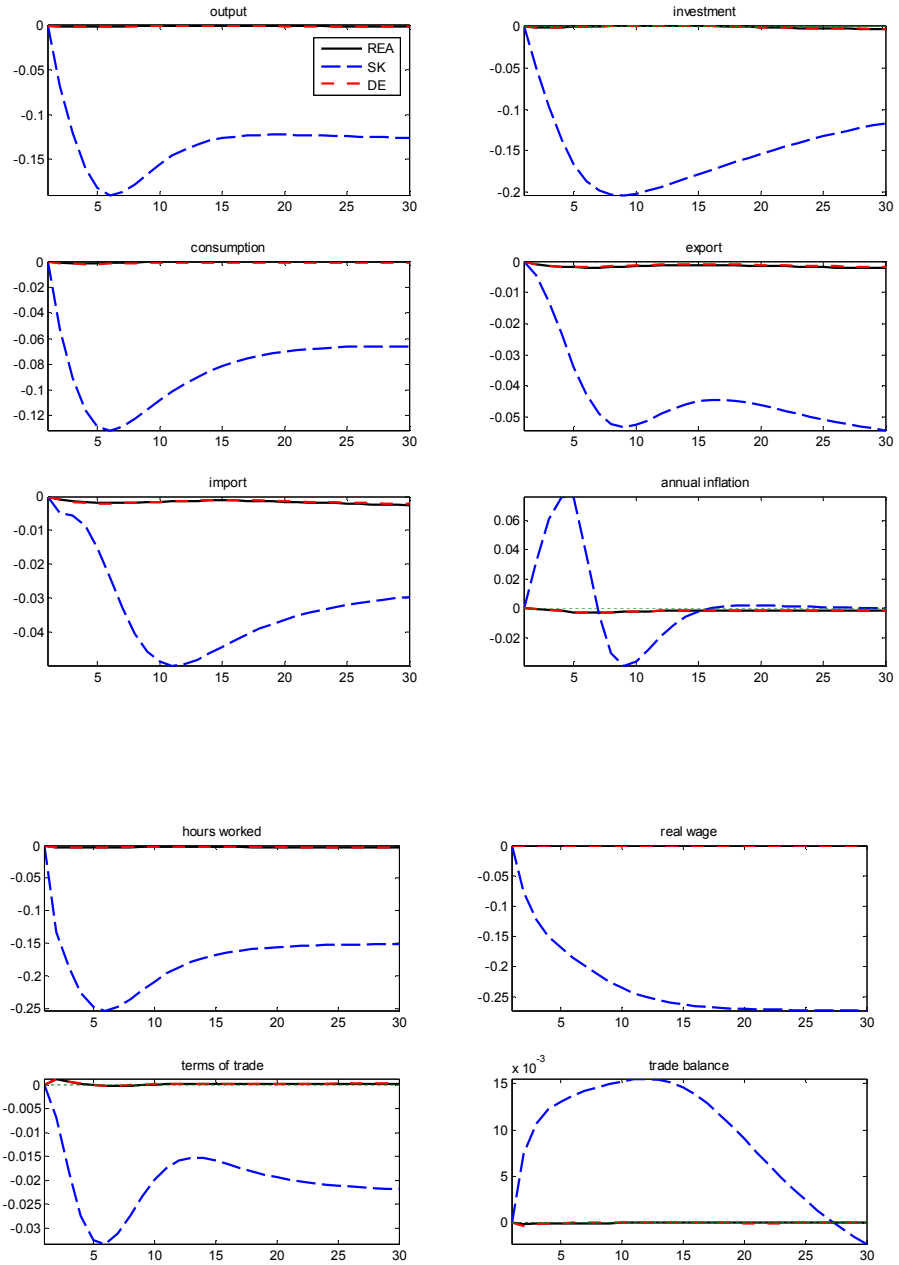
5.3. TRANSITIONAL DYNAMICS

5.3.1. SEPARATE ADJUSTMENT OF INDIVIDUAL TAX RATES

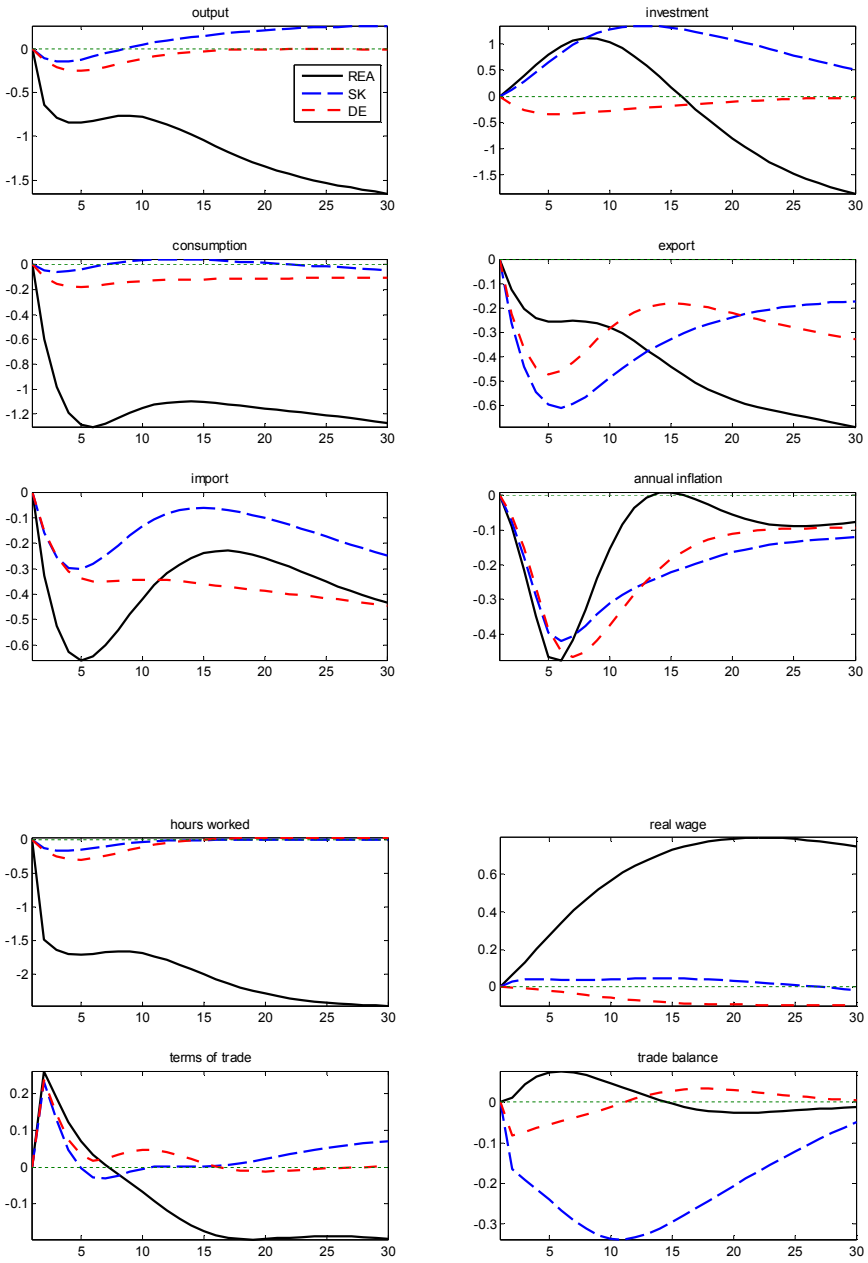
Slovakia: adjustment of households' labour income taxes



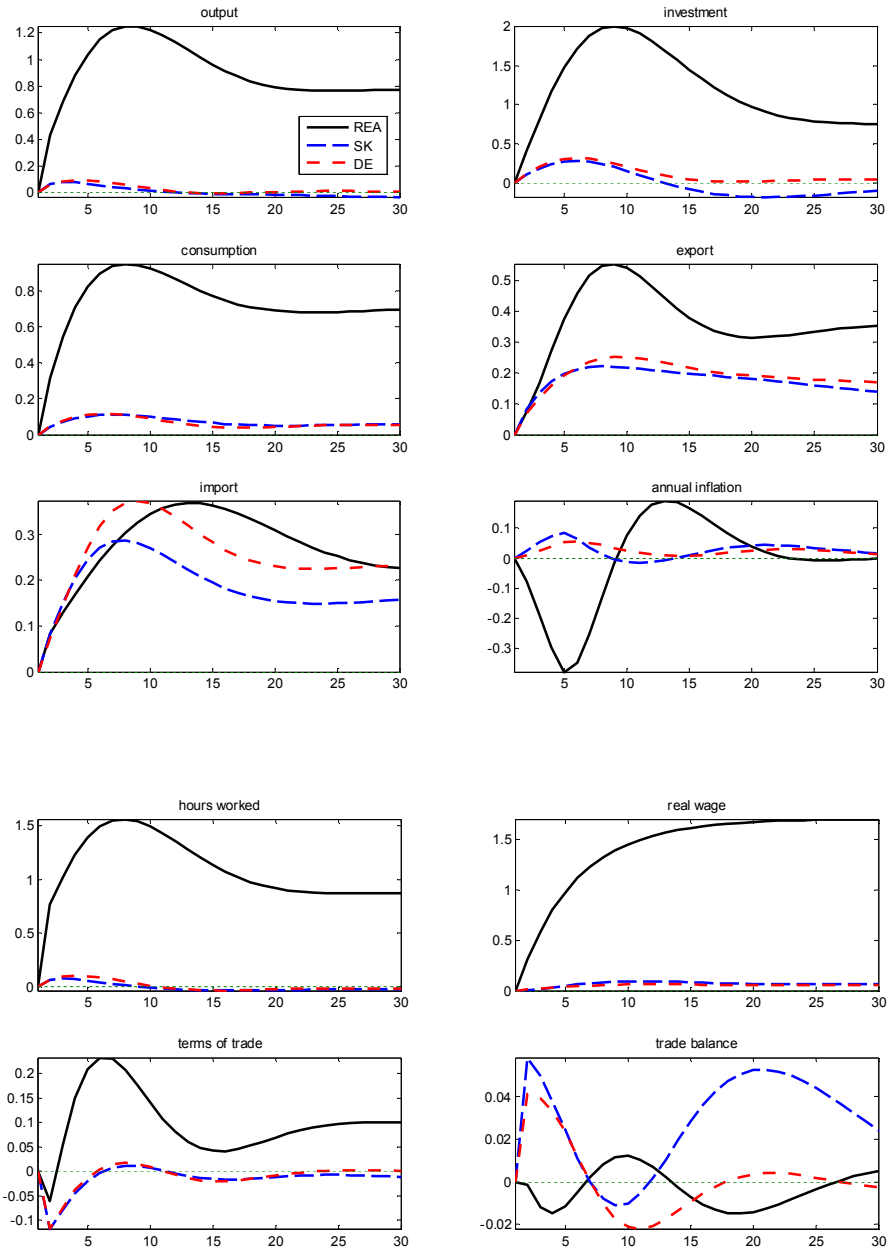
Slovakia: decrease in social contributions of employers



Rest of the euro area: adjustment of households' labour taxes

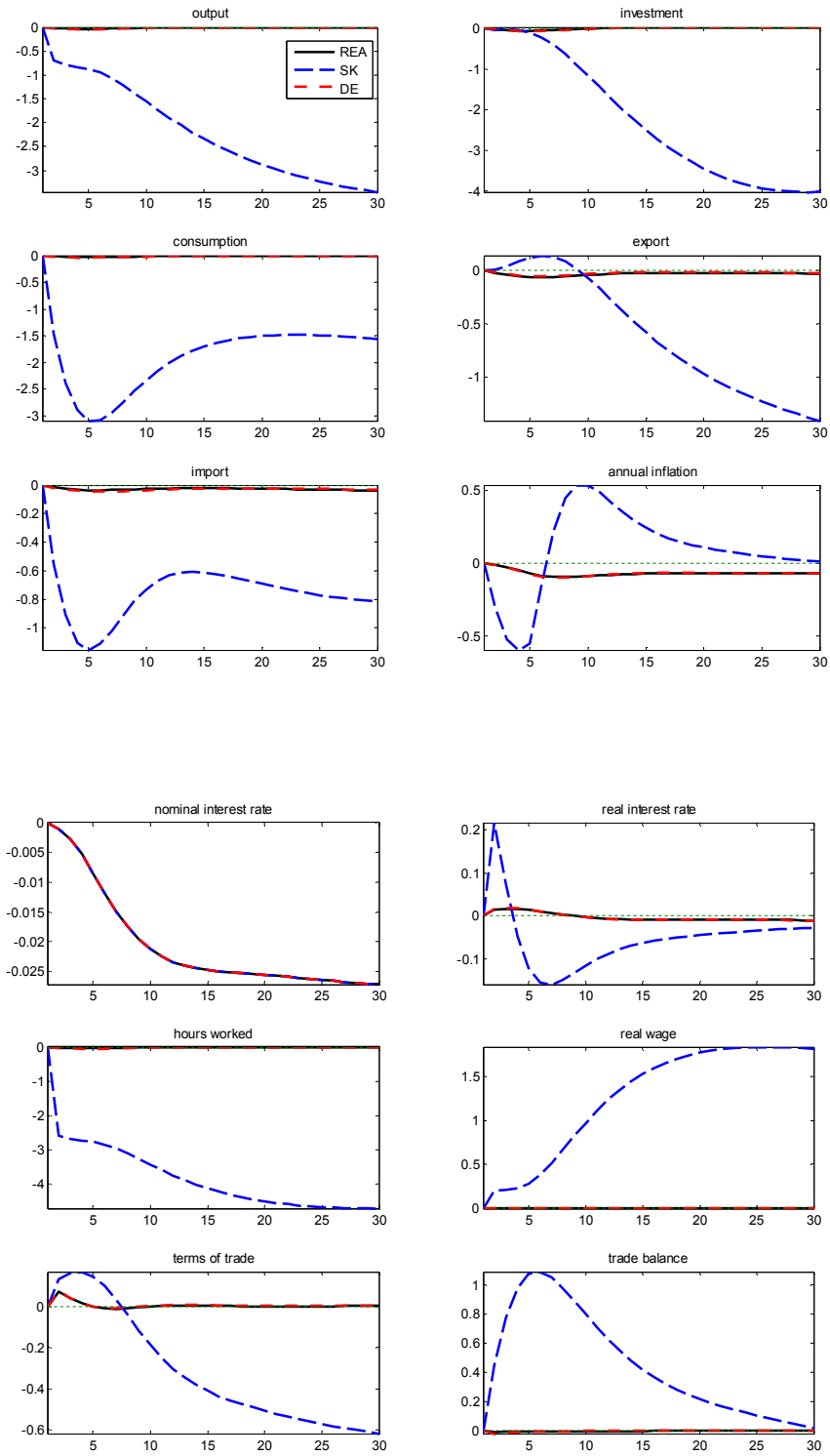


Rest of the euro area: decrease in social contributions of employers



5.3.2. ADJUSTMENT OF TAXES IN COUNTRIES SEPARATELY

Tax changes in Slovakia



Tax changes in the rest of the euro area