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Structural Reforms and Stabilization Policies in the Euro Area

Abstract. Specifying a structurally built NKM model for EMU, and identifying in it the determinants of the potential output and the short-run cyclical factors, we consider structural reforms and monetary and fiscal policies in the euro area. Especially, we analyse whether structural reforms are deflationary or boost the economy in the short run and create spillovers within the euro area under the zero lower bound (ZLB) of the interest rate. We find that a structural reform towards a more competitive economy by lowering the mark ups in the goods and labour market is beneficial both in the short and long run, and both under normal and the ZLB situation in the financial markets. Coordination of reforms within the euro area is also called for, because the spillovers from reforms are typically negative. The national governments searching for an optimal structural policy can delegate the stabilization efforts to the ECB in a long-run equilibrium, but in the short run this separation does not hold in general. We find that in a recession the reform policy is typically curtailed, while in a boom it initially exceeds the long-run equilibrium of reform activity. Proper fiscal policy can alleviate this problematic feature in structural reform policies.

Key words: Structural reform, EMU, coordination

JEL Code: E630, E61, F420

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1. Introduction

The euro area is plagued by a difficult phase characterized by cyclical and structural setbacks. It has been broadly understood that the countercyclical room to counter the ongoing prolonged recession by expansionary fiscal policies is quite limited and in the problem countries outright impossible. Instead, recourse to structural reforms has been widely raised to the forefront.

The analysis of structural reforms was earlier often cast in terms which were very general displaying only the benefits and costs of such policies. This nonstructural approach had its merits and dismerits. It gave insight in general terms on the desirability of structural reforms, but was of quite little value in considering the effects and proper measures of policies to be implemented in actual policy making. More recently, the structural reforms have been considered in terms of fully formulated models, typically in the general equilibrium framework and evaluated then through numerical simulations. Of the former approach, see e.g. Campoy and Negrete (2010), of the latter Eggertsson, Ferrero and Raffo (2014).

The scope of structural measures is in practice manifold. They can in broad terms be identified as measures alleviating problems in the operation of the supply side of the economy, and how they lead to an improvement in the overall economy. See OECD (2015) for a broad review of structural reforms and their effects and Commission (2014) for reform activity in the EU. The key transmission mechanism is the working of the labour and goods markets, which are the corner stone of the structural measures, and reforms raising productivity. Typically also tax policy is considered in this connection, see e.g. the review and analysis of structural reforms and tax policies by Catalano and Pezzola (2014).

The aim of the current paper is to build a concise, but realistic framework for the analysis of both the supply and demand side of the economy, with their interaction and the international spillovers of such policies within the euro area. Our approach is to explicitly model the labour market and its long-run equilibrium, the fiscal policy and the monetary policy by the ECB, also under the zero lower bound (ZLB) of the interest rate policies in the NKM model for the euro area.

We consider numerically three types of policy exercises. First, as elsewhere in the literature, we lower the mark ups between the prices and the cost in the goods market, and wage setting and the outside option in the labour market, which reflect the imperfect competition in these markets, by a fixed amount so that there is a change towards a more competitive economy through tax policies. We consider both the reform in a single EMU country and coordination of reforms throughout the euro area. Second, we identify the reform to consist of measures leading to an expansion in the aggregate supply through a rise in total factor productivity (TFP) as in Neck and Haber (2007) and a lowering of the equilibrium rate of unemployment, arising from reforming the economy as more competitive, but without being able to identify the specific policy measures leading to this outcome. And third, we consider the optimal reform policy aiming at both long-run gains and short-run stabilization in conjunction with the monetary policy by the ECB aiming at the stabilization in the euro area and the national fiscal policies.

It is often claimed that successful structural reforms necessitate expansionary demand management policies because the measures are initially contractionary and often widen the budget deficit. This outcome is, e.g., found out by Eggertsson, Ferrero and Raffo (2014), especially under the zero lower bound (ZLB) of the interest rate, while Cacciatore, Duval and Fiori (2012) and Vogel (2014) in broad terms reach an opposite outcome. The key channel leading to this outcome is the rise in the real interest rate in ZLB as a result of deflation linked to the reform. In our analysis we also reach a positive outcome from a structural reform. We analyse the asserted short-run deflationary effect of structural reforms and conclude that it is not so crucial as suggested by Eggertsson, Ferrero and Raffo (2014). The reason for this effect is that expectations of the future rise in the potential output lead to an expansion already in the current aggregate demand, a key, but, true, controversial property of the basic forward-looking NKM model. As a reform achieved through lowering some of the tax parameters typically leads to a widening of the budget deficit, combining with the reform a tightening in the fiscal policies, i.e., reduction in government expenditure, cuts some, but not all of the gains of a structural reform. The ZLB also cuts some of the effects of a positive structural reform, but leaves anyway the overall balance of the measure as positive.

The second exercise is a rise in the productivity caused by a structural reform in the goods market. This policy is also beneficial, and in contrast to that above, it improves the budget balance.

Typically, the reforms create negative spillovers within the euro area as they raise the competitiveness of the country concerned. So, we find deflation from reforms in the euro area, but basically only in those countries that do not reform their economies. This can be eliminated by carrying out a similar reform in a coordinated way in general in the various euro area countries. Second, the coordination of reforms, i.e. carrying out identical reforms all over the euro area can eliminate the initial deflationary impact of a reform in a single country. We also infer that a crucial issue is the commitment of a country to a permanent reform. If this is not achieved, the gain from reform is much curtailed, or even lacking fully.

In contrast to many recent studies on the subject, we also consider as a third issue the optimal reform activity, and allow it to depend on the size of the cost of reforming the economy from the initial status quo. Especially, we analyse it in combination with the stabilisation policy delegated to the ECB. There is a positive result in the earlier literature by Dixit and Lambertini (2003) on the coordination of fiscal policies and the single monetary policy by the ECB. Their crucial result is that there is an efficient separation of the national fiscal policies and the single monetary policy if the various national policy-makers and the ECB are unanimous about the natural rates of output and the inflation target to be the desired ones. This result also holds even though the national governments weigh differently the output and inflation targets than the ECB. Here our results are similar as the long-run equilibrium of reform and stabilization policies, but we also show that numerically this separation does not hold in the short to medium run. A problematic outcome is that a cyclical downturn typically slows down the reform activity, while in a booming country it gets a boost. Fiscal policies can in principle alleviate this awkward feature in policy making.

The organization of the paper is such that in Section 2 we build the framework for the analysis. In Section 3 we consider the basic case of reforming the goods and labour market as more competitive. In Section 4 we consider the reform measure raising productivity. Section 5 considers the

endogenous reform policy in conjunction with the stabilisation policy by the ECB and the national fiscal policies. Section 6 concludes.

2. The model

Earlier, it was common to model the effects of structural reforms in a way using an ambiguous non-structural approach to modelling the EU economies, specifying the gains and losses related to policies, and the analysis was cast directly in the form of an objective function of the policy-makers. As is now common in the literature, also here our goal is to overcome this shortcoming and to explicitly model the transmission of structural reforms, and the gains and costs of them. In this respect, we have to, i.a., take a standpoint to the question, how the structural reforms affect economic developments. There are two quite different ways of this specification in the literature. First, it is specified that a reform affects permanently the growth rate of the economy, secondly, it is assumed that a reform just raises the potential output, i.e. it only has a level effect. Padoan, Silo and van der Noord (2013) is an example of the former, while Haber and Neck (2007) after a brief discussion adopt the latter assumption. This standpoint can have remarkable effects on the analysis of economic reforms. In this paper we consider, as standard, the level effect to be more sensible, as the economic reform is typically a one-shot measure boosting the supply side, i.a., the labour supply and productivity, the effects of which will gradually be eroded over time with respect to the growth rate.

Our approach is based on identifying both the potential output, which is affected by the structural reforms and the tax policies, and the short-run output affected by aggregate demand, and the evolution of the potential output and its effect on inflation. We also describe the functioning of the labour market with the determination of the equilibrium rate of unemployment, which is affected by the reform policy. We also combine the behaviour of the ECB to the model. In the paper we try to capture the economic situation prevailing currently in the euro area, with a limited scope for the policy-making by the ECB.

We build the following aggregate AD-AS model which is modified to be a dynamic NKM model in the EMU context. The model is fitted in the standard way to an EMU comprising of two identical economies as to behaviour. This resembles the approach adopted in e.g. Alho (2013). For simplicity, we model the euro area as a closed region in the world economy. Typically, a NKM model only considers the aggregate demand and stipulates the goods market supply through the inflation equation. Here our model consists of the demand and supply side in the goods market, the public sector and the basic labour market relationships.

The prototype economy is composed of two production sectors: export (X) and domestic consumption goods (H) sectors, the latter of which also provides the public consumption goods (G). These items are made by the final goods firms which transform the intermediate goods into final goods under perfect competition. The intermediate goods sector is common to the economy and it produces goods under monopolistic competition. Let us start from the final goods firms. The

production Y_{kt} of the final good sector k is composed of the intermediate goods $Y_{kt}(f)$ of the firms in this sector,

$$Y_{kt} = \left[(\frac{1}{\gamma_k})^{1/\varepsilon_k} \int_0^{\gamma_k} Y_{kt}(f)^{(\varepsilon_k - 1)/\varepsilon_k} df \right]^{\varepsilon_k/(\varepsilon_k - 1)}, \quad (1)$$

where γ_k is the size of the sector in the economy and ε_k is the elasticity of substitution between the goods in this sector. The representative final goods firm in sector k maximises the profit

$$P_{kt} Y_{kt} - \int_0^{\gamma_k} \left[P_{kt}(f) Y_{kt}(f) + (\tau_k - 1) P_{kt}(f) Y_{kt}(f) \right] df \ , \quad (2)$$

where $\tau_k \geq 1$ displays the iceberg cost of exports related to the export sector. (There is no such item within the domestic sectors.) The demand functions are in the standard way

$$Y_{kt}(f) = \frac{1}{\gamma_k} \left[\frac{\tau_k P_{kt}(f)}{P_{kt}} \right]^{-\varepsilon_k} Y_{kt} \quad (3)$$

The price index is then the following

$$P_{kt} = \left[\frac{1}{\gamma_k} \int_0^{\gamma_k} (P_{kt} \tau_k)^{1-\varepsilon_k} df \right]^{1/(1-\varepsilon_k)} \quad (4)$$

Let us next describe the equilibrium in the final goods markets. The aggregate demand is made by the exports X, consumption of home made goods C^h and public consumption G. We can specify the aggregate consumption C to be composed of domestic and foreign imported C^{imp} goods in the following way,

$$C = \left[(\frac{1}{\vartheta_h})^{1/\vartheta} (C^h)^{(\delta-1)/\delta} + (\frac{1}{\vartheta_{imp}})^{1/\delta} (C^{imp})^{(\delta-1)/\delta} \right]^{\delta/(\delta-1)} . \quad (5)$$

We could further define these consumption items to be composed of various firm level items in the standard way, but this can be skipped here, as it replicates the features presented above, and is well documented in the literature, see e.g. Eggertsson, Ferrero and Raffo (2014). We use lower letters to display the logarithm of a capital-letter variable, i.e., z = log(Z). The aggregate demand (with superscript D), in the first stage, is based on the following income identity for countries i and j, i,j =1,2, i≠ j,

$$y_{i,t}^D = \omega_C c_{i,t}^h + \omega_X x_{i,t} + \omega_g g_{i,t} \ , \quad (6)$$

where y is output, c^h is the consumption of domestically produced goods, x is exports and g public consumption and ω_k is the share of demand item k in GDP in the steady state. The aggregate

consumer demand c by components of domestic and imported goods can be written using a CES formulation for the utility function approximatively in the following way,

$$c_{i,t}^{h} = c_{i,t} + \vartheta_{i}^{h} - \delta(p_{i,t} - p_{j,t}) \ , \tag{7}$$

where ϑ is the preference parameter and δ is the elasticity of substitution parameter (positive) and p_i is the log of the price level in country i of domestically produced goods. The exports of country i are made by consumer demand for imported goods in country j, and they can be presented by a similar function as in (7), mutatis mutandis.

The consumer-worker has a unit endowment of time in labour market activities which she or he can plan to use as a worker (L) or unemployed (U) with a unit benefit b. The intertemporal budget constraint of the representative consumer k in country i is,

$$(1+t_{Ci})P_{ti}C_{tk} + E_{t-1}X_{t-1,t}B_{i,t} + D_{tk} = (1+r_t)D_{k,t-1} + (1-t_W)W_{tk}L_{tk} + b_{ik}(1-L_{kt}) + \Pi_{tk} \, , \tag{8}$$

where t_C is the consumption tax rate (VAT), D is the stock of government debt held by the consumer at the end of the period, B is the stock of risky assets (both at the end of period t), E is the expectation operator, $X_{t-1,t}$ is the stochastic discount factor between t-1 and t, r is the interest rate set by the ECB for the euro area, t_W is the labour income tax rate, W is the wage rate, and Π is the profit (dividends) earned by intermediate goods firms and extended to the household owners. We assume complete financial markets for risky assets and have therefore a unique discount factor in the following way: $(1+r_t)^{-1} = E_{t-1}X_{t-1,t}$ (see e.g. Teranishi 2015, 168). The consumer k maximizes the intertemporal utility function V, composed of the utility related to consumption and the disutility related to working,

$$V_{kt} = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{C_{ks}^{1-\sigma}}{1-\sigma} - \xi \frac{L_{ks}^{1+\eta}}{1+\eta} \right) \ , \tag{9}$$

where β is the discount factor (< 1), σ is the intertemporal elasticity of substitution parameter, and η > 0 is the inverse of the Frisch elasticity of labour supply The log of the (aggregate) consumption is then determined by the Euler equation,

$$c_{i,t} = Ec_{i,t+1} - \sigma^{-1}(r_t - E\pi_{i,t+1} + \log\beta) \ . \tag{10}$$

Here π is the inflation rate, measured by the consumer prices. Write then the income identity in Eq. (6) for the next period t+1, and subtract in the usual manner the expected aggregate demand for the period t+1 from that in period t, and further, insert (10) into (8) and this then into (6) and use the same kind of procedure for exports, i.e., imports by country j. This yields the following expression for the IS-curve for output, [1]

[1] Note that we have assumed that there is no variation in the trade costs between the periods (see Eq. (4) above), although this would open us the way to consider the possibility of enhancing the operation of the EU single market. We leave this for further study.

$$y_{i,t} = Ey_{i,t+1} - \omega_{i,c}\sigma^{-1}(r_{i,t} - E\pi_{i,t+1} - rr_{e,i}) - (\omega_{i,c} + \omega_{i,X})\delta(-E\pi^{d}_{i,t+1} + E\pi^{d}_{j,t+1}) + \omega_{i,g}(g_{i,t} - Eg_{i,t+1}) - \omega_{j,X}\sigma^{-1}(r_{j,t} - E\pi_{j,t+1} - rr_{e,j}) \quad (11)$$

where the superscript d in the inflation rate depicts the producer price inflation (see on this below). We see that the financial markets within the EMU link the economies of the countries together so that a rise in the interest rate in one EMU country also hurts its neighbour through the export demand. We also see that improved competitiveness operates through, not the static price level as such, but through a risen expected future inflation rate, in comparison to that in the neighbouring country.

The output in the intermediate goods firms is made by the following C-D production function which is in logarithmic form,

$$y_{kt}(f) = \rho + \alpha l_{kt}(f),\ 0 < \alpha < 1, \quad (12)$$

where ρ is the common (log of the) total factor productivity (TFP) and the labour input l is that of the firm f (see below). By combining Eqs. (3) and (12) and integrating we can derive an aggregate production function for the common intermediate goods sector following in part Eggertsson, Ferrero and Raffo (2014), and using the mean value theorem in the integration of the labour input,

$$y_{kt} + \log\Delta_{kt} = \rho + \alpha \log \bar{L}_{kt},\ \bar{L}^{\alpha}_{kt} = \int_0^1 L_{kt}(f)^{\alpha} df, \quad (13)$$

where $\bar{L}_{kt}$ is now the aggregate labour input and Δ is the index of price dispersion[2], the first term on the right-hand side of Eq. (3) integrated over the interval $[0,1]$. The aggregate potential output in country i (denoted by superscript P) y^{P}_{it} is defined so that the labour input is equal to $l^{S}_{i} - u_{i,e}$, where u^{e} is the equilibrium unemployment rate, and l^{S} is the aggregate labour supply. In the short run output is determined by the aggregate demand (superscript D), and so is the level of employment, too. In a static context, we skip the time notation when not needed. The IS-curve in (11) is next formulated in the standard manner in terms of the output gap, $gap_{i,t} = y^{D}_{i,t} - y^{P}_{i,t}$, with the change in the potential output then affecting as a productivity shock the natural rate of interest, see e.g. Teranishi (2015).

Because the only variable production factor is labour, the tax rate on capital income does not have an impact on the outcome of the model. [3] The equilibrium labour supply (with superscript S) can be derived to be the following in logs, after plugging into it the determination of the real wage (see more on this below). Note that we assume that the labour supply in country i is linked to the equilibrium of the economy, and is thereby a kind of a notional variable,

$$(\chi + (\sigma - 1)\alpha + 1)l^{S}_{i} = \log(\alpha) - \log(\xi) + \rho_{i}(1 - \sigma) + \sigma\tilde{g}_{i} - \Delta_{Qi} - t_{Wi} - t_{Ci} - b_{Wi}, \quad (14)$$

[2] This index converges in equilibrium to zero (in log), see Eggertsson, Ferrero and Raffo (2014).
[3] The capital stock may be mobile between the countries so that it does not pay to tax it all initially.

where $\tilde{g} = \omega_g g$ is the share of public expenditure in GDP, and Δ_Q is the mark up factor in pricing in the goods market in log, b_W is the benefit in relation to the wage rate assumed fixed (see below, the derivation of (14) is a straightforward maximisation of (9) and available at request from the author). In the initial equilibrium where the foreign trade balance is zero, we have $C_i = (1-\tilde{g}_i)Y_i$.

Let us next derive the price and wage setting, first in equilibrium, and the consequent equilibrium unemployment rate, see for details Alho (2015). The equilibrium wage level, i.e., the equilibrium functional income distribution, is as follows, through price setting by the firms,

$$w_k = \log(\alpha) + p_k^d + y_k - l_k - \Delta_{Qk} \ , \tag{15}$$

where l is again the log of employment, p^d is the log of the producer price level before the consumption tax (rate t_C) and Δ_Q is the mark up factor in pricing in the goods market in log, reflecting the imperfection in the intermediate goods sector, i.e. it is approximately $\Delta_{Qk} = \varepsilon_k^{-1}$. The firms in the intermediate goods sector bargain over wages with a trade union, representing a section of the labour force where the individual workers are up to a productivity differential perfect substitutes for each other, so that the firm profit is made by the following

$$\Pi_{kt} = P_{Qt} Q_{kt} - W_k \int_{j \in U_k} e_j L_j dj \tag{16}$$

where W_k is the average wage in the union U_k of the firm k and e is the productivity indicator of the worker with mean unity. The bargained wage is given by the following in logs, to be composed of rent sharing and the outside option, see Layard, Nickell and Jackman (2005) and Alho (2015) for details. The aggregate wage level in country i can be written in log terms on the basis of Eq. (33) in the Appendix,

$$w_{it} = (p_{it}^d + y_{it} - l_{it}) + \psi_i(t_{Wt}, t_{Ct}, np_{it}) + \tilde{b}_{it} - \phi u_{it} \ , \tag{17}$$

where $\tilde{b}$ is the unemployment benefit in relation to productivity, np is the relative bargaining power of the union vis-à-vis the employer and $\psi_1, \psi_2, \psi_3, \phi > 0$ (see the Appendix). Now equating (15) and (17) we get the equilibrium unemployment rate as follows,

$$u_i^e = \frac{1}{\phi}(\Delta_{Qi} + \psi_i + \tilde{b}_i + \log(\alpha)) \, . \tag{18}$$

In equilibrium, the price mark-up factor is the same and by averaging over the replacement rates, the unemployment rate refers to the average national rate. Let us then turn to price dynamics, to derive the inflation rate. The marginal cost, incorporated below in the pricing in equilibrium and in the Calvo price index, is the following in country i,

$$\log(MC(f)) = \log(MC_i) = w_i + \log(\alpha) + l_i - y_i + \frac{\partial w_i}{\partial l_i^S} \, , \tag{19}$$

where the last term is denoted by Δ_{Li} , the mark up in the labour market through labour supply. The desired price setting is, if the prices are set without frictions, then in country i $p_{it}^{d*} = \log(MC_{it}) + \Delta_{Qi}$. Let us then insert Eq. (17) into Eq. (19) and we can derive the deviation of the optimal price from the actual to be as follows,

$$p_{it}^{d*} - p_{it}^{d} = -\log(\alpha) + \psi_{it} - \phi u_{it} + \tilde{b}_{it} + \Delta_{Li} + \Delta_{Qi} \ . \tag{20}$$

In equilibrium, the left-hand side of Eq. (20) is zero and we can solve for –log(α) from this. The actual unemployment rate is $u_{it} = l_{it}^{S} - (y_{it}^{D} - b_{it}) / \alpha$. This allows us to write the deviation of the real marginal cost from the equilibrium, see Wickens (2012), ch. 9.5 for a similar argumentation, which is then incorporated as an item in the intertemporal optimization of price setting,

$$mc_i - p_i^C = (\psi_i - \psi_{i,e}) + \frac{\phi}{\alpha}\left[(y_i^D - y_{i,e}) - (\rho_i - \rho_{i,e})\right] - \phi(l_i^S - l_{i,e}^S) + (\Delta_{Li} - \Delta_{L,i,e}) - \Delta_{Q,i,e} - t_{i,C} \ . \tag{21}$$

Here p^C is the price index inclusive of the VAT. As standard, the case of perfect competition is achieved in (21) in equilibrium by channelling a proper sales subsidy to the firms.

The aggregate price level and inflation then evolve as follows, in the standard set up, see e.g. Sienknecht (2011). The dynamic inflation rate is then the following, according to a Calvo price adjustment mechanism,

$$\pi_{it}^{d} = (1-\beta)\pi^* + \beta E\pi_{i,t+1}^{d} + \theta(mc_{it} - p_{it}^{C}) , \tag{22}$$

where π^* is the inflation target (trend) of the ECB and the last term measures the deviation of the real marginal costs from the equilibrium. θ is a convolution of parameters reflecting the stickiness of prices as in the standard inflation model, $\theta = (1-\omega)(1-\beta\omega)/\omega$, where $1-\omega$ is the probability of no price change during the unit period and mc and p^C is the deviation from the steady state. The firms not optimising their price setting inflate it according to the target inflation rate.

Eq. (22) applies for the domestically produced good while the consumer inflation rate is also affected by the inflation rate in the neighbouring country through import price,

$$\pi_{i,t} = (1-\omega_{i,X})\pi_{i,t}^{d} + \omega_{i,X}\pi_{j,t} + (t_{Ci,t} - t_{Ci,t-1}) \ . \tag{23}$$

The primary government budget deficit h, in relation to GDP, is made of the difference between expenditure g and total taxes,

$$h_i = \tilde{g}_i + \tilde{b}_i u_i - t_{Wi}\frac{W_i L_i}{P_i^d Y_i} - \omega_C t_{Ci} - t_i^{rest} \ , \tag{24}$$

where $\tilde{b}$ is the unemployment benefit in relation to labour productivity, ω_C is again the share of consumption in GDP, and t^{rest} is the share of other taxes, net. The public consumption G is composed of a similar CES aggregate of domestic goods as the domestic consumption sector. The

real public debt D accumulates as follows, with the debt being denominated in one-period instruments,[4]

$$D_{it} = h_{it}Y_{it} + (1 + r_{it} - \pi_{it})D_{i,t-1} \ . \tag{25}$$

We assume that the financial markets are homogeneous within EMU. The ECB selects the common interest rate r by the following goal function, which can be derived as an approximation from the welfare function of the consumers, see e.g. Teranishi (2015),

$$V_t^{ECB} = -E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\xi_1 (\overline{\pi}_s - \overline{\pi}^*)^2 + \xi_2 \overline{gap}_s^2 \right] , \tag{26}$$

where the output gap is again defined as $y^D - y^P$. A bar above a variable denotes the euro area average and π^* is the target inflation rate. Assume that the ECB is near the steady state after a demand shock, as it is in these model simulations. The optimal short-run trade-off between output and inflation from the ECB' s point of view is assumed not to be achievable in the euro area in the present situation so that the trade-off is as follows,

$$\xi_1 (\overline{\pi}_t - \overline{\pi}^*) + \xi_2 \overline{y}_{GAP,t} \frac{d\overline{y}_{GAP}}{d\overline{\pi}} = \Delta_{ECB} < \ 0 . \tag{27}$$

This situation means that the short-term interest rate is fixed to the Zero Lower Bound (ZLB), see below for more details.

We define the structural reform policy of the country in two ways. First, we can take the decision-making to be exogenous, as in Eggertsson, Ferreiro and Raffo (2014) and Vogel (2014) so that the mark ups in the goods and labour market are lowered by a fixed amount, typically one percentage point both. We also depict below, how reductions in these mark ups can be put into effect through changes in the policy parameters, basically through tax changes.

Secondly, we can take the decision-making of the respective government to be based on the following goal function which is based on the utilitarian and political aspects, the former being presented in (9) above,

$$V_{it}^G = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{(Y_{is}^P)^{1-\sigma}}{1-\sigma} - \frac{(Y_{is}^P)^{1+\eta}}{1+\eta} - \frac{n_i}{2} (Y_{is}^p - Y_{i,0}^p)^2 - \lambda_i (y_{is}^d - y_{is}^p)^2 - \chi_i (\pi_{is} - \pi^*)^2 \right) \ . \tag{28}$$

Here the first term in (28) captures the social utility of a higher potential output and the second the disutility of working more for it. The third term indicates the disutility of carrying out structural reforms which may be politically harmful. The last terms capture the short-run disutility connected to the cyclical situation. The term of the output gap is based on the fact that in the short run employment is determined positively by the aggregate demand and negatively by the productivity

[4] We do not add an explicit condition linking government indebtedness and deficit to guarantee sustainability, but check first in the simulations the rise in the public debt, and then correct the stance of fiscal policy, if needed.

which is enhanced by structural reforms. The weights λ_i, χ_i and n_i are positive. We also consider below the short run stabilization to be delegated to the ECB and the national fiscal policies.

3. Numerical simulations

3.1. Preliminaries of parameterisation and calibration

We next want to illustrate numerically the properties of the model derived above, as to a large extent the results of the policy measures depend on the magnitude of the relevant parameters. The model is cast in annual terms, so that the unit period below is one year.

Let us first consider the identification of the change in the euro area towards a more competitive goods and labour market. In our case we consider this to take place in two stages. First, similarly as Eggertsson, Ferrero and Raffo (2014), we basically assume that the euro area country, or both of them, carry out reductions of the mark up in the goods and labour market and put these into effect through proper reductions in the tax parameters. So, as to the goods market equilibrium pricing, we depict a reduction in the VAT rate t_C by one percentage point, and then solve from a similar size of reduction in the ψ-function in the labour market equilibrium in Eq. (17) the required change in the labour income tax t_W, see the Appendix for details. Numerically, this means that the reduction in the income tax rate is roughly 3%-points. We consider these changes first as such in isolation, and as these lead to a quite marked increase in the public sector indebtedness, we combine with them a reduction in the public expenditure to balance the budget.

As to the case of productivity enhancing measure, we calibrate the impact of the key policy variable of structural reform in the goods market in such a way that it corresponds to the estimation results by Wyerstrass and Jaenicke (2007). They got the result that reforming the goods market in Europe to the level of the US in competitive terms means that the mark up factor $1+\Delta_Q$ is lowered by 10 per cent. This then implies according to their estimation result that the total factor productivity rises in the EU by 0.57 per cent. So we assume in a fairly standard manner that the initial mark up in the goods market in the EU is 20% (before taxes).

These changes in the policy variables are then inserted into the determination of the equilibrium rate of unemployment in Eq. (18). We assume that the initial equilibrium rate of unemployment is 8% in both countries. The reaction ϕ of the wage claims in Eq. (17) with respect to the unemployment rate is set to 3 on the basis of the estimation results by Tyrväinen (1995). We estimated in Alho (2015) the wage equation as specified in (34) in the Appendix for Finland for 1975-2010 (without the tax variables) and got the value -2.9 for φ. In the labour market calibration (see the Appendix) we then reach an estimate of the negotiation power of unions vis-à-vis the employer which is 1.4 and that that the reduction in the labour tax lowers the equilibrium wage setting with a coefficient ψ_2 = 0.3. The actual unemployment rate converges to the equilibrium as a function of output gap

with a coefficient of 0.2 reflecting the Okun law. The supply side reforms at the same time mean a productivity shock lowering the natural rate of interest, see on this e.g. Teranishi (2015).

The initial value of the public expenditure is 40% of GDP, the tax rate on labour income is 30%, and the VAT tax is 20%. The replacement rate of the unemployment benefit is 50% of the wage level. The rest of the tax revenue is then solved to be 12% of GDP. The initial public debt ratio of the euro area countries is fixed to be the 80% in both countries.

The NKM Phillips curve assumes that, quite typically that within a quarter, 60% of firms keep their prices as fixed. This assumption has then been used in the transformation of the typically quarterly Phillips curve into an annual context by taking also into account in the θ parameter the value of the ϕ and α parameters. This gives the value for θ in Eq. (22) of 0.039 (details are available from the author). The wage bargaining is assumed to take place annually.

The interest rate setting by the ECB is in quite an important position in the properties of the model. We assume that the ECB obeys the following modified Taylor rule,

$$r = rzlb_1 + rzlb_2(r_0 + 0.5\overline{gap} + 1.5(\overline{\pi} - \pi^*)) \ . \tag{29}$$

In the initial equilibrium of full employment r_0 is fixed to 2%, and the target inflation rate π^* to 2% p.a. In equilibrium with no output gaps, the equilibrium real interest rate in Eq. (11) is zero which corresponds to the recent estimates of the natural rate of interest. At times, the ECB has to face the ZLB, and (29) has to be adopted in the manner shown so that the parameter rzlb1 = 0.1%, and $rzlb_2 = 0$ for the period when the ZLB is binding and thereafter $rzlb_2$ returns in two years to unity and the normal Taylor rule guides the interest rate setting henceforth. Further, in some cases, to reach a situation of the ZLB, we assume that there is a deflationary autoregressive demand shock of -5%-points to the aggregate demand in the first period, to mimic the onset of the euro crisis, with the autoregressive parameter being 0.5.

The IS curve is numerically parameterised, using fairly standard assumptions so that $\sigma = 2$. Labour supply is determined so that $\eta = 2$. The parameters σ and η in the private and government goal are both defined broadly on the basis of Chen, Cúrdia and Ferrero (2012). The elasticity of substitution in foreign trade is fixed to 1.5. The share of consumption in output is fixed to 0.5, and exports to 0.3. The actual labour supply converges to the equilibrium in (14) through a partial adjustment scheme.

The n-cost parameter in (27) is initially fixed to 0.01, so that a reform costs 1% of output, which is then varied in the simulations.

And finally, we consider the optimal reform policy, where it is solved from a dynamic optimisation of the government welfare function, in conjunction with the monetary policy by the ECB, aimed to be responsible of the stabilisation within the euro area.

We consider reforms both in one country and then the coordination of reforms in the various euro area countries. We also assume basically that the reforms are permanent, with an exception in

Section 4. We impose terminal conditions to the model so that the forward-looking variables reach in the long run a constant difference.

4. The reduction of the mark ups

Let us first consider a structural reform in a single country (but using the two-country model). We gather the key results in Tables 1, 2 and 3. Table 1 depicts the situation under normal interest rate setting so that the ZLB is not binding. As was mentioned above, the mark ups are reduced through tax measures, by lowering the VAT tax rate and the tax rate on labour income. These are selected to be the channel of structural reform as they can be identified in our model as definitive policy measures. In reality, there are many other channels affecting directly the imperfection in the goods market, but which are not explicitly evaluated in a macro model like ours. In the next section we, however, consider such an exercise.

A basic property of our forward-looking model is that a reform expanding the supply side of the economy is also fully and immediately reflected in the aggregate demand and thereby in the actual output. This is due to the fact that a rise in the potential output is reflected in the expectations of the future level of output. This property has to be kept in mind while considering the results below. We could, of course, add to the model an adjustment mechanism, where the rise in output to match demand takes place under costs of adjustment, but we leave this possibility aside in the present paper.[5]

Table 1. The impact of the reduction of the mark ups in the goods and labour markets by 1 percentage points in country 1 under normal conditions in the financial markets, percentage point deviations from the steady state (for details see the text)

Variable	Year 1	Year 2	Long run, 10 y.
Output in country 1	2.77	2.24	1.90
Output in country 2	-0.71	-0.78	-0.22
Inflation in country 1	-1.04	-0.03	-0.14
Inflation in country 2	-0.30	-0.18	-0.15
Interest rate	-0.71	-0.05	-0.15
Gov. deficit in c. 1	1.76	1.85	1.94
Unemployment rate c. 1	-1.59	-1.46	-1.32

We see that the structural reform is expansionary both in the short run and the long run in the reforming country. The only problem is that there is a constant government deficit and therefore the public sector debt ratio rises in 10 years by 15 %-points. Let us therefore complement this exercise with a measure which balances the government finances with a reduction of the government expenditure by 1.9 percentage points in relation to GDP. Now we get the following results, see Table 2.

[5] There is no persistence in the basic model, similarly as in Tarkka and Kortelainen (2006).

Table 2. The impact of the reduction of the mark ups by 1 percentage point in country 1, combined with a reduction in the government expenditure, under normal conditions in the financial markets, percentage point deviations from the steady state, for details see the text

Variable	Year 1	Year 2	Long run
Output in country 1	1.23	0.85	0.82
Output in country 2	0.28	-0.07	-0.02
Inflation in country 1	-1.04	0.00	-0.01
Inflation in country 2	-0.21	-0.01	-0.01
Interest rate	-0.74	0.00	-0.01
Gov. deficit in c. 1	0.04	0.09	0.10
Unemployment rate c.1	-1.31	-1.23	-1.22

The reform package does not produce such a large expansion as in the case above, which is due to the fact that the cut in government expenditure leads due to the income effect to a smaller rise in the equilibrium labour supply, see Eq. (14) above. However, we can conclude that the structural reforms as such lead to a deficit in the government budget, but the elimination of which does not offset the positive impacts of the reform policies.

Let us next consider the case of a structural reform, when the euro area faces the zero lower bound of the interest rate. We assume that the euro area is hit by a demand contraction of 5 %-points in the first year, and that the contraction is reduced over time by obeying an autoregressive process with a coefficient of 0.5. The recession then lasts for 5-6 years. This means that we have to first modify the baseline without a reform to match the situation where the ZLB binds. The baseline indicates that the interest rate turns negative in the years 1 and 2, -1.6 and -0.1 %-points, respectively. As specified above in Eq. (29), this leads to a situation where the interest rate is for the two years fixed to 0.1% and then returns in two years back to the normal Taylor rule.

Table 3. The impact of the reduction of the mark ups by 1 percentage point in country 1, under the ZLB in the financial markets, percentage point deviations from the baseline, for details see the text

Variable	Year 1	Year 2	Long run
Output in country 1	2.37	2.20	1.90
Output in country 2	-1.11	-0.83	-0.21
Inflation in country 1	-1.05	-0.35	-0.15
Inflation in country 2	-0.31	-0.19	-0.15
Interest rate	0.0	0.0	-0.15
Gov. deficit in c. 1	1.75	1.82	1.93
Unemployment rate 1	-1.51	-1.45	-1.31

By comparing the Tables 1 and 3, we see that the ZLB cuts some of the positive results of the structural reforms, but, however, the gains still remain clearly positive in our set up. It is to be noted that the ZLB increases the negative spillover from the reforming country to the neighbouring non-reforming country. In the long run, as expected, a temporary ZLB does not produce any difference. It is, of course, true that the real interest rate is higher under the ZLB and that its effects depend on the magnitude of the intertemporal elasticity of substitution, the parameter σ in the consumption equation and the impact of competitiveness in Eq. (11).[6] We made some experimentation with respect σ by using the value two for it, as in Eggertsson, Ferrero and Raffo (2014). However, the outcome was only a somewhat lower impact of reform policy in the short run on GDP which was around 0.5 %-points compared to those in Table 3, for both countries.

Let us still consider the coordination of reforms so that the same reform is carried out in two similar euro area partners. Both of them reduce the mark ups in their goods and labour markets using the same kind of measures in the tax policies. We get the following results, see Table 4.

Table 4. The impact of the reduction of the mark ups by 1 percentage points in countries 1 and 2, under normal conditions in the financial markets, percentage point deviations from the baseline, for details see the text

Variable	Year 1	Year 2	Long run
Output in c. 1 and 2	2.06	1.45	1.69
Inflation in c. 1 and 2	-1.34	-0.21	-0.29
Interest rate	-1.43	-0.01	-0.30
Gov. deficit in c. 1 and 2, in rel. to GDP	1.85	1.95	1.96
Unemployment rate in c. 1 and 2	-1.45	-1.30	-1.28

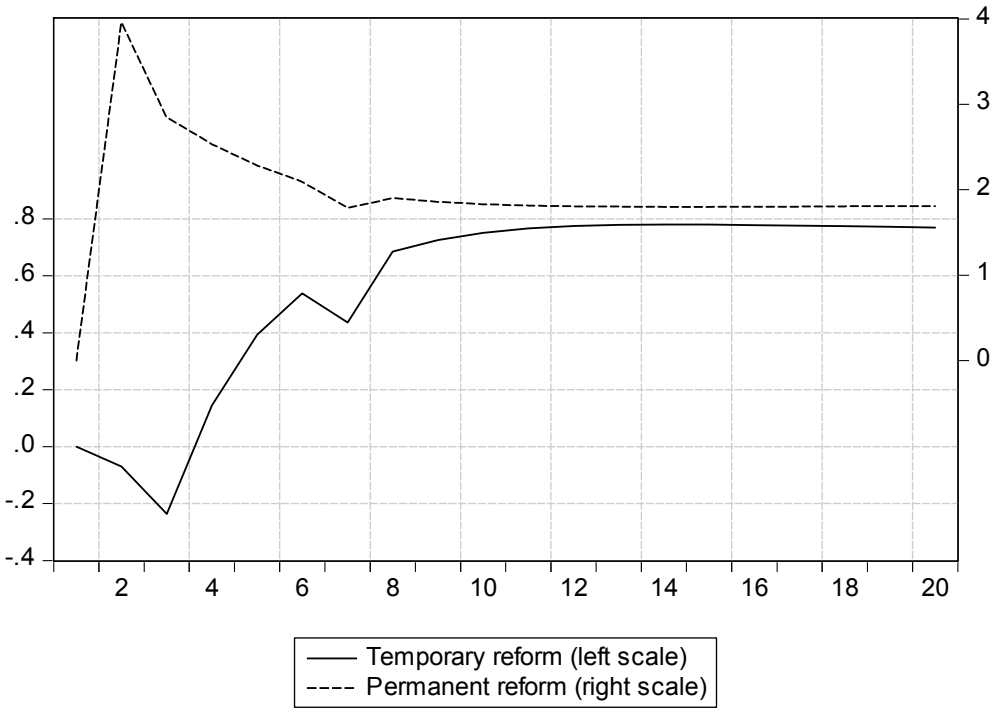
From this we see that now, in contrast to the results above, both countries gain, but the reforming country less under coordination than under isolation. We conclude that a coordination of the reforms is called for in the EU. Again, the reform through tax policy measures leads to a marked accumulation in the public debt over time. If we eliminate this similarly as above, the gain in GDP is reduced to 1.5 %-points in period 1 and converges then to 0.8 %-points.

Let us still add a consideration concerning whether the reforms are permanent or temporary. This can have a major impact on the outcome of policies, as we now demonstrate. Imagine that in country 1 a reform is put into effect for 5 years (years 2-6), and after that the continuation of the reform is uncertain, with a probability of 0.5. The other country 2 commits to a permanent reform. In Figure 1 we see that the country with a temporary reform gains much less than its partner. The latter also gets a boost in the beginning based on its enhanced competitiveness. We could still further note that a temporary reform with no continuation put into action is deflationary in the

[6] Again, the reform leads to quite a marked increase in public debt, similarly as in Table 1. If we eliminate this by cutting the public expenditure (by 1.9 %-points in relation to GDP), the positive impact of reform is still positive, in country 1 roughly 0.8 %-points in GDP.

country concerned, also in the short run. Therefore, the commitment to a reform is quite a crucial issue in practice in policy making.

Figure 1. The temporary and permanent reform in the euro area, GDP in relation to steady state, per cent, for details see the text above



5. Productivity enhancing measure

Let us then consider a policy which enhances productivity through a more competitive goods market. As analysed by Wyerstarss and Jaenicke (2007) a reduction of the mark up factor $1+\Delta_Q$ in the EU by 10 per cent to the level of the US will raise the EU total factor productivity by 0.57 per cent. Let us assume that this reduction takes place in three years so that the initial $\Delta_Q = 0.2$ is driven down to the level of 0.08, without, however, being able to identify explicitly the measure leading to this outcome. Now we get the following results, see Table 5.

Table 5. The impact of a reduction of the mark up in the goods market in a single euro area country enhancing productivity in three years under normal conditions in the financial markets, percentage point deviations from the baseline, for details see the text

Variable	Year 1	Year 2	Long run
Output in country 1	2.06	2.12	3.24
Output in country 2	0.31	0.62	-0.13
Inflation in country 1	0.24	0.29	-0.13
Inflation in country 2	0.06	0.07	-0.13
Interest rate	0.56	0.07	-0.14
Gov. deficit in c. 1	-0.14	-0.91	-2.76
Unemployment rate 1	-0.20	-1.34	-4.07

We see that now in contrast to the above measures, the government budget turns into a surplus. There is a marked reduction in the debt ratio over time, by more than 20 %-points in a ten years' time. As a deviation to the above case in Table 1, also the measure of reducing the mark up in the goods market so that it is initially above the steady state level, is inflationary. This is due to the fact that lowering of the mark up in the goods market raises the equilibrium producer wage (see Eq. (15)). But, of course, the increase in productivity is deflationary as such in Eq. (21). The problem with this kind of analysis is that it does not specify the specific policy measures which lead to such an outcome, in contrast to what was analysed above in Section 4.

6. Optimal reform policy and stabilization efforts

Let us then as a final item turn to consider the case where the structural reform is selected endogenously as based on both long-run benefits and harms and on short-run gains and losses, and where the ECB carries out the short-run stabilization within the euro area. So, we now maximise the target function of a national government in Eq. (28) and that by the ECB in Eq. (26) under the constraints imposed by the NKM model. We assume similarly as Teranishi (2015) that the ECB can credibly commit to a policy rule.

We now consider a structural reform which expands the supply side of the economy without explicitly specifying the chain from it to the reform parameters e.g. in the field of taxation. Let us first consider the country i in isolation and omit consideration of the spillovers within the euro area in connection with the policy in country i. Let us specify the Lagrangian function with μ_{1t} and μ_{2t} being the Lagrangian constraints (from the ECB's point of view) related to the IS curve and the inflation equation (now π^d), respectively. Maximisation with respect to $\log Y^P$, the output gap and the inflation rate gives now the following optimality conditions,

$$(Y_{it}^{P})^{1-\sigma} - (Y_{it}^{P})^{1+\eta} - e_i(Y_{it}^{p} - 1)Y_{it}^{p} + \lambda_i gap_{it} - \mu_{1t} + \mu_{1,t-1}\beta^{-1} + \mu_{2t}\theta = 0 \ , \tag{30}$$

$$-\xi_2 s_i gap_{it} + \mu_{1t} - \mu_{1,t-1}\beta^{-1} - \mu_{2t}\theta = 0 \text{ and} \tag{31}$$

$$-\xi_1 s_i(\pi_{it} - \pi^*) - \sigma^{-1}\beta^{-1}\mu_{1,t-1} - (\omega_c + \omega_M)\delta\beta^{-1}\mu_{1,t-1} + \mu_{2t} - \mu_{2,t-1} = 0 \ . \tag{32}$$

In (31) and (32) s_i is the share of the country i in the preferences of the ECB (in our case $s_i = 0.5$). Initially, the economy is in a steady state and thereby we can fix $\mu_{1,0} = \mu_{2,0} = 0$ similarly as in Teranishi (2015).

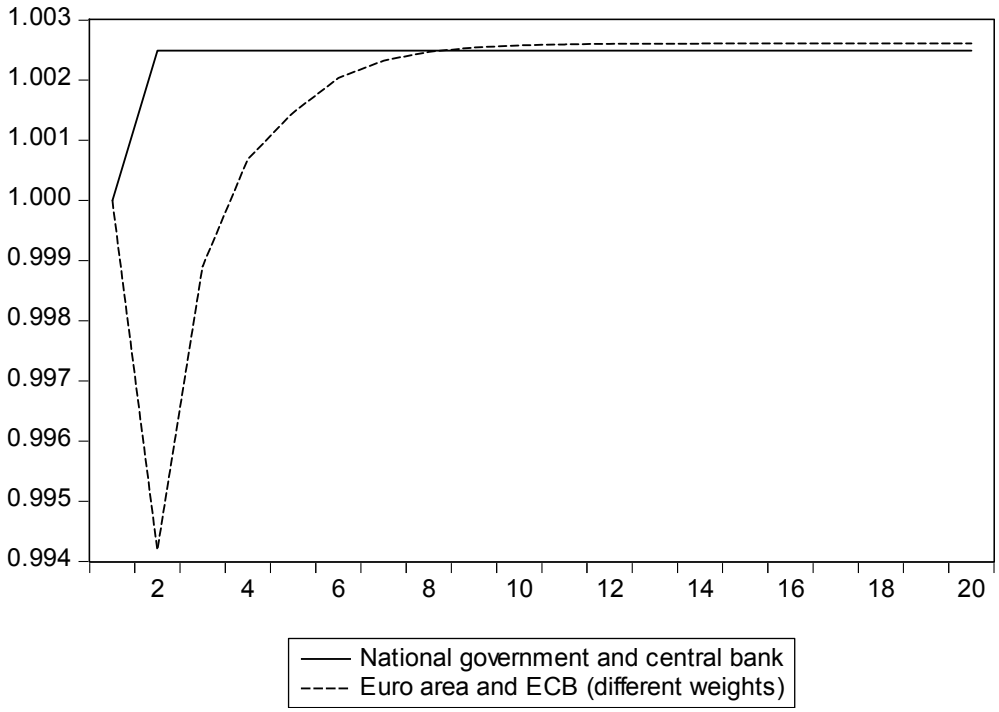
By inserting (31) into (30), we can infer that the optimal structural policy is independent of the cycle in this specification if the country concerned has a national central bank which sets identical weights on the output stabilisation as the government ($s_i = 1$ and parameters $\lambda_i = \xi_2$). These optimal policies, i.e., the long-run structural policies and the short-run cyclical stabilisation can then be solved separately from each other. However, in EMU this result does not hold as the ECB only takes care of output stabilisation in the whole union ($s_i < 1$). On the other hand, the crucial aspect in the long run is whether the euro area countries and the ECB have identical long-run targets for output and inflation, as shown by Dixit and Lambertini (2003). Then the ECB and the national fiscal authorities can reach the first best outcome, i.e. the natural rates of output and the inflation target by the ECB. This holds irrespective of the fact that they may set different relative weights on the targets. This situation does not prevent this equilibrium outcome from being realised. But we show here numerically that this separation does not hold in the short to medium run.

Dixit and Lambertini (2003) also show that this result holds irrespective of the game theoretic set up between the monetary policy of the ECB and national fiscal policy makers, i.e. irrespective of credibility aspects and commitment, and the order of move in behaviour. In our set up it also holds under the ZLB.

Let us accordingly consider a reform when there is an outside or internal pressure to carry out a reform in the sense that there is a reduction in the social marginal disutility of work. Let this negative shock be 1%, added to the right-hand side of Eq. (30). By stipulating various costs for the structural reform n in the target (28), we come in numerical solutions to the conclusion that the magnitude of this cost only very little affects the optimal choice of a structural reform, i.e. Y^P.

Let us then take the possibility that the policy goal weights on output stabilization of the national policy maker and the ECB differ in Eqs. (30) and (31). To illustrate, let the weight of λ be 0.75 for the national policy maker and ξ_2 0.5 for the ECB. Let the interest rate be fixed in ZLB in the same way as above in a recession facing the euro area. Now we come to the following solution for the structural reform under an aggregate demand contraction.

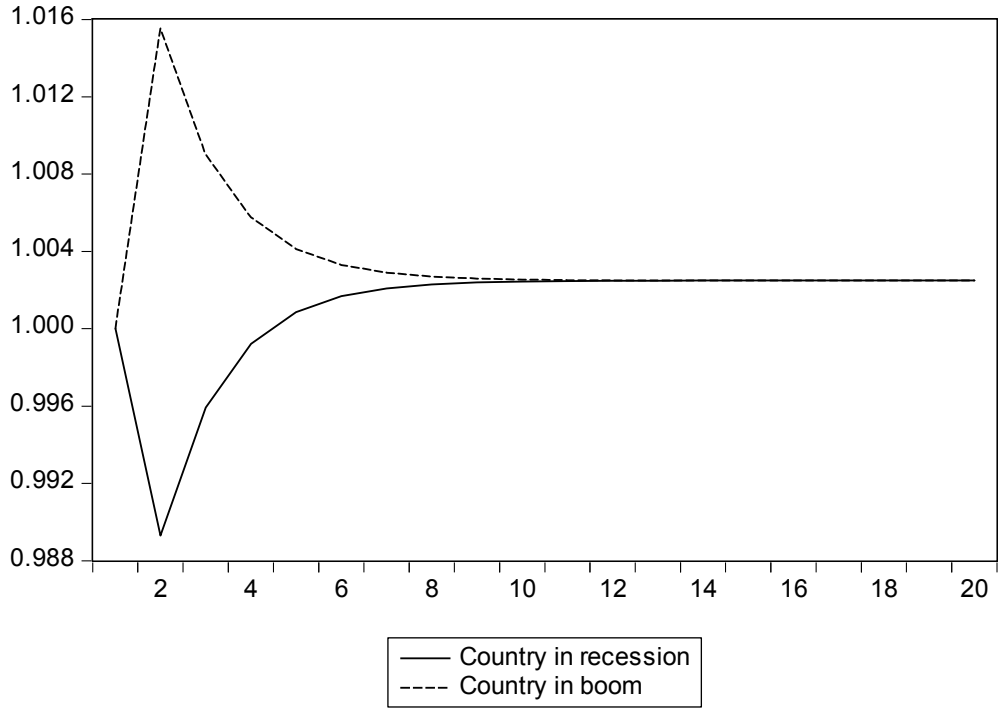
Fig. 2. The optimal reform policy under similar and different weights on output stabilisation by the national policy maker and the ECB, the potential output in relation to the steady state, for details see the text



We see that over the medium run during the recession the country concerned carries out a smaller reform policy and is even willing to make a reverse in it in the short run, in order to reduce the output gap in the short run. If the reverse holds, the reform activity overshoots the long run optimum and converges to it from above (see below). With identical weights the separation holds even in the short run, but not in EMU (see above).

Let us then consider an asymmetric two-country case where one of the euro area countries is in a recession and the other is in a boom. Both countries face a similar preference shock with respect to structural reforms as above. Now we get the following outcome as to the structural reforms to be selected.

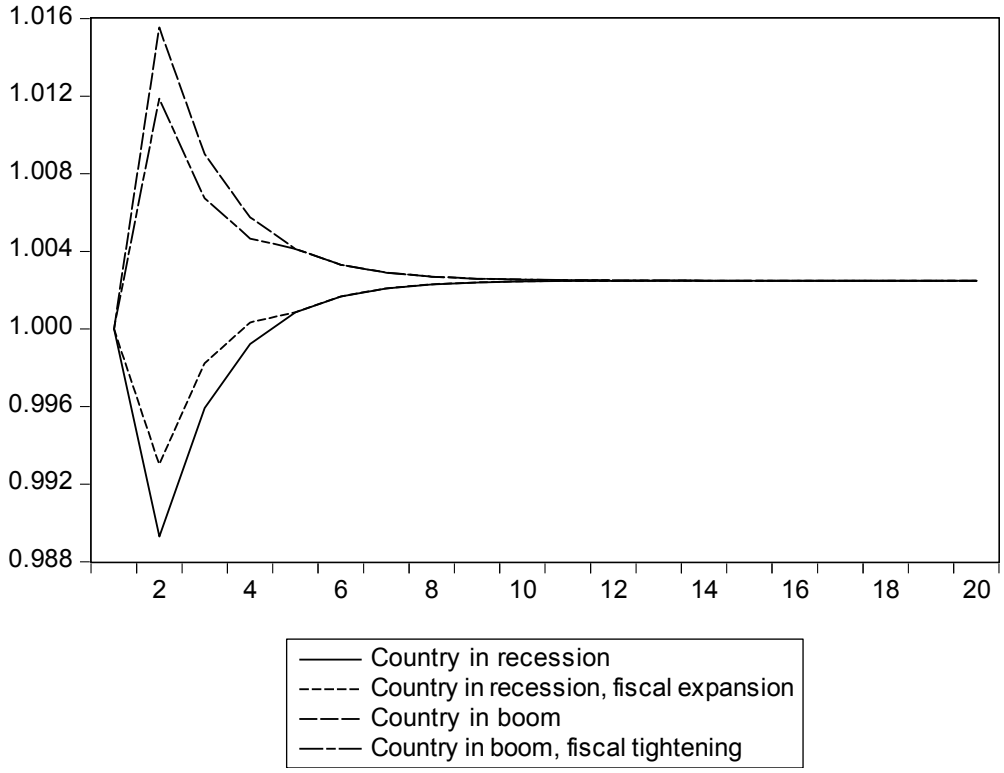
Fig. 3. The optimal reform policies in the euro area under different weights by the national policy maker and the ECB, the potential output in relation to the steady state in the euro area, for details see the text



We see that the result by Dixit and Lambertini (2003) takes almost ten years before it is reached. It is somewhat of a puzzle for policy-making in practice that in a boom the willingness to carry out a structural reform is higher than in a recession in the short to medium run.

Let us still add a consideration of fiscal policy to this analysis. We can find that an expansionary fiscal policy: i.e., a temporary increase in public expenditure and gradual elimination of g in Eq. (11) will make the undesired reaction in the structural reform smaller. To illustrate, we assume that the fiscal expansion lasts for three years so that the g-variable in Eq. (11) is 3% in year 2, 2% in year 3, and 1% in in year 4 of GDP more than in the steady state, and the difference vanishes thereafter. In the boom country there is a fiscal tightening of the same magnitude. Now the reduction of the potential output below the initial steady state in a recession will be smaller and possibly avoided altogether in such a case, see Fig. 4. Thus, national fiscal policy can act as a substitute for the lacking national monetary policy in EMU. From the figure we, however, see that the change in the stance of fiscal policies should be quite sizeable in order to have a major impact on the reform policies to be selected.

Fig. 4. The optimal reform policies in the euro area under different weights by the national policy maker and the ECB, combined with different fiscal positions, the potential output in relation to the steady state in the euro area, for details see the text



6. Concluding remarks

We have here considered the analysis of structural reforms in the euro area. The methodology was to consider both an exogenous reform making the euro area more competitive and an endogenous reform based on long-run and short-run considerations. Especially, we were interested in the effects of reform activity under the zero lower bound of interest rates prevailing currently in the EU. We could infer that the structural reform is expansionary as to output even in the short run, and that the ZLB eliminates some of the gain, but not all of it. In this sense our results are more in line with the positive view of Vogel (2014) than the negative one by Eggertsson, Ferrero and Raffo (2014). However, the gains from structural reforms are here much bigger than those by Vogel (2014), and we should make some experimentation with additional features of the model. The immediate reaction of output to the rise of aggregate demand raises some questions as to it not being very realistic. We could modify this by assuming that the rise in production to match demand takes place under adjustment costs which would slow down the actual rise in production. We leave also this point to further study.

We could infer several interesting results with respect to reform policies and their coordination in the euro area, complementing those, and to some being different from those in the recent literature, as reached by Eggertsson, Ferrero and Raffo (2014). However, we should carry out some more experimentation with respect to the sensitivity analysis concerning some of the key parameters of the model. The feature of the reform policy to lower the indirect tax rate may cause some question as it is normally recommended by the international organisations like the OECD and the EU

Commission that the reduction of more harmful tax components like labour and company taxation should be compensated with raising the VAT rate. Here, as elsewhere in the recent literature, this policy option is only considered as a component of the price wedge and a means to reach a situation which is nearer the first best situation.

The analysis of endogenous selection of structural reforms was considered in connection with the stabilisation policy by the ECB. We could infer that the delegation of stabilisation to it holds in the long run but not in the short to medium run, complementing thereby the analysis of Dixit and Lambertini (2003) establishing a long-run separation of monetary and fiscal policies if the policy makers just agree on the long-run targets of output and inflation.

Appendix. Calibration of the labour market equilibrium

The equilibrium in the labour market is based on the following wage setting derived in a slightly more general Nash bargaining framework than above between the union and employer firm[7], where the wage W depends on both rent sharing (of productivity) and the outside option b, see Alho (2015),

$$W = A(P^d Q / L) + Bb,\ A, B > 0\,. \tag{33}$$

Here $\log(A) \approx -(1-t_W)\dfrac{W}{(np)b} < 0$ and B = 1 in our case. This applies to each union (see Eq. (16) above), and assume that the unions are of equal size. Then (33) applies to the aggregate economy as well. From this we can derive the approximative logarithmic representation, by adding to it a factor which captures the handicap created by unemployment in the outside option,

$$w = prod + (1-t_W)\left[\frac{w}{(np)prod} - \frac{w}{(np)b}\right] + \frac{b}{prod} - \phi u\ . \tag{34}$$

From this equation (34) and the price setting equation above in (15), analogously as above in Section 2, we can derive the equilibrium in the labour market,

$$\phi u_e = -\log(\alpha) + \frac{1-t_W}{np}\left[\alpha(1-\Delta_Q) - \frac{W}{b}\right] + (1+t_W)\alpha(1-\Delta_Q)\frac{b}{W} + \Delta_Q\ . \tag{35}$$

Once we fix the coefficient ϕ of unemployment (here to a value of 3), we can from this calibrate the negotiation power np starting from the initial equilibrium level of unemployment, which we fix to be 8% in the EU case. The calibration produces the value of np = 1.4. The next step is then to solve numerically from this the reaction of the unemployment rate with respect to the tax rates and np incorporated in the ψ-function above.

[7] The framework is a special case with a Cobb-Douglas production function and no indirect labour taxes.

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