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Structural reforms at the zero bound

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Abstract

The paper uses the a 2-sector multi-region (reforming euro-area region, rest of euro area, rest of world) of the QUEST macroeconomic model to analyse the impact of structural reforms on economic activity in a macroeconomic environment in which the zero bound on monetary policy rates is temporarily binding. The model simulations focus on structural policies with deflationary impact, namely reforms that increase competition and reduce mark-ups and labour costs in the economy. The simulations suggest that the short-term output response to reforms can indeed be negative. Such negative effects are, however, small and rather short-lived in the model incorporating a variety of transmission channels. Simulations that compare current and pre-announced future reforms do, furthermore, not support the idea that postponing structural reforms improves economic conditions at the zero bound. Judged by the impact on economic activity, pre-commitment to future reforms performs worse than frontloaded implementation.

JEL Classification: E20, E30, E60, F40.

Keywords: DSGE model, structural policies, zero bound, real interest rate, wealth effect, pre-commitment

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1. INTRODUCTION

Euro-Area (EA) Member States, particularly those most exposed to the euro area crisis, have undertaken structural reforms of significant scale in recent years to strengthen their economies' supply side, regain competitiveness vis-à-vis trading partners and improve the situation of public finances. The reforms have occurred in an economic environment characterised by depressed demand and by monetary policy rates close to the zero bound. Hence, the question how structural reforms affect economic activity in an environment in which the zero bound on monetary policy rates is binding, ruling out the standard monetary accommodation of supply-enhancing reforms. The answer to this question has significant implications for the design and sequencing of economic policy at the current juncture.

This paper uses the European Commission's quantitative macroeconomic model QUEST to analyse the impact of structural reforms on economic activity in a macroeconomic environment in which the zero bound on monetary policy rates is temporarily binding. The binding zero bound rules out standard monetary expansion to accommodate supply-side policies. The model simulations focus on structural policies with deflationary impact, namely reforms that increase competition and reduce mark-ups and production costs in the non-tradable sector of the economy.

Several recent academic contributions have portrayed structural reforms as contractionary at the zero bound and, hence, counter-productive at the current juncture. The QUEST results in this paper suggest that the short-term output effects of reforms can indeed be negative. Such negative effects are, however, small and rather short-lived in a model incorporating a larger number of transmission channels. Short-term effects clearly also depend on the specific reform measures.

The paper also addresses the question of whether postponing reforms to post-zero-bound periods would be beneficial from the perspective of economic activity in the short term. Some authors have argued that a credible commitment to future reforms could reach the benefits of reform without inflicting short-term costs in terms of economic activity. The argument that credible commitment to future reform can raise economic activity even in the pre-reform short term rests on the positive impact of anticipated positive wealth effects on private domestic demand. QUEST simulations that compare the effects of current reforms and pre-announced future reforms do, in the end, not support the idea that postponing structural reforms improves economic conditions at the zero bound.

2. THE CASE FOR STRUCTURAL REFORMS

Hit by the financial and debt crisis and the unravelling of intra-EA imbalances, several Member States have undertaken far-reaching structural reforms in recent years to strengthen their economies' supply side, regain competitiveness vis-à-vis trading partners, and improve the situation of public finances. The main rationale for structural reforms in product and factor markets is the expected output, income and employment gains in the medium and long term. Recent analysis using the European Commission's QUEST model (European Commission, 2013; Varga et al., 2013) illustrates the significant medium- and long-term efficiency and per-capita income gains that can be expected from product market reforms and labour-market-related education and tax reforms. Similar results have been obtained with other macroeconomic models. Examples include Lusinyan and Muir (2012) for analysis with the IMF GIMF model and Gomes et al. (2013) for analysis with the ECB's EAGLE model. Empirical studies such as Bouis and Duval (2011) also show positive long-term effects from structural reforms.

In addition to positive medium- and long-term effects, structural reforms also influence economic dynamics in the shorter term. Theory and econometric evidence suggest that some structural policies strengthen macroeconomic resilience by reducing the persistence of cyclical fluctuations and by lowering the cumulative output loss in the aftermath of contractionary shocks (Duval and Vogel, 2008). In the context of external rebalancing inside the EA, models of aggregate supply and demand suggest that the gain in trade competitiveness associated with supply-side reforms mitigates the decline in output associated with (necessary) domestic demand contraction (Vogel, 2012). Growth of the denominator in debt-to-GDP ratios should also improve the sustainability of private and public debt and lower debt-elastic risk premia in financing costs.

3. THE IMPORTANCE OF THE ZERO BOUND

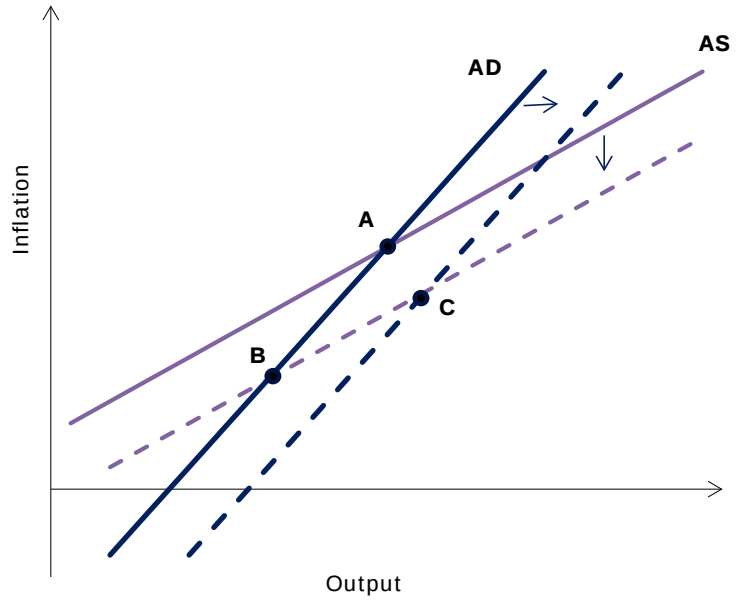
The short-term effects of structural reforms depend on the accompanying macro policies. The impact of reforms that increase the economy's potential output is more favourable when monetary or fiscal policy is available to stimulate aggregate demand. Stimulating demand in order to match the shift in the aggregate supply curve accelerates the transition to the new, higher level of potential output and counteracts the deflationary impact of the supply expansion. When nominal policy rates are at, or close to, the zero bound, monetary policy lacks the traditional instruments to accommodate the supply expansion, however.

Against this background, recent contributions to academic and policy debates have questioned the benefits of structural reforms in an environment of depressed demand. While the positive impact of reforms on long-term activity and debt sustainability remains undisputed, concern is with their short-term effects at the current juncture. In particular, the influential paper by Eggertsson et al. (2014) argues that structural reforms become counter-productive, namely contractionary, in the short- to medium-term if monetary policy is constrained at the zero lower bound (ZLB) and, hence, unable to accommodate supply expansion by the standard means of lowering policy rates.

The concern that structural policies may be contractionary at the ZLB derives from the reform-related increase in the real interest rate. Structural reforms that enhance aggregate supply in the economy put downward pressure on prices. This decline in the price level increases the real interest rate when nominal rates are stuck at zero. If the real rate increase dampens aggregate demand, economic activity will fall rather than increase.

Eggertsson et al. (2014) illustrate the effect in a modified diagram of aggregate supply (AS) and aggregate demand (AD), which is reproduced in Figure 1. The difference between the standard AS-AD diagram of "normal times" and Figure 1 for the ZLB is that the AD schedule is upward-sloping rather than downward-sloping in the latter. The upward-sloping AD schedule reflects the real interest rate effect of inflation at the ZLB. Lower inflation increases the real rate and dampens interest-sensitive demand, whereas higher inflation lowers the real rate and stimulates interest-sensitive demand. The economy’s equilibrium point is the intersection of AS and AD.

Figure 1: **Aggregate supply and demand at the zero bound**



Source: Eggertsson et al. (2014)

Product and labour market reforms that shift the level of potential output have two effects in the stylised diagram: First and foremost, the AS schedule shifts downwards as the upward pressure on costs and prices declines for any level of output. Second, the AD schedule to the right, because expected increases in wealth and invest-

ment profitability strengthen consumption and investment demand for given levels of current inflation and real interest rates.

It is the first effect, i.e. the standard AS shift, which is contractionary in the ZLB environment. It raises real interest rates and, hence, weakens interest-sensitive aggregate demand. In Figure 1 it moves the economy to point B. The second effect, i.e. the shift of the modified AD curve, is inflationary. In Figure 1, in conjunction with the AS shift, it moves the economy to point C. The relative strength of the two effects is ultimately a quantitative question. Depending on the relative strength, reforms may be either contractionary or expansionary in the short term at the ZLB. In the words of Eggertsson et al. (2014: 10): "the question of which effect dominates is ultimately quantitative."

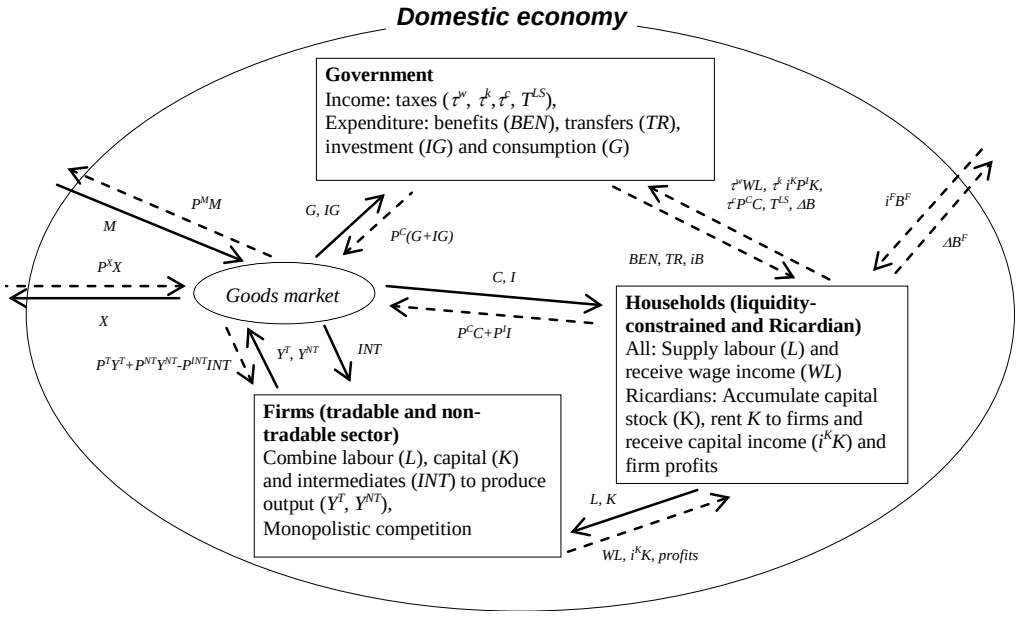
Policy simulations with structural macroeconomic models are a tool to provide a quantitative answer to this question. The structural macroeconomic models also illustrate the transmission channels, their determinants and their individual importance. Eggertsson et al. (2014) use a small-scale dynamic general equilibrium model to substantiate their argument that reforms may be counterproductive at the ZLB. In particular, they look at price and wage mark-up reduction in the non-tradable (service) sector in a macroeconomic environment with depressed aggregate demand and binding ZLB. The model implies downward price adjustment in response to the reform that leads to a significant increase in the real interest rate and amplifies the recession. Hence, they conclude that structural reforms of this kind may do more harm than help at the current juncture.

The following parts of the present paper replicate the policy experiment of Eggertsson et al. (2014) in QUEST and review theirs conclusions on the basis of QUEST's richer model structure. As starting point the next section describes the structure of the QUEST version used for this analysis.

4. MODEL DESCRIPTION

The analysis in this paper uses the QUEST III model (Ratto et al., 2009). QUEST III is a quarterly macroeconomic model and a member of the class of New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models. The model has rigorous microeconomic foundations derived from utility and profit maximization and includes frictions in goods, labour and financial markets.

Figure 2: **Basic structure of QUEST III regions with tradable and nontradable sectors**



The model version used here is a multi-region open-economy setup with two production sectors that, respective-

ly, produce tradable (T) and nontradable (NT) goods. There are two types of households: liquidity-constrained households (l), and intertemporally optimising Ricardian households (r). All households consume and supply labour. In addition, Ricardian households invest into domestic productive capital, domestic government bonds and a foreign bond, own the firms, and obtain the firms' profits. There is no cross-border mobility of labour. The government levies taxes and spends its revenue on consumption, public investment, social benefits, transfers, and debt service.

The paper uses a 3-region setup with a reforming region inside the EA, the rest of the EA (REA), and the rest of the world (RoW). The two regions in the EA share a common monetary policy and a common nominal exchange rate vis-à-vis the RoW. Figure 2 sketches the basic structure of the respective regional blocks.

4.1. PRODUCTION

Each region is home to firms j operating in the T and NT sectors. Individual firms in T and NT are indexed by the superscript j=(t, nt). Each firm produces a variety of the T or NT good that is an imperfect substitute for varieties produced by other firms. Sectoral output O_t^J with J=(T, NT) is a CES aggregate of the varieties O_t^j:

$$(1) \qquad O_t^J \equiv \left[\int_0^1 (O_t^j)^{(\sigma_j - 1)/\sigma_j} \, dj \right]^{\sigma_j/(\sigma_j - 1)}$$

where σ_j is the elasticity of substitution between varieties j in sector J. The elasticity value can differ between T and NT, implying sector-specific price mark-ups. Given the imperfect substitutability, firms are monopolistically competitive in the goods market and face a demand function for their output:

$$(2) \qquad O_t^j = (P_t^j / P_t^J)^{-\sigma_j} O_t^J$$

The firms in sector T sell consumption and investment goods and intermediate inputs to domestic and foreign private households and firms and consumption and investment goods to domestic and foreign governments. The NT sector sells consumption goods to domestic households, consumption and investment goods to the domestic government, and intermediate inputs to domestic firms. Hence, all private investment in physical capital consists of T goods.

Output is produced with a CES technology that combines value-added (Y_t^j) and intermediate inputs (INT_t^j). It nests a Cobb-Douglas technology with capital (K_t^j), production workers ($L_t^j - LO_t^j$) and public infrastructure (KG_t) for the production of Y_t^j:

$$(3) \qquad O_t^j = [(1 - \sin^j)^{1/\sigma_{in}} (Y_t^j)^{(\sigma_{in}-1)/\sigma_{in}} + (\sin^j)^{1/\sigma_{in}} (INT_t^j)^{(\sigma_{in}-1)/\sigma_{in}}]^{\sigma_{in}/(\sigma_{in}-1)}$$

$$(4) \qquad Y_t^j = A_t^j (ucap_t^j K_t^j)^{1-\alpha} (L_t^j - LO_t^j)^{\alpha} KG_t^{\alpha_g} - FCY_t^j$$

where $\sin^j$ and σ_{in} are, respectively, the steady-state share of intermediates in output and the elasticity of substitution between intermediates and value-added, and A_t^j, $ucap_t^j$, LO_t^j and FCY_t^j are total factor productivity (TFP), capacity utilisation, overhead labour and fixed costs of producing.[1]

Firm-level employment L_t^j is a CES aggregate of the labour services supplied by individual households i:

[1] Lower case letters denote ratios and rates. In particular, $p_t^j \equiv P_t^j / P_t$ is the price of good *j* relative to the GDP deflator, $w_t \equiv W_t / P_t$ is the real wage, $ucap_t^j$ is actual relative to steady-state (full) capital utilisation, and e_t is the nominal exchange rate defined as the price of foreign in domestic currency.

(5) $$L_t^j \equiv \left[\int_0^1 L_t^{i,j(\theta-1)/\theta} di \right]^{\theta/(\theta-1)}$$

where θ indicates the degree of substitutability between the different types of labour i.

The objective of the firm is to maximise real profits (Pr_t^j):

(6) $$\mathrm{Pr}_t^j = p_t^j O_t^j - p_t^{INT,j} INT_t^j - (1+ssc_t^J) w_t L_t^j - p_t^I I_t^j - (adj_t^{P,j} + adj_t^{L,j} + adj_t^{ucap,j})$$

where ssc_t^J , w_t , i_t^J and p_t^I are the employer social security contributions, the real wage, the rental rate of capital, and the price of capital. The firms are owned by the intertemporally optimising households that receive the firms' profits.

The firms face technology and regulatory constraints that restrict their capacity to adjust. These constraints are modelled as adjustment costs with the following convex functional forms:

(7a) $$adj_t^{L,j} \equiv \gamma_L w_t (\Delta L_t^j)^2 / 2$$

(7b) $$adj_t^{P,j} \equiv \gamma_P (\pi_t^j)^2 Y_t^j / 2 \text{ with } \pi_t^j \equiv P_t^j / P_{t-1}^j - 1$$

(7c) $$adj_t^{ucap,j} \equiv p_t^I K_t^j [\gamma_{ucap,1} (ucap_t^j - 1) + \gamma_{ucap,2} (ucap_t^j - 1)^2] / 2$$

The firms choose labour input, capital services, capacity utilisation, the price of output j, and the volume of output j given the demand function (2), the production technology (3) and (4), and the adjustment costs (7). The first-order conditions (FOC) are:

(8a) $$\frac{\partial \mathrm{Pr}_t^j}{\partial L_t^j} => \frac{\partial O_t^j}{\partial L_t^j} \eta_t^j - \gamma_L w_t \Delta L_t^j + \gamma_L \beta E_t (\lambda_{t+1}^r / \lambda_t^r \; w_{t+1} \Delta L_{t+1}^j) = (1+ssc_t^J) w_t$$

(8b) $$\frac{\partial \mathrm{Pr}_t^j}{\partial K_t^j} => \frac{\partial O_t^j}{\partial K_t^j} \eta_t^j = i_t^J \, p_t^I$$

(8c) $$\frac{\partial \mathrm{Pr}_t^j}{\partial ucap_t^j} => \frac{\partial O_t^j}{\partial ucap_t^j} \eta_t^j = p_t^I K_t^j [\gamma_{ucap,1} + \gamma_{ucap,2} (ucap_t^j - 1)]$$

(8d) $$\frac{\partial \mathrm{Pr}_t^j}{\partial O_t^j} => \eta_t^j = 1 - 1/\sigma^j - \varepsilon_t^J - \gamma_P \left[\beta E_t (\lambda_{t+1}^r / \lambda_t^r \; \pi_{t+1}^j) - \pi_t^j \right]$$

where η_t^j is the Lagrange multiplier associated with the production technology, λ_t^r the marginal value of wealth in consumption terms as defined by equation (13) below, and ε_t^J is a sector-specific shock to the price mark-up.

Equation (8a) implies that optimising firms equate the marginal product of labour net of adjustment costs to wage costs. Social security contributions (ssc_t^J) affects labour costs for employers and, hence, labour demand. Temporary (permanent) shocks to ssc_t^J have temporary (permanent) effects on labour demand. The model in-

cludes employment adjustment frictions, but no hysteresis effects following which temporary shocks to employment would affect employment levels in the long run.

Equations (8b-c) jointly determine the optimal capital stock and capacity utilisation by equating the marginal value product of capital to the rental price and the marginal product of capital services to the marginal cost of increasing capacity. Equation (8d) defines the price mark-up factor as function of the elasticity of substitution and price adjustment costs. QUEST follows the empirical literature and allows for backward-looking elements in price setting by assuming that the fraction *1-sfp* of firms indexes prices to past inflation, which leads to the specification:

$$(8d') \qquad \eta_t^j = 1 - 1/\sigma^j - \varepsilon_t^J - \gamma_P \left[\beta E_t(\lambda_{t+1}^r / \lambda_t^r)(sfpE_t\pi_{t+1}^j + (1-sfp)\pi_{t-1}^j) - \pi_t^j \right] \text{ with } 0 \le sfp \le 1$$

for the inverse of the price mark-ups in the T and NT sectors. Given the symmetry of objectives and constraints across firms j in sector J, the superscript j for individual firms can be dropped to obtain aggregate sectoral equations for T and NT. The price setting decision establishes a link between output and prices in the economy. For constant technology, factor demand and/or capacity utilisation increase (decline) with increasing (declining) demand for output, which leads to an increase (decline) in factor and production costs and, hence, an increase (decline) in the price level of domestic output.

4.2. HOUSEHOLDS

The household sector consists of a continuum of households $i \in [0,1]$. There are $0 \le s^l \le 1$ households that are liquidity constrained and indexed by the superscript l. These households do not invest or trade on asset markets and consume their disposable income at each period in time. The fraction $1 - s^l$ of households is Ricardian and indexed by the superscript r. The period utility function is identical for each household type. It is separable in consumption (C_t^i) and leisure ($1 - L_t^i$), allows for habit persistence in consumption (h) and is given by:

$$(9) \qquad U(C_t^i, 1 - L_t^i) = \ln(C_t^i - hC_{t-1}) + \omega / (1-\kappa)(1 - L_t^i)^{1-\kappa}$$

where ω is the weight of the utility of leisure in total period utility, and κ is the inverse of the elasticity of labour supply.

Both types of households supply differentiated labour services to unions that maximise a joint utility function for each type of labour i. It is assumed that types of labour are distributed equally across both household types. Nominal wage rigidity is introduced through adjustment costs for changing wages. These adjustment costs are borne by the households.

4.2.1. Ricardian households

Ricardian households have full access to financial markets. They hold domestic government bonds (B_t^G), foreign bonds (B_t^F) and the real capital stock (K_t^j) of the T and NT sectors. Ricardian households receive labour income, returns on financial assets, rental income from lending capital to firms, and the profit income from firm ownership. Domestic firms are owned by domestic Ricardian households. Income from labour is taxed at rate t^w, corporate income at rate t^k and consumption at rate t^c. In addition, there is a lump-sum tax T^{LS}.

Income from financial assets is subject to different types of risk. Domestic bonds yield a risk-free nominal return of i_t, but returns on foreign bonds (i_t^F) are subject to a risk premium ($rprem_t$) linked to the country's net foreign indebtedness. An equity premium ($i_t^K - i_t$) on productive capital arises due to the uncertainty about the future value of the capital stock. The Lagrangian of the maximisation problem is:

$$Max \quad V_0^r = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t^r, 1 - L_t^r)$$

$$(10) \qquad -\mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^t \left(\begin{array}{l} (1+t_t^c) p_t^C C_t^r + \sum_J p_t^{I,J} I_t^J + \frac{B_t^G}{P_t} + e_t \frac{B_t^F}{P_t} - (1+i_{t-1}) \frac{B_{t-1}^G}{P_t} \\ -(1+i_{t-1}^F + rprem_t) e_t \frac{B_{t-1}^F}{P_t} - \sum_J ((1-t_t^k) i_{t-1}^{K,J} + t_t^k \delta^{k,J}) p_{t-1}^{I,J} K_{t-1}^J \\ -(1-t_t^W) w_t L_t^r + \frac{\gamma_W}{2} (\Delta W_t / W_{t-1})^2 L_t - \sum_J \mathrm{Pr}_t^J - \frac{T_t^{LS,r}}{P_t} \\ -\frac{BEN_t}{P_t} (1 - NPART_t - L_t^r) - \frac{TR_t^r}{P_t} + \sum_J adj_t^{K,J} + \sum_J adj_t^{I,J} + adj_t^W \end{array} \right)$$

$$-\mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^t \left(\sum_J \xi_t^j (K_t^J - J_t^J - (1-\delta^{K,J}) K_{t-1}^J) \right)$$

where the adjustment costs have the functional forms:

$$(11a) \qquad adj_t^{K,J} \equiv \gamma_{K,J} (I_t^J / K_{t-1}^J - \delta^J)^2 K_{t-1}^J / 2$$

$$(11b) \qquad adj_t^{I,J} \equiv \gamma_{I,J} (\Delta I_t^J)^2 / 2$$

$$(11c) \qquad adj_t^W \equiv \gamma_W (\pi_t^W)^2 L_t / 2$$

and where p_t^C and p_t^I are the consumption and investment price deflators relative to the GDP deflator.

The FOCs of the optimisation problem provide the intertemporal consumption rule, where the ratio of the marginal utility of consumption in periods t and t+1 is equated to the real interest rate adjusted for the rate of time preference:

$$(12) \qquad \beta E_t (\lambda_{t+1}^r / \lambda_t^r) = 1 / (1 + r_t)$$

$$(13) \qquad \lambda_t^r = 1 / [(1+t_t^c)\, p_t^c (C_t^r - h C_{t-1}^r)]$$

with the real interest rate $r_t = i_t - E_t \pi_{t+1}$, i.e. the nominal rate minus the expected per-cent change in GDP deflator.

The FOC for investment provides an investment rule linking capital formation to the shadow price of capital:

$$(14) \qquad \gamma_{K,J} \left(\frac{I_t^{K,J}}{K_{t-1}^J} - \delta^{K,J} \right) + \gamma_{I,J} \Delta I_t^J - \gamma_{I,J} \beta E_t \left(\frac{\lambda_{t+1}^r}{\lambda_t^r} \frac{p_{t+1}^{I,J}}{p_t^{I,J}} \Delta I_{t+1}^{K,j} \right) = q_t^J - 1$$

and q_t^J corresponds to the present discounted value of the rental income from physical capital:

$$(15) \qquad \begin{array}{l} q_t^J = (1 - \sin)(O_t^J / Y_t^J)^{1/\sigma_{in}} \eta_t^J P_t^J / P_t^I (1 - t_t^K)(1-\alpha)(Y_t^J - A_t^J FCY_t^J) / K_t^J \\ + t_t^k \delta^J - \gamma_{ucap1,J} (ucap_t - 1) - \gamma_{ucap2,J} (ucap_t - 1)^2 / 2 + (1 - i_t^J - \delta^J) \mathrm{E}_t q_{t+1}^J \end{array}$$

The FOC for investment in foreign bonds gives the UIP condition:

$$(16) \qquad i_t = i_t^F + (E_t \Delta e_{t+1}) / e_t + rprem_t$$

which determines the nominal exchange rate of the euro vis-à-vis the RoW. Inside the EA, the common currency corresponds to a fixed nominal exchange rate between EA members, so that risk premia lead to intra-EA interest differentials.

4.2.2. Liquidity-constrained households

Liquidity-constrained households do not optimise the intertemporal consumption path, but simply consume their entire disposable income at each date. Real consumption of household l is thus determined by the net wage and transfer income minus the lump-sum tax:

$$(17) \qquad (1+t_t^c) P_t^c C_t^l = (1-t_t^w) W_t L_t^l + TR_t^l + BEN_t (1 - NPART_t - L_t^l) - T_t^{LS,l}$$

The labour supply behaviour of liquidity-constrained households is determined by the utility function (9) which also applies to Ricardian households and is described next.

4.2.3. Wage setting

A trade union is maximising a joint utility function for each type of labour i. It is assumed that types of labour are distributed equally over Ricardian and liquidity-constrained households with their respective population weights. The trade union sets wages by maximising a weighted average of the utility functions of these households. The wage rule is obtained by equating a weighted average of the marginal utility of leisure to a weighted average of the marginal utility of consumption times the real consumption wage of both household types, adjusted for a wage mark-up ($1/\eta_t^W$):

$$(18) \qquad \frac{(1-s^l) U_{1-L,t}^r + s^l U_{1-L,t}^l}{(1-s^l) U_{c,t}^r + s^l U_{c,t}^l} = \frac{(1-t_t^W) W_t - BEN_t}{(1+t_t^C) P_t^C} \eta_t^W$$

Wage mark-ups fluctuate around $1/\theta$, which is the inverse of the elasticity of substitution between different varieties of labour services. Fluctuations arise from wage stickiness and shocks to the wage mark-up (ε_t^w). In the presence of wage stickiness, the fraction *1-sfw* of workers ($0 \le sfw \le 1$) indexes wage growth π_t^W to price inflation in the previous period:

$$(19) \qquad \eta_t^W = 1 - 1/\theta - \varepsilon_t^W - \beta\gamma_W / \theta E_t [\lambda_{t+1}^r / \lambda_t^r (\pi_{t+1}^W - (1-sfw)\pi_t) - (\pi_t^W - (1-sfw)\pi_{t-1})]$$

The (semi-)elasticity of wage inflation with respect to employment is given by κ / γ_W, i.e. it is positively related to the inverse of the elasticity of labour supply and inversely related to wage adjustment costs.

4.2.4. Aggregation

The aggregate value of any household-specific variable X_t^i in per-capita terms is given by $X_t \equiv \int_0^1 X_t^i di = (1-s^l) X_t^r + s^l X_t^l$ since the households within each group are identical with respect to their consumption and labour supply decisions. Hence, aggregate consumption is given by:

$$(20a) \qquad C_t = (1-s^l) C_t^r + s^l C_t^l$$

and aggregate employment by:

(20b) $L_t = (1-s^l)L_t^r + s^l L_t^l$ with $L_t^r = L_t^l$.

4.3. FISCAL AND MONETARY POLICY

Real government purchases (G_t) and investment (IG_t) are kept constant in real terms. The stock of public infrastructure that enters the production function (4) develops according to:

(21) $$KG_t = IG_t + (1-\delta^g)KG_{t-1}$$

Nominal transfers (TR_t) are indexed to consumer prices:

(22) $$TR_t = \overline{tr}P_t^C$$

The nominal benefits paid to the non-employed part of the labour force correspond to the exogenous replacement rate (*benr*) times the nominal wage:

(23) $$BEN_t = \overline{benr}W_t$$

The government receives consumption tax, labour tax, corporate tax and lump-sum tax revenue as well as social security contributions. Nominal government debt (B_t) evolves according to:

(24) $$\begin{aligned} B_t = {} & (1+i_{t-1})B_{t-1} + P_t^C(G_t + IG_t) + TR_t + BEN_t(1-NPART_t - L_t) - T_t^{LS} - t_t^c P_t^C C_t \\ & - \sum_J (t_t^w + ssc_t^J)W_t L_t^J - \sum_J t_t^k [P_t^J O_t^J - P_t^{INT,J} INT_t^J - (1+ssc_t^J)W_t L_t^J - \delta^J P_t^I K_{t-1}^J] \end{aligned}$$

The labour tax is used to stabilise the debt-to-GDP ratio:

(25) $$\Delta t_t^w = \tau^b (B_t / (4P_t Y_t) - \overline{btar}) + \tau^{def} \Delta(B_t / P_t)$$

with btar being the target level of government debt to GDP. The consumption tax and corporate income tax rates, the rate of social security contributions and the amount of lump-sum taxes are exogenous.

Monetary policy follows a Taylor rule that allows for a smoothing of the interest rate response to inflation and the output gap:

(26) $$i_t = \rho_i i_{t-1} + (1-\rho_i)\left(\bar{r} + \pi^{tar} + \tau_\pi(\pi_t^C - \pi^{tar}) + \tau_y ygap_t\right)$$

The central bank has an inflation target π^{tar}, adjusts its policy rate when actual CPI inflation deviates from the target and also responds to the output gap (*ygap*). Monetary policy in the EA focuses on EA averages of inflation and the output gap.

The output gap is not calculated as the difference between actual and efficient output, but derived from a production function framework, which is the standard practice of output gap calculation for fiscal surveillance and monetary policy. More precisely, the output gap is defined as deviation of factor utilisation from its long-run trend:

(27) $$ygap_t \equiv \alpha \ln(L_t / L_t^{ss}) + (1-\alpha)\ln(ucap_t / ucap_t^{ss})$$

The variables L_t^{ss} and $ucap_t^{ss}$ are moving averages of employment and capacity utilisation rates:

(28a) $L_t^{ss} = \rho^L L_{t-1}^{ss} + (1-\rho^L) L_t$

(28b) $ucap_t^{ss} = \rho^{ucap} ucap_{t-1}^{ss} + (1-\rho^{ucap}) ucap_t^j$

The moving averages are restricted to move slowly in response to actual values.

4.4. TRADE AND FINANCIAL LINKAGES

This sub-section describes the key relationships for the dynamics of the trade balance, the current account and the net foreign asset position in response to relative price and demand adjustment. Previous sub-sections have determined aggregate domestic consumption, investment and government expenditure, but not the allocation of demand between T versus NT output and domestically produced versus imported T goods.

In order to facilitate aggregation, private households and the government are assumed to have identical preferences across goods used for private and government consumption and public investment. Let $Z \in (C, G, IG)$ be the demand by private households and the government, and let their preferences for T and NT goods be given by the CES functions:

(29) $$Z_t = \left[(1-s_{tnt})^{1/\sigma_{tnt}} (Z_t^{NT})^{(\sigma_{tnt}-1)/\sigma_{tnt}} + s_{tnt}^{1/\sigma_{tnt}} (Z_t^{TT})^{(\sigma_{tnt}-1)/\sigma_{tnt}} \right]^{\sigma_{tnt}/(\sigma_{tnt}-1)}$$

where Z^{NT} is an index of demand across the NT varieties, and Z^{TT} is a bundle of domestically produced (Z^T) and imported (Z^M) T goods:

(30) $$Z_t^{TT} = \left[(1-s_m)^{1/\sigma_x} (Z_t^T)^{(\sigma_x-1)/\sigma_x} + s_m^{1/\sigma_x} (Z_t^M)^{(\sigma_x-1)/\sigma_x} \right]^{\sigma_x/(\sigma_x-1)}$$

The elasticity of substitution between the bundles of NT and T goods is σ_{tnt}. The elasticity of substitution between the bundles of domestically produced and imported T goods is σ_x. The steady-state shares of T goods in Z_t and of imports Z_t^{TT} are s_{tnt} and s_m, respectively. All investment in physical capital in the T and NT sectors consists of T goods.

The CES aggregate (29) combining T and NT goods gives the following demand functions:

(31a) $Z_t^T = s_{tnt} (P_t^T / P_t^C)^{-\sigma_{tnt}} (C_t + G_t + IG_t)$

(31b) $Z_t^{NT} = (1-s_{tnt}) (P_t^{NT} / P_t^C)^{-\sigma_{tnt}} (C_t + G_t + IG_t)$

The intermediate inputs in sector J=(T, NT) are also composites of T and NT analogously to equations (29) and (30) with T either domestically produced or imported:

(32) $$INT_t^J = \left[(1-\sin_{tnt}^J)^{1/\sigma_{tnt}} (INT_t^{NT,J})^{(\sigma_{tnt}-1)/\sigma_{tnt}} + (\sin_{tnt}^J)^{1/\sigma_{tnt}} (INT_t^{T,J})^{(\sigma_{tnt}-1)/\sigma_{tnt}} \right]^{\sigma_{tnt}/(\sigma_{tnt}-1)}$$

(33) $$INT_t^{TT,J} = \left[(1-s_m)^{1/\sigma_x} (INT_t^{T,J})^{(\sigma_x-1)/\sigma_x} + s_m^{1/\sigma_x} (INT_t^{M,J})^{(\sigma_x-1)/\sigma_x} \right]^{\sigma_x/(\sigma_x-1)}$$

This gives demand functions for T and NT intermediates analogously to (31):

(34a) $INT_t^{T,J} = \sin_{tnt}^J (P_t^T / P_t^{INT,J})^{-\sigma_{tnt}} INT_t^J$

(34b) $$INT_t^{NT,J} = (1-\sin_{tnt}^{J})(P_t^{NT} / P_t^{INT,J})^{-\sigma_{tnt}} INT_t^{J}$$

Combining the demand functions corresponding to (30) and (33) and allowing for sluggish volume responses to price changes (ρ_m) gives the import demand equation:

(35) $$M_t = \rho_m M_{t-1} + (1-\rho_m) s_m \left(\frac{e_t P_t^M}{P_t^T} \right)^{-\sigma_x} (Z_t^T + \sum_J I_t^j + \sum_J INT_t^{T,J})$$

Including inertia in the response of trade volumes to prices is able to generate a J-curve response of the trade balance to changes in the real exchange rate; in addition there is inertia in import prices (ρ_{pm}):

(36) $$P_t^M = \rho_{pm} P_{t-1}^M + (1-\rho_{pm}) \left[\sum_{f=1}^{F} \left(s_m^f \frac{e_t^f P_t^{T,f}}{P_t^X} \right)^{1-\sigma_f} \right]^{1/(1-\sigma_f)}$$

where s_m^f is the share of the country of origin f in domestic imports and $P_t^{T,f}$ the price of tradables set by producers in f.

Bilateral imports from the individual model regions (f), which are foreign regions from the perspective of the domestic economy, are given by:

(37) $$M_t^f = \rho_{m1} M_{t-1}^f + (1-\rho_{m1}) s^f \left(\frac{e_t^f P_t^{T,f}}{e_t P_t^M} \right)^{-\sigma_f} M_t$$

which allows for sluggish adjustment (ρ_{m1}) of the import basket to changes in the relative price.

The exports of the domestic economy equal the sum of bilateral imports of foreign regions from the domestic economy. The trade balance of the domestic economy is net trade in value terms:

(38) $$TB_t \equiv P_t^T X_t - e_t P_t^M M_t$$

Adding interest income on the net foreign asset (NFA) position gives the current account:

(39) $$CA_t \equiv i_{t-1}^* e_t B_{t-1}^* + P_t^T X_t - e_t P_t^M M_t$$

The law of motion for the NFA position is:

(40) $$e_t B_t^* = (1+i_{t-1}^*) e_t B_{t-1}^* + P_t^T X_t - e_t P_t^M M_t$$

The focus on the NFA position abstracts from valuation effects on the gross asset or liability side.

The model requires an external closure to rule out explosive NFA dynamics as illustrated by Schmitt-Grohé and Uribe (2003). The model uses a closure rule that relates the external risk premium in (16) to the NFA position of the domestic economy relative to the baseline (target) position bwy^T :

(41) $$rprem_t = -rprem(e_t B_t^F / (4 P_t Y_t) - bwy^T)$$

An increase (decline) in the NFA position of the domestic economy increases (reduces) the risk on foreign relative to domestic bonds. An increase in the relative risk of domestic assets in response to a fall in the domestic NFA position reduces domestic consumption and investment demand, which improves the trade balance and stabilises the NFA position.

4.5. PARAMETERISATION

The paper uses a 3-region version of QUEST with tradable (T) and non-tradable (NT) sectors. Within the euro area (EA) we distinguish between a reforming region and the rest of the EA (REA), and besides the EA there is a rest of the world (RoW). The region of reforming EA countries accounts for 30 % of EA GDP. The 30% share is purely illustrative, but corresponds approximately to the proportion of EA GDP accounted for by Greece, Italy, Portugal and Spain combined, i.e. by countries that have made particular efforts to reform in response to the EA crisis (e.g., Buti and Turrini, 2012). Eggertsson et al. (2014) show the impact of reforms on domestic economic activity at the ZLB to be largely independent of the reforming region's size.

The parameterisation of the model's long-term equilibrium is based on input-output tables, public finance statistics and the AMECO database and summarised in Table 1 for the reforming EA region. The parameter values governing the model dynamics in the short and medium term, e.g. substitution elasticity values, nominal and real adjustment costs, inertia in trade prices and volumes, the share of liquidity-constrained households, consumption habits, and policy response parameters, are based on the estimates by Ratto et al. (2009) and Kollmann et al. (2014).

Table 1: **Model parameters and ratios**

Name	Value	Name	Value
Frictions:		Elasticity of substitution between value added and intermediates (σ_{in})	0.50
Average price duration (quarters)	5	Fix costs of production (FCY) to GDP	0.17
Average wage duration (quarters)	3	Overhead labour (LO) to total employment	0.06
Import price stickiness (ρ_{pm})	0.90	Steady-state intermediate share T (sin^{T})	0.74
Labour adjustment cost (γ_L)	25.0	Steady-state intermediate share NT (sin^{NT})	0.44
Capital adjustment cost (γ_K)	20.0	Steady-state T intermediate share in T (sin_{tnt}^{T})	0.61
Investment adjustment cost (γ_I)	75.0	Steady-state T intermediate share in NT (sin_{tnt}^{NT})	0.43
Linear capacity-utilisation adjustment cost ($\gamma_{ucap,1}$)	0.04	Elasticity of substitution between types of labour (θ)	6.5
Quadratic capacity-utilisation adjustment cost ($\gamma_{ucap,2}$)	0.05	Depreciation rate T capital stock (δ^{T})	0.02
Share of forward-looking price setters (sfp)	0.90	Depreciation rate NT capital stock (δ^{NT})	0.01
Share of forward-looking wage setters (sfw)	0.90	Depreciation rate public capital stock (δ^{g})	0.01
Preferences:		Equity premium (i^{K}-i)	0.01
Share of LC households (s^{l})	0.40	Persistence of potential employment (ρ_L)	0.95
Discount factor (β)	0.997	Potential capacity utilisation persistence (ρ_{ucap})	0.99
Habit persistence (h)	0.70	Fiscal policy:	
Inverse of elasticity of labour supply (κ)	-5.00	Corporate profit tax (t^{k})	0.28
Utility weight of leisure (ω)	0.001	Consumption tax (t^{c})	0.17
Labour force to population (1-NPART)	0.71	Labour income tax (t^{w})	0.25
Steady-state employment to population (L)	0.66	Social security contributions (ssc)	0.15
Elasticity of substitution T varieties (σ_T)	8.3	Transfer share (try)	0.16
Elasticity of substitution NT varieties (σ_{NT})	5.0	Benefit replacement rate (benr)	0.40
Elasticity of substitution T-NT (σ_{tnt})	0.50	Baseline government debt to GDP (btar)	0.62
Elasticity of substitution in total trade (σ_x)	1.50	Parameter debt (τ^{b})	0.01
Elasticity of substitution between import sources (σ_f)	0.99	Parameter deficit (τ^{def})	0.10
Steady-state consumption share of T (s_{tnt})	0.41	Risk premium (risk)	0.0025
Steady-state consumption share of imports (s_m)	0.41	National accounts (share of GDP):	
Persistence in total import demand (ρ_m)	0.90	Private consumption	0.67
Persistence in bilateral import demand (ρ_{m1})	0.90	Investment	0.10
Production:		Government purchases	0.19
Cobb-Douglas labour parameter (α)	0.65	Government investment	0.04
Cobb-Douglas public capital stock parameter (α_g)	0.09	Imports	0.46

As reform scenario we replicate the Eggertsson et al. (2014) scenario of one percentage-point (pp) wage cost and price mark-up cuts in the NT sector for the reforming EA region. Because of cross-sectorial labour mobility and an economy-wide labour supply in the model, we implement labour costs reduction in the NT sector by a one percentage-point reduction in employer social security contributions in the NT sector (ssc_t^{NT}) instead of one percentage-point wage mark-up reduction, which would also apply to tradable production. No exogenous changes are made to the REA and RoW blocks. The reform is implemented fully on impact, i.e. no stepwise phasing-in, and believed to be permanent by the economic agents. The nominal rigidities, such as the degree of price and wage stickiness, and real rigidities in the model are held constant in all regions.

5. SIMULATION RESULTS

Policy simulations with structural macroeconomic models illustrate the transmission channels from structural policies to macroeconomic outcomes, their individual importance, and the determinants of transmission speed and strength. Eggertsson et al. (2014) use a small-scale dynamic general equilibrium model to substantiate the argument that structural policies may be counterproductive at the ZLB. The QUEST model, in comparison, is significantly more complex and offers a more detailed picture of the economy. Three differences are particularly relevant in the present context:

(1) Unlike Eggertsson et al. (2014), QUEST includes investment in physical capital. Investment increases in response to reforms that increase the profitability of physical capital. The increase in investment demand amplifies the outward shift of the AD schedule, i.e. the positive demand effect of structural reforms, in the short and medium term.

(2) QUEST includes liquidity-constrained (LC) households besides intertemporally optimising Ricardian households. The first group (LC) consumes its entire period disposable income at each point in time, whereas the latter group (NLC) smoothens consumption expenditure over time (NLC). LC consumers are insensitive to changes in real interest rates, but benefit from falling price levels to the extent that falling prices increase the purchasing power of wage and transfer incomes.

(3) QUEST includes trade with the RoW, which amplifies the price competitiveness gain associated with lower domestic goods prices.

The presence of LC consumers and the stronger trade competitiveness effect strengthen the negative link between the price level and aggregate demand. In Figure 1 they imply a counter-clockwise rotation of the AD curve. The AD curve becomes steeper at the ZLB and may even revert to its standard form of “normal times”, i.e. a downward sloping demand schedule.

5.1. ZERO-BOUND VERSUS STANDARD EFFECTS

The results for the combination of a one percentage-point price and wage mark-up reduction in the non-tradable (services) sector are displayed in Table 2. They point to small, but positive short-term GDP effects in "normal times", i.e. away from the ZLB.

Responding to increasing potential output and falling inflation, the central bank reduces nominal interest rates in this case, although the reduction remains moderate given the limited weight (30 %) of the region in the EA aggregate output and inflation. Consequently, the real interest rate in the reforming region of the EA increases temporarily even without binding ZLB constraint.[2] Short-term real GDP gains are much smaller than expected long-term gains in the model due to nominal and real rigidities in goods and factor markets.[3]

Table 3 shows results for reforms when the zero bound is binding. More precisely, the ZLB is binding for EA monetary policy in the initial two years of the simulation. The short-term impact of the reforms on output is slightly negative at the binding ZLB also in the QUEST model, but the effect is one order of magnitude smaller

[2] Hence, the situation of a small country in monetary union is similar to that of a country with independent monetary policy at the ZLB. Small unilateral reformers in monetary union are constantly in a quasi-ZLB environment.
[3] For an empirical characterisation of the sluggish pass-through to real variables, see Bouis et al. (2012).

than in Eggertsson et al. (2014).[4] The initial decline in real GDP relative to the pre-reform baseline is due to the contraction of interest-sensitive domestic demand.

The reason for the smaller and only short-lived contraction in economic activity is additional and countervailing transmission channels that are omitted in simpler models: First, stronger competition and the related expected increase in economic activity strengthen economy-wide corporate investment in the short term also at the ZLB.[5] Second, the presence of liquidity-constrained (LC) households along with Ricardian households (NLC) in the economy weakens the impact of the real interest rate on consumption decisions. These households are without access to capital markets that would allow them to smooth consumption over time and, instead, simply consume their current disposable income. From the perspective of liquidity-constrained households, falling goods prices and higher employment raise the level of real income and translate into higher consumption. Third, the price competitiveness of tradables from the reforming countries improves relative to the rest of the EA and the rest of the world. Export volumes increase and import volumes decline, adding a positive contribution of trade to output growth. The competitiveness gain occurs even though reforms target the non-tradable sector in the example. Lower prices for non-tradable intermediates and the dampening of nominal wage claims following the increase in the purchasing power of given nominal wages also translate into lower tradable production costs (Vogel, 2014).[6]

Table 2: **Impact of reforms in 'normal times', reforming EA region[1]**

Year	1	2	3	4	5	10
Real GDP	0.09	0.26	0.38	0.46	0.50	0.65
Employment	0.09	0.15	0.19	0.21	0.22	0.31
Consumption	-0.12	0.01	0.18	0.28	0.33	0.48
LC	0.44	0.95	1.31	1.55	1.71	2.10
NLC	-0.32	-0.33	-0.23	-0.18	-0.16	-0.10
Investment	0.63	1.17	1.38	1.43	1.43	1.34
Exports	0.05	0.15	0.24	0.31	0.36	0.51
Imports	-0.03	-0.07	-0.06	-0.04	0.00	0.08
GDP deflator	-0.39	-0.75	-0.89	-0.93	-0.94	-1.03
CPI	-0.36	-0.68	-0.80	-0.83	-0.84	-0.90
REER	0.58	0.95	1.09	1.13	1.15	1.24
Nominal interest rate	-0.04	-0.04	-0.02	0.00	0.00	0.00
Real interest rate	0.43	0.16	0.05	0.01	0.01	0.02
Public debt (% of GDP)	0.05	0.03	-0.15	-0.36	-0.56	-1.18
Trade balance (% of GDP)	-0.02	-0.03	-0.02	-0.02	-0.01	-0.02

[1] Results in the upper and lower parts of the table indicate percentage and percentage-point deviations from the no-reform baseline respectively. An increase in the real effective exchange rate (REER) indicates real effective depreciation.

[4] The permanent one percentage-point (pp) reduction in wage and price mark-ups in the non-tradable sector lowers the inflation rate by 0.5 pp, increases real interest rates by 0.4 pp and reduces output by an additional 0.1 pp in Eggertsson et al. (2014) compared to the no-reform baseline. See Table 3 in Eggertsson et al. (2014) for more information.

[5] The comparison between Tables 2 and 3 shows that investment at the ZLB increases less strongly than in "normal times" due to the more pronounced increase in the real interest rate. Even at the ZLB, however, investment demand still increases in response to the reforms and mitigates the demand decline.

[6] Compared with the "normal times" scenario (Table 2), exports increase by less and imports decline by more at the ZLB (Table 3). Monetary accommodation in 'normal times' leads to exchange rate depreciation, which strengthens export demand, but stronger domestic demand also dampens the import decline in this case. The real effective exchange rate (REER) depreciation is weaker given the lack of monetary accommodation at the ZLB, implying less short-term export growth. Weaker domestic demand also reduces import volumes at the ZLB, however.

Hence, while the short-term response of economic activity is certainly more favourable when monetary policy is available to accommodate the supply expansion by lower interest rates, the QUEST results suggest a more positive assessment of the short-term effects of structural reforms than Eggertsson *et al.* (2014) and related contributions that have been based on smaller, less encompassing models of the economic structure. The mark-up reductions considered here have only small negative initial output effects in the simulations at the ZLB.

Table 3: **Impact of reforms with binding zero bound, reforming EA region**[1]

Year	1	2	3	4	5	10
Real GDP	-0.01	0.13	0.29	0.38	0.43	0.57
Employment	0.01	0.06	0.13	0.16	0.18	0.26
Consumption	-0.28	-0.20	0.01	0.15	0.22	0.38
LC	0.35	0.76	1.09	1.34	1.51	1.92
NLC	-0.51	-0.54	-0.38	-0.28	-0.24	-0.16
Investment	0.27	0.71	1.02	1.19	1.24	1.24
Exports	0.02	0.08	0.16	0.22	0.27	0.41
Imports	-0.06	-0.16	-0.19	-0.18	-0.14	-0.02
GDP deflator	-0.46	-0.91	-1.11	-1.19	-1.22	-1.39
CPI	-0.43	-0.84	-1.01	-1.08	-1.11	-1.25
REER	0.40	0.85	1.05	1.11	1.13	1.21
Nominal interest rate	0.00	0.00	-0.01	-0.02	-0.02	-0.01
Real interest rate	0.59	0.27	0.10	0.03	0.01	0.02
Public debt (% of GDP)	0.17	0.32	0.20	-0.01	-0.22	-0.98
Trade balance (% of GDP)	-0.03	-0.03	-0.02	-0.01	-0.01	-0.02

[1] Results in the upper and lower parts of the table indicate percentage and percentage-point deviations from the no-reform baseline respectively. An increase in the real effective exchange rate (REER) indicates real effective depreciation.

Additional factors that are not captured by the QUEST model simulations may further improve outcomes in the shorter term: Non-standard measures of monetary policy at the zero bound should mitigate negative demand and output effects to the extent that they reduce financing costs and improve credit availability. The impact of structural reforms on, in particular, investment depends on their impact on lending rates and the availability of credit. The (risk-free) short-term real interest rate is only one factor in this respect. Another one is the spread between short-term policy rates and financing costs. To the extent that structural reforms strengthen confidence in the economic outlook, they may also reduce the spread between the short-term policy rate and lending rates in the economy, which would strengthen demand.

An additional channel through which reforms may support demand in the short term is the value of collateral for borrowing. As shown by Andrés et al. (2014), structural reforms that improve economic prospects and the valuation of assets may be able to relax credit constraints and shorten the duration of deleveraging by improving the value of collateral. The endogenous shortening of private demand compression would also tend to shorten the duration of ZLB episodes, adding to the gains from structural reforms.

The growth of the denominator in debt-to-GDP or debt-to-income ratios should also facilitate debt sustainability and lead to lower debt-elastic risk premia in financing costs. In the short run, though, nominal GDP may decline and the debt-to-GDP ratio increase due to the deflationary impact of reforms. This negative impact of debt deflation on demand is less pronounced when debt is predominantly long-term debt. It is more important when households have debt that needs to be repaid in the short term.

Last but not least, short-term and long-term effects of structural reforms depend obviously on the precise nature of the implemented measures. The mark-up reductions in Eggertsson et al. (2014) and in Tables 2 and 3 are short-cuts for structural reforms with strong deflationary effects. To replicate the Eggertsson et al. (2014) policy experiment, reforms in Tables 2 and 3 are restricted to mark-up reductions, while adjustment frictions such as the degree of price and wage stickiness are kept constant. The short-term costs in Table 3 rest on the contractionary real interest rate effect of deflationary reforms at the ZLB. Reform packages that increase price and wage flexibility in addition to reducing the mark-up could mitigate contractionary short-term effects of deflationary reforms at the ZLB. In particular, they should reduce the length of the period of heightened real interest rates and accelerate the speed at which enhanced competition translates into gains in the purchasing power of wages, lower investment prices and improved price competitiveness.

Other structural policies have smaller short- and medium-term price effects and are, hence, less exposed to the adverse real interest effect at the ZLB. These measures include particular tax reforms, e.g. a shift from labour to consumption taxation, R&D policies, and policies to improve labour-market matching.[7] Some policies, such as reducing job protection or benefit generosity, on the other hand tend to increase the short-term costs of recessions even under normal monetary conditions.[8]

5.2. DOES IT PAY TO POSTPONE REFORMS?

Lags in the pass-through of structural reforms to real variables are a function of nominal and real rigidities in the economy. Rigidities in prices and wages, in particular, slow their adjustment and dampen the real interest rate increase at a temporarily binding ZLB. These lags in the pass-through, also called inside lags, are incorporated in the model simulations in Tables 2 and 3. Another type of lag is delays in implementation of reforms, the so-called outside lag.

Economists that have warned against the contractionary effects of deflationary reforms at the current juncture have tended to advocate postponing their implementation. Following this line of reasoning, the delayed implementation, i.e. the outside lag, is a virtue rather than a vice as long as the announcement of future reforms is credible.

The credible commitment to future reforms, so the argument made, e.g., in Eggertsson et al. (2004) and Fernández-Villaverde (2011), raises expected future output and income levels. The positive wealth effect strengthens current private demand. Intertemporally optimising agents will increase consumption immediately in response to higher expected future wealth, which, in turn, will stimulate current economic activity. The positive impact of the wealth effect might even be larger at the ZLB where it will not be mitigated by monetary tightening that would typically occur in normal times. In the words of Eggertsson et al. (2014: 19), delayed implementation "retains the long-run benefits of structural reforms without imposing the short-term costs in terms of deflation."

The idea of credible commitment to future reforms appears problematic already on political grounds. It would require economic agents to have correct expectations about a fully credible commitment to reform. Lack of credibility would substantially weaken, or even invalidate, the argument. Full ex-ante legislation of future reforms may provide a partial remedy, but the general reversibility of decisions in the democratic process remains.

Even if credible commitment was feasible, however, the advantage of delaying reforms would rest on the presumed strength of the wealth effect and of intertemporal substitutability. Turning again to the more complex representation of the economy in the QUEST model shows that the factors which mitigate negative short-term effects of structural reforms at the ZLB also reduce the *current* benefits from *future* reforms.

Table 4 shows QUEST results for a scenario with credible commitment to future reforms. More precisely, the same wage and price mark-up reductions as in Tables 2 and 3 are announced in the first year, but implemented only in the third year. As before, the ZLB is binding in years 1 and 2. Hence, the reform occurs in a post-ZLB

[7] The beneficial effects of, for example, a shift in taxation from labour-based social security contributions to consumption also take time to fully materialise given nominal and real rigidities in the economy. However, the tax shift does not show the temporary output contraction observed for the deflationary mark-up reduction at the ZLB in Table II.1.2, because the deflationary impact of falling labour costs is accompanied by an inflationary impact of higher consumption taxes.

[8] See Varga et al. (2013) for a comparison of short-, medium- and long-term effects of different structural measures in QUEST. Differences in the price effect of particular reform measures in a dynamic model are also stressed by Cacciatore et al. (2012). Bouis et al. (2012) provide an empirical analysis of the effects of various labour and product market reforms over different time horizons.

environment. The pre-announcement of the reform is assumed to be fully credible and the reforms are fully anticipated by the private sector.

Comparing the effect on economic activity of credibly pre-announced future reforms in Table 4 with the one of currently implemented reforms at the ZLB in Table 3 does not support the idea that postponing reforms would improve economic conditions in the short term and prevent the negative short-term impact of contemporaneous reforms at the ZLB in Table 3. Instead, the delay deteriorates the short-term economic outlook compared to current implementation. The short-term output and employment effects in Table 4 are more negative than the corresponding results in Table 3.

Table 4: **Impact of pre-announced future reforms with current ZLB, reforming EA region**[1]

Year	1	2	3	4	5	10
Real GDP	-0.08	0.00	0.21	0.37	0.45	0.61
Employment	-0.09	-0.09	0.08	0.16	0.19	0.26
Consumption	-0.33	-0.38	-0.14	0.10	0.23	0.43
LC	0.04	0.27	0.76	1.17	1.44	1.97
NLC	-0.46	-0.62	-0.46	-0.28	-0.20	-0.12
Investment	0.50	1.00	1.28	1.41	1.43	1.31
Exports	0.04	0.12	0.20	0.28	0.34	0.48
Imports	-0.03	-0.09	-0.12	-0.11	-0.07	0.06
GDP deflator	-0.14	-0.38	-0.68	-0.84	-0.89	-0.99
CPI	-0.11	-0.32	-0.60	-0.74	-0.79	-0.87
REER	0.31	0.59	0.91	1.07	1.12	1.20
Nominal interest rate	0.00	0.00	-0.01	-0.02	-0.01	0.00
Real interest rate	0.23	0.31	0.21	0.06	0.01	0.03
Public debt (% of GDP)	0.14	0.30	0.29	0.09	-0.15	-1.05
Trade balance (% of GDP)	0.00	0.00	0.01	0.01	0.01	-0.02

[1] Results in the upper and lower parts of the table indicate percentage and percentage-point deviations from the no-reform baseline respectively. An increase in the real effective exchange rate (REER) indicates real effective depreciation.

On the positive side, the delay dampens the real interest rate increase at the ZLB in the short term, which stabilises the consumption demand by intertemporally optimising households compared to the reforms at the ZLB in Table 3.[9] This is the channel emphasised by Eggertsson et al. (2014). Also investment demand is stronger in the short term given the weaker counteracting real interest rate effect.

This advantage of pre-commitment to future reforms is, however, outweighed by additional factors. Future reforms do, firstly, not raise the purchasing power of current income to the same extent, so that the growth in consumption demand by liquidity-constrained households is delayed. Consequently, the positive short-term contribution to domestic demand of LC consumption (Table 3) is missing. Postponing the implementation of reforms, secondly, also delays the improvement in price competitiveness and the resulting expenditure switching from imported to domestically produced goods. The delay in the increase of net trade volumes also weighs negatively

[9] Even in the case of *future* reforms the real interest rate increases somewhat at the ZLB. The reason is the presence of price and wage stickiness in the model. The households and firms anticipate the impact of future reforms on future wage and price levels. With wage and price stickiness (due either to binding wage and price contracts or a desire to smooth price and wage adjustments over time), current wage and price setting already incorporates these expectations and leads to partial downward adjustment of wages and prices already in the pre-reform period.

on the short-term response of domestic output. Hence, the results in Table 4 do not support the idea that postponing reforms to the future is better than implementing them at the ZLB.

6. CONCLUSIONS

This paper has discussed the impact of structural policies at the zero lower bound (ZLB) based on the recent academic literature and simulations with the European Commission's QUEST model. In particular, it has focused on potentially negative short-term effects of structural policies on economic activity at the ZLB.

The simulation results show that the binding ZLB reduces short- and medium-term gains from structural reforms compared to a situation in which monetary policy responds with expansionary interest rate reduction to absorb the increase in potential output. Small countries in monetary union that implement structural reforms unilaterally face a very similar situation also in "normal times".

The simulations with the QUEST model also suggest that reforms with significant deflationary effects can, indeed, have negative short-term effects on economic activity at the ZLB as consequence of rising real interest rate in the absence of monetary accommodation. The negative short-term impact is small and limited to the first year, however. The small-scale economic models that suggest larger and more prolonged contractionary effects tend to omit a number of mitigating channels which dampen the contractionary impact of rising real rates on economic activity. The additional channels that act in the opposite direction include the impact of reforms on the profitability of investment, on the disposable income of liquidity-constrained households, and on trade competitiveness.

The impact on economic activity depends, obviously, also on the precise policy measures. Mark-up and labour cost reduction, which has been the focus of the analysis, has relatively strong deflationary effects that amplify the contractionary real interest increase at the ZLB. Other measures, such as fiscal devaluation, R&D policies and policies to facilitate sectorial adjustment and labour-market matching, are less deflationary than mark-up reduction as proxy for competition-enhancing reform, so that contractionary real interest effect should be less pronounced in the former cases. Short-term effects could also improve in response to reform packages that combine increased competition with faster nominal and real adjustment. Non-standard measures of monetary policy and positive confidence effects from reforms, which are not included in the model-based analysis, may furthermore mitigate negative demand and output effects by reducing the spread between policy rates and lending rates as well as by improving credit availability.

Beyond the practical problem of credible pre-commitment, the QUEST results do, in the end, not support the idea that postponing reforms to post-ZLB periods is better than current implementation at the ZLB when assessed in terms of economic activity. The reason is that transmission channels that mitigate the costs of reforms at the ZLB, such as the impact of reforms on real disposable income and trade competitiveness, also reduce the role of the expansionary anticipation effect associated with future reforms and future income gains.

The policy implication of the analysis is that recent warnings of adverse effects from structural reforms at the current juncture appear to overemphasise potential short-term costs. While it is certainly true that an accommodative monetary policy stance would facilitate the adjustment in “normal times”, reforms at the ZLB do not appear to imply significant short-term costs in terms of aggregate economic activity. Furthermore, the results also suggest that, even in the case of fully credible pre-commitment, postponing reforms is no better alternative.

The paper's focus on policies that increase competition and reduce market power and labour costs does not imply that these measures should dominate the policy agenda. In the long term, economic prospects hinge critically on increasing productivity, which emphasises the crucial role of policies that can help stimulating factor productivity growth. In the short term, macroeconomic policies that strengthen aggregate demand would help exit recession. The paper's argument is rather, and more narrowly, that structural reforms are no impediment to an economic recovery. Besides their supply-side and long-term effects they also have the potential to support aggregate demand at the current juncture.

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