European Commission

ISSN 1725-3187

EUROPEAN ECONOMY

Economic Papers 470 | November 2012

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Economic and Financial Affairs

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KC-AI-12-470-EN-N
ISBN 978-92-79-22991-6
doi: 10.2765/27699

The performance of simple fiscal policy rules in monetary union

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Abstract:

The paper analyses the stabilising potential of simple fiscal policy rules for a small open economy in monetary union in a 2-region DSGE model with nominal and real rigidities. We consider simple fiscal instrument rules for government purchases, transfers, and consumption, labour and capital taxes in analogy to interest rate rules in monetary policy. The paper finds a dichotomy in the welfare effects of fiscal policy for liquidity-constrained and intertemporal optimising households, i.e. policies enhancing the welfare of one group tend to reduce the welfare of the other one. Moderate average welfare gains from optimal policy contrast with large losses from non-optimal policy. Fiscal rules that respond to employment fluctuations may be preferred to rules responding to indicators of price competitiveness, because optimal policy in the former corresponds more closely to the idea of countercyclical stabilisation. The paper also emphasises the strong impact of the budgetary closure rule on the welfare effects of business cycle stabilisation.

JEL classification: E37, E62, F41

Keywords: fiscal policy, monetary union, simple instrument rules, welfare

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We thank Elena Flores, Davide Furceri, Robert King, Georgios Kouretas, Athanasios Papadopoulos, Apostolos Serletis, George Tavlas and participants of the 16th Annual Conference on Macroeconomic Analysis and International Finance for helpful discussions, comments and suggestions. The views in this paper are personal and should not be attributed to the European Commission. Corresponding author: Lukas Vogel, DG ECFIN, European Commission, CHAR 14/233, B-1049 Brussels, Belgium; email: lukas.vogel@ec.europa.eu.

1. Introduction

This paper investigates the potential of simple fiscal policy rules to stabilise cyclical fluctuations and reduce the welfare cost of supply and demand shocks in monetary union. The focus is on the stabilisation of asymmetric shocks at the level of small member states, which are not stabilised by the reaction of the common monetary policy to area-wide variables, so that fiscal policy remains the (only) macroeconomic policy tool available.

The paper, hence, reconsiders a classical question of the currency union literature, namely the importance and potential of fiscal policy to stabilise asymmetric shocks at the level of the member countries. We address the question in a setting that differentiates between alternative fiscal instruments (government purchases, transfers, and consumption, labour and capital taxes) and applies the idea of simple instrument rules to the conduct of fiscal policy.

We focus the discussion on the potential of simple fiscal instrument rules to stabilise and reduce the welfare costs of temporary demand and supply shocks, i.e. business cycle fluctuations around a sustainable long-term growth path. The paper analyses temporary changes in fiscal variables in reaction to temporary macroeconomic fluctuations. It does not address the potential of fiscal reforms to correct persistent imbalances in monetary union through internal devaluation (e.g., de Mooij and Keen 2012, Farhi et al. 2011), even though cyclical stabilisation in the short term may help preventing the build-up of persistent imbalances in a setting with strong inertia in economic forces.

The paper does also not analyse situations in which union-wide monetary policy is constraint at the zero bound or by frictions in the monetary transmission channel, so that country-level fiscal policies might (have to) substitute for monetary policy at the level of the monetary union aggregate. An adequate framework for this type of question would have to develop on the (conditions for) cooperative and non-cooperative fiscal policy interaction.

Although macroeconomic policy faces new and urgent challenges in the context of the financial crisis and euro area imbalances, the classical question of business cycle stabilisation in a monetary union with asymmetric shocks remains a relevant one. The empirical literature for Europe and the United States demonstrates that the degree of shock smoothing by market forces is limited in advanced economies. Afonso and Furceri (2008) show for the euro area that shock smoothing by private savings and intertemporal income transfers is moderate and

that smoothing through cross-border factor income flows is low, which implies that international risk sharing is weak. Similarly, Asdrubali et al. (1996) and Athanasoulis and van Wincoop (2001) document limited shock smoothing through household savings and capital markets across U.S. states. At the same time, these studies and Arreaza et al. (1998) illustrate the shock-smoothing potential of fiscal policy inside EMU and in the U.S.

The paper develops a two-region New Keynesian DSGE model with goods, labour and financial market frictions. The analysis of fiscal stabilisation policy focuses on a small member country in monetary union, which excludes feedback to monetary policy and the rest of monetary union (RoU) in the model. Besides this simplifying implication, the focus on a small member economy is motivated by the fact that the potential of fiscal policy to stabilise business cycle fluctuations is particularly relevant for small member countries of monetary union as the latter have no/little impact on union-wide aggregates and tend to be more exposed to idiosyncratic supply and demand shocks because of higher openness and stronger specialisation. The small-country setting differs from previous research that has focused on fiscal policy in monetary unions of two large/symmetric countries and the interactions between centralised monetary and decentralised fiscal policy with a smaller set of policy instruments (e.g., Beetsma and Jensen, 2004; Ferrero, 2009; Kirsanova et al., 2007).

This papers' analytical framework is inspired by Galí and Monacelli (2008) who discuss optimal monetary and fiscal policy in a monetary union of small economies with government purchases as fiscal instrument, price stickiness as friction, and technology shocks as exogenous disturbance. We broaden the analysis in a number of important dimensions by: (1) considering simple fiscal instrument rules for a range of policy parameters instead of focusing exclusively on optimal policy, which provides information about the robustness of simple instrument rules, the potential welfare gain from optimal stabilisation and the welfare costs of non-optimal policy, (2) having a larger variety of policy instruments (government purchases, transfers, and consumption, labour and capital taxes), (3) introducing physical capital, which appears important in the context of distortionary taxation, (4) including additional frictions (wage stickiness, financial frictions, capital adjustment costs, and a time-to-build constraint for capital) and (5) adding demand shocks to the model. The model does include neither government employment nor public investment. Government purchases are modelled as consumption of private-sector output. All employment is private-sector employment.

In light of the empirical evidence (e.g., Kollmann, 1996) we depart from the assumption of perfect cross-border risk sharing in Beetsma and Jensen (2004), Ferrero (2009), Galí and Monacelli (2008) and Kirsanova et al. (2007) and introduce a debt-dependent country risk premium (e.g., Schmitt-Grohé and Uribe, 2003) as closure for the external account. On the domestic side, we introduce liquidity-constrained (LC) along non-constrained (NLC) households. LC households have no access to financial markets and always consume their currently disposable labour and transfer income. NLC households have access to financial markets to save/borrow in order to smooth income and consumption over time.

The presence of LC households can account for the positive correlation between private and government consumption at business cycle frequencies (e.g., Galí et al., 2007), and estimated macro models of the euro area (e.g., Forni et al., 2009; Ratto et al., 2009) indicate the share of LC households to be high. The presence of LC households broadens the case for stabilisation policy beyond price/wage stickiness. As the government has an advantage over LC households in terms of its access to capital market, it can smooth the income and utility of LC households and mitigate the welfare cost of the LC households' borrowing/lending constraint.

The paper finds a dichotomy in the welfare effects of fiscal policy responses to cyclical fluctuations for LC and NLC households. Policies that are welfare enhancing from the perspective of LC households tend to be costly from the perspective of NLC households. The potential overall welfare gain under the on-average optimal simple rule is typically moderate when compared to the potential welfare costs of non-optimal policy. The potential welfare gains for LC households are much larger, however, as those typically found in models of stabilisation policy that only include intertemporally optimising agents. The analysis also emphasises the strong impact of the budgetary closure rule for government debt/deficit stabilisation on the welfare results.

2. Model

The model consists of two regions: the small (domestic) member country of monetary union and the rest of monetary union (RoU). The model includes monopolistic competition in goods and labour markets, nominal price and wage stickiness, liquidity constraints, capital and labour as inputs into production, and a set of fiscal variables, namely consumption, labour income and capital taxes, government purchases and public transfers. The presence of intertemporal optimising (NLC), i.e. households that can freely borrow and save to smooth con-

sumption over time, and liquidity-constrained (LC) households, i.e. households without access to financial markets who in each period consume their entire current disposable wage and transfer income, implies that fiscal variables have both substitution and income effects.

The RoU variables and monetary policy are given from the perspective of the small economy. Goods and financial markets are imperfectly integrated across borders, namely there is home bias in the demand for goods and a debt-dependent country risk premium, and labour is immobile between countries.

Households

The household sector consists of a continuum of households *i*. The welfare of household *i* is the discounted sum of the period utilities:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} (C_t^i)^{1-\sigma} + \frac{\chi}{1-\sigma} G_t^{1-\sigma} - \frac{\kappa}{1+\varphi} (L_t^i)^{1+\varphi} \right) \tag{2.1}$$

Household utility is additive in private consumption C_t^i, government purchases G_t and work L_t^i. The parameters β, χ, 1/σ, κ and 1/φ are the discount factor, the utility weight of government purchases, the intertemporal elasticity of substitution, the disutility weight work, and the elasticity of labour supply. The benchmark model assumes log consumption utility, i.e. σ=1.

The households decide about private consumption and labour supply given their respective budget constraints. Government consumption enters household utility, but is not a choice variable of the households. Instead, the level of government consumption is chosen by the government as described below.

NLC households, who are a fraction 1-*slc* of the population, make optimal intertemporal choices given their intertemporal budget constraint:

$$\begin{aligned} &(1-\tau_t^w) W_t^i L_t^i + (1+i_{t-1}) B_{t-1} + \left(1 + i_{t-1}^* - \omega \frac{B_{H,t-1}^*}{4 P_{H,t-1} Y_{t-1}} + \varepsilon_t^r\right) B_{t-1}^* + TR_t + (1-\tau_t^k) i_t^k K_{t-1}^i \\ &+ \tau_t^k d P_t K_{t-1}^i + PR_t = (1+\tau_t^c) P_t C_t^{NLC} + P_t I_t^i + B_t + B_{H,t}^* + \gamma_w / 2 (\pi_t^{w,i})^2 P_{H,t} L_t + TAX_t \end{aligned} \tag{2.2}$$

The revenue side includes the nominal wage income $W_t^i L_t^i$ net of the (linear) labour income tax τ_t^w, the payment on maturing one-period domestic government bonds B_{t-1} including in-

terest i_{t-1}, the repayment of one-period net foreign assets $B^*_{H,t-1}$ including interest, which is the sum of the foreign rate i^*_{t-1}, the endogenous part of the risk premium $-\omega B^*_{H,t-1}/(4P_{H,t-1}Y_{t-1})$ and the exogenous component ε^r_t, lump-sum transfers from the government TR_t, the return to capital $(1-\tau^k_t)i^k_t K^i_{t-1} + \tau^k_t \delta P_t K^i_{t-1}$ net of capital taxes τ^k_t and depreciation allowances $\tau^k_t \delta$, and profit income PR_t from firm ownership. The expenditure side combines nominal consumption $P_t C^{NLC}_t$ taxed at rate τ^c_t, where P_t is the consumer price index (CPI), nominal investment in physical capital $P_t I^i_t$, financial investment in domestic bonds and (net) foreign assets, and quadratic costs γ_w of wage adjustment $(\pi^{w,i}_t \circ W^i_t / W^i_{t-1} - 1)$, where $P_{H,t}$ is the price level of domestic output. Finally, TAX_t is a lump-sum tax levied only on NLC households and introduced to provide a hypothetical non-distortionary benchmark for the fiscal closure rule.

The accumulation of physical capital follows the law of motion:

$$K^i_t = I^i_t + (1-\delta)K^i_{t-1} - \frac{\gamma_k}{2}\left(\frac{I^i_t}{K^i_{t-1}} - \delta\right)^2 K^i_{t-1} \tag{2.3}$$

including capital depreciation at rate δ and quadratic cost γ_k of capital stock adjustment.

The NLC households maximise (2.1) given equations (2.2) and (2.3), which provides the first-order conditions (FOC) for consumption, financial asset holdings and real capital investment:

$$1/(C^{NLC}_t)^{\sigma} - (1+\tau^c_t)\lambda^{NLC}_t = 0 \tag{2.4}$$

$$\lambda^{NLC}_t / P_t - \beta(1+i_t)E_t(\lambda^{NLC}_{t+1} / P_{t+1}) = 0$$

$$\frac{\lambda^{NLC}_t}{P_t} - \beta\left(1+i^*_t - \omega\frac{B^*_{H,t-1}}{4P_{H,t-1}Y_{t-1}} + \varepsilon^r_t\right)E_t\left(\frac{\lambda^{NLC}_{t+1}}{P_{t+1}}\right) = 0$$

$$P_t\lambda^{NLC}_t - \mu_t(1-\gamma_k NI^i_t) = 0$$

$$\beta E_t\lambda^{NLC}_{t+1}((1-\tau^k_{t+1})i^k_{t+1} + \tau^k_{t+1}\delta P_{t+1}) - \mu_t + \beta E_t\mu_{t+1}\left(1-\delta - \frac{\gamma_k}{2(NI^i_{t+1})^2} + \gamma_k NI^i_{t+1}I^i_{t+1}/K^i_t\right) = 0$$

where E_t is the expectations operator, λ^{NLC}_t is the Lagrange multiplier associated with (2.2),

η is the Lagrange multiplier associated with (2.3), and $NI_t^i \equiv I_t^i / K_{t-1}^i - \delta$.

Combining the first two FOCs gives the Euler equation for the optimal path of NLC consumption:

$$\beta E_t \left[\frac{1+\tau_t^c}{1+\tau_{t+1}^c} \frac{P_t}{P_{t+1}} \left(\frac{C_t^{NLC}}{C_{t+1}^{NLC}} \right)^{\sigma} \right] = \frac{1}{1+i_t} \tag{2.5}$$

Combing the second and third FOC for domestic bonds and foreign assets gives an interest parity condition including the risk premium:

$$i_t = i_t^* - \omega \frac{B_{H,t-1}^*}{4 P_{H,t-1} Y_{t-1}} + \varepsilon_t^r \tag{2.6}$$

with ω>0 and the exogenous AR(1) risk-premium shock:

$$\varepsilon_t^r = \rho_r \varepsilon_{t-1}^r + \eta_t^r \tag{2.7}$$

where ρ_r is the shock persistence and η_t^r an innovation with zero mean and standard deviation σ_r. Note that equation (2.6) does not include an exchange rate term as we consider regions in a monetary union.

The period budget constraint of LC households constituting the share *slc* of the population is:

$$(1-\tau_t^w) W_t^i L_t^i + TR_t + TR_t^{LC} = (1+\tau_t^c) P_t C_t^{LC} + \gamma_w / 2 (\pi_t^{w,i})^2 P_{H,t} L_t^{LC} \tag{2.8}$$

where TR_t^{LC} are targeted transfers to LC consumers, which will be considered as an alternative to the general transfers TR_t in the discussion of fiscal stabilisation.

Real consumption by LC households is constrained by the disposable labour and transfer income and equals:

$$(1+\tau_t^c) P_t C_t^{LC} = (1-\tau_t^w) W_t^i L_t^i + TR_t + TR_t^{LC} - \gamma_w / 2 (\pi_t^{w,i})^2 P_{H,t} L_t \tag{2.9}$$

The marginal value of the LC households' income is analogous to the FOC for equation NLC households as:

$$1/(C_t^{LC})^{s} - (1+t_t^c)/_t^{LC} = 0 \tag{2.10}$$

The per-capita level of consumption in the aggregate is the weighted average of NLC and LC consumption:

$$C_t \circ (1- slc)C_t^{NLC} + slcC_t^{LC} \tag{2.11}$$

Private demand combines domestically produced ($C_{H,t}^i, I_{H,t}^i$) and imported ($C_{F,t}^i, I_{F,t}^i$) goods. Assuming the same trade price elasticity for consumption and investment demand, we can aggregate $Z_t \hat{I} (C_t^{NLC}, C_t^{LC}, I_t)$ and write:

$$Z_t^{(h-1)/h} = h^{1/h} Z_{H,t}^{(h-1)/h} + (1- h)^{1/h} Z_{F,t}^{(h-1)/h} \tag{2.12}$$

where the parameters h and h indicate the steady-state home bias and the elasticity of substitution between domestically produced goods and imports. The resulting demand by domestic households for domestically produced goods and imports are:

$$Z_{H,t} = h(P_{H,t} / P_t)^{-h} Z_t \tag{2.13}$$

$$Z_{F,t} = (1- h)(P_{F,t} / P_t)^{-h} Z_t \tag{2.14}$$

The bundle of domestically produced goods $Z_{H,t}$ is itself a composite of goods varieties Z_t^j:

$$Z_{H,t}^{(e-1)/e} = \int_0^1 (Z_t^j)^{(e-1)/e} dj \tag{2.15}$$

where ε is the elasticity of substitution between these varieties. Each variety is produced by a specialised firm *j*. The demand for variety *j* is given by:

$$Z_t^j = (P_t^j / P_{H,t})^{-e} Z_{H,t} \tag{2.16}$$

The elasticity ε determines the price setting power of individual firms. The pricing margin of firms declines with increasing ε, because higher values of ε magnify the impact of deviations from competitor prices on firm *j*'s market share.

The households *i* supply labour services L_t^i in a monopolistically competitive labour market. Total labour is a composite of the differentiated labour services:

$$L_t^{(q-1)/q} = \int_0^1 (L_t^i)^{(q-1)/q} di \tag{2.17}$$

with θ being the elasticity of substitution between the varieties of labour services. The minimisation of labour costs by firms gives the demand function for variety *i* as:

$$L_t^i = (W_t^i / W_t)^{-q} L_t \tag{2.18}$$

The market power of worker *i* declines with increasing θ, because higher values of θ amplify the fall in the relative demand for L_t^i in response to higher individual wage claims.

The labour services are distributed equally across NLC and LC households, and specialised labour unions represent the different types of labour services *i* in the wage setting. The wage setting is subject to quadratic adjustment costs, which provide an incentive to smooth the wage adjustment and which lead to nominal wage stickiness. The optimisation problem of the labour union representing the labour service *i* is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(-\frac{\kappa}{1+\varphi} (L_t^i)^{1+\varphi} + \lambda_t^i (1-\tau_t^w) \frac{W_t^i}{P_t} L_t^i - \lambda_t^i \frac{\gamma_w}{2} (\pi_t^{w,i})^2 \frac{P_{H,t}}{P_t} L_t \right) \tag{2.19}$$

The optimal wage maximises (2.19) given labour demand (2.18) and the marginal value of NLC income (2.4) and LC income(2.10). The wage is the same for NLC and LC households, and the unions average the marginal value of NLC and LC income according to the population share of the two types of households.

The optimisation problem is symmetric across unions *i*, which implies identical wages ($W_t^i = W_t$) and labour demand ($L_t^i = L_t$) across households. The wage setting equation is:

$$(1-\tau_t^w) \frac{W_t}{P_t} = \frac{\theta}{\theta-1} \frac{\kappa L_t^{\varphi}}{\lambda_t^{tot}} - \frac{\gamma_w}{\theta-1} \frac{W_t}{W_{t-1}} \frac{P_{H,t}}{P_t} \pi_t^w + \frac{\gamma_w}{\theta-1} \beta E_t \left(\frac{\lambda_{t+1}^{tot}}{\lambda_t^{tot}} \frac{W_{t+1}}{W_t} \frac{P_{H,t+1}}{P_{t+1}} \frac{L_{t+1}}{L_t} \pi_{t+1}^w \right) \tag{2.20}$$

with

$$\lambda_t^{tot} \equiv (1-slc)\lambda_t^{NLC} + slc\,\lambda_t^{LC} \tag{2.21}$$

where the gross wage claims increase with increasing labour taxation (τ_t^w) for given levels of employment.

Government sector

The government collects labour, capital, consumption and lump-sum taxes and issues one-period bonds to finance government purchases, general and targeted transfers and the servicing of outstanding debt B_{t-1}:

$$t_t^w W_t L_t + t_t^k (i_t^k - \delta) K_{t-1} + t_t^c P_t C_t + (1 - slc) TAX_t + B_t = P_t G_t + TR_t + slc TR_t^{LC} + (1 + i_{t-1}) B_{t-1} \quad (2.22)$$

Government purchases are an aggregate of domestically produced and imported goods analogously to private demand in (2.12) and (2.15):[1]

$$G_t^{(\eta-1)/\eta} = \eta^{1/\eta} G_{H,t}^{(\eta-1)/\eta} + (1-\eta)^{1/\eta} G_{F,t}^{(\eta-1)/\eta} \quad (2.23)$$

$$G_{H,t}^{(\varepsilon-1)/\varepsilon} = \int_0^1 (G_t^j)^{(\varepsilon-1)/\varepsilon} dj \quad (2.24)$$

which gives equivalent demand functions for the alternative bundles and varieties:

$$G_{H,t} = \eta (P_{H,t} / P_t)^{-\eta} G_t \quad (2.25)$$

$$G_{F,t} = (1-\eta)(P_{F,t} / P_t)^{-\eta} G_t \quad (2.26)$$

$$G_t^j = (P_t^j / P_{H,t})^{-\varepsilon} G_{H,t} \quad (2.27)$$

The government needs to adjust tax revenue or expenditure to stabilise government debt and deficits around target values. This paper considers three alternative closure rules

The government can adjust purchases, transfers and tax rates in response to cyclical fluctuations.[2] The policy takes the form of simple fiscal instrument rules that are similar to simple interest rate rules in monetary policy:

$$\frac{G_t}{Y_t} = \rho \frac{G_{t-1}}{Y_{t-1}} + (1-\rho)\frac{\overline{G}}{Y} + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \quad (2.28)$$

[1] The EU's internal market and public procurement policies have weakened the case for the alternative assumption of strong/full home bias in government consumption.

[2] We only consider fiscal policy rules that do not discriminate between domestic and foreign goods. Adao et al. (2009) show that adjustable differentiated sales taxes on domestically produced and imported goods eliminate the welfare costs of losing monetary autonomy under certain conditions. Such origin-based tax discrimination appears incompatible with internal market rules, however.

$$\frac{TR_{cs,t}}{P_{H,t}Y_t} = \rho \frac{TR_{cs,t-1}}{P_{H,t-1}Y_{t-1}} + (1-\rho)\frac{\overline{TR_{cs}}}{P_H Y} + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \tag{2.29}$$

$$\frac{TR_t^{LC}}{P_{H,t}Y_t} = \rho \frac{TR_{t-1}^{LC}}{P_{H,t-1}Y_{t-1}} + (1-\rho)\frac{\overline{TR^{LC}}}{P_H Y} + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \tag{2.30}$$

$$t_t^c = \rho t_{t-1}^c + (1-\rho)\bar{t}^c + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \tag{2.31}$$

$$t_{cs,t}^w = \rho t_{cs,t-1}^w + (1-\rho)\bar{t}_{cs}^w + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \tag{2.32}$$

$$t_t^k = \rho t_{t-1}^k + (1-\rho)\bar{t}^k + (1-\rho)\chi_p \ln\left(\frac{P_{H,t-1}}{P_{F,t-1}}\right) \tag{2.33}$$

where $TR_{cs,t}$ and $t_{cs,t}^w$ are transfer and labour tax components earmarked for the business cycle stabilisation.

The emphasis on simple instrument rules owes to their practical advantages over fully optimal policy solutions. Contrary to the fully optimal policy solution, simple rules use a limited set of information. Compliance with simple rules is, consequently, easier to monitor than the commitment to fully optimal policy, and the feasibility of compliance monitoring mitigates the credibility/time-consistency problem. Credibility is crucial, because it determines the policy maker's ability to anchor the expectations of households and firms. In addition, it is plausible to assume that simple rules are easier to implement than the optimal commitment solutions, which strengthens the government's ability to react timely to business cycle fluctuations. The simulations in the subsequent sections of the paper assess the potential welfare gain from fiscal instrument rules in the context of supply and demand shocks.

The instrument rules (2.28)-(2.33) respond with one quarter delay to economic conditions, i.e. include a recognition/implementation lag as in Kirsanova et al. (2007), whereas Beetsma and Jensen (2004), Ferrero (2009), and Galí and Monacelli (2008) assume contemporaneous feedback.

The instrument rules (2.28)-(2.33) imply a response of fiscal variables to fluctuations in the

terms of trade (ToT), which in the model are an indicator for the real effective exchange rate. The policy response to fluctuations in the relative price of domestically produced products is motivated by the key role of price competitiveness for output and external balances in a monetary union. The terms of trade are included in fiscal rules also by Ferrero (2009) and are a robust indicator of capacity utilisation and price competitiveness under supply and demand shocks. The use of ToT *levels* instead of first differences in (2.28)-(2.33) derives from the fact that output stabilisation in the open economy requires stabilisation of relative price levels. In addition, relative price level targeting is more aggressive than relative inflation targeting for given values of ξ_p, which accelerates relative price adjustment in the presence of nominal price and wage stickiness.[3]

The analysis has been repeated with versions of (2.28)-(2.33) including a response to (lagged) output growth in addition to the ToT response. The advantage of output growth over theoretical output gaps in policy rules is the observability of the former. Augmenting the instrument rules (2.28)-(2.33) by a direct response to output growth makes little difference from the welfare perspective, however. To keep the discussion focused, the paper does not include the respective results.

We have also tested differences between domestic and RoU output *levels* as indicator of economic activity and found contradictory signals for the fiscal stance. While positive domestic technology shocks would suggest demand expansion to match the higher output potential, positive demand shocks should trigger fiscal contraction to avoid an overheating of the economy. A uniform fiscal response to relative output levels irrespective of the underlying shock does not achieve such differentiation. Namely, fiscal tightening in response to a TFP-related increase in domestic output amplifies fluctuations in employment and factor use instead of dampening them. The session of robustness checks will present results for a policy rules reacting to relative levels of employment, however.

[3] In this sense, the policy rules are similar to price-level as opposed to inflation targeting in monetary policy, which is discusses by Cournède and Moccero (2009). However, an important difference is that ToT stationarity in a small member country of monetary union, i.e. taking export import prices as given, requires stationarity of the domestic price level. In an economy with flexible nominal exchange rate, ToT stationarity is compatible with non-stationarity of domestic prices as long as the combination of domestic prices and the nominal exchange rate is stationary.

The government adjusts tax transfer payments or taxes to stabilise government debt and the budget deficit at their target levels. In the simulations we first consider lump-sum taxes as instrument in the budgetary closure rule:

$$\frac{TAX_t}{P_{H,t}Y_t} = \frac{TAX_{t-1}}{P_{H,t-1}Y_{t-1}} + \chi_b \left(\frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} - btar \right) + \chi_d \frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} \tag{2.34}$$

where TAX_t is levied only from NLC households and *btar* is the target debt-to-GDP ratio. The lump-sum closure (2.34) is standard in the literature. It provides a theoretically appealing benchmark, because it has neither distortionary nor relevant income effects for NLC or LC households. Hence, scenarios with lump-sum closure show the impact of the fiscal rules (2.28)-(2.33) without additional distortions or income effects from budgetary stabilisation and are therefore suited to illustrate the pure impact of the policy rules (2.28)-(2.33) without second-round effects from debt/deficit stabilisation.

In practice, lump-sum taxation is rare; most tax revenue comes from direct taxes. A more realistic budget closure is:

$$t^w_{ds,t} = t^w_{ds,t-1} + \chi_b \left(\frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} - btar \right) + \chi_d \frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} \tag{2.35}$$

with $t^w_t \equiv t^w_{cs,t} + t^w_{ds,t}$. If the closure rule (2.35) is active, the government increases the labour tax rate to collect additional revenue if debt and/or deficit levels exceed the target values. The labour tax closure increases the complexity of the model dynamics by affecting the labour supply decision of workers and the disposable period income and consumption demand of LC households. Hence, the closure generates fluctuations in supply and demand, which can reduce or even offset the impact of the instrument rules (2.28)-(2.33).

As intermediate case we also consider a budget closure by general lump-sum transfers:

$$\frac{TR_{ds,t}}{P_{H,t}Y_t} = \frac{TR_{ds,t-1}}{P_{H,t-1}Y_{t-1}} - \chi_b \left(\frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} - btar \right) - \chi_d \frac{B_{t-1}}{4P_{H,t-1}Y_{t-1}} \tag{2.36}$$

with $TR_t \equiv TR_{cs,t} + TR_{ds,t}$. The lump-sum transfers are not directly distortionary, but enter the budget constraint of LC consumers in the model. The impact on LC disposable income affects the marginal valuation of income (2.10), which enters the labour supply decision (2.20). The

direction of the effect differs from the labour tax closure, however. The labour supply contracts when labour tax rates increase and expands in the case of lower transfers.

Firms

The economy is home to a continuum of monopolistically competitive firms. Firms are owned by NLC households, which consequently receive the firms' profits. Each firm *j* produces a differentiated good Y_t^j with capital K_{t-1}^j, labour L_t^j and Cobb-Douglass production technology:

$$Y_t^j = A_t (K_{t-1}^j)^{\alpha} (L_t^j)^{1-\alpha} \tag{2.37}$$

with $0 < \alpha < 1$. Total factor productivity A_t is identical across firms and follows the AR(1) process:

$$\ln A_t = (1 - \rho_a) \ln \bar{A} + \rho_a \ln A_{t-1} + \eta_t^a \tag{2.38}$$

where ρ_a indicates the shock persistence and η_t^a is an innovation with zero mean and standard deviation σ_a.

The cost-minimal combination of capital and labour is given by:

$$\frac{L_t^j}{K_{t-1}^j} = \frac{1-\alpha}{\alpha} \frac{i_t^k}{W_t} \tag{2.39}$$

which implies for the nominal marginal costs MC_t^j of the optimising firm:

$$MC_t^j = \frac{(i_t^k)^{\alpha} W_t^{1-\alpha}}{A_t \alpha^{\alpha} (1-\alpha)^{1-\alpha}} \tag{2.40}$$

and $MC_t^j = MC_t$. The firms face quadratic price adjustment costs γ_p and set prices P_t^j to maximise the discounted expected profit:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t^{NLC}}{\lambda_0^{NLC}} \left(\frac{P_t^j}{P_{H,t}} Y_t^j - \frac{MC_t^j}{P_{H,t}} Y_t^j - \frac{\gamma_p}{2} (\pi_t^{p,j})^2 Y_t \right) \tag{2.41}$$

with $\pi_t^{p,j} \equiv P_t^j / P_{t-1}^j - 1$. The FOC with respect to P_t^j given the demand functions (2.16) and

(2.27), the production technology (2.37) and the marginal utility of wealth of NLC households (2.4) describes the pricing behaviour of firm *j*. As the FOC is identical for all firms, pricing decisions are symmetric ($P_t^j = P_{H,t}$):

$$P_{H,t} = \frac{\varepsilon}{\varepsilon - 1 + \gamma_p \frac{P_{H,t}}{P_{H,t-1}} \pi_{H,t} - \gamma_p \beta E_t \left(\frac{\lambda_{t+1}^{NLC}}{\lambda_t^{NLC}} \frac{P_{H,t+1}}{P_{H,t}} \frac{Y_{t+1}}{Y_t} \pi_{H,t+1} \right)} MC_t \tag{2.42}$$

with $\pi_{H,t} \equiv P_{H,t} / P_{H,t-1} - 1$ as the percentage change of the GDP price deflator.[4] Contrary to the Calvo model of staggered price setting which implies price dispersion, the pricing behaviour under quadratic adjustment is symmetric across firms at each period in time, so that firm-level output can be aggregated easily to total domestic production:

$$Y_t = \int_0^1 A_t (K_{t-1}^j)^{\alpha} (L_t^j)^{1-\alpha} dj = A_t K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{2.43}$$

Many small New Keynesian models with focus on monetary policy abstract for endogenous capital and use production functions with labour as the only (variable) input. Casares and McCallum (2006), and Woodford (2003) show that appropriately calibrated models with constant capital can replicate business-cycle features and match models with endogenous investment fairly well with respect to the output and inflation responses namely to monetary shocks. However, the focus in this paper on fiscal policy adds a feedback from fiscal variables, notably distortionary taxes, to physical investment, which is captured by modelling capital accumulation as endogenous process.

External accounts

The total demand for domestic output is the sum of final domestic demand, net exports and the wage/price adjustment costs ADC_t:

$$Y_t = \frac{P_t}{P_{H,t}} (C_t + I_t + G_t) + X_t - \frac{P_{F,t}}{P_{H,t}} (C_{F,t} + I_{F,t} + G_{F,t}) + ADC_t \tag{2.44}$$

[4] Kumhof and Laxton (2009) use inflation adjustment instead of price adjustment costs in their discussion of simple fiscal policy rules for open economies. Contrary to the standard *price* adjustment costs implying purely forward-looking inflation dynamics, *inflation* adjustment costs are a mechanism to generate endogenous inflation persistence.

$$ADC_t \equiv \frac{g_w}{2}(p_t^w)^2 L_t + \frac{g_p}{2}(p_{H,t})^2 Y_t$$

Inserting household and government demand functions (2.13)-(2.14) and (2.25)-(2.26) in (2.12) and (2.23) gives the consumer price level P_t without the consumption tax:

$$P_t^{1-\eta} = \eta P_{H,t}^{1-\eta} + (1-\eta) P_{F,t}^{1-\eta} \tag{2.45}$$

Exports X_t correspond to the import demand of the RoU analogously to equation (2.14):

$$X_t = (1-\eta)\zeta (P_{H,t}/P_t^*)^{-\eta} Y_t^* \tag{2.46}$$

which uses the fact that the GDP deflator and the CPI in the RoU are (almost) identical from the perspective of the small domestic economy. The parameter $\zeta \equiv \bar{Y}/\bar{Y}^*$ captures the relative size of the two regions and ensures consistency of the trade flows. We exclude price discrimination between countries, i.e. the law of one price holds.

Combining the budget constraints of the private sector, i.e. (2.2) and (2.8), and the government (2.22) with the revenue-side definition of GDP as the sum of factor and profit income gives the aggregate resource constraint of the domestic economy:

$$B_{H,t}^* = (1+i_{t-1})B_{H,t-1}^* + P_{H,t}Y_t - P_t(C_t + I_t + G_t) - P_{H,t}ADC_t \tag{2.47}$$

which is also the law of motion for the net foreign asset (NFA) position. As specified in (2.6), the nominal interest rate in the domestic economy depends on the NFA position to rule out explosive NFA dynamics (e.g., Schmitt-Grohé and Uribe, 2003) and the exogenous risk-premium shock.

Rest of monetary union

The RoU is treated as one single block. Trade with the small country is negligible in relation to output and domestic demand, so that we approximate the RoU as closed economy. The welfare function parallels the one for households in the small member country:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma}(C_t^{i*})^{1-\sigma} + \frac{\chi}{1-\sigma}(G_t^*)^{1-\sigma} - \frac{\kappa}{1+\varphi}(L_t^{i*})^{1+\varphi} \right) \tag{2.48}$$

The equivalent budget constraints imply analogous consumption, investment and labour sup-

ply decisions:

$$1/(C_t^{NLC*})^{s} - (1+t_t^{c*})/_t^{NLC*} = 0$$

$$/_t^{NLC*} / P_t^* - b(1+i_t^*)E_t(/_{t+1}^{NLC*} / P_{t+1}^*) = 0$$

$$P_t^* /_t^{NLC*} - m_t^*(1 - g_k NI_t^{i*}) = 0$$

$$bE_t /_{t+1}^{NLC*}((1 - t_{t+1}^{k*})i_{t+1}^{k*} + t_{t+1}^{k*} dP_{t+1}^*) - m_t^* + bE_t m_{t+1}^* \left(1 - d - \frac{g_k}{2}(NI_{t+1}^{i*})^2 + g_k NI_{t+1}^{i*} \frac{I_{t+1}^{i,*}}{K_t^{i,*}}\right) = 0$$

$$(1+t_t^{c*})P_t^* C_t^{LC*} = (1 - t_t^{w*})W_t^{i*} L_t^{i*} + TR_t^* - g_w / 2(p_t^{w,i*})^2 L_t^* \tag{2.49}$$

$$C_t^* \equiv (1 - slc)C_t^{NLC*} + slc C_t^{LC*} \tag{2.50}$$

$$(1 - t_t^{w*})\frac{W_t^*}{P_t^*} = \frac{q}{q-1}\frac{k(L_t^*)^j}{/_t^{tot*}} - \frac{g_w}{q-1}\frac{W_t^*}{W_{t-1}^*}p_t^{w*} + \frac{g_w}{q-1}bE_t\left(\frac{/_{t+1}^{tot*}}{/_t^{tot*}}\frac{W_{t+1}^*}{W_t^*}\frac{L_{t+1}^*}{L_t^*}p_{t+1}^{w*}\right) \tag{2.51}$$

The government budget constraint is:

$$t_t^{w*} W_t^* L_t^* + t_t^{k*}(i_t^{k*} - d)K_{t-1}^* + t_t^{c*} P_t^* C_t^* + B_t^* = P_t^* G_t^* + TR_t^* + (1+i_{t-1}^*)B_{t-1}^* \tag{2.52}$$

where $B_t^* \equiv B_{H,t}^* + B_{F,t}^*$. The fraction $B_{H,t}^*$ equals the NFA position of the small domestic economy and $B_{F,t}^*$ is RoU government debt held by RoU households.

The government adjusts labour income taxes when public debt and deficits deviate from the target levels:

$$t_t^{w*} = t_{t-1}^{w*} + f_b\left(\frac{B_{t-1}^*}{4P_{t-1}^* Y_{t-1}^*} - btar\right) + f_d \Delta\frac{B_{t-1}^*}{4P_{t-1}^* Y_{t-1}^*} \tag{2.53}$$

Fiscal authorities in the RoU may also react to cyclical fluctuations. However, given our focus on the small domestic member country and the availability of monetary policy at the aggregate RoU level, we abstract from countercyclical fiscal rules in the RoU.

The central bank sets interest rates according to the simple rule:

$$i_t^* = \gamma_i i_{t-1}^* + (1-\gamma_i)(1-\beta)/\beta + (1-\gamma_i)(\gamma_y \Delta \ln Y_{t-1}^* + \gamma_p \pi_{t-1}^*) \tag{2.54}$$

The RoU firms face a profit maximisation problem analogous to firms in the small domestic economy, which determines the foreign price level:

$$P_t^* = \frac{\varepsilon}{\varepsilon - 1 + \theta_p \frac{P_t^*}{P_{t-1}^*}\pi_t^* - \theta_p \beta E_t \left(\frac{\lambda_{t+1}^{NLC*}}{\lambda_t^{NLC*}} \frac{P_{t+1}^*}{P_t^*} \frac{Y_{t+1}^*}{Y_t^*} \pi_{t+1}^* \right)} MC_t^* \tag{2.55}$$

with $\pi_t^* \equiv P_t^* / P_{t-1}^* - 1$. Total production is the aggregate of firm-level production:

$$Y_t^* = \int_0^1 A_t^* (K_{t-1}^{j*})^{\alpha} (L_t^{j*})^{1-\alpha} dj = A_t^* (K_{t-1}^*)^{\alpha} (L_t^*)^{1-\alpha} \tag{2.56}$$

Demand in the RoU region is the sum of private consumption, investment, government purchases and adjustment costs:

$$Y_t^* = C_t^* + I_t^* + G_t^* + ADC_t^* \tag{2.57}$$

$$ADC_t^* \equiv \frac{\theta_w}{2} (\pi_t^{w*})^2 L_t^* + \frac{\theta_p}{2} (\pi_t^*)^2 Y_t^*$$

The NFA position of the RoU is the mirror image of the small domestic economy's NFA position. However, given that $\zeta \equiv \bar{Y} / \bar{Y}^*$ is very small, the NFA position can be neglected in the aggregate resource constraint of the RoU.

Calibration

The model parameters and exogenous variables have to be given numerical values to simulate the model, which are summarised in Table 1. The data for the calibration are taken from the European Commission's AMECO and the OECD Main Economic Indicator (MEI) database.

The parameter that determine the steady-state ratios are chosen to replicate the average share of private consumption (60%), investment (20%) and government purchases (20%) in euro area GDP and the average capital stock of 300% of annual GDP during 1999-2009. The model treats all investment as private investment.

The tax rates on consumption, labour and capital income are euro area averages for 1999-

2009 from the European Commission's Taxation Trends in the European Union database. Given the level of government purchases and the distortionary tax revenue, the steady-state volume of lump-sum transfers is chosen to stabilise government debt at 70% of GDP, which is the euro area average 1999-2009. The parameters of the debt-stabilisation rule imply tax rate increases of 0.001 (1.0) percentage points per percentage-point increase in government debt-to-GDP (deficit-to-GDP) ratios beyond their target levels. The parameters of the monetary policy rule are standard and without bearing on our results.

Table 1: Parameters and steady-state ratios of the model

Parameter	Symbol	Value
Consumption	C/Y	0.60
Investment	I/Y	0.20
Government purchases	G/Y	0.20
Capital stock	K/Y	12.0
Consumption tax rate	τ^c	0.18
Labour tax rate	τ^w	0.35
Capital tax rate	τ^k	0.44
Lump-sum tax	TAX/Y	0.00
General transfers	TR/Y	0.12
Targeted transfers	TR^{LC}/Y	0.00
Debt-to-GDP target	btar	0.70
Fiscal reaction to debt	ξ_b	0.001
Fiscal reaction to deficits	ξ_d	1.00
Fiscal instrument persistence	ρ	0.50
Interest rate persistence	ψ_i	0.75
Coefficient on output growth	ψ_y	0.05
Coefficient on inflation	ψ_π	1.15
Cobb-Douglass parameter	α	0.40
Discount factor	β	0.995
Country risk premium	ω	-0.0025
Steady-state TFP level	A	0.47
Substitution elasticity for goods varieties j	ε	6.0
Substitution elasticity for labour services i	θ	6.0
Home bias	h	0.50
Weight of utility of government purchases	χ	0.33
Weight of labour disutility	κ	1.79
Intertemporal elasticity of substitution	$1/\sigma$	1.00
Labour supply elasticity	$1/\varphi$	0.25
Share LC households	slc	0.40
Trade price elasticity	η	1.5
Price adjustment costs	γ_p	50
Wage adjustment costs	γ_w	80
Capital adjustment costs	γ_k	30
Persistence of TFP shock	ρ_a	0.92
Persistence of risk premium shock	ρ_r	0.85
Standard deviation TFP innovation	σ_a	0.018
Standard deviation of risk innovation	σ_r	0.024

The Cobb-Douglass parameter α=0.40 is derived from the average labour income share and the marginal return to capital in the steady state. The quarterly capital depreciation rate compatible with the steady-state ratios of investment and capital is 1.7%, which together with the tax rate on capital income implies a quarterly equity premium of 2.2%, a quarterly interest rate on bonds of 0.6% and the quarterly discount factor β=0.994. The endogenous component of the country risk premium is set to ω=0.0025, i.e. one percentage-point deterioration in the NFA-to-GDP position increases the annualised borrowing rate by one basis point. An external risk premium of this size has been estimated for Spain by Aspachs-Bracons and Rabanal (2010).

The steady-state TFP level of 0.47 equalises both sides of the production function for our metric of factor inputs and output. The values of ε=6 and θ=6 for the elasticity of substitution between differentiated goods and labour services implies steady-state price and wage mark-ups of 20% that are in line with empirical estimates by Christopoulou and Vermeulen (2008). Home bias in the demand for goods h=0.50 in the small domestic economy equals 1 minus the average import-to-GDP ratio of a group of eight smaller EA-12 countries during 1999-2009.[5]

The weights of public purchases (χ=1/3) and employment (κ=1.79) in the utility function are chosen so that the euro area average levels of consumption, government purchases and employment for 1999-2009 satisfy the households' optimality conditions. The intertemporal elasticity of substitution is set to $1/\sigma$=1.0 in the benchmark model, i.e. standard logarithmic consumption utility. The value $1/\varphi$=0.25 for the elasticity of labour supply lies in the range of microeconomic estimates, even though DSGE models often use higher values (e.g., Evers et al., 2008; Fiorito and Zanella, 2008). The estimates for the share of liquidity-constrained households (slc) in the euro area cluster around 0.40 (e.g., Forni et al., 2009; Ratto et al., 2009).

The aggregate trade price elasticity η=1.5 corresponds to euro area estimates by Imbs and Méjean (2010), and the impact of higher value will be tested in the section on robustness checks. Price and wage adjustment costs are set to match the average price and wage durations of 4 and 5 quarters reported by Druant et al. (2009) and Knell (2010) and to generate demand and employment volatility in the range of empirical values for the group of smaller

[5] The countries are AUT, BEL, ESP, FIN, GRC, IRL, NLD and PRT. The focus on this group of smaller countries among the early EA members is motivated by the fact that these countries have already more than one decade of EA history to quantify the role of asymmetric shocks.

EA-12 members given the exogenous shocks. The parameter for capital adjustment costs is chosen to obtain empirically plausible values for the volatility of investment.

The technology (TFP) shock is the estimated AR(1) process for the model-consistent Solow residual given the data on real output and factor inputs. The shock is estimated on the gap between the Solow residuals of the smaller EA-12 countries and the euro area average TFP level in 1999q1-2009q4. The use of TFP gaps relative to the euro area average rather than of absolute TFP levels derives from the focus on asymmetric shocks the. In the same spirit, the risk-premium shock is the estimated AR(1) dynamics of the smaller EA-12 countries' interest rate spread over the German rate for 10-year government bonds in 1999q1-2009q4. The null hypothesis that the estimated innovations to the relative TFP level and the risk premium are uncorrelated is not rejected at conventional levels.

Table 2: Comparing model and data moments

Variable	Baseline calibration		Actual data					
	Correlation with output	Standard deviation	Correlation with output			Standard deviation		
			Mean	Max	Min	Mean	Max	Min
Output	1.00	0.02	1.00	1.00	1.00	0.02	0.03	0.01
Consumption	0.67	1.61	0.78	0.94	0.42	0.74	1.21	0.26
Investment	0.66	3.18	0.82	0.94	0.68	2.77	3.59	1.70
Gov. purchases	1.00	1.00	0.17	0.48	-0.12	0.97	2.47	0.42
Trade balance	-0.42	1.03	-0.25	0.20	-0.66	1.13	1.42	0.80
Employment	0.39	1.18	0.63	0.96	0.29	0.70	1.40	0.47
Inflation	0.10	0.15	0.12	0.68	-0.40	0.57	1.05	0.37

Note: All moments are based on quarterly data. Except for inflation and the trade balance, the variables are in logarithms and model-generated and data series HP-filtered (λ=1600). The mean for actual data is the non-weighted average AUT, BEL, ESP, FIN, GRC, IRL, NLD and PRT during 1999q1-2009q4; maximum and minimum values refer to the highest and lowest ranking country in this group for a particular measure. The data are seasonally and working-day adjusted. The trade balance is relative to GDP, and inflation is the year-on-year percentage change in the core CPI. The standard deviation is the absolute standard deviation for output and the standard deviation relative to the standard deviation of output for all other variables.

Table 2 compares characteristic moments of the benchmark model under the combination of TFP and risk premium shocks and in the absence of fiscal stabilisation of business cycle fluctuations to data for the group of smaller EA12 countries in the period 1999q1-2009q4. The table shows that the model matches important aspects of the data. Namely, the model replicates the correlation of private demand, the trade balance, employment and inflation with output at business cycle frequencies in qualitative terms. Data patterns of the relative volatility are also replicated. Namely, the model replicates the observed high volatility of investment. The size of model-generated the trade balance and employment volatility lies within the range

of values in the data. Compared to the data, private consumption is more volatile in the model, which is linked to fixing the share of government purchases to GDP in the baseline model, so that private demand absorbs additional fluctuations in aggregate demand. The low volatility of CPI inflation in the model relative to the data can be linked partly to the assumption of constant import prices in the model simulations, which derives from the exclusive focus on country-specific shocks.

We present simulations for the different fiscal instrument rules for an interval of values of ξ_p in steps of 0.1 and display the welfare gains or costs of $\xi_p \neq 0$ in steady-state consumption equivalents for NLC households, LC households and the population average, which is the weighted average of both groups.

3. Fiscal policy rules and welfare

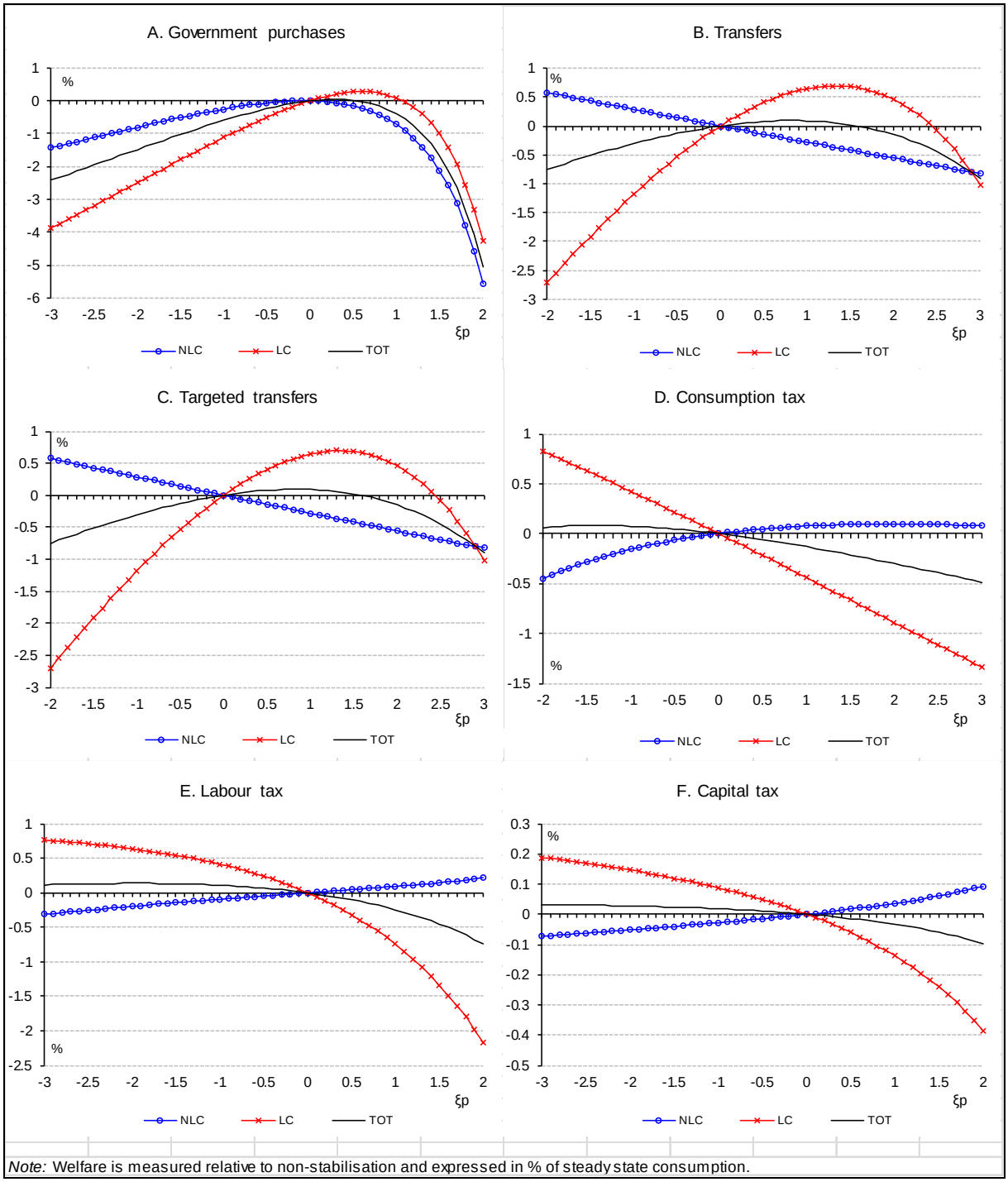
We now turn to the welfare effects of fiscal policy rules of type (2.28)-(2.33), namely the potential welfare gain in the context of business cycle stabilisation. The simulations will illustrate that the link between cyclical and debt/deficit stabilisation is important in the assessment of the welfare effects of fiscal policy. If a deviation of the government debt/deficit level from target in the context of business cycle stabilisation has to be offset by distortionary fiscal instruments, the associated supply and demand effects must be included in welfare comparisons.

Given the relevance of second-round effects associated with the budget closure rule, we first present a scenario in which such effects are absent. In this scenario, the closure rule (2.34) implements debt/deficit stabilisation. As the lump-sum taxes are levied exclusively on NLC households, they do not alter the disposable period income of LC consumers. Given the symmetric design of the fiscal stabilisation rules (2.28)-(2.33), the net lump-sum revenue collected from NLC households for budget stabilisation zero in the long run.

Figure 1 illustrates the performance of the fiscal policy rules (2.28)-(2.33) in welfare terms in the environment with TFP and risk premium shocks and with the lump-sum tax closure rule (2.34). The welfare effects are larger for LC consumers, who are unable to smooth income fluctuations over time, i.e. LC households benefit (suffer) more than NLC households from fiscal policies that stabilise (amplify) temporary income fluctuations. As LC and NLC households have the same welfare function (2.1), LC welfare increases if fiscal policy mitigates the

liquidity constraint in a way that allows LC households to mimic the optimal response of NLC households to the different shocks.

Figure 1: Welfare under fiscal rules with budget stabilisation by lump-sum tax



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

We obtain the following results for the different fiscal instruments with lump-sum budget closure in Figure 1:

- Government purchase rule (A): The optimal policy from the perspective of *NLC* households is (basically) no response in (2.28) to the terms of trade, i.e. $\xi_p=0$, so that the share of government purchases in GDP is constant over time. NLC households can freely borrow and lend to smooth the level of private consumption, so that welfare costs for NLC households relate to inefficient fluctuations of employment and consumption in the presence of price and wage stickiness and the resource costs of adjustment, which have to be weighed against additional volatility of government purchases in the welfare comparison (2.1). The optimal policy from the perspective of *LC* households is to increase government purchases relative to GDP in response to increasing terms of trade (ToT). This rather procyclical policy mitigates the tightness of the liquidity constraint and allows LC consumers to approximate the response of NLC households. As example consider the increase in domestic goods prices in response to a decline of TFP (negative supply shock) or the risk premium (positive demand shock). The negative TFP shock implies a fall in real wages and wage income. Increasing government demand mitigates the decline in LC disposable income and consumption in this context, whereas a reduction in government purchases would amplify the drop in LC revenues. The risk premium decline leads to an increase in investment and NLC consumption demand as the real interest rate declines; higher investment translates into higher marginal labour productivity, higher real wages and higher employment. LC consumption increases by less than NLC consumption, however, because LC consumers cannot borrow against future income in an environment of falling real interest rates. The procyclical increase of government purchases provides LC consumers with additional income in this situation and allows the latter to expand consumption similarly to NLC households.

- General transfer rule (B): The optimal response from the perspective of *LC* households is a positive reaction of transfers to the ToT in (2.29), i.e. to increase transfers when prices of domestic goods increase relative to foreign prices. The rationale for this rather *procyclical* response corresponds to the optimality of procyclical government purchases: increasing domestic prices in response to contracting supply or expanding NLC consumption and investment demand tighten the budget constraint of LC households by reducing the real value of the disposable wage income. Procyclical transfers smooth the purchasing power and real consumption stream of LC households by increasing (reducing) nominal income when consumption is relatively expensive

(cheap). Hence, procyclical transfers substitute for the borrowing/lending by NLC consumers and allow LC households to smooth consumption over time. *NLC* households, on the other hand, benefit from *countercyclical* transfers. The countercyclical transfers do not affect the life-time income on NLC households, but dampen excess demand in situations of supply contraction or demand expansion, with the effect of reducing fluctuations in wages and prices, the associated adjustment costs and employment in the case of demand shocks. Note also that in the case of the transfer rule the welfare gains (losses) from optimal (non-optimal) policy are higher (less severe) than for the government purchase rule. The reason is that procyclical (countercyclical) transfers stabilise LC consumption (employment) without increasing the volatility in government purchases which is itself detrimental from the welfare (2.1) perspective.

- Targeted transfer rule (C): In the case of targeted transfers (2.30), the optimal policy response to movements in the ToT is identical to the optimal response of general transfers in (2.29), i.e. rather procyclical transfers are optimal from the LC perspective as they mitigate the tightness of the liquidity constraint, whereas countercyclical transfers are optimal from the NLC perspective which mitigate the importance of nominal wage and price stickiness in the adjustment to shocks. As the impact on NLC welfare passes through the impact of transfers on LC consumption, general and targeted transfers that provide LC households with the same additional per capita income have identical effects as long as they are financed by lump-sum taxes levied on NLC households.

- Consumption tax rule (D): The optimal response from the perspective of *LC* households is a rather *procyclical* reaction to the ToT in (2.31), i.e. to reduce (increase) the tax rate when prices of domestically produced goods and the CPI are relatively high (low). The logic is the same as for the procyclical response of transfer or government purchases above: lowering (increasing) the tax rate when pre-tax prices are high (low) stabilises the real consumption value of the disposable income of LC households, mitigates the tightness of the liquidity constraint and weakens the correlation between wage income and consumption. Hence, procyclical taxation that stabilises the consumption value of income provides some substitute for NLC borrowing/lending to smooth real consumption to bring LC consumption closer to the optimal NLC response. The optimal tax response to the ToT is rather *countercyclical* from the NLC

perspective, i.e. increasing the tax rate when the ToT increase. Again the rationale is the dampening impact on wage and cost pressure, which dampens the relevance of nominal wage and price stickiness and the associated adjustment costs and employment fluctuations especially in response to demand shocks. The potential NLC welfare gain is smaller than with the transfer rule, however, as increasing (reducing) the tax rate when pre-tax prices are relatively high (low) amplifies the volatility of NLC consumption, which is costly in welfare terms.

- Labour tax rule (E): The optimal labour tax response to the ToT in (2.32) from the perspective of LC households is to reduce (increase) the tax rate when prices of domestically produced goods and the CPI are relatively high (low). The rationale is as for the other instruments above, namely the smoothing of after-tax disposable income especially in the case of negative (positive) supply shocks when wage income falls (rises) but goods prices increase (decrease). A labour tax reduction when the ToT increase in response to a drop in TFP, which also implies a drop in pre-tax real wages, stabilises the net wage income of LC consumers. The tax rate reduction also increases labour supply, which adds to the stabilisation of the after-tax real labour income. From the perspective of NLC households, the optimal response is to reduce (increase) the tax when the ToT fall (increase) in response to positive (negative) supply or negative (positive) demand shocks as this policy stabilises employment and keeps demand and employment closer to the levels that would prevail in an economy without nominal wage/price stickiness and liquidity constraints.

- Capital tax rule (F): The welfare evaluation of the capital tax rule (2.33) follows the same logic as in the case of the other fiscal instruments. The optimal policy from the perspective of *LC* households is to reduce (increase) the tax rate when the ToT and the domestic CPI are relatively high (low). Contrary to transfers, consumption and labour taxes, the impact of the capital tax on LC households is indirect, so that the effects and welfare gains of similar tax rate adjustments on LC households are weaker than in the other cases. Reducing (increasing) the capital tax rate when the ToT are relatively high (low) as consequence especially of negative (positive) TFP shocks stabilises the income of LC consumers indirectly: The tax reduction (increase) in response to falling (increasing) TFP raises (dampens) investment demand and capital accumulation; the investment response dampens the fall (rise) in labour productivity and real wages and

dampens the fluctuation in LC income and consumption. The same tax response to the ToT has a less stabilising impact in the case of positive (negative) interest rate shocks, because in this case the ToT increase is the consequence of an interest reduction that stimulates NLC consumption and investment demand. In the case of falling (increasing) TFP, the policy of reducing (increasing) the capital tax when prices increase (fall) increases (reduces) investment incentives in periods in which capital productivity is relatively low (high), which reduces life-time income and welfare of NLC consumers.

Taken together, the optimal policy for LC consumers in the case of a lump-sum government debt/deficit closure is rather procyclical, i.e. increasing (reducing) government spending and transfers and reducing (increasing) taxes when domestic prices are relatively high (low). The rationale is that this policy mitigates the liquidity constraint and dampens price-driven fluctuations in the purchasing power of the disposable income, so that LC consumption moves closer to the optimal NLC consumption response. The stabilisation of purchasing power appears to be particularly relevant in the case of TFP shocks where higher (lower) product prices coincide with falling (rising) real wages.

Welfare gains for NLC consumer typically require a rather *countercyclical* policy that reduces the impact of nominal rigidities, lowers the resource costs of real and nominal adjustment and stabilises employment at levels that would prevail in an economy without price/wage stickiness and liquidity constraints. Intuitively, the countercyclical fiscal response is particularly relevant in the case of demand shocks where price/wage stickiness amplify output and employment fluctuations compared to the flexible economy case. But also in the case of positive (negative) TFP shocks, where prices fall (increase), countercyclical policy is stabilising from the NLC perspective as it moves demand in the direction of the supply shift, which reduces the need for price/wage adjustment and hence the impact of nominal rigidities on the volatility of real variables.

The potential welfare gains for LC households in Figure 1 are fairly high compared to standard results for monetary or fiscal stabilisation policy in the literature that focus on intertemporal maximising agents. Kirsanova et al. (2007), e.g., find gains of 0.001% of steady-state consumption in a model with only Ricardian (NLC) households and purely forward-

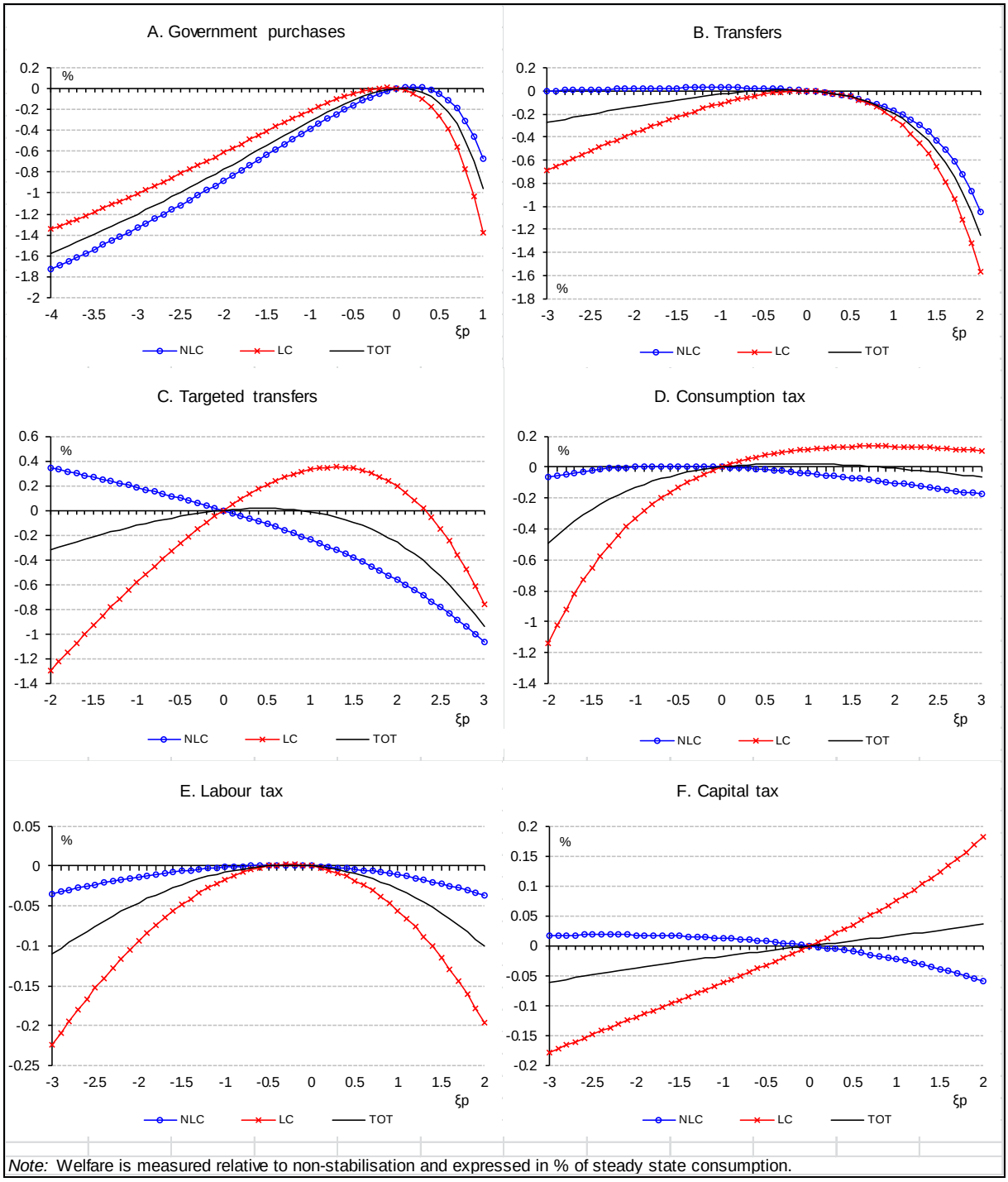
looking inflation dynamics.[6] Their result aligns with the absence of significant gains from countercyclical government purchases for NLC consumers in our model, although our analysis suggests that welfare gains for NLC households increase if one allows for an adjustment of distortionary taxes to business cycle fluctuations. Ferrero (2009) obtains welfare gains of up to 5% of steady-state consumption for flexible taxation rules in a model of monetary union with two large economies in which fiscal policy at the country level affects area-wide variables, notably inflation and inflation expectations, and in an environment in which shocks are larger and more persistent and in which the intertemporal elasticity of substitution of the NLC households is lower than in our benchmark calibration.

LC welfare gains derive from the fact that the government has an advantage over LC households in smoothing the impact of shocks (see also Kumhof and Laxton, 2009). Potential overall welfare gains, which are the weighted average of LC and NLC welfare, are much lower, however, because policies that are welfare-enhancing (welfare-reducing) for LC consumers are typically welfare-reducing (welfare-enhancing) for NLC households in the model. Furthermore, overall welfare gains from optimal policy are much smaller than the potential welfare loss from non-optimal policy. This has to be weighed against a combined welfare cost of the TFP and risk premium shocks of 0.55% (0.33%) of steady-state consumption for LC (NLC) households in the economy with nominal and real rigidities when fiscal policy does not respond to cyclical fluctuations.

The lump-sum budget closure is theoretically appealing, but not particularly realistic in practice. Most fiscal instruments are distortionary, notably those taxes that account for most of the government revenue. The budget closure (2.35) reflects this fact and imposes debt/deficit stabilisation based on the labour income tax. The labour tax affects the net disposable income of LC consumers and labour supply, wage claims and the factor mix in the economy. Results for the labour tax closure that otherwise correspond to the scenarios of Figure 1 are displayed in Figure 2.

[6] Kirsanova et al. (2007) also illustrate that there are other features than liquidity constraints, namely increasing endogenous inflation persistence, that increase the welfare costs of cyclical fluctuations and the potential gain from stabilisation policy, because fiscal/monetary stabilisation can dampen the persistence-driven overshooting price/wage adjustment in response to shocks.

Figure 2: Welfare under fiscal rules with budget stabilisation by labour tax



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

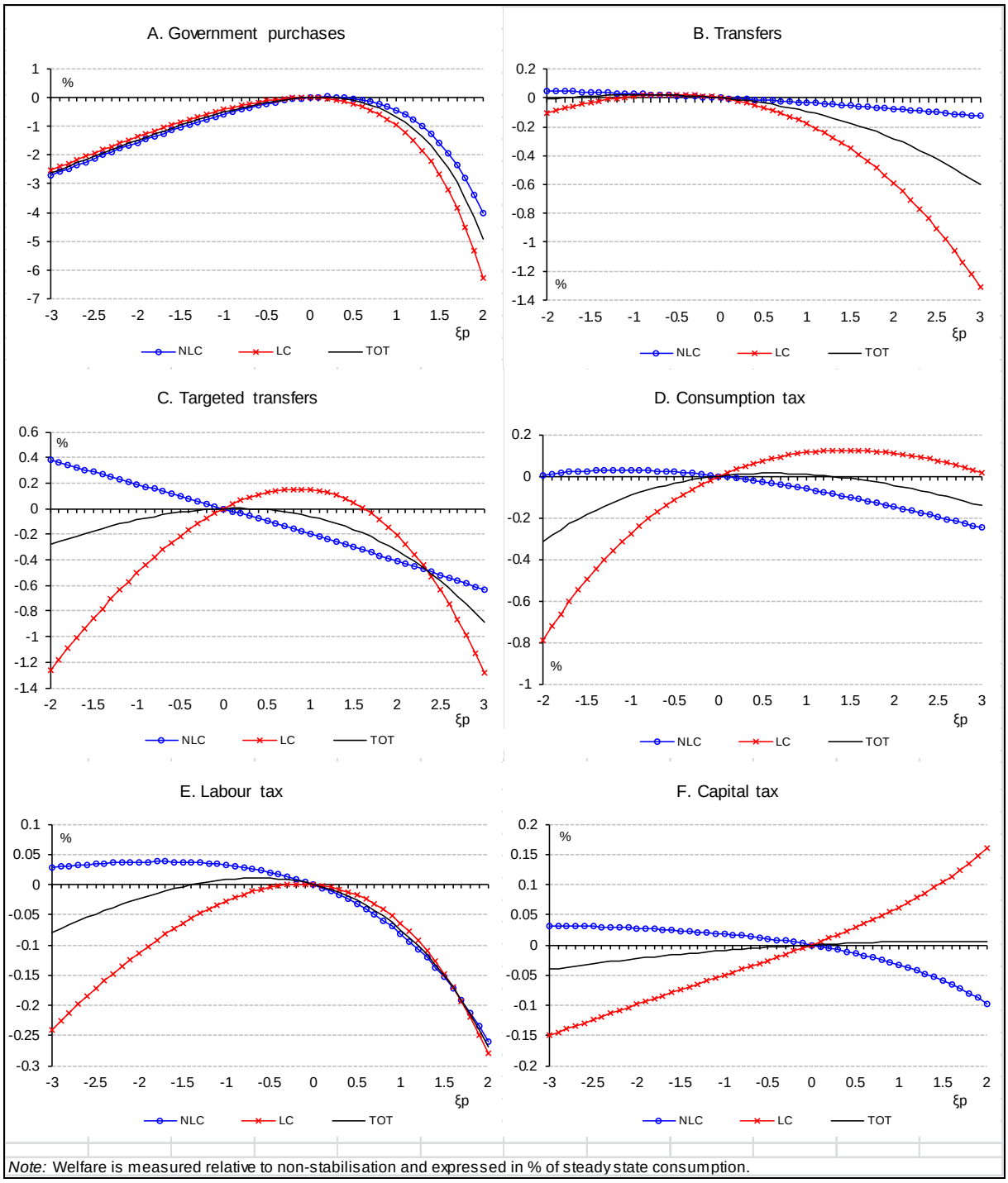
The results in Figure 2 are striking: The debt/deficit closure by labour taxation reduces the feasible welfare gains from cyclical stabilisation dramatically compared to the lump-sum closure and basically inverts the optimality results for the adjustment of consumption and capital taxes in response to cyclical fluctuations. The two results are intuitively plausible, however. The debt/deficit stabilisation by labour taxes adds a distortion to the model that affects both

supply and demand. Consider an example in which the government increases transfers to stabilise the income of LC households. The increase in government debt and deficit levels triggers an increase in the labour tax. The labour tax increase itself reduces after-tax wages and the disposable income of LC households, so that the net effect on income stabilisation is smaller than previously under the lump-sum closure; the labour tax adjustment also introduces additional fluctuations in labour supply that are likely to increase the volatility of employment and the associated welfare loss. Hence, potential net welfare gains from stabilisation policies (2.28)-(2.33) tend to be smaller if budgetary implication need to be stabilised by distortionary labour taxes.

The reversal of the optimal response of consumption and capital taxes to the ToT in Figure 2 compared to Figure 1 follows the same logic. Figure 1 illustrates that the potential welfare gain from labour tax rate adjustment for LC and NLC households tends to exceed the potential welfare gains from optimal consumption or capital tax adjustment. Hence, the optimal consumption or capital tax response changes sign in Figure 2 to allow for an offsetting labour tax response that is more efficient in addressing the welfare costs of the underlying friction. Consider, e.g., the capital tax: From the perspective of LC households, the optimal policy is no longer to reduce the tax rate in response to negative TFP shocks in order to stimulate capital accumulation and dampen the drop in real wages. Instead, optimal policy from the LC households' perspective now increases the capital tax to collect additional tax revenue that in turn allows reducing the labour income tax compared to a situation without capital tax increase. The labour tax directly raises the after tax income of LC households and is more efficient in stabilising LC disposable income than the indirect real wage effect of lower capital taxes. The results illustrate the importance of the budgetary impact of fiscal policy and of the underlying closure rule for the effectiveness of fiscal stabilisation policies.

Figure 3 displays the welfare effects of the policy rules (2.28)-(2.33) for the government debt/deficit closure by lump-sum transfers (2.36). The closure by lump-sum transfer adjustment is an intermediate case between the closure by lump-sum taxes on NLC households (2.34) and the closure by labour income taxation (2.35). The general transfer closure (2.36) lacks the distorting impact of labour taxation on labour supply and employment, but is not income-neutral for LC households, because transfer adjustments apply here to transfers received by NLC and LC households alike.

Figure 3: Welfare under fiscal rules with budget stabilisation by general transfers



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

The implications of the transfer-based debt/deficit closure for LC households in Figure 3 are similar to those of the labour tax closure in Figure 2 give the similar impact of both instruments on the disposable period income. The potential gain from cyclical transfer adjustment in response to falling (rising) LC purchasing power is reduced as the cyclical response is partly offset by the endogenous reaction of transfers to increasing (declining) debt/deficit levels.

Also similarly to Figure 2, the optimal response of taxes to ToT fluctuation from the perspective of LC households is reversed compared to Figure 1. The reason is that transfers are more efficient in mitigating the impact of the liquidity constraint than the adjustment of distortionary taxes, which partly work only through indirect channels. Here again the logic is that higher budget surpluses free space for higher lump-sum transfers and LC disposable income. The optimal tax policy from the perspective of NLC households also becomes rather *procyclical,* i.e. reducing the consumption, labour and capital tax burden in periods of excess demand and increasing prices, because the reduction of distortionary taxes financed by lower transfers, which at the same time reduce LC demand, provides a means to increase factor supply and reduce price and wage pressure. Hence, the optimal policy for NLC households is a tax shift from distortionary taxes to lump-sum taxes (here, lower transfers) in periods of excess demand, i.e. periods of relative supply shortage.

4. Robustness checks

This section provides a number of robustness checks across several dimensions of the model to assess the generality of the previous results. Unless it is explicitly mentioned otherwise, the checks focus on the policy rule for government purchases (2.28) and the lump-sum tax closure for government debt/deficit stabilisation that underlies the results in Figure 1.

4.1 Policy response to employment

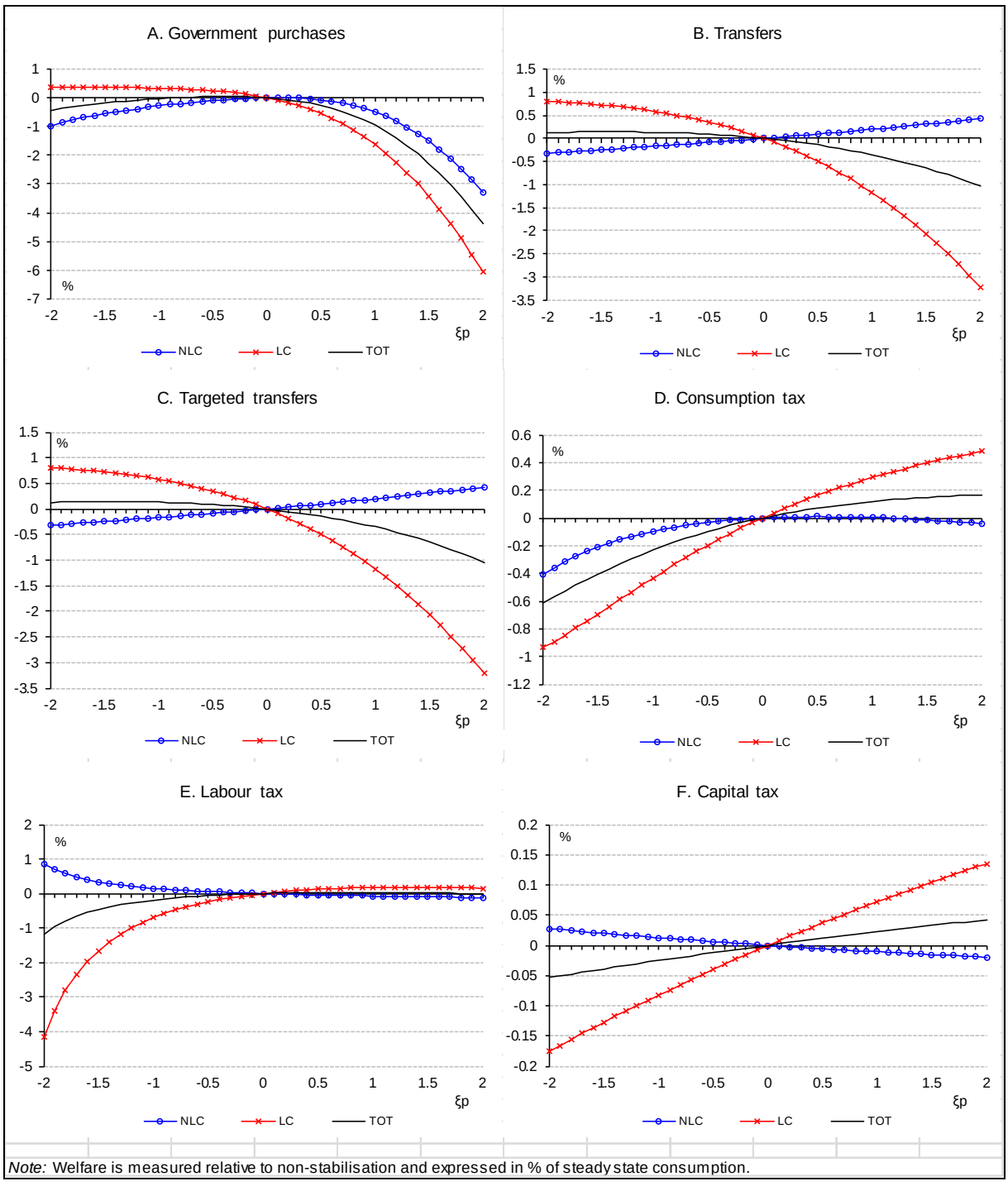
The results in section 3 may be surprising insofar as they suggest a rather procyclical response of fiscal policy to be optimal for LC consumers. LC welfare increases if government purchases and transfers are raised or taxes cut in response to an increase in the ToT. The fiscal policy rules (2.28)-(2.33) were based on the ToT as they are a more robust indicator of excess demand than output levels and because the output gap, i.e. the difference between actual output and output in the flexible economy, as alternative indicator has the theoretical disadvantage of being non-observable.

Figure 4 presents results for an alternative indictor of cyclical fluctuations, namely the domestic level of employment relative to employment in the RoU, where the latter is constant in the simulations. The fiscal policy rule (2.28) then becomes:

$$\frac{G_t}{Y_t} = \rho \frac{G_{t-1}}{Y_{t-1}} + (1-\rho)\frac{\overline{G}}{Y} + (1-\rho)\chi_p \ln\left(\frac{L_{t-1}}{L^*_{t-1}}\right) \tag{3.1}$$

The same modification is made in the other fiscal instrument rules (2.29)-(2.33).

Figure 4: Welfare under fiscal rule responding to the level of employment



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

Contrary to the reaction to the ToT, the optimal reaction of fiscal variables to cyclical fluctua-

tions in employment becomes rather *countercyclical* from the perspective of LC consumers, i.e. reducing government purchases/transfers or increasing taxes when employment is relatively high and increase government purchases/transfers or reducing taxes when employment is relatively low.

The logic behind the optimality of countercyclical responses to (relative) employment levels can be illustrated for TFP and risk premium shocks alike. A positive TFP shock increases productivity and output. The presence of nominal price stickiness delays the downward adjustment of prices, however. Demand and production in the sticky-price economy increase less than potential output and demand and production in the flexible economy. Employment remains stable in the flexible economy, but declines in the economy with nominal rigidities in which actual output lags behind the TFP increase. Hence, price stickiness delays the downward price adjustment and reduces employment in the event of positive TFP shocks. The sluggish price adjustment and the fall in employment reduce the real disposable income of LC households compared to the flexible economy. An increase of government purchases/transfers or tax reductions stimulate aggregate demand, stabilise employment and brings LC disposable income closer to the income level that would prevail in the flexible economy. The symmetric logic applies to the countercyclical response to negative TFP shocks.

Positive shocks to the risk premium reduce the interest-sensitive consumption and investment demand by NLC households. As downward price and wage adjustment in the economy with price and wage stickiness is weaker than in the flexible economy, demand and output levels decline more strongly in the former and imply a stronger decline of disposable period income. The countercyclical increase of government expenditure or tax reduction stabilises demand and employment in this situation and brings the behaviour of LC households closer to the behaviour of consumption in the flexible economy without price/wage stickiness and liquidity constraints. Symmetric reasoning applies to demand expansions in response to negative risk premium shocks.

An alternative to (3.1) is a fiscal instrument rule in which government purchases react to the employment gap as log difference between actual employment and the level of employment that would prevail in an economy without price/wage stickiness and liquidity constraints (L^f_{t-1}):

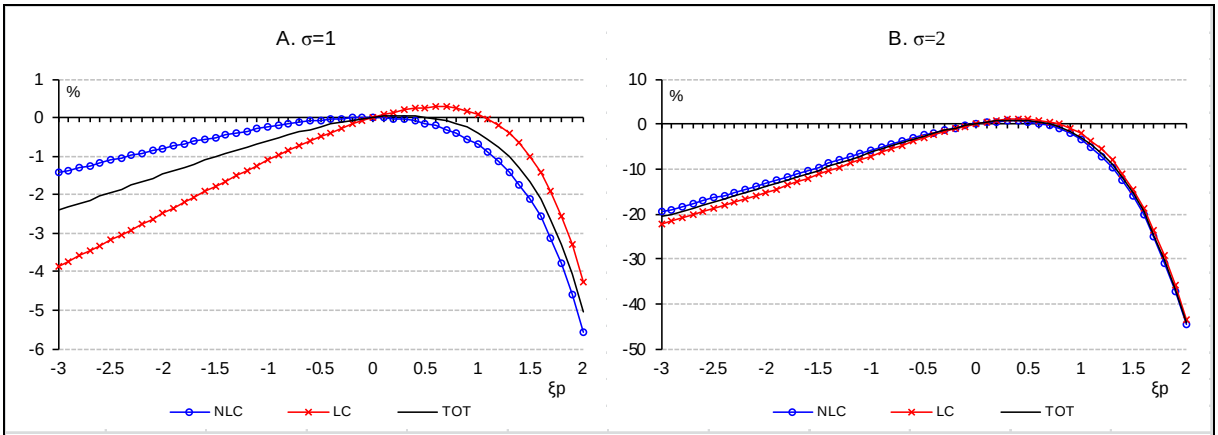
$$\frac{G_t}{Y_t} = \rho \frac{G_{t-1}}{Y_{t-1}} + (1-\rho)\frac{\overline{G}}{Y} + (1-\rho)\chi_p \ln\left(\frac{L_{t-1}}{L^f_{t-1}}\right) \tag{3.2}$$

The policy rule (3.2) for government purchases gives welfare results for LC and NLC households that are very similar to the results in Figure 4.

4.2 Intertemporal elasticity of substitution

The benchmark model in Table 1 assumes that the intertemporal elasticity of substitution is unity (σ=1), which corresponds to log consumption utility. Panel A of Figure 5 corresponds to Panel A of Figure 1. Panel B of Figure 5 presents results for an alternative scenario, in which the intertemporal elasticity of substitution is reduced to one half (σ=2). The shape of the LC and NLC losses associated with particular parameter values in the policy rule for government purchases (2.28) remains the same, but the magnitude of gains and losses increases. The potential welfare gain for LC (NLC) households increases from 0.3% (0.0%) of steady-state consumption (σ=1) to 1.3% (0.6%) of steady-state consumption (σ=2), and for both household types the optimal fiscal reaction is mildly procyclical, implying a positive response of government purchases to fluctuation in the ToT. Other than increasing the potential welfare gain from fiscal responses to cyclical fluctuations, lower values of the intertemporal elasticity of substitution also increase the welfare costs of non-optimal policy significantly as losses of up to 45% of steady-state consumption in Panel B of Figure 5 illustrate.

Figure 5: Welfare under lower intertemporal elasticity of substitution



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

4.3 Response to consumer prices

Section 3 considered fiscal instrument rules (2.28)-(2.31) that react to fluctuation in the ToT, which here is the price of domestically produced goods relative to the foreign price level given that all goods are tradable and price discrimination excluded in the model.

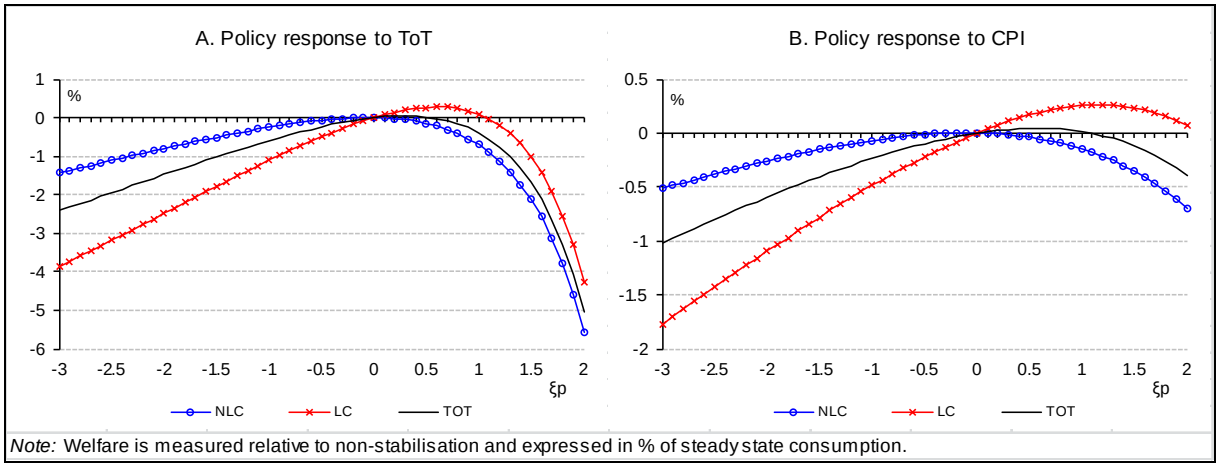
An alternative specification to (2.28) may adjust government purchases in response to fluctuations in the CPI relative to consumer prices in the RoU:

$$\frac{G_t}{Y_t} = \rho \frac{G_{t-1}}{Y_{t-1}} + (1-\rho)\frac{\overline{G}}{Y} + (1-\rho)\chi_p \ln\left(\frac{P_{t-1}}{P^*_{t-1}}\right) \tag{3.3}$$

The practical advantage of this alternative is that CPI data tend to available more timely than data for the GDP deflator, which is a precondition for timely (discretionary) policy responses.

Figure 6 shows that the welfare results for the ToT-based and CPI-based reaction functions are very similar in qualitative terms. The difference between the two policy rules is that the optimal policy from the perspective of LC households shifts to the right on the ξ_p axis, i.e. the optimal policy response becomes seemingly more aggressive with (3.3). The reason is that the price level of domestically produced goods accounts for half of the domestic CPI and that foreign prices are constant in the simulations. Consequently, the ξ_p coefficient in the policy rule (3.3) needs to be twice as large as in (2.28) to generate the same response of government purchases to cyclical conditions as in the ToT-based reaction function.

Figure 6: Welfare under fiscal rule responding to the CPI



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

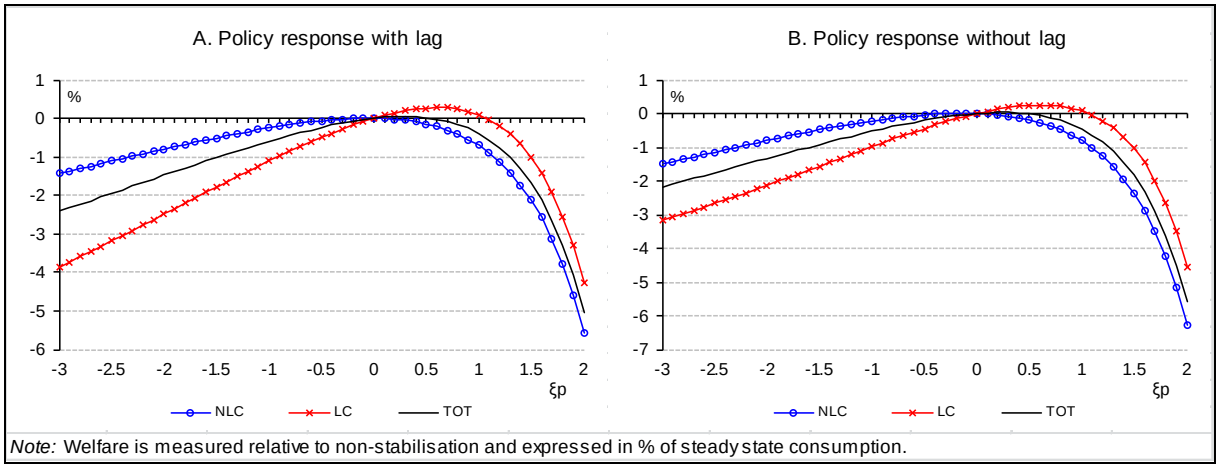
4.4 Reaction speed

The fiscal instrument rules (2.28)-(2.31) react with one quarter lag to the ToT to incorporate the notion of recognition/implementation lags in the conduct of fiscal policy. Figure 7 shows at whether the lagged reaction reduces the stabilising potential substantially by comparing (2.28) to an instrument rule with contemporaneous response to the ToT:

$$\frac{G_t}{Y_t} = (1-\rho)\frac{\overline{G}}{Y} + \rho\frac{G_{t-1}}{Y_{t-1}} + (1-\rho)\chi_p \ln\left(\frac{P_{H,t}}{P_{F,t}}\right) \tag{3.4}$$

The two panels in Figure 7 indicate no substantial difference between the lagged and the contemporaneous response of government purchases to the ToT. The shapes and positions of the LC and NLC welfare curves remain almost unchanged.

Figure 7: Welfare under fiscal rule with contemporaneous response



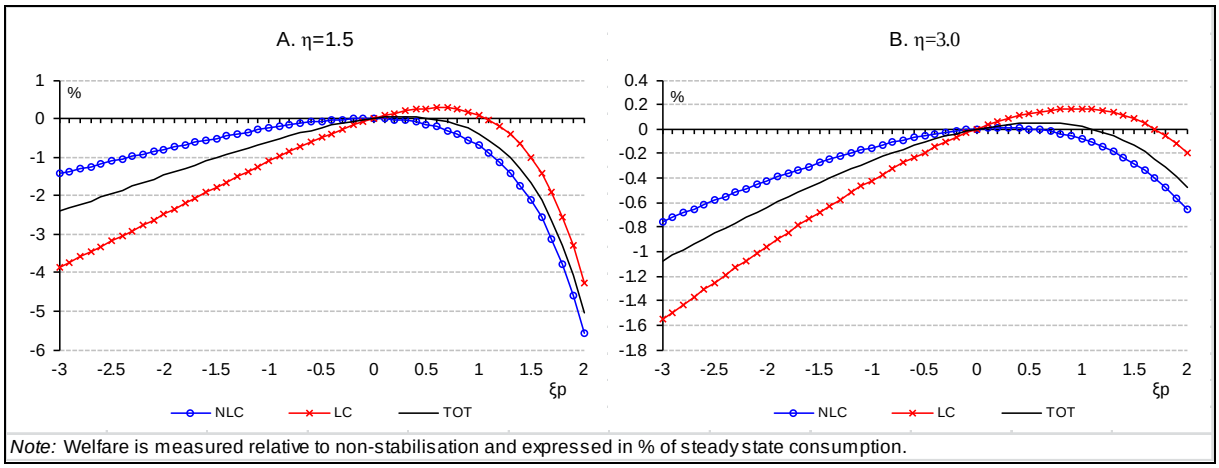
Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

4.5 Trade price elasticity

The benchmark model adopted a price elasticity of trade flows of η=1.5 (Table 1). The value corresponds to estimates based on aggregate time-series data (e.g., Imbs and Méjean, 2010) and to parameter estimated in DSGE models of the euro area (e.g., Ratto et al., 2009). The value of η=1.5 also performs well in replicating the volatility of the trade balance in response to cyclical fluctuations (Table 2). Micro-data estimates, on the other hand, finds higher trade price elasticities for several sectors and euro area countries. Correcting for aggregation bias, Imbs and Méjean (2010) suggest trade elasticity values of η=3, which we use for the robust-

ness check in Figure 8.

Figure 8: Welfare under higher trade price elasticity



Note: Welfare is measured relative to non-stabilisation and expressed in % of steady state consumption.

Higher values of the trade price elasticity strengthen the trade channel as automatic stabiliser in response to demand and supply shocks. They also reduce the impact of fluctuation in domestic prices on the real disposable income of LC consumers, because domestically produced goods (imports) are more easily substituted by imports (domestically produced goods) when the relative price of the former increases. Higher values of the trade price elasticity consequently reduce the potential welfare gain from fiscal stabilisation, most notably for LC households for whom it declines from 0.3% to 0.2% of steady state consumption.

5. Conclusions

The paper analyses fiscal stabilisation policy in a DSGE model for a small open economy in monetary union. The model includes financial, goods and labour market frictions and is calibrated to match data moments of small euro area countries over the period 1999-2009.

The paper uses the model to discuss the welfare effects on liquidity-constrained (LC) and intertemporal optimising (NLC) households of simple instruments rules in which government purchases, transfers and taxation react to supply (TFP) and demand (risk premium) shocks. Instead of limiting the discussion on optimal simple rules, we show welfare gains/costs for a broader range of policy parameters to illustrate the robustness of the simple rules and the costs of non-optimal policy.

We find a dichotomy in the welfare gains/costs from simple fiscal instrument rules for LC and

NLC households. In situations where LC households gain from a particular fiscal policy rule, NLC households tend to lose from the latter. Hence, which policy is optimal depends on the household type. The overall welfare effect as the population-weighted average on LC and NLC welfare gains/costs tends to follow the outcome for LC households as the impact of fiscal policy on LC household welfare in the model is typically much larger than the impact on NLC welfare.

In the benchmark setting, fiscal variables react to fluctuations in the terms of trade (ToT) as indicator for excess demand in the economy and lump-sum taxes on NLC households are the fiscal instrument used to close the government budget constraint and stabilise government debt and deficits at their target levels. The optimal policy from the perspective of LC consumers is rather procyclical in this environment, i.e. increasing (reducing) government spending and transfers and reducing (increasing) taxes when the level of domestic prices is relatively high (low). Given the home bias in consumption and the assumed exogeneity of import prices, domestic consumer prices fluctuate proportionally with the price level of domestically produced goods. The procyclical fiscal policy response mitigates the liquidity constraint and dampens price-driven fluctuations in the purchasing power of the disposable income, so that LC households come closer to replicating the optimal response of NLC households in response to TFP and risk premium shocks. Increasing (reducing) transfers and government purchases, which generate additional demand and wage income, or reducing (increasing) taxes when goods are relatively expensive (cheap) moves the disposable nominal income of LC consumers in line with goods prices. It stabilises the real disposable income of LC households and allows the latter to consume a smooth stream of consumption in real terms despite the liquidity constraint. NLC households have no extra gain from such procyclical fiscal policy as they are able to smooth the real stream of consumption through intertemporal income transfer, i.e. by borrowing and lending in financial markets. An increase in nominal disposable income to smooth real consumption when domestic prices are high will, however, lead to increasing net imports, i.e. a deterioration of the trade balance.

The (lower) welfare gains for NLC consumer typically require countercyclical policies which keep actual output close to potential output. The countercyclical policy of stabilising actual output around its potential level reduces upward/downward price and wage pressure in the economy, which reduces the impact and economic costs of nominal price/wage and real rigidities. The countercyclical policy helps stabilising activity and employment closer to the levels

that would prevail in an economy without price/wage stickiness and liquidity constraints.

The paper also shows that fiscal policy rules that react to fluctuation in the (relative) level of employment or the employment gap are good and robust alternatives to instrument rules reacting to the ToT. Fiscal policy rules that respond to fluctuations in employment or the employment gap stabilise employment around the level that would prevail in the flexible economy. Through this channel such rules also stabilise the disposable income of LC households, so that LC consumption comes closer to tracking consumption in the flexible economy. In fiscal rules where the instrument reacts to employment, optimal policy from the perspective of LC households is countercyclical, i.e. increasing expenditure (reducing taxes) if employment is relatively low and vice versa, which is more in line with conventional views of optimal fiscal policy than the apparently procyclical reaction to the terms of trade.

The analysis also shows that assumptions about government debt/deficit stabilisation, i.e. the nature of the budget closure rule, are very important for the welfare implications of fiscal policy. Changing the government debt/deficit closure from (idealistic) lump-sum taxes to, e.g., distortionary labour taxation lowers the potential welfare gain from fiscal stabilisation policies and inverts the optimality results for consumption and capital taxes.

The analysis focuses on cyclical stabilisation in response to *temporary* shocks that imply temporary deviations of macroeconomic variables from steady-state levels. It does not address the potential of fiscal variables to correct persistent imbalances in competitiveness and economic activity, which is the topic of the literature on fiscal devaluations (e.g., de Mooij and Keen, 2012; Farhi et al., 2011). The result that rather procyclical fiscal policy, which increases (reduces) government expenditure (taxes) when domestic goods are relatively expensive (excess demand) would be optimal from the perspective of LC households, appears rather problematic from the external imbalance perspective, because such policy tend to amplify the swings in domestic demand and external accounts. Subsequent work could discuss the implications of the optimal policies for current account and net foreign asset positions. Fiscal policy rules with countercyclical response to employment may be preferable from this perspective. Further work may also enlarge the set of fiscal instruments available for stabilisation purposes to include, e.g., government employment, public investment, and unemployment benefits.

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