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Stabilisation and rebalancing with fiscal or monetary devaluation: a model-based comparison

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Stabilisation and rebalancing with fiscal or monetary devaluation

A model-based comparison

Lukas Vogel

Abstract

The paper uses a small open economy general-equilibrium model to compare fiscal and nominal exchange rate devaluation with respect to their impact on economic activity and the current account. In particular, it investigates the extent to which fiscal devaluation mimics nominal exchange rate adjustment and mitigates the output loss associated with demand rebalancing and external adjustment. The results suggest that internal or external devaluation can support external adjustment and mitigate its impact on economic activity, without leading to lasting adjustment themselves. However, the quantitative contribution of a tax shift from labour to consumption, the standard example of fiscal devaluation, remains moderate.

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1. INTRODUCTION

The experience of the euro area (EA) illustrates that price dynamics and real exchange rates can diverge greatly between countries that share a nominal exchange rate (EXR) or even a common currency. Much of the external adjustment (trade balance improvement) in countries at the EA periphery in recent years occurred through import contraction rather than export growth, i.e. it has been driven by week domestic demand rather than competitiveness gains (Kang and Shambaugh 2014, Tressel and Wang 2014, Tressel et al. 2014).

Against this background, the concept of internal (fiscal) devaluation has gained particular attention in the rebalancing debate, which refers to real EXR adjustment under fixed nominal EXRs. The idea of fiscal devaluation is that fiscal tools can be used to support and accelerate real EXR adjustment, improve price competitiveness, reduce external imbalances and support domestic economic activity in the absence of flexible nominal EXRs and monetary policy independence.

As long as wages and prices are somewhat flexible on the downside, wage and price adjustment should eventually produce internal devaluation also in the absence of supportive policies. In particular, downward pressure on wages and prices should increase price competitiveness and strengthen net trade in an economy characterised by contracting demand. Sluggish price and wage adjustment can imply substantial economic costs in terms of declining economic activity and employment in the transition period, however. In the presence of downward nominal rigidity, real wage and price adjustment becomes particularly muted in an environment of globally low aggregate inflation. Therefore, the costs and limits of purely market-based adjustment have motivated the search for policies to support real devaluation.

This paper addresses the question of whether fiscal devaluation measures can support external rebalancing and mitigate the costs in terms of falling domestic economic activity by shifting adjustment from domestic demand contraction towards net export growth. The paper uses the European Commission's QUEST macroeconomic model (Ratto et al. 2009) to provide a quantitative general-equilibrium analysis of two sets of measures, i.e. (i) a government revenue shift from employer social security contributions (SSC) to the consumption tax (VAT), and (ii) an import tax-export subsidy combination. The tax shift from labour to consumption corresponds to the general use of "fiscal devaluation" in the current literature (e.g., Burgert and Roeger 2014, de Mooij and Keen 2013, Engler et al. 2014, Koske 2013, Puglisi 2014), whereas import taxes and export subsidies are conceptually close substitutes to nominal EXR adjustment as they directly affect the net price of exports and imports, as stressed by Keynes (1981).

The paper by Farhi et al. (2015) derives exact conditions for the equivalence of fiscal (in the form of a tax shift from labour to consumption or a combination of import tax and export subsidy) and monetary devaluation (nominal EXR re-pegging) in a simple New-Keynesian open economy model. The comparison becomes more complex in QUEST and other large-scale models that add, e.g., different household types, trade in intermediate inputs, and a broader set of adjustment frictions. This paper does not aim at extending the equivalence results to a more complex model environment, but considers fiscal measures of a simple form and compares numerical outcomes instead. The comparison focuses on the ability of fiscal devaluation to support rebalancing and stabilise economic activity in a demand-driven recession. The inclusion in the model of different types of households also allows for a discussion of distributional effects of the different policy measures.

The optimal policy perspective in Langot et al. (2012) analyses the welfare implications of the tax shift from labour to consumption based on household utility and stresses the existence of a trade-off between lower labour market distortions and the decline of agents' purchasing power on the import side. The present paper with its perspective on rebalancing relates to situations in which domestic demand and external deficits are unsustainably high, so that falling import demand is part of the rebalancing rather than a negative side effect. Instead of utility-based welfare comparison, the policy measures are compared according to their impact on external accounts and domestic economic activity.

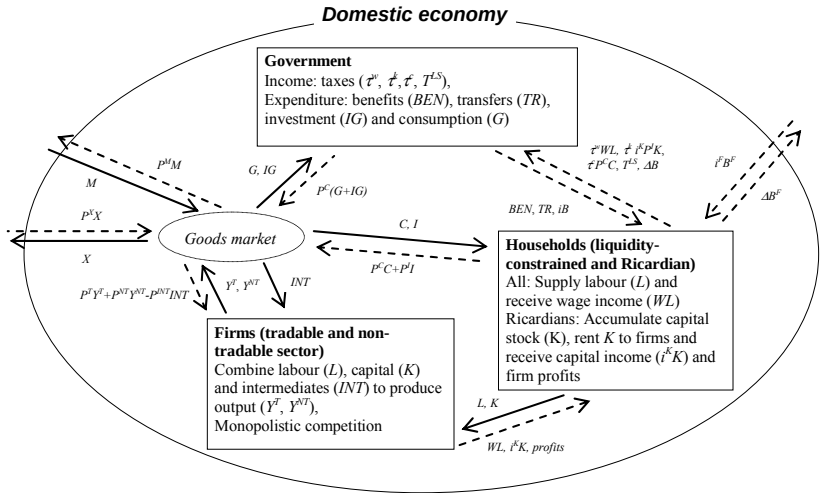
A further aspect of fiscal devaluation is the question of cross-border spillovers, i.e. whether fiscal devaluation benefits neighbouring countries by strengthening activity and import demand in the reforming economy, or whether it leads to a deterioration of price competitive-ness and activity elsewhere. Lipinska and von Thadden (2012) argue that there is little spillover from fiscal devaluation between countries in a monetary union. This paper excludes the

question of spillover and the question of potential foreign "retaliation" on the basis of our small-economy assumption for the reforming country.

2. ANALYTICAL FRAMEWORK

The analysis uses a QUEST version for a small open economy with two production sectors (tradable and non-tradable goods) and international trade in final goods and intermediate inputs. Graph 1 summarises the main model blocks. A detailed model description is provided in the appendix.

Graph 1: Basic structure of QUEST with tradable and nontradable sectors



The household sector of the model includes two types of households, namely intertemporally optimising households (60% of the population) and liquidity-constrained ones (40%). Inter-temporally optimising households have access to financial markets to smooth consumption over time and invest in different assets, namely productive capital, government bonds, and foreign assets. Liquidity-constrained households simply consume their current disposable wage and transfer income in every period.

The production sector of the model features monopolistic competition in labour and goods markets. Labour unions set wages; monopolistically competitive firms set prices. The wages and prices adjust sluggishly to demand and supply shocks. Besides nominal price and wage stickiness, the model also includes real rigidities such as labour and capital adjustment costs and inertia in the response of trade to changes in relative prices, which gives rise to a J-curve effect in the trade balance. The model includes trade in final and intermediate goods. The inclusion of trade in intermediates accounts for the importance of global value chains in the production process and the significant import content of exports. The share of imported value added in gross exports has reached 20-30% in the large EU Member States in recent years and is substantially higher for smaller and more open economies (Ollivaud et al. 2015).

The government consumes, invests in public infrastructure, and pays benefits and transfers to households. Government spending on consumption and investment are kept constant in real terms. The government levies taxes on consumption, labour and corporate income, and issues debt to finance the expenditures. A budget-closure rule based on lump-sum taxes is in place to ensure the stability of government debt in the long term. The fiscal devaluation measures in the simulations are ex-ante (i.e. all else equal) budgetary neutral, but ex-post tax revenue may be affected through tax-base effects.

The nominal EXR of the domestic economy is fixed. The nominal short-term interest rate in the domestic economy equals the foreign rate plus an endogenous country-specific risk premium that depends on the net foreign asset (NFA) position of the domestic economy. Negative NFA positions, i.e. net foreign indebtedness, imply a positive risk premium.

Following the standard notion of fiscal devaluation, the simulations consider a reduction in labour and production costs by shifting government revenue collection from employer SSC to the VAT. As theoretical benchmark the subsequent section also depicts a hypothetical combination of an import tax and an export subsidy, i.e. a combination that directly changes the price of tradables and improves trade competitiveness.

The import tax-export subsidy combination seems closest to nominal EXR depreciation. The import tax increases the price of imported goods, while the export subsidy reduces the price of exports. Hence, both measures improve the price competitiveness of domestic tradable goods in domestic and foreign markets and imply expenditure switching towards goods produced in the domestic economy. The share of domestically produced goods in domestic demand increases (fewer imports); the share of domestic exports in foreign demand increases (more exports). With trade in intermediate goods, however, import taxes and export subsidies that apply to final goods and intermediates alike mitigate the competitiveness gain. Like nominal EXR depreciation, an import tax on intermediates also raises domestic production costs through higher prices of imported intermediaries, whereas export subsidies subsidise not only foreign final demand but also production abroad.

In addition to the immediate impact on relative prices, fiscal measures also have second round effects. In particular, import taxes create upward pressure on domestic prices via growing wage claims and production costs if labour supply is sensitive to the real purchasing power of wages. Such pass-through into domestic prices raises inflation expectations and reduces real interest rates in the adjustment process, which strengthens domestic and import demand.

The import tax-export subsidy combination is an interesting benchmark as its transmission is very similar to the transmission of EXR devaluation into prices and real variables. In practice, international trade rules preclude such scenario, whereas taxes on product categories that are predominantly imported or temporary support to export-oriented industries can replicate (only) some of the effects. As previously mentioned, the theoretical import tax-export subsidy scenario also excludes retaliation by trading partners that otherwise offsets competitiveness gains for the domestic economy.

The tax shift from labour to consumption as standard internal devaluation scenario replicates the effects of external devaluation in so far as it makes domestic consumption more and domestic production less expensive due to the reduction in domestic labour costs. Higher after-tax consumption prices and lower production costs now apply to all goods and services, how-ever, and not only to imported and exported ones.

Based on data for 2007, Boscá et al. (2013) show that EMU member states with a high levels of SSC used to tax consumption relatively lightly, which suggests space for a tax shift from labour to consumption. They also depict a negative correlation between a high tax burden on labour relative to consumption taxation and current account positions, suggesting that the tax mix affects net trade and the current account.

The following section will presents simulation results for the impact of fiscal devaluation on economic activity, relative prices and the external position and compares these results to the impact of nominal EXR adjustment. The measures are implemented on the baseline of an economy in recession characterised by a strong contraction in domestic private consumption and investment demand.

3. SIMULATION RESULTS

This section compares fiscal devaluation with nominal EXR adjustment for an economy in recession. More specifically, the economy is subject to negative shocks to domestic demand which lead to a domestic demand contraction by 10% on impact, i.e. a contraction of domestic demand in the order of magnitude experienced by several European economies in recent years. The fall in domestic demand is spread proportionally across private consumption and investment in the example.

The panels of the following figures show five different policy settings (summarised in Table 1): First, the domestic economy with fixed nominal EXR and without fiscal devaluation (FIX). Second, the domestic economy with fixed nominal EXR and a large ex-ante budgetary neutral (permanent) tax shift from labour to consumption that reduces

the SSC rate by ten percentage points and increases the VAT rate by seven percentage points (SSC).[1] Third, the domestic economy with fixed nominal EXR with the theoretical case of a budgetary neutral (permanent) export subsidy of ten percent financed by import taxation of the same level (XSU).[2] Fourth, the domestic economy keeps a nominal peg, but the peg is adjusted (permanently) in the direction of ten percent depreciation of the domestic currency (REP); obviously re-pegging is possible only with a domestic currency, not within monetary union. Fifth, the same contractionary demand shocks in an otherwise identical economy with flexible nominal EXR (FXR) in which monetary policy follows the instrument rule $i_t = \rho i_{t-1} + (1-\rho)\alpha E_t \sum_{i=1}^{4} 0.25\pi^{C}_{t+i}$ with interest rates and CPI inflation defined in deviations from theirs long-term trends, and with ρ=0.7 and α=1.5.[3]

Table 1: Different monetary and fiscal policy settings in the simulations

Label	Nominal exchange rate	Fiscal measures
FIX	Fix	-
SSC	Fix	10pp SSC reduction; 7pp VAT increase
XSU	Fix	10% export subsidy and import tax
REP	10% devaluation	-
FXR	Flexible	-

Graph 2 present the responses of main macroeconomic variables to the 10% domestic demand contraction under the five alternative policy settings summarised in Table 1. The scenario assumes that the economy enters recession with a balanced net foreign asset position; an alternative scenario in which the economy enters the recession with high levels of foreign indebtedness can be found further below.

The contraction of domestic demand pushes domestic wages and prices downwards. Given the exogenous nominal interest rate in the fixed EXR setting (FIX) the real interest rate increases on impact, which reinforces the decline in interest-sensitive domestic demand. The real effective EXR (REER) depreciates, which leads to an improvement in the trade balance (TB) and the current account (CA). The persistent CA improvement translates into a persistent improvement in the net foreign asset (NFA) position. Government debt rises due to a sharp deterioration in the primary budget balance (shrinking tax bases, higher expenditure on unemployment benefits) until the budget-closure rule offsets the negative tax base effect.

Comparing the different scenarios, the initial contraction of economic activity as measured by the drop in real GDP and employment is strongest in the setting with fixed EXR and unchanged fiscal policy (FIX) in which domestic demand contracts strongly due to the sharp increase in the real interest rate (4pp on impact) associated with gradual price adjustment. Export volumes improve moderately and gradually (peaking at 6% improvement after 5 years) due to the sluggish REER depreciation under the fixed nominal EXR. The FIX scenario displays sizable improvement in the CA position. However, this improvement is driven mainly by the contraction of domestic and import demand rather than by export growth.

Adjusting the EXR peg to devalue the domestic currency (REP) dampens the contraction of economic activity substantially compared to FIX. The 10% devaluation in Graph 2 almost offsets the decline in economic activity associated with the contraction of domestic demand. REP limits the trough in real GDP (employment) to -2% (-1%) compared to the -8% (-6%) contraction in FIX, i.e. it offsets ¾ of the initial contraction in economic activity. In particular, REP strengthens net exports, so that the improvement in net trade is driven predominantly by export growth. The EXR devaluation implies upward pressure on prices as imports become more expensive, which

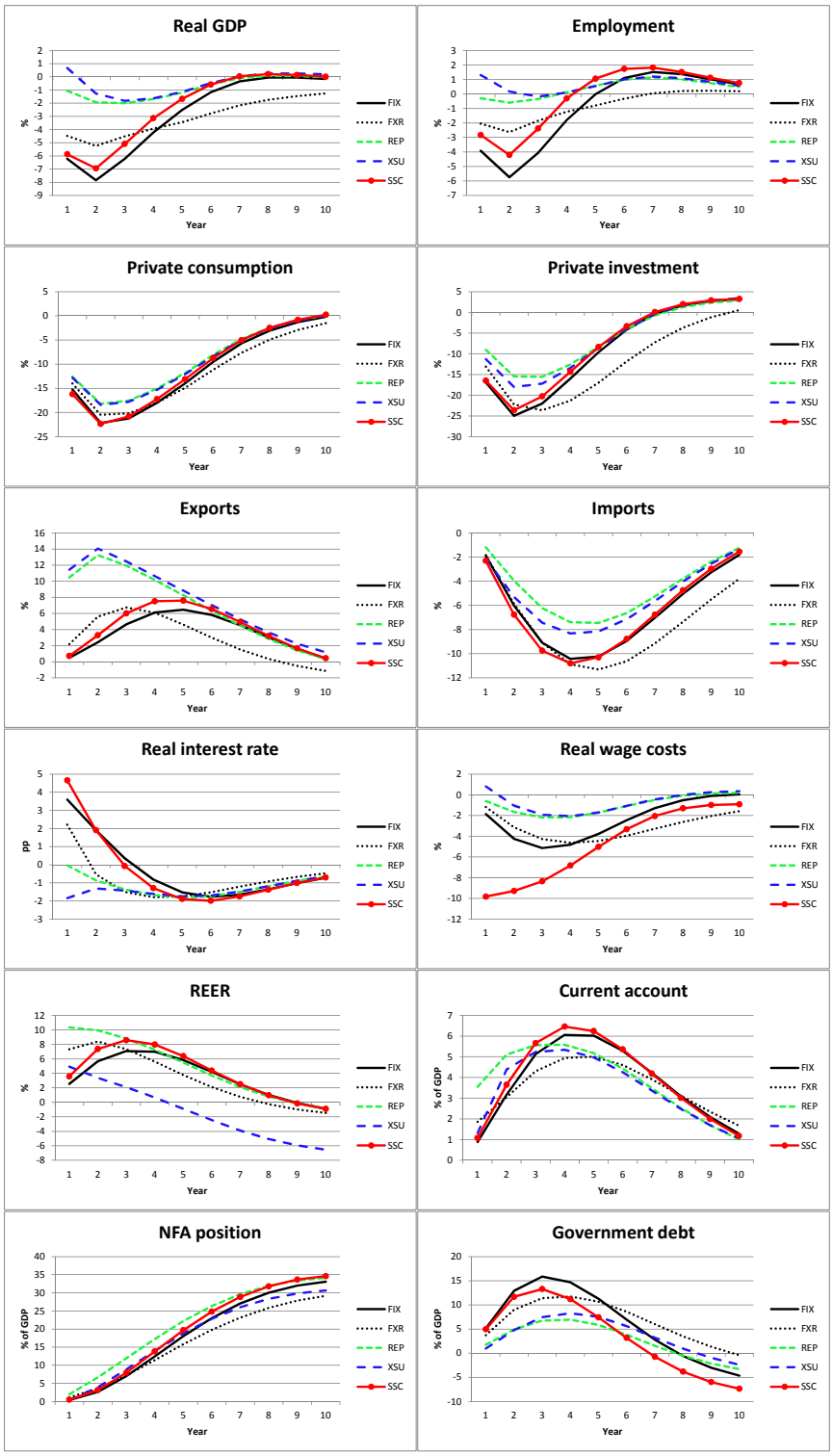
[1] The level of employer SSC in EU countries is within the range of 10-40 per cent of labour costs, but the tax shifts that have been implemented in selected EU Member States in recent years have been much smaller (Bernoth et al. 2014).

[2] Export subsidies imply a transfer of wealth to foreigners, leading to deterioration of the trade balance and the NFA position at given trade volumes. The import tax does not affect foreign prices and has no direct wealth effect under the small-country assumption. A demand shift towards domestic output in response to an import tax may raise domestic wages and prices, however, and increase export prices unless compensated by export subsidies. The latter would imply an income transfer from foreigners to the domestic households if domestic and foreign goods are imperfect substitutes, i.e. if domestic households have some price setting power.

[3] The monetary policy rule implements CPI inflation targeting at a one-year horizon and includes interest rate persistence that generates a 2-quarter half-life of past interest rate decisions. The parameters are in the range of parameter estimates and calibrations in the literature, but remain purely illustrative. Alternative monetary policy rules with other parameter values or additional arguments would lead to quantitatively different FXR results.

increases the real interest rate. The decline in the real interest rate and the stabilisation of output and employment stabilise domestic and particularly investment demand. By stabilising economic activity, REP also limits the deterioration in the primary government balance and the rise in government debt. The rise in government debt to GDP peaks at 7pp compared to 16pp under the unchanged EXR peg (FIX).

Graph 2: Fiscal and exchange rate devaluation with initially balanced NFA position



Note: An increase in the REER represents real effective exchange rate depreciation.

The nominal and real EXR adjustment and the degree of stabilisation in the REP scenario of 10% EXR devaluation is stronger than the scenario with flexible EXR and independent monetary policy (FXR), due to gradual adjustment of the policy rate in response to price developments. The gradual adjustment leads to an initial increase in the real interest rate, which dampens interest-sensitive domestic demand. Consequently, the CA improvement is driven more by contracting imports rather than increasing exports compared to the REP scenario. A more aggressive and immediate monetary policy response to output contraction and below-target inflation would improve the stabilising impact of monetary policy in FXR in the short term. Such aggressive response may not be feasible when monetary policy reaches the zero bound (ZLB) in the recession, a situation in which alternative (fiscal) measures gain relevance also in economies with flexible EXR and independent monetary policy; see, e.g., Correia et al. (2013) on fiscal policy options at the ZLB.[4]

The theoretical case of a joint import tax and export subsidy of 10% each (XSU) has very similar effects to the 10% EXR devaluation (REP) in Graph 2. The increase in import prices leads to a temporary decline in the real interest rate, which mitigates the fall in domestic demand. Subsidised exports increase strongly, while the decline in import demand is mitigated by the stabilisation of domestic demand. Real GDP and employment even increase on impact for the 10% tax and subsidy combination; smaller policy changes would imply less positive GDP effects. The CA improvement is driven by strong export growth rather than falling import demand. Similarly to the impact of EXR devaluation on relative prices, the CA improvement is mitigated by the wealth transfer to foreign households and firms that the export subsidy implies.

The tax shift from labour (10pp SSC reduction) to consumption (7pp VAT increase) in Graph 2 (SSC) finally implies a very limited degree of output stabilisation compared to EXR devaluation (REP) or the export subsidy-import tax combination (XSU). Despite of the quantitatively large tax shift the drop in real GDP is reduced only by 1pp from -8% to -7%. The mitigating impact on the fall in employment is larger, 2pp from -6% to -4%, due to the substitution effect associated with falling labour costs. REER depreciation is gradual due to price stickiness that implies an initial feeding of SSC reduction into firm profits rather than lower goods prices. The gradual improvement in price competitiveness translates into only gradual improvement in export performance. Export growth is weaker than the decline in import demand, pointing to an improvement in the external position that is mainly driven by the contraction of domestic demand.

The fact that the labour-consumption tax shift in Graph 2 is very large compared to historic experience in OECD countries and compared to the revenues (6-7% of GDP on average) from employer social security contributions and the VAT in OECD economies (Koske 2013) underlines the modest contribution of the tax shift to economic stabilisation and external rebalancing in the short and medium term.

Other than the limited stabilising impact in the short run, the permanent SSC-VAT tax shift implies positive employment effects in the long run, which are absent in the case of nominal EXR adjustment. The positive employment effect derives from the implied shift in the tax burden from labour to all kinds of income (see, e.g., Burgert and Roeger 2014, Koske 2013). Nominal wage claims adjust to the higher VAT rate, i.e. the decline in purchasing power. But as long as the VAT base is larger than the SSC base, the VAT increase is smaller than the SSC rate reduction in the ex-ante budgetary neutral scenario, which leads to a lasting decline in labour costs. Hence, if workers or unions bargain for the real consumption wage, positive employment effects derive from a broadening of the tax base, so that the SSC rate falls by more than the VAT increase. The latter is the case in the SSC scenario underlying Graph 2, in which the VAT increase spreads the tax burden more widely from workers towards capital income earners and benefit and transfer, notably pension, recipients. Long-run employment and output gains are higher if higher ex-post tax revenue from an ex-ante revenue-neutral tax shift leads to a reduction in distortionary taxes on production as opposed to (as here) a reduction in the lump-sum tax. The negative wealth effect associated with the export subsidy in the export subsidy-import tax scenario (XSU) also has a positive impact on employment in the long term.

[4] In fact, the monetary policy rule in the FXR scenario of Figure 2 lowers the nominal short-term rate by almost 4pp in the short run. Interest rate cuts of this size are precluded by the ZLB in most advanced economies at the current juncture. The relative performance of fiscal devaluation may appear more favourable against this background. An alternative is the adoption of non-standard monetary policy tools that can provide monetary accommodation when short-term policy rates are hitting the ZLB.

In sum, the results in Graph 2 suggests that the tax shift from labour to consumption has rather moderate impact on output and employment stabilisation during recessions. The 10pp SSC cut together with 7pp VAT increase dampens real GDP and employment contraction by 1pp and 2pp respectively and improves export performance by up to 2pp compared to the no-policy-change scenario. Nominal EXR devaluation and (unilateral) trade taxes and subsidies of similar size imply much stronger stabilisation of economic activity in the short term and lead to more export-driven TB and CA adjustment.

The SSC-VAT tax shift in Graph 2, which implies a shift in government revenue of 5% of GDP, improves the TB and the CA by up to 0.5% of GDP. Results reported in Engler et al. (2014), namely 0.2% of GDP TB improvement for 1% of GDP fiscal devaluation, are slightly higher, but in the same order of magnitude. The impact on real GDP, i.e. a dampening of the output contraction by up to 1 pp for 5% of GDP SSC-VAT tax shift in Graph 2, is smaller than the 1.2% output gain associated with 1% of GDP fiscal devaluation in Engler et al. (2014). Gomes et al. (2014) find medium-term real GDP gains of up to 0.5% and TB improvement of 0.5% of GDP for fiscal devaluation of 1% of GDP. The model comparison in ECB (2012) reports peak effects for the real GDP increase of 0.2-0.5% for fiscal devaluation of 1% of GDP that correspond at the lower bound to the result in Graph 2.[5]

Compared to Engler et al. (2014), the version of the QUEST model used in this paper includes additional elements that dampen the impact of fiscal devaluation, notably the distinction between tradable (T) and non-tradable (NT) goods. An economy-wide fiscal devaluation of a given size implies less competitiveness improvement when the NT share in total output is high, which is the case in our example where non-tradables account on average for circa 60% of output. Similarly, the inclusion in QUEST of trade in intermediate inputs mitigates the impact of falling labour costs on product prices. The EAGLE model used by Gomes et al. (2014) and ECB (2012) also includes the T-NT distinction and trade in intermediate products. The EAGLE simulations adopt comparatively high values for the elasticity of labour supply and the price elasticity of trade, however, which strengthens the employment and competitiveness effects of the tax shift.

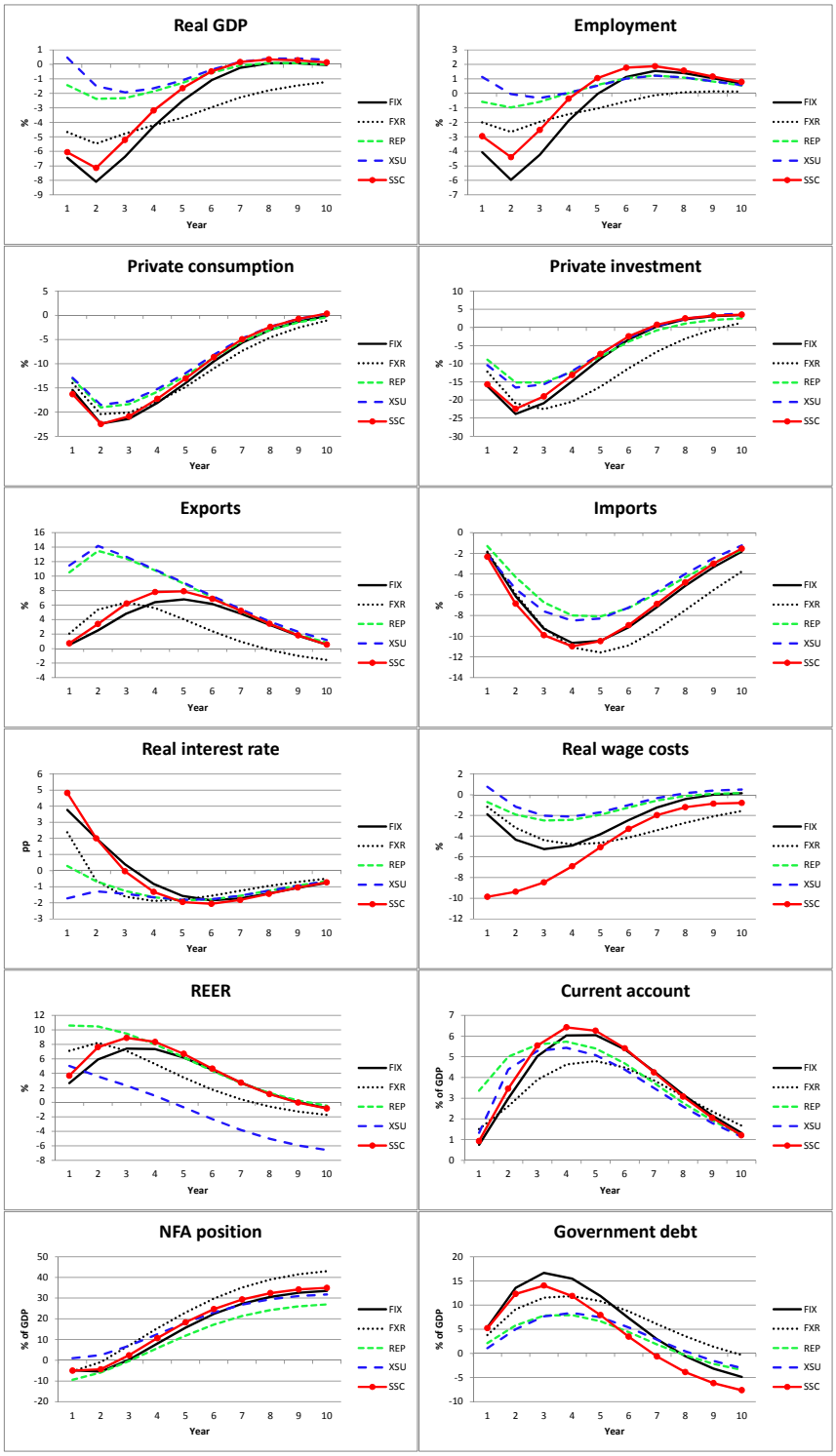
Gomes et al. (2014) also stress the importance of price and wage stickiness for the effective-ness of the SSC-VAT tax shift in the short run. Price stickiness slows decelerates the pass-through of lower labour costs into lower product prices and price competitiveness gains, which mitigates positive output and TB effects; wage stickiness mitigates the pass-through of higher consumption taxes into higher nominal wage claims and strengthens the positive GDP and TB effects in the short term.

An additional factor that affects the effectiveness of the SSC-VAT tax shift is the indexation of benefits and transfers paid by the government sector. The results in Graph 2 are for a mod-el setting in which unemployment benefits correspond to the replacement rate times the wage level and where transfers are indexed to the general price level, but not to the VAT increase. Non-indexation of benefits and transfers to the VAT hike implies that recipients of benefits and transfers also face a reduction in their real consumption income on impact. The disposable income of benefit recipients increases gradually as wages rise. In fact, the reform without indexation of benefits and transfers to the VAT increase amounts to a combination of tax reform and social security reform, with real income losses for transfer recipients. The positive GDP impact of the SSC-VAT tax shift in QUEST would be smaller if nominal benefits and transfers were indexed to the VAT increase as indexation would imply an (immediate) in-crease in the reservation wage and reduce labour supply.

The general performance of monetary and fiscal devaluation remains very similar if the economy in recession is characterised by high levels of external foreign-currency debt. Graph 3 shows impulse responses for the adjustment path when the domestic economy enters recession with net foreign debt of 100% of GDP. The main difference is the initial deterioration of the NFA-to-GDP ratio that derives from the denominator effect of nominal GDP decline which initially more than offsets the gradual improvement in the CA position. Only the combination of 10% import tax and export subsidy (XSU) avoids further deterioration of the NFA position on impact by achieving a high degree of GDP stabilisation. Nominal exchange rate devaluation by 10% (REP) achieves similar GDP stabilisation. The devaluation increases the value of foreign-currency debt in domestic-price terms, however, which is the effect stressed, e.g., by Keynes (1981).

[5] See Koske (2013) and Puglisi (2014) for comprehensive surveys of the econometric and model-based evidence on the impact of the labour-consumption tax shift.

Graph 3: Fiscal and exchange rate devaluation with foreign debt



Note: An increase in the REER represents real effective exchange rate depreciation.

The simulation results also show that neither fiscal nor monetary devaluation as such generate permanent improvements in the external position. The current account position improves temporarily due to competitiveness gains, but converges towards the path under fixed nominal exchange rates without fiscal devaluation in the longer term and eventually returns to the baseline level. While the improvement of the NFA stock is more persistent, CA

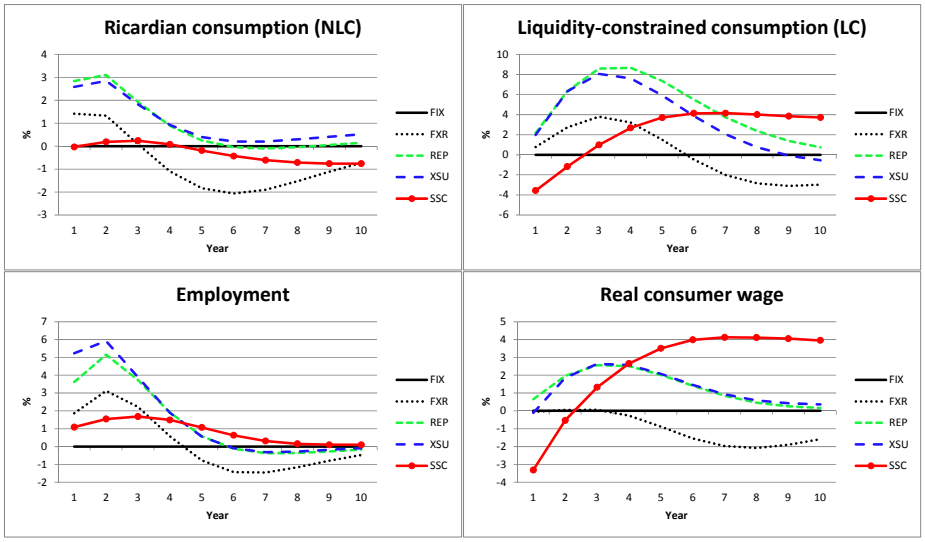
adjustment remains temporary if not accompanied by a lasting rebalancing of demand in line with the economies output potential (Vogel 2012, 2013).

An important aspect of fiscal devaluation measures is their potential distributional implications. A common argument states that the SSC-VAT tax shift is regressive as poorer households have a higher propensity to consume out of their income, so that their tax payments will increase more than proportionally. Burgert and Roeger (2014), however, show that the SSC-VAT tax shift is progressive insofar as it shifts taxation from labour to all sorts of income, in particular to capital and rental income which predominantly goes to richer households.

This paper does not provide a detailed discussion of the distributional effects of fiscal devaluation, for which readers should turn to Burgert and Roeger (2014) instead. An approximate answer can focus on the consumption pattern of the two household groups in the model, i.e. the richer Ricardian (NLC) households that are the owners of the economy's wealth and receive related income, and the poorer liquidity-constrained (LC) consumers who only receive wages, benefit and transfer income. A tax shift that penalised the poorer LC households on the income side should translate into a decline in LC real consumption.

Graph 4, which is based on the simulations displayed in Graph 2, reports NLC and LC consumption along with employment and the real consumer wage. The real consumer wage accounts for changes in the CPI deflator and particularly for the VAT increase in the SSC-VAT tax shift scenario (SSC). The variables are plotted relative to the economy with fixed nominal EXR and without further policy action (FIX).

Graph 4: F Ricardian and liquidity-constrained households' consumption



Note: Impulse responses show the percentage-point deviation from responses in the FIX scenario.

Graph 4 shows that the SSC-VAT tax shift (SSC) leads to an initial decline in LC real consumption due to the loss in purchasing power associated with the VAT increase. LC consumption raises above the FIX level in year 3, however, and remains above the FIX level thereafter. The medium- and long-term increase in LC consumption in SSC derives from the employment gain compared to FIX and the catch-up of nominal wage claims with the VAT increase in the medium term. Given the broader VAT tax base and, hence, the smaller VAT increase under an ex-ante budgetary neutral scheme, real wage costs remain below the FIX case in response to the SSC reduction even after the adjustment of nominal wage claims. Therefore, Graph 4 does not support the view that the SSC-VAT tax shift would be regressive for lower-income groups in the medium and longer term.

Indexation of benefits and transfers to the VAT increase would dampen the loss in purchasing power for recipients, but also weaken the positive long-run effect of a permanent tax shift by increasing the reservation wage. The non-indexation scenario in Graph 4 is in line with benefit systems in most EU and OECD countries that do not comprise an automatic indexation of unemployment benefits to changes in the VAT (Koske 2013).

4. CONCLUSIONS

This paper has compared the contribution of nominal exchange rate (external) and fiscal (internal) devaluation to macroeconomic stabilisation and current account rebalancing based on a small open economy version of the QUEST macroeconomic general-equilibrium model. In particular, starting from a domestic demand contraction in the order of magnitude experienced by several European economies periphery in recent years it has analysed whether fiscal tools such as a combination of (measures mimicking) import taxes and export subsidies or a tax shift from labour to consumption can reproduce the impact of nominal exchange rate adjustment in an economy with fixed nominal exchange rate and accelerate external rebalancing and mitigates the domestic costs in terms of economic activity by shifting current account adjustment from import-demand contraction to export growth. In other words, how much does fiscal devaluation help limiting the output contraction associated with domestic demand contraction by strengthening price competitiveness and net exports a time when domestic demand is contracting?

Among the fiscal measures included, the hypothetical import tax/export subsidy combination performs very similar to nominal exchange rate re-pegging. Both measures with the illustrative size of 10% used in the simulations imply an almost full offsetting of the real output con-traction of 8% associated with the contraction of domestic demand by 10%. The stabilising impact on economic activity of a tax shift from labour (10% SSC reduction) to consumption (7% VAT increase), which corresponds to a revenue shift of around 5% of GDP, remains comparably modest, dampening initial real GDP contraction from -8% to -7% and the drop in employment from -6% to -4%. Compared to the trade tax/subsidy and the re-pegging case, current account adjustment under the labour-consumption tax shift relies more on import con-traction than on export growth.

The fact that the labour-consumption tax shift analysed in this paper is very large compared to historic experience in OECD countries and compared to revenues from employer social security contributions and the VAT in OECD economies underlines the modest contribution of the tax shift to economic stabilisation and external rebalancing in the short and medium term. A permanent labour-consumption tax shift has positive employment effects in the long term, however, that derive from a broadening of the tax base towards other types of income and an associated reduction of labour costs. This positive long-run effect is larger if fiscal space from additional tax revenue associated with positive employment and output effects is used for a (further) reduction of distortionary taxes on the production side.

Despite the moderate performance of the standard fiscal devaluation package, i.e. the labour-consumption tax shift, adjustment would not necessarily be smoother in an economy with flexible exchange rate in which the central bank sets policy rates following a policy rule with a high weight on inflation. This holds even more if monetary policy is operating close to the zero bound and could, hence, not react with strong policy rate reduction during a recession.

Even if the fiscal measures are permanent, their impact on external variables remains temporary. The same holds for nominal exchange rate devaluation. In the presence of price and wage stickiness, the real effects of nominal exchange rate movements persist until relative prices have adjusted to the underlying demand and supply conditions. Several channels inter-act in the transmission: the competitiveness gain that improves the trade balance due to expenditure switching abroad and domestically towards domestically produced goods; the real interest channel, following which higher expected (imported) inflation would raise real interest rates and total and import demand; the positive income effect of policy measures with positive long-term impact on economic activity, which imply a more positive response of domestic and import demand.

The simulation results show that neither fiscal nor monetary devaluation as such generate permanent improvements in the external position. The current account position improves temporarily due to competitiveness gains, but converges towards the path under fixed nominal exchange rates without fiscal devaluation in the longer term and eventually returns to the baseline level. While the improvement of the net foreign asset stock is more persistent, current account adjustment remains temporary if not accompanied by a lasting rebalancing of demand in line with the economies output potential.

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APPENDIX: 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.

The model version used here is a small open economy version with two production sectors that, respectively, produce tradable (T) and non-tradable (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, they own the firms, and they 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. Short-term interest rates are set by the national central bank in the case of nominal exchange rate (EXR) flexibility and monetary independence, or determined by foreign interest rates in the case of a fixed EXR regime.

A.1. PRODUCTION

The domestic economy 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 private households and firms, the domestic government and the rest of the world (RoW). The NT sector sells consumption goods to domestic households, consumption and investment goods to the domestic government, and intermediate inputs to domestic firms. 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.[6]

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

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

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):

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

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:

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

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

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

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:

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

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

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

[6] 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.

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

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

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 inflation dynamics 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.

A.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) $$U(C_t^i, 1 - L_t^i) = (1-h)/(1-\sigma_c)(C_t^i - hC_{t-1})^{1-\sigma_c} + \omega/(1-\kappa)(1-L_t^i)^{1-\kappa}$$

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.

A.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:

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

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

with the real interest rate here defined as $r_t = i_t - E_t \pi_{t+1}$, 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:

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

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

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

which determines the nominal exchange rate vis-à-vis the RoW. There are no capital controls that would insulate domestic from international capital markets and separate domestic monetary from exchange rate policy.

A.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:

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

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.

A.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 ($1/\eta_t^W$):

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

The wage mark-up fluctuates 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:

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

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.

A.2.3. 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) $$C_t = (1-s^l)C_t^r + s^l C_t^l$$

and aggregate employment by:

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

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

where t_t^M is an tax on the domestic-currency value of imports, $e_t P_t^M$, and t_t^X is a tax on exports, i.e. $t_t^X < 0$ is an export subsidy. Both t_t^M and t_t^X are zero in the baseline calibration of the model.

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

(25) $$\Delta T_t^{LS} = \tau^b \left(B_{t-1}/(P_{t-1}Y_{t-1}) - btar \right) + \tau^{def} \Delta \left(B_t/(Y_t P_t) \right)$$

with btar being the target level of government debt to GDP. The consumption tax, the labour income tax, the corporate income tax, the rate of social security contributions, the import tax and the export subsidy are exogenous and adjusted in the fiscal devaluation scenarios as described in the main text.

When the exchange rate is fixed, short-term interest rates in the small open economy are determined by the foreign level of interest rates. In the case of a monetary union, the policy rate is set on the basis of union-wide aggregates. In the case of independent monetary policy, domestic short-term rates follow a Taylor-type monetary policy rule in which the policy rate responds to CPI inflation and the output gap:

$$(26) \qquad i_t = \rho_i i_{t-1} + (1-\rho_i)\left(\bar{r} + \pi^{tar} + \tau_\pi \sum_{i=0}^{n} \frac{1}{n} (\mathrm{E}_t\, \pi^{C}_{t+i} - \pi^{tar}) + \tau_y ygap_t\right)$$

The central bank has an inflation target π^{tar}, adjusts its policy rate when actual or expected CPI inflation deviate from the target and may also responds to the output gap (*ygap*). 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:

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

where $L_t^{ss} \equiv \rho^L L_{t-1}^{ss} + (1-\rho^L) L_t$ and $ucap_t^{ss} \equiv \rho^{ucap} ucap_{t-1}^{ss} + (1-\rho^{ucap}) ucap_t^{j}$ are moving averages of employment and capacity utilisation rates.

A.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=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:

$$(28) \qquad Z_t = \left[(1-s_{tnt})^{\frac{1}{\sigma_{tnt}}} (Z_t^{NT})^{\frac{\sigma_{tnt}-1}{\sigma_{tnt}}} + s_{tnt}^{\frac{1}{\sigma_{tnt}}} (Z_t^{TT})^{\frac{\sigma_{tnt}-1}{\sigma_{tnt}}} \right]^{\frac{\sigma_{tnt}}{\sigma_{tnt}-1}}$$

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:

$$(29) \qquad Z_t^{TT} = \left[(1-s_m)^{\frac{1}{\sigma_x}} (Z_t^{T})^{\frac{\sigma_x-1}{\sigma_x}} + s_m^{\frac{1}{\sigma_x}} (Z_t^{M})^{\frac{\sigma_x-1}{\sigma_x}} \right]^{\frac{\sigma_x}{\sigma_x-1}}$$

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 (28) combining T and NT goods gives the following demand functions:

(30a) $$Z_t^T = s_{tnt}(P_t^T / P_t^C)^{-\sigma_{tnt}}(C_t + G_t + IG_t)$$

(30b) $$Z_t^{NT} = (1-s_{tnt})(P_t^{NT} / P_t^C)^{-\sigma_{tnt}}(C_t + G_t + IG_t)$$

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:

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

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

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

(33a) $$INT_t^{T,J} = \sin_{tnt}^J (P_t^T / P_t^{INT,J})^{-\sigma_{tnt}} INT_t^J$$

(33b) $$INT_t^{NT,J} = (1-\sin_{tnt}^J)(P_t^{NT} / P_t^{INT,J})^{-\sigma_{tnt}} INT_t^J$$

Combining the demand functions corresponding to (29) and (32) and allowing for sluggish volume responses to price changes (ρ_m) gives the import demand equation:

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

with t_t^M as the import tax, P_t^M as the import price in foreign currency and e_t as the nominal (effective) exchange rate. Analogous assumptions for demand in the rest of the world give the export demand equation:

(35) $$X_t = \rho_X X_{t-1} + (1-\rho_X) s_m^F \left(\frac{(1+t_t^X) P_t^X}{e_t P_t^{T*}} \right)^{-\sigma_x} (Z_t^{T*} + \sum_J I_t^{J*} + \sum_J INT_t^{T,J*})$$

Equations (34-35) incorporate a sluggish response (ρ_M and ρ_X) of trade volumes to relative prices, which can replicate the J-curve effect of exchange rate depreciation. The export price is augmented in (35) by an export tax t_t^X that becomes an export subsidy for $t_t^X < 0$.

Exporters sell domestically produced tradables in the world market. The export price (P_t^X) depends on the price of tradable output and, capturing an element of pricing to market, the lagged export price adjusted by changes in the nominal exchange rate:

(36) $$P_t^X = (1-\rho_{PX}) P_t^T + \rho_{PX} \, e_t \big/ e_{t-1} \, P_{t-1}^X$$

The trade balance of the domestic economy is net trade in value terms:

(37) $$TB_t \equiv (1+t_t^X)P_t^X X_t - e_t P_t^M M_t$$

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

(38) $$CA_t \equiv i_{t-1}^* e_t B_{t-1}^* + (1+t_t^X)P_t^X X_t - e_t P_t^F M_t$$

The law of motion for the NFA position is:

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

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:

(40) $$rprem_t = -rprem(e_t B_t^* / (4PY_t) - bwy^T)$$

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.

A.5. PARAMETERISATION

The parameter and baseline values of the model reflect data for a small open European economy such as Sweden. Following standard practice, the big real ratios, notably trade openness, consumption and investment shares, government size, and the wage share, are set on the basis of national accounts data. The sectoral disaggregation (tradables versus non-tradables) and the share of intermediates are based on input-output tables from the GTAP (Global Trade Analysis Project) database.

Fluctuations around the long-term growth path are governed by nominal and real rigidities in conjunction with exogenous shocks. The parameters of nominal price and wage rigidity are set to generate average wage and price durations of 3 and 5 quarters respectively. The price elasticity of trade is in the range of average aggregate time series estimates in Imbs and Méjean (2010). Evidence for the sluggish adjustment of import and export demand and the gradual pass-through of exchange rate movements to import and export prices is provided, e.g., by Bussière et al. (2014). The chosen parameter are summarised in Table A.1.

Table A.1: Model parameters and steady-state ratios

Name	Value	Name	Value
Frictions:		Fix costs of production (FCY) to GDP	0.13
Price adjustment costs (γ_P)	20	Overhead labour (LO) to total employment	0.04
Wage adjustment costs (γ_W)	120	Elasticity of substitution between value added and intermediates (σ_{in})	0.5
Import price stickiness (ρ_{pm})	0.8	Intermediate share T (sin^T)	0.68
Export price stickiness (ρ_{px})	0.8	Intermediate share NT (sin^{NT})	0.50
Labour adjustment cost (γ_L)	25	T intermediate share in T (sin_{tnt}^T)	0.62
Capital adjustment cost (γ_K)	20	T intermediate share in NT (sin_{tnt}^{NT})	0.42
Investment adjustment cost (γ_I)	75	Substitutability between types of labour (θ)	6
Linear capacity-utilisation adjustment cost ($\gamma_{ucap,1}$)	0.04	Depreciation rate T capital stock (δ^T)	0.02
Quadratic capacity-utilisation adjustment cost	0.05	Depreciation rate NT capital stock (δ^{NT})	0.01

($\gamma_{ucap,2}$)			
Share of forward-looking price setters (sfp)	0.9	Depreciation rate public capital stock (δ^g)	0.01
Share of forward-looking wage setters (sfw)	0.9	Equity premium (i^K-i)	0.01
Preferences:		Persistence of potential employment (ρ^L)	0.95
Share of LC households (s^l)	0.4	Persistence of potential capacity (ρ^{ucap})	0.99
Discount factor (β)	0.997	Fiscal policy:	
Habit persistence (h)	0.7	Corporate profit tax (t^k)	0.35
Intertemporal elasticity of substitution ($1/\sigma_c$)	1	Consumption tax (t^c)	0.27
Inverse of elasticity of labour supply (κ)	-5	Labour income tax (t^w)	0.39
Utility weight of leisure (ω)	0.0005	Social security contributions (ssc)	0.15
Labour force (1-NPART) to population	0.71	Transfer share (try)	0.16
Employment (L) to population in steady state	0.66	Benefit replacement rate (benr)	0.40
Elasticity of substitution T varieties (σ_T)	8	Baseline government debt to GDP (btar)	0.4
Elasticity of substitution NT varieties (σ_{NT})	6	Parameter debt (τ^b)	0.01
Elasticity of substitution T-NT (σ_{tnt})	0.5	Parameter deficit (τ^{def})	0.10
Elasticity of substitution in trade (σ_x)	1.5	Risk premium (risk)	0.001
Consumption share of T (s_{tnt})	0.4	National accounts (share of GDP):	
Consumption share of imports (s_m)	0.4	Private consumption	0.59
Persistence in import demand (ρ_m)	0.9	Private non-construction investment	0.09
Persistence in export demand (ρ_x)	0.6	Government purchases	0.28
Production:		Government investment	0.04
Labour parameter (α)	0.65	Imports	0.44
Public capital stock parameter (α_g)	0.09	Exports	0.44

A.6. REFERENCES

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