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Estudos e Documentos de Trabalho

Working Papers

23 | 2010

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October 2010

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BANCO DE PORTUGAL

Edition

Economics and Research Department

Av. Almirante Reis, 71-6th

1150-012 Lisboa

www.bportugal.pt

Pre-press and Distribution

Administrative Services Department Documentation, Editing and Museum Division Editing and Publishing Unit Av. Almirante Reis, 71-2nd 1150-012 Lisboa

Printing

Administrative Services Department Logistics Division

Lisbon, September 2010

Number of copies

170

ISBN 978-989-678-050-0

ISSN 0870-0117

Legal Deposit no. 3664/83

Fiscal stimulus and exit strategies in a small euro area economy^{*}

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October 25, 2010

Abstract

This article is focused on fiscal stimulus and exit strategies in a small euro area economy. The analysis is based on a New-Keynesian general equilibrium model with non-Ricardian features introduced in Almeida, Castro and Félix (2010). We define a benchmark fiscal stimulus and, conditional on alternative exit strategies, clarify its macroeconomic effects. We investigate if a fiscal stimulus can be enhanced (or harmed) by particular exit strategies. The impact multipliers proved insufficient to discriminate between alternative strategies. However, since the policy impacts are not limited to the short run, there are relevant effects over the medium run that can be used to evaluate the different strategies. It will be claimed that (i) the announcement of a promptly and timely exit strategy, contemporaneous to the announcement of the fiscal stimulus, with a consolidation period that is not prolonged indefinitively, may improve the effectiveness of the stimulus and that (ii) exit strategies based on Government consumption cuts tend to dominate over other alternatives, such as transfers cuts or tax rate increases.

Keywords: fiscal stimulus, exit strategy, DSGE model, euro area, small-open economy. *JEL classification numbers*: E62, F41, H62

^{*}An earlier version of this article was presented at the December 2009 meeting of the WGEM at the European Central Bank. We would like to thank our discussant Juha Kilponen and all participants of the WGEM meeting for their valuable comments and suggestions. The views expressed in this paper are those of the authors and do not necessarily reflect the views of Banco de Portugal. Any errors and mistakes remain ours.

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1 Introduction

The international financial crisis raised fears of a global economic meltdown. The crisis, which turned out to be severe, prolonged and imply demanding resource reallocations, gained momentum since its outbreak in mid-2007, and led to abrupt declines in demand, international trade and economic activity worlwide. The necessary adjustment to protracted and unpredictably large negative shocks was feared to affect not only each country individually, but also the world economy, possibly creating new waves of harsh consequences. The only natural comparison in history was the Great Depression in the 1930s. The situation required a prompt action from policymakers.

Plans of fiscal and monetary stimulus were put forward worldwide in 2009. Besides non-conventional monetary policy measures especially designed to deal with the heightened tensions in financial markets, such as non-standard quantitative policies, monetary authorities set intervention rates at historically low levels for a protracted period. In the end of 2009, the targeted federal funds rate in the US was placed in the range 0.00 - 0.25per cent, the main refinancing fixed rate in the euro area was set at 1.00 per cent, while the overnight target rate in Japan was set to 0.30 per cent. In the same vein, fiscal authorities adopted massive fiscal stimulus plans, put in place extraordinary Government backed guarantees, and many of them intervened directly on financial institutions, to avoid bankruptcies and limit systemic risk. Fiscal imbalances increased well beyond those merely implied by the operation of fiscal stabilisers. In 2009, Government debt increased by several percentage points of GDP - not decimals -, and fiscal deficits reached high levels. In the Spring 2010 Economic Forecast, the European Commission (EC) reported fiscal deficit estimates for 2009-2010 above 10 per cent for the United States of America (US) and the United Kingdom (UK), around 7 per cent for Japan, and above 6 per cent for the euro area as a whole, figures well above historical averages even in recessionary periods.

The stimulus plans brought monetary and fiscal policy actions to the center stage of an intense debate. It was important to assess the effectiveness of the stimulus measures in taming the collapse of the financial system and the economic activity meltdown at a global scale, and to evaluate the role of exit strategies, in a context in which it was not clear at times that private demand would hold autonomously, at least in some advanced economies (IMF 2010). While the liquidity provided by central banks will need to be absorbed as extraordinary lending operations mature, fiscal consolidation measures will have to be implemented to halt the upward trend in public debt to GDP ratios. The building up of fiscal imbalances and the lack of clear exit strategies was among the main factors that raised doubts on the ability of some euro area economies to honour their public debt services and triggered a surge in sovereign debt spreads, making it clear that fiscal consolidation measures will have to be adopted in more vulnerable economies.

This article is focused on the role of exit strategies in a small euro area economy. Our concern is twofold. Firstly, a number of small euro area economies has been under pressure from financial markets since late 2009, when it became evident that large fiscal imbalances were inevitable and that there was no clear exit strategy. Secondly, fiscal policy is the only tool that domestic authorities can use to smooth adverse idiosyncratic shocks, implying that regaining the margin of manoeuvre is crucial to restore a sound macroeconomic framework.

The discussion is based on *PESSOA*, a New-Keynesian model introduced in Almeida, Castro and Félix (2010), whose structure draws on several contributions, notably Kumhof, Muir, Mursula and Laxton (2010). The model was designed and calibrated to fit the characteristics of a small open economy (SOE) integrated in a monetary union. The SOE structure implies that foreign variables (which correspond to the rest of the monetary union), namely foreign interest rates, output and prices, are assumed to be orthogonal to domestic developments, as in Adolfson, Laseén, Lindé and Villani (2007). Hence, the stability of the model is granted by the full credibility of the inflation objective and by the large elasticities of real trade variables to real exchange rate fluctuations, since domestic price levels are pinned down by the external constraint that sets a unique steady-state real exchange rate. To use an expression from Giavazzi and Pagano (1988), the SOE in *PESSOA* is effectively "tying its hands" with the rest of the euro area.

Contrary to most DSGE models in the literature on SOE, *PESSOA* is intrinsically non-Ricardian, featuring finite-lifetime households, following Blanchard (1985) and Yaari (1965), distortionary taxation and a share of liquidity constrained households, in line with Galí, López-Salido and Vallés (2007). These features, coupled with a rich fiscal block, make the model particularly suited to analyse fiscal policy issues. In particular, the finite-lifetime framework creates a non-trivial role for fiscal policy over the medium and long run, introducing a source of non-Ricardian behaviour absent in the workhorse infinitely-lived agents environment. In addition, the Blanchard-Yaari framework allows for the endogenous determination of the net foreign asset position (Harrison, Nikolov, Quinn, Ramsay, Scott and Thomas 2005), thereby delivering a more realistic co-movement between public debt and the net foreign asset position, in contrast with the infinitely lived agents case (Schmitt-Grohe and Uribe 2003).

The contribution of this article is to assess the macroeconomic impacts, in the context of a Blanchard-Yaari framework, of alternative exit strategies in a small-euro area economy. We highlight the importance of announcing the exit strategy contemporaneously to the announcement of the stimulus package, and analyse the impact of considering alternative fiscal instruments to ensure not only a sustainable public debt path, but also a timely and promptly fiscal consolidation period. In addition, we analyse alternative timings and intensities to start the exit strategy, under the assumption of perfect foresight and full credibility of the fiscal authority.

The structure of the article is as follows. In section 2, we motivate the article and survey the literature. The model is presented in section 3, along with the calibration strategy. Section 4 addresses the impact of alternative instruments and of different exit timings on the main macroeconomic aggregates. Section 5 concludes and puts forward some policy implications.

2 Motivation

The fiscal activism to cope with the economic crisis, in combination with the operation of automatic stabilisers, led to major imbalances in advanced economies. In many countries, structural imbalances in the public sector clearly exceeded the announced stimulus packages. These developments were particularly worrisome in economies that already had ongoing long-run sustainability issues, namely due to structural features such as ageing and its future impacts in social security outlays or developments in health expenditures.

According to the European Commission (EC) projection of Spring 2010, public debt stocks are projected to climb in several countries, between 2008 and 2011, by not less than 20 pp. (Figure 1), while fiscal deficits are not anticipated to be reverted visibly before 2011 (Figure 2). In this context, fiscal consolidation issues emerge naturally at the policy debate forefront and are high on the policymakers agenda, in particular in the euro area, where the generosity of public pensions and health care systems may be facing more risks than before the outbreak of the international economic crisis.

Both the EC and the European Central Bank (ECB) have made public statements that highlight the importance of exit strategies and long-term sustainability. For instance, the President of the ECB clarified the problem as follows:

"[M]any euro area governments are faced with high and sharply rising fiscal imbalances. If not addressed by a clear and credible exit strategy, this could seriously risk undermining public confidence in the sustainability of public finances and the economic recovery.¹"

This view is aligned with the one expressed in EC (2009), according to which:

"[F]iscal measures to increase confidence and support demand are only successful if they are perceived by the markets and public opinion as temporary and consistent with long-term sustainability" (p. 53).

In short, the announcement of a clear and adequate fiscal consolidation strategy seems in fact part of any sustainable and credible fiscal stimulus package. This is the main focus of this article. The main questions are: what is the best exit strategy from a fiscal stimulus programme for a SOE operating in a monetary union? Is there a dominant fiscal instrument to ground the consolidation? How much does the timing and the intensity of the consolidation matter?

The fiscal package herein considered is assumed to be fully credible and temporary and the exit strategy is presumably well-defined. In particular, the assumption of full credibility of the fiscal authorities ensures that the sovereign risk premium is unaffected

 $^{^1}$ Jean-Claude Trichet, Frankfurt am Main, 5 November 2009, available at http://www.ecb.int/press/pressconf/2009/html/is091105.en.html









Source: EC (Spring 2010 forecasts). Annual data.

by the implementation of the fiscal stimulus package as well as by the corresponding exit strategy.². In addition, the temporary nature of the stimulus is also crucial, since permanent fiscal expansions (a permanent increase in government expenditure, for instance) create sizeable negative wealth effects, undermining medium-run economic growth prospects and, in extreme cases, backfire the initial intentions of the fiscal authorities. Finally, an adequate exit strategy that ensures fiscal sustainability is a key factor behind the behaviour of financial markets participants. If sustainability concerns arise, this affects

 $^{^{2}}$ For an assessment of the impacts in the case of limited credibility please refer to Almeida, Castro, Félix and Maria (2010), in which it is pointed out that limited credibility reduces the fiscal multipliers in a SOE operating in a monetary union.



Figure 3: Sovereign debt spreads in the euro area (in basis points)

Source: Thomson Reuters. Daily data up to 2010, July,15 (moving average of previous 90 days).

Note: The sovereign debt spread is calculated as the difference between 10-years Government bond yields of each country and Germany.

the credibility of the fiscal authorities and tends to translate into sovereign debt spread hikes, jeopardising the full credibility assumption. This was likely the case in some euro area economies, namely Greece and to a smaller extent Ireland, Portugal, Spain and Italy (Figure 3). Therefore, these recent developments put in evidence that participation in a monetary union is not a bulletproof credibility vest. Indeed, even within a monetary union framework, financial market participants may discriminate economies revealing larger imbalances and more fragile budgetary perspectives. Hence, any exit strategy should be designed so as to avoid damaging credibility and pressuring risk premium upwards.

There is mounting literature on exit strategies and fiscal consolidation. Coenen, Mohr and Straub (2008) discuss fiscal consolidation strategies in the euro area using a two country open-economy model (Coenen, McAdam and Straub 2007) and assess the macroeconomic impact of a permanent decline in public debt ratio using both expenditure and revenue based strategies. The results suggest that fiscal consolidation has positive longrun impacts on key macroeconomic aggregates, in particular when the improved budgetary position is used to cut distortionary taxes in the final steady-state. Corsetti, Meier and Müller (2009) address the role of spending reversals in the context of a temporary fiscal stimulus and conclude that the impact of fiscal stimulus depends on expectations about future consolidation strategies, and that consolidation based on spending cuts increased the adherence to time series evidence for the US. Leeper, Plante and Traum (2009) use an estimated DSGE model for US that includes a rich set of fiscal instruments to respond to the evolution of debt and find that the impact of fiscal policy shocks in the main macroeconomic aggregates may differ substantially from models only allowing for non-distortionary taxes. Moreover, it is pointed out that impact multipliers of debt-financed fiscal stimulus can differ substantially from long-term multipliers. Kumhof, Clinton, Mursula and Laxton (2010) use a multi-country DSGE model with finitely-lived agents to show that a well-targeted fiscal consolidation is likely to foster economic growth in the medium and long run and illustrate the relevance of the credibility of the fiscal authorities in reducing the short-run costs of the fiscal consolidation. Finally, Caprioli, Rizza and Tommasino (2010) provide formal theoretical rationale, in a DSGE model, to the policy advices of international institutions that call for a substantial and fast debt reduction. The results are confronted with those of the mainstream optimal fiscal policy literature that calls for debt stabilization. If debt holders fear a government default, the article shows that an increase in debt, followed by fiscal consolidation, is the optimal fiscal policy to finance an exogenous stream of public expenditure.

Against this background, this paper is a contribution to the discussion of exit strategies in several fronts. Unlike most of the research on fiscal stimulus, which is based on the infinitely-lived agents framework featuring liquidity constrained households, we use an intrinsically non-Ricardian DSGE model with finitely lived households (Kumhof and Laxton 2009b). In addition, the discussion of alternative exit strategies addressed at boosting credibility of the temporary nature of the fiscal stimulus may alert policymakers in the sense that expectations' management might be as important as the stimulus strategy itself.

3 A model for a small euro area economy

This section presents *PESSOA*, the New-Keynesian dynamic general equilibrium model behind the analysis of the macroeconomic impacts of a fiscal stimulus. The model was introduced and calibrated for Portugal in Almeida, Castro and Félix (2010) and used to analyse shocks that hit the Portuguese economy over the last decade in Almeida, Castro and Félix (2009). It can however be easily re-calibrated to fit the characteristics of any other small euro area economy. The model has intrinsic non-Ricardian features largely inspired in the IMF's Global Integrated Monetary and Fiscal model presented in Kumhof, Muir, Mursula and Laxton (2010). The current setup was enhanced to allow for richer fiscal policy simulations. The SOE structure implies assuming that the rest of the monetary union is not affected by domestic shocks. This is tantamount to say that union aggregates and, therefore, monetary policy decisions are orthogonal to developments in the SOE, as in Adolfson et al. (2007).

It is well known that breaking the Ricardian equivalence is of paramount importance to generate realistic impulse response functions of private consumption in the advent of a fiscal shock (Blanchard 1985, Galí et al. 2007). Contrary to most DSGE models in the literature on SOE, PESSOA is intrinsically non-Ricardian, featuring: finitely-lived households in line with the stochastic lifetime framework proposed by Blanchard (1985) and Yaari (1965); distortionary taxation on households consumption, labour and capital income; and liquidity constrained households as in Galí et al. (2007). The fiscal block of the model is rich enough to account for several types of distortionary taxation, lump-sum transfers to households (to all or to a targeted group), and government expenditure.

This setup generates a non-trivial role for fiscal policy not only in the short-run but also in the medium and long-run. As clarified in Frenkel and Razin (1996) and in Kumhof and Laxton (2009b), the finitely lived agents framework implies that households discount future events at a higher rate than the Government (the so-called over-discounting behaviour). This creates sizeable wealth effects of public debt, which are absent in the workhorse infinitely-lived agent framework. In particular, households strongly prefer debt issuance to tax financing of Government expenditure, since they attach a positive probability to the fact that they might not be around in the future when taxes required to meet debt issued today are levied. It should be mentioned that technically it is not the event that current generations will die that generates the non-Ricardian effect, but rather the fact that future generations will bear some of the tax burden (Buiter 1988). In addition, the Blanchard-Yaari framework allows for the endogenous determination of the net foreign asset (NFA) position (Harrison et al. 2005), since in a finite lifetime the amount of assets/debt that a household can accumulate is inevitably limited by life expectancy.³ This represents an appealing feature for the simulation of permanent fiscal shocks, since it generates a positive correlation between public debt and the net foreign debt position of the economy. On the contrary, in the workhorse infinitely lived agents model, the steady-state net foreign asset position is pinned down exogenously (Schmitt-Grohe and Uribe 2003), implying that changes in steady-state public debt are fully offset by private saving and are, by assumption, uncorrelated with the net foreign debt.

Since *PESSOA* is designed for a SOE integrated in a monetary union, the adjustment mechanism of the economy to domestic shocks is rather different from the standard setup, in which monetary policy and real interest rate movements are crucial to render the model dynamically stable. In *PESSOA*, monetary policy is trivial in the sense that the domestic interest rate is orthogonal to domestic shocks and can only deviate from the rest of the union rate by a risk premium that is assumed to be exogenous. This implies that domestic shocks affecting domestic inflation developments tend to generate powerful effects on the real interest rate, amplifying the fluctuations of the economy. The dynamic stability of the model is ensured instead by an active role of the real exchange rate (which in the case of an irrevocably fixed nominal exchange rate simply reflects the relative price of domestic goods vs. foreign goods), in the adjustment of international trade in goods and assets. Domestic agents in *PESSOA* are assumed to only trade in goods and assets/debt with agents in the monetary union. Therefore, real exchange rate fluctuations have sizeable impacts on competitiveness, trade and thus in the net foreign asset/debt position of the economy. This position is pinned down in the steady state by the foreign asset/debt level constraint and its impact in households financial wealth (and, ultimately, in consumption). Since foreign prices developments are assumed to be independent of domestic shocks, the

 $^{^{3}}$ It should pointed out that by definition a SOE does not affect the world investment-savings balance and, therefore, the world real interest rate. Hence, infinitely lived agents will be able to borrow or lend in infinite amounts that can be paid or received in the indefinite future. For further details refer to Barro and Sala-i-Martin (1995).

real exchange rate pins down uniquely the domestic price level.

Finally, *PESSOA* features a number of nominal and real rigidities that give rise to realistic short-run impacts. On the nominal side, there is differentiation in the labour and product markets, allowing for monopolistic competition and staggered wage and price inflation. On the real side, the model incorporates external habit formation in consumption and adjustment costs on investment and import contents.

The model is populated by households, which will be presented in detail in subsection 3.1; unions, presented in subsection 3.2; and firms (intermediate goods producers and final goods producers), which will be presented in subsection 3.3. These agents interact with a Government, which is described in subsection 3.4. The rest of the world, corresponding to the rest of the monetary union, is presented in subsection 3.5, while the market clearing conditions are presented in subsection 3.6. The model calibration is clarified in subsection 3.7.

3.1 Households

Households evolve in line with the overlapping generations scheme first proposed in Blanchard (1985). All of them have a finite lifetime, facing an instant probability of death $1 - \theta$ in each period (θ is the probability of surviving between two consecutive periods), which is constant throughout life, independent of age and equal for all households.⁴ However, the overall size of the population is assumed to remain constant and equal to N households, implying that in each period $N(1 - \theta)$ households die and the same number of households is born. In addition, two types of households coexist: type \mathcal{A} , the asset holders, who can access asset markets and perform both intra and inter-temporal optimisation, smoothing out their consumption over lifetime by trading assets; and type \mathcal{B} , the liquidity constrained households that do not access asset markets and are, therefore, not allowed to engage in inter-temporal optimisation, consuming all of their income in each and every period as in Galí et al. (2007). The share of type \mathcal{B} households is assumed to be ψ , implying that in each period there coexist $N(1 - \psi)$ households holding assets and $N\psi$ liquidity constrained households.

A representative household of type $H \in \{\mathcal{A}, \mathcal{B}\}$ with age *a* derives utility from consumption, $C_{a,t}^{H}$, and leisure, $1 - L_{a,t}^{H}$, according to a CRRA utility function (with $L_{a,t}^{H}$ representing labour supply). The household's expected lifetime utility is:

$$E_t \sum_{s=0}^{\infty} (\beta \theta)^s \frac{1}{1-\gamma} \left[\left(\frac{C_{a+s,t+s}^H}{Hab_{a+s,t+s}^H} \right)^{\eta^H} (1 - L_{a+s,t+s}^H)^{1-\eta^H} \right]^{1-\gamma}$$
(1)

⁴The probability of an individual dying after t periods of life is equal to $(1 - \theta)\theta^{t-1}$ and the expected life horizon at any point in time is equal to $(1 - \theta)^{-1}$. Probability $1 - \theta$ can also be interpreted as a probability of "economic death" or a degree of "myopia" (Blanchard 1985, Frenkel and Razin 1996, Harrison et al. 2005, Bayoumi and Sgherri 2006). It represents the inverse of the average planning horizon of the household, which is likely to be far more shorter than its biologic lifetime. Bayoumi and Sgherri (2006) present econometric evidence for the US.

where E_t is the expectation operator, $0 \leq \beta \leq 1$ stands for the standard time discount factor, $\gamma > 0$ is the coefficient of risk aversion and $0 \leq \eta^H \leq 1$ is a distribution parameter. Hab_t^H represents external habits, defined in *per capita* terms as $[C_{t-1}^{\mathcal{A}}/(N(1-\psi))]^v$ and $[C_{t-1}^{\mathcal{B}}/(N\psi)]^v$ for type \mathcal{A} and \mathcal{B} households, respectively, with parameter $0 \leq v \leq 1$ controlling for the degree of habit persistence.⁵

Households of type \mathcal{A} save in both domestic and foreign government bonds, $B_{a,t}$ and $B_{a,t}^*$, which yield gross nominal interest rates i_t and i_t^* , respectively, from period t to period t+1 (by convention, interest is paid at the beginning of period t+1). Domestic public debt is assumed to be solely held by domestic agents (full home bias). Besides returns from financial assets, these households also receive labour income, earning a wage rate, W_t , adjusted by the household's age-specific productivity level, $\Phi_a = k\chi^a$, where k is a scaling factor and $0 \leq \chi \leq 1$ is the labour productivity rate of decay per period that mimics life-cycle profile. Furthermore, they receive dividends from firms and from labour unions (the later reflect a wage premia that will be motivated later on). These are represented by $D_{a,t}^{\mathcal{A}}(x)$ where x can be: the intermediate goods producers of tradable (\mathcal{T}) and non-tradable goods (\mathcal{N}); the final goods producers of private consumption (\mathcal{C}), government consumption (\mathcal{G}), capital (\mathcal{I}), or export goods (\mathcal{X}); or labour unions (\mathcal{U}). Finally, households are taxed by the Government in their consumption and labour activities by $\tau_{C,t}$ and $\tau_{L,t}$, respectively, and receive transfers from the domestic Government and from abroad, $TRG_t^{\mathcal{A}}$ and $TRX_t^{\mathcal{A}}$, respectively.

The asset holders' optimisation problem consists in setting the path of consumption, labour, domestic and foreign asset holdings, that maximises (1) subject to the following budget constraint:

$$P_{t}C_{a,t}^{\mathcal{A}} + B_{a,t} + B_{a,t}^{*} \leq \frac{1}{\theta} \left[i_{t-1}B_{a-1,t-1} + i_{t-1}^{*}\Psi_{t}B_{a-1,t-1}^{*} \right] + W_{t}\Phi_{a}L_{a,t}^{\mathcal{A}}(1-\tau_{L,t}) + \sum_{\substack{x=\mathcal{N},\mathcal{T},\mathcal{C},\\\mathcal{G},\mathcal{I},\mathcal{X},\mathcal{U}}} D_{a,t}^{\mathcal{A}}(x) + TRG_{t}^{\mathcal{A}} + TRX_{t}^{\mathcal{A}}$$
(2)

where $P_t = (1 + \tau_{C,t})P_t^C$, the after-tax price of the final consumption good, is the numeraire price of the economy and P_t^C is the before-tax price of the final consumption good.

Type \mathcal{A} households are not indifferent between government expenditure financing with tax levies or debt issuance (which corresponds to future taxes). They strongly prefer debt issuance and take part of government bond holdings as net wealth. This non-Ricardian feature results essentially from finite lifetime and is amplified by the life-cycle income profile due to declining lifetime productivity. The intuition is that if government expenditure is financed with debt issuance, a finite lifetime household will hold part of this debt, but may not be around at the time taxes are levied, implying that part of the debt can be used to finance private consumption expenditures during lifetime, instead of being used to face

⁵Aggregation across generations is made possible by assuming that habits are multiplicative instead of additive. However, it should be recognised that this generates a low habit persistence.

future tax payments. These effects are magnified by the fact that the labour income tax represents an important part of overall tax revenue. The life-cycle profile implies that even if a household is alive at the time taxes are levied, it can be at very low productivity and wage levels, which reduces its labour income tax payments. Finite lifetimes and life-cycle income profile create households relatively more short-term oriented, as they over-discount future events.

For type \mathcal{B} households, the lack of access to assets/debt market implies that the intertemporal optimisation problem collapses to an intra-temporal optimisation problem (due to the impossibility of shifting consumption across periods by trading in assets). These households merely choose consumption and labour that maximise their instant utility introducing an additional layer of non-Ricardian behavior that is crucial to obtain realistic short-run responses of consumption to fiscal stimulus (Galí et al. 2007). Therefore, shocks occurring in a given period are totally reflected in the budget constraint of that period and create powerful income effects.

The optimisation problem of liquidity constrained households is then to maximise (1) subject to the following budget constraint:

$$P_t C_{a,t}^{\mathcal{B}} \le W_t \Phi_a L_{a,t}^{\mathcal{B}} (1 - \tau_{L,t}) + D_{a,t}^{\mathcal{B}} (\mathcal{U}) + TRG_t^{\mathcal{B}} + TRX_t^{\mathcal{B}}$$
(3)

where all variables have the interpretation previously defined for asset holders.

The households utility maximisation problem delivers a condition for each type of household that yields their optimal consumption-leisure allocation, the consumption function, which depends on wealth in the case of asset holders and on per-period income in the case of liquidity constrained households, and a degenerated interest rate parity condition. The consumption function expresses consumption as a function of human and financial wealth. Human wealth corresponds to the expected present discounted value of labour supply endowments and dividend income, while financial wealth is composed by the households' current domestic and foreign asset holdings. The interest rate parity condition defines the equilibrium in the bonds market and essentially implies that domestic interest rates depart from foreign interest rates by an exogenous risk premium, Ψ (in short, $i_t = i_t^* \Psi$).

3.2 Unions

There is a continuum of labour unions in the economy, indexed by $h \in [0, 1]$, who buy the homogeneous labour from households and transform it into different varieties, $U_t(h)$. The labour differentiation scheme gives market power to each union over its respective variety, allowing it to charge manufacturers a wage, $V_t(h)$, higher than the one paid to households. The different varieties are then combined to produce a labour bundle, $U_t(j)$, sold to manufacturer j at an aggregate wage, V_t , higher than W_t . This wedge reflects the fact that manufacturers pay a higher price for $U_t(j)$, as it incorporates differentiated labour inputs, contrary to the labour supplied by households. Each manufacturer demands a certain quantity of all varieties of labour to be included in the labour bundle. Aggregating across manufacturers, the demand for variety h is given by:

$$U_t(h) = \left(\frac{V_t(h)}{V_t}\right)^{-\sigma_{U,t}} U_t \tag{4}$$

where $0 \leq \sigma_{U,t} \leq \infty$ is the elasticity of substitution across different varieties of labour, which determines the degree of union h market power, i.e., the markup charged over the wage paid to households in the steady state.

The wage-setting process is costly, with abrupt union wage $(V_t(h))$ changes being more costly than smooth wage adjustments. This is implemented by assuming that labour unions incur in wage adjustment costs, $\Gamma_t^{\mathcal{U}}(h)$. In the spirit of Ireland (2001) and Laxton and Pesenti (2003), quadratic adjustment costs are used:

$$\Gamma_t^{\mathcal{U}}(h) = \frac{\phi_{\mathcal{U}}}{2} T_t U_t \left(\frac{V_t(h)/V_{t-1}(h)}{V_{t-1}/V_{t-2}} - 1 \right)^2$$
(5)

where $\phi_{\mathcal{U}}$ is the adjustment cost parameter and T_t is the level of the labour-augmenting technical progress, which enters as a scaling factor, ensuring that adjustment costs do not vanish along the balanced growth path.

Each labour union h solves the following maximisation problem:

$$\max_{V_t(h)} E_t \sum_{s=0}^{\infty} \tilde{R}_{t,s} D_{t+s}^{\mathcal{U}}(h)$$
(6)

subject to labour demand conditions and adjustment costs. $\tilde{R}_{t,s} = \prod_{l=1}^{s} \frac{\theta}{r_{t+l-1}}$ for s > 0(1 for s = 0) stands for the subjective real discount factor and $r_t = \frac{i_t}{\pi_{t+1}^e}$ is the real interest rate, with π_{t+1}^e being the numeraire good expected inflation rate. Period t dividends, $D_t^{\mathcal{U}}(h)$, are defined as:

$$D_t^{\mathcal{U}}(h) = (1 - \tau_{L,t}) \left[(V_t(h) - W_t) U_t(h) - P_t \Gamma_t^{\mathcal{U}}(h) \right]$$

$$\tag{7}$$

It should be noted that usually households directly provide the differentiated services and explore the corresponding market power in New-Keynesian general equilibrium models, while wages are subject to a staggered adjustment process à la Calvo in line with Erceg, Henderson and Levin (2000), in many cases with indexation, as in Smets and Wouters (2007) and Altig, Christiano, Eichenbaum and Linde (2005). This is not the case in the model used herein. Such option creates heterogenous labour and wages across households that can jeopardise aggregation in a model with an overlapping generations environment and a life-cycle income profile (since it increases the degree of wage heterogeneity across cohorts already in place due to the life-cyle income profile). Therefore, to keep the model tractable, the differentiated wage-setting problem is performed by the union, as in Kumhof, Muir, Mursula and Laxton (2010), while wage stickiness is modelled as in (5).

3.3 Firms

The production block of the model features two types of firms: manufacturers, who produce intermediate goods, and distributors, who produce final goods. Manufacturers combine labour and capital to produce different varieties of tradable (\mathcal{T}) and non-tradable (\mathcal{N}) intermediate goods. Labour is purchased from unions, while capital is obtained through the accumulation of new capital goods (investment) bought from the respective distributor. The intermediate goods are then sold to distributors, who combine them with imports to produce a differentiated final good variety. There are four types of final goods: consumer goods (\mathcal{C}); new capital goods (\mathcal{I}); government consumption goods (\mathcal{G}) and export goods (\mathcal{X}), which differ in its content of tradable, non-tradable and imported goods.

Manufacturers

For each type of intermediate good $J \in \{\mathcal{T}, \mathcal{N}\}$ there is a continuum of manufacturing firms $j \in [0, 1]$. Each firm produces a different variety of the good, $Z_t^J(j)$, using capital, $K_t^J(j)$, and labour, $U_t^J(j)$, as inputs. It sells its good at price $P_t^J(j)$, which is higher than the marginal cost, reflecting the market power generated by product differentiation.

The production technology is modelled using the following CES function:

$$Z_t^J(j) = \left((1 - \alpha_U^J)^{\frac{1}{\xi_{ZJ}}} \left(K_t^J(j) \right)^{\frac{\xi_{ZJ} - 1}{\xi_{ZJ}}} + (\alpha_U^J)^{\frac{1}{\xi_{ZJ}}} \left(T_t A_t^J U_t^J(j) \right)^{\frac{\xi_{ZJ} - 1}{\xi_{ZJ}}} \right)^{\frac{\xi_{ZJ} - 1}{\xi_{ZJ} - 1}}$$
(8)

where $0 \leq \xi_{ZJ} \leq \infty$ is the elasticity of substitution between capital and labour in sector J; $0 \leq \alpha_U^J \leq 1$ is the quasi-labour income share; A_t^J is a stationary sector-specific technology shock; T_t is a labour-augmenting technical progress, assumed to evolve deterministically at a constant exogenous rate g, such that $T_t/T_{t-1} = g$.

To accumulate capital, manufacturers invest, $I_t^J(j)$, subject to a standard capital accumulation condition:

$$K_{t+1}^{J}(j) = (1 - \delta^{J})K_{t}^{J}(j) + I_{t}^{J}(j)$$
(9)

where $0 \leq \delta^J \leq 1$ is a sector-specific depreciation rate.

In order to obtain a smooth response of production factor quantities to changes in their desired level, investment and labour are subject to quadratic real adjustment costs, $\Gamma_t^{\mathcal{I}J}(j)$ and $\Gamma_t^{\mathcal{U}J}(j)$, respectively, given by:

$$\Gamma_t^{\mathcal{I}J}(j) = \frac{\phi_{\mathcal{I}J}}{2} I_t^J \left(\frac{I_t^J(j)/g}{I_{t-1}^J(j)} - 1 \right)^2 \tag{10}$$

$$\Gamma_t^{\mathcal{U}J}(j) = \frac{\phi_{\mathcal{U}J}}{2} U_t^J \left(\frac{U_t^J(j)}{U_{t-1}^J(j)} - 1 \right)^2$$
(11)

where $\phi_{\mathcal{I}J}$ and $\phi_{\mathcal{U}J}$ determine how costly is to change investment and labour services for firms in sector J; and I_t^J and U_t^J are aggregate investment and labour, respectively.

Furthermore, in order to obtain a realistic short-run behaviour of intermediate goods price inflation, quadratic adjustment costs, $\Gamma_t^{PJ}(j)$, following Rotemberg (1982), are considered:

$$\Gamma_t^{PJ}(j) = \frac{\phi_{PJ}}{2} Z_t^J \left(\frac{P_t^J(j)/P_{t-1}^J(j)}{P_{t-1}^J/P_{t-2}^J} - 1 \right)^2$$
(12)

where ϕ_{PJ} determines how costly is to adjust prices for firms operating in sector J; Z_t^J is the aggregate output of sector J, which is sold to distributors at the price P_t^J .

Each distributor demands a certain quantity of each variety of type J intermediate good, by solving a standard cost minimisation problem. Aggregating across distributors, the demand for variety j is given by:

$$Z_t^J(j) = \left(\frac{P_t^J(j)}{P_t^J}\right)^{-\sigma_{J,t}} Z_t^J$$
(13)

where $0 \leq \sigma_{J,t} \leq \infty$ is the elasticity of substitution between type J good varieties.

Each intermediate goods producer j solves the following maximisation problem:

$$\max_{P_t^J(j), I_t^J(j), U_t^J(j), K_{t+1}^J(j)} \quad E_t \sum_{s=0}^{\infty} \tilde{R}_{t,s} D_{t+s}^J(j)$$
(14)

subject to the constraints imposed by the production technology, capital accumulation condition, adjustment costs and demand conditions. Period t dividends, $D_t^J(j)$, are defined as:

$$D_t^J(j) = Operational \ cashflow_t - \tau_{K,t} \times [Net \ operational \ profit_t]$$

The *Operational cashflow*_t is defined as the difference between overall revenue and expenditure, as follows:

$$P_{t}^{J}(j)Z_{t}^{J}(j) - \left[(1 + \tau_{SP,t})V_{t}U_{t}^{J}(j) + P_{t}^{\mathcal{I}}I_{t}^{J}(j) + P_{t}^{\mathcal{I}}\Gamma_{t}^{\mathcal{I}J}(j) + V_{t}\Gamma_{t}^{\mathcal{U}J}(j) + P_{t}^{J}\Gamma_{t}^{PJ}(j) + P_{t}^{J}T_{t}\omega^{J} \right]$$

with $P_t^J(j)Z_t^J(j)$ corresponding to overall revenue, $(1 + \tau_{SP,t})V_tU_t^J(j)$ being labour costs inclusive of employer social security contributions $(\tau_{SP,t}$ is presented below in subsection 3.4), and $P_t^{\mathcal{I}}I_t^J(j)$ standing for investment spending, where $P_t^{\mathcal{I}}$ is the price of new capital goods. The term $P_t^{\mathcal{I}}\Gamma_t^{\mathcal{I}J}(j) + V_t\Gamma_t^{UJ}(j) + P_t^J\Gamma_t^{PJ}(j)$ includes costs related with price adjustments and with changes in the quantities of labour and capital used. Finally, a real fixed cost term, ω_J , scaled by the technological progress and by the output price level, $P_t^J T_t \omega^J$, is used to ensure that economic profits arising from monopolistic competition are largely depleted in the steady state and, therefore, there are no firms entering or leaving the market.⁶

A dividend income tax, $\tau_{K,t}$, is charged on *Net operational profit*, which differs from *Operational cashflow* by the fact that capital depreciation is tax rebatable, but investment expenditures are not. *Net operational profit* is defined as:

$$P_{t}^{J}(j)Z_{t}^{J}(j) - \left[(1 + \tau_{SP,t})V_{t}U_{t}^{J}(j) + P_{t}^{\mathcal{I}}q_{t}^{J}\delta^{J}K_{t}^{J}(j) + P_{t}^{\mathcal{I}}\Gamma_{t}^{\mathcal{I}J}(j) + V_{t}\Gamma_{t}^{UJ}(j) + P_{t}^{J}\Gamma_{t}^{PJ}(j) + P_{t}^{J}T_{t}\omega^{J} \right]$$

where q_t^J is the shadow price of a unit of installed capital in terms of new capital goods (Tobin's-Q).

Distributors

For each type of final good $F \in \{C, \mathcal{G}, \mathcal{I}, \mathcal{X}\}$ there is a continuum of distributors $f \in [0, 1]$. Each type of final good is demanded by a unique type of costumer: consumer goods (\mathcal{C}) are demanded by households, new capital goods (\mathcal{I}) are demanded by manufacturing firms, government consumption goods (\mathcal{G}) are demanded by the Government, and export goods (\mathcal{X}) are demanded by foreign costumers. Distributors sell their goods at price $P_t^F(f)$, which already incorporates a markup over the marginal costs.

Each distributor uses a two-stage production technology. In the first stage, the distributor combines domestic tradable goods, $Z_t^{TF}(f)$, with imported goods, $M_t^F(f)$, to obtain $Y_t^{\mathcal{A}F}(f)$, which is an assembled good of variety f; in the second stage, the distributor combines the assembled good with domestic non-tradable goods, $Z_t^{\mathcal{N}F}(f)$, to produce variety f of the final good, $Y_t^F(f)$, which is then sold to its costumers. The production technology is formalised as a sector-specific nested CES technology.

The production function for variety f of the assembled good of type F is defined as:

$$Y_t^{\mathcal{A}F}(f) = \left[(\alpha_{\mathcal{A}F})^{\frac{1}{\xi_{\mathcal{A}F}}} \left(Z_t^{\mathcal{T}F}(f) \right)^{\frac{\xi_{\mathcal{A}F}-1}{\xi_{\mathcal{A}F}}} + (1 - \alpha_{\mathcal{A}F})^{\frac{1}{\xi_{\mathcal{A}F}}} \left(M_t^F(f) \left[1 - \Gamma_t^{\mathcal{A}F}(f) \right] \right)^{\frac{\xi_{\mathcal{A}F}-1}{\xi_{\mathcal{A}F}}} \right]^{\frac{\xi_{\mathcal{A}F}-1}{\xi_{\mathcal{A}F}}}$$
(15)

where $0 \leq \xi_{\mathcal{A}F} \leq \infty$ is the elasticity of substitution between the domestic and the imported tradable goods; $0 \leq \alpha_{\mathcal{A}F} \leq 1$ is a home bias parameter; and $\Gamma_t^{\mathcal{A}F}(f)$ stands for a real adjustment cost on changes in variety f import content, $M_t^F(f)/Y_t^{\mathcal{A}F}(f)$, given by:

$$\Gamma_t^{\mathcal{A}F}(f) = \frac{\phi_{\mathcal{A}F}}{2} \frac{\left(\mathcal{A}_t^{\mathcal{A}F}(f) - 1\right)^2}{1 + \left(\mathcal{A}_t^{\mathcal{A}F}(f) - 1\right)^2} \quad \text{with} \quad \mathcal{A}_t^{\mathcal{A}F}(f) = \frac{M_t^F(f)/Y_t^{\mathcal{A}F}(f)}{M_{t-1}^F/Y_{t-1}^{\mathcal{A}F}} \tag{16}$$

where $\phi_{\mathcal{A}F}$ is a sector-specific adjustment cost parameter; M_t^F and $Y_t^{\mathcal{A}F}$ represent aggregate imports and assembled goods, respectively.

The production function of the variety f of the final good of type F is defined as:

$$Y_t^F(f) = \left[(1 - \alpha_F)^{\frac{1}{\xi_F}} \left(Y_t^{AF}(f) \right)^{\frac{\xi_F - 1}{\xi_F}} + (\alpha_F)^{\frac{1}{\xi_F}} \left(Z_t^{NF}(f) \right)^{\frac{\xi_F - 1}{\xi_F}} \right]^{\frac{\xi_F}{\xi_F - 1}}$$
(17)

⁶The fixed cost term is defined as a constant share of nominal output, ensuring that it does not vanish along the inflationary balanced growth path of the economy.

where $0 \le \xi_F \le \infty$ is the elasticity of substitution between assembled and non-tradable goods, and $0 \le \alpha_F \le 1$ is the non-tradable goods bias parameter.

As in the case of labour unions and manufacturers, distributors also face quadratic costs in the adjustment of the final good price, $\Gamma_t^{PF}(f)$, which take the following form:

$$\Gamma_t^{PF}(f) = \frac{\phi_{PF}}{2} Y_t^F \left(\frac{P_t^F(f) / P_{t-1}^F(f)}{P_{t-1}^F / P_{t-2}^F} - 1 \right)^2$$
(18)

where ϕ_{PF} is the sector-specific price adjustment cost parameter; Y_t^F is the aggregate output of final good F, to be sold at price P_t^F .

Aggregate demand for variety f of final good F is given by:

$$Y_t^F(f) = \left(\frac{P_t^F(j)}{P_t^F}\right)^{-\sigma_{F,t}} Y_t^F$$
(19)

where $0 \leq \sigma_{F,t} \leq \infty$ is the elasticity of substitution between type F good varieties.

Each final goods producer f solves the following dividend maximisation problem:

$$\max_{P_t^F(f), Z_t^{TF}(f), Z_t^{NF}(f), M_t^F(f)} E_t \sum_{s=0}^{\infty} \tilde{R}_{t,s} D_{t+s}^F(f)$$
(20)

subject to the constraints imposed by the production technology, adjustment costs and demand conditions. Period t dividends, $D_t^F(j)$, are defined as:

$$D_{t}^{F}(f) = (1 - \tau_{K,t}) \left[P_{t}^{F}(f) Y_{t}^{F}(f) - P_{t}^{T} Z_{t}^{TF}(f) - P_{t}^{N} Z_{t}^{NF}(f) - P_{t}^{*} M_{t}^{F}(f) - P_{t}^{F} \Gamma_{t}^{PF}(f) - P_{t}^{F} T_{t} \omega^{F} \right]$$

which corresponds to the after-tax difference between overall revenue $P_t^F(f)Y_t^F(f)$ and expenditure, including input costs, $P_t^T Z_t^{TF}(f) + P_t^N Z_t^{NF}(f) + P_t^* M_t^F(f)$, and adjustment and fixed costs, $P_t^F(f)\Gamma_t^{PF}(f) + P_t^F(f)T_t\omega^F$. Finally, P_t^* is the price of imported goods, $M_t^F(f)$, set in the rest of the world market.

3.4 The Government

The fiscal block of the model is detailed enough to allow for the assessment of macroeconomic impacts of alternative fiscal policy strategies. Government has a number of fiscal instruments that can be used to stabilise the business cycle that affect macroeconomic aggregates differently. In addition, Government may also finance current expenditure using future tax revenues by managing a public debt stock. The disaggregation considered for the public sector account is illustrated in Table 1.

On the expenditure side, the government faces spending with: the government consumption good, $P_t^{\mathcal{G}}G_t$ (recall that $P_t^{\mathcal{G}}$ is the price charged by distributors for the government consumption good); lump-sum transfers to households, TRG_t ; and debt interest outlays, $(i_{t-1} - 1)B_{t-1}$, where B_{t-1} are one-period bonds which pay an interest rate i_{t-1} at the beginning of period t. On the revenue side, the government receives funds from: foreign transfers from the rest of the world, TRE_t ; the labour income tax paid on wage income, $RV_{L,t} = \tau_{L,t} \left(V_t U_t - P_t \Gamma_t^U \right)$; the tax paid by households on consumption expenditures, $RV_{C,t} = \tau_{C,t} P_t^C C_t$; employers' social security contributions due on payroll, $RV_{SP,t} = \tau_{SP} V_t U_t$; corporate income taxes paid by firms (both manufacturers and distributors) on operational profits, $RV_{K,t}$, defined as:

$$RV_{K,t} = \sum_{J=\mathcal{T},\mathcal{N}} \tau_{K,t} \left[P_t^J \left(Z_t^J - \Gamma_t^{PJ} - T_t \omega^J \right) - (1 + \tau_{SP,t}) V_t U_t^J - P_t^I \left(q_t^J \delta^J K_t^J + \Gamma_t^{IJ} \right) \right] + \sum_{F=\mathcal{C},\mathcal{I},\mathcal{G},\mathcal{X}} \tau_{K,t} \left[P_t^F \left(Y_t^F - \Gamma_t^{PF} - T_t \omega^F \right) - P_t^T Z_t^{TF} - P_t^* M_t^F - P_t^N Z_t^{NF} \right]$$

In addition, the Government issues one-period bonds, paying interest outlays at the beginning of period t on the stock held from period t - 1, $i_{t-1}B_{t-1}$. For the sake of simplicity, full home bias is assumed, i.e. all government debt is held by domestic households. However, households can access international debt markets and borrow abroad to buy the government bonds.

It should be noted that the Government finances its expenditure mostly through distortionary taxation (present or future). In particular, higher taxation on labour income and/or higher social security contributions rate induce households to substitute consumption for leisure and/or manufacturers to use technologies with higher capital intensity. In addition, an increase in the consumption tax rate also induces households to substitute away from consumption.

The issuance of public debt allows for the postponement of charging the taxes required to finance expenditure in each period, implying that the public sector account does not need to balance out in each and every period. This has a non-trivial impact in households decisions, since the model is inherently non-Ricardian and, therefore, part of the public debt is taken as net wealth by asset holders.

The Government's budget constraint can be represented as:

$$B_t = i_{t-1}B_{t-1} + P_t^{\mathcal{G}}G_t + TRG_t - RV_t - TRE_t$$
(21)

where $RV_t = \sum_{A=C,L,SP,K} RV_{A,t}$ are overall revenues.

To ensure that the public debt follows a non-explosive path, a fiscal policy rule is

Expenditures		Revenues		
	C			
Govt. Consumption	$P_t^{9}G_t$	Consumption tax	$RV_{C,t}$	
Transfers	TRG_t	Soc. Sec. Contributions	$RV_{SP,t}$	
Interest Payments	$(i_{t-1} - 1)B_{t-1}$	Labour income tax	$RV_{L,t}$	
		Corporate income tax	$RV_{K,t}$	
		Foreign transfers	TRE_t	
Fiscal balance	$-(B_t - B_{t-1})$			

Table 1: Simplified public sector account

featured, imposing that public debt and the fiscal balance (henceforth $SG_t = B_{t-1} - B_t$) converge to pre-determined target ratios in the steady state. The fiscal balance target ratio, $\left(\frac{SG}{GDP}\right)_t^{target}$, pins down a unique public debt target ratio, $\left(\frac{B}{GDP}\right)_t^{target}$, which is also a key steady-state figure. For each period, the fiscal rule sets the fiscal balance that is consistent with a stable debt path, imposing that the budget constraint is binding and at least one of the fiscal instruments must adjust endogenously to fulfil it. Following Kumhof and Laxton (2009*a*), this rule takes the following form:

$$\left(\frac{SG}{GDP}\right)_{t} = \left(\frac{SG}{GDP}\right)_{t}^{target} + d_1 \left(\frac{RV_t - RV_t^{ss}}{GDP_t^{ss}}\right) + d_2 \left(\frac{B_t}{GDP_t^{ss}} - \left(\frac{B}{GDP}\right)_t^{target}\right)$$
(22)

where RV_t^{ss} is overall tax revenue with tax bases evaluated at their steady-state levels; GDP_t and GDP_t^{ss} are the observed and the steady-state levels of Gross Domestic Product. The convergence dynamics, namely the speed of convergence and the response to business cycle fluctuations, depend on the fiscal rule parameters. Parameter d_1 controls for the response to the tax revenue gap, while d_2 controls for the Government (in)tolerance to deviations of debt from the target ratio. Since these gaps vanish in the steady state, the rule implies that the fiscal balance converges to its target level.

At this point, the fiscal instrument that becomes an endogenous variable remains to be defined. This is an open fiscal policy decision and is largely a political matter. *Ex-ante*, the government has the following fiscal instruments: government consumption (G_t) , lump-sum transfers to households (TRG_t) (which can be targeted at asset holders or liquidity constrained households), the labour income tax rate $(\tau_{L,t})$, the consumption tax rate $(\tau_{C,t})$, the employer's social security contributions rate (τ_{SP}) and the corporate income tax rate $(\tau_{K,t})^7$. However, *ex-post* one of this instruments is endogenously adjusted to met the fiscal balance imposed by the fiscal rule.⁸ The most common option relies on the use of the labour income tax rate as the endogenous fiscal policy instrument (Harrison et al. 2005, Kilponen and Ripatti 2005, Kumhof, Muir, Mursula and Laxton 2010, Kumhof and Laxton 2007). The benchmark specification of *PESSOA* also takes this option, but it allows for other possibilities, including not only the remaining taxes, but also transfers to households or Government consumption. In addition, it is also possible to consider alternative combinations of instruments.

Finally, a word of caution is needed. Although the above-mentioned fiscal block is suited to implement several types of fiscal simulations, the model remains a simplification of reality that is crucial to keep it tractable. In particular, government consumption represents a pure distortion, since it does not affect the marginal utility of consumption and leisure or firms productivity level. Therefore, the only tangible impact of Government consumption is changing demand conditions for a specific type of final good, which is particulary intensive in non-tradable intermediate goods and has a negligible import

⁷The distinction between government consumption and investment is not considered in the model.

⁸In many studies, the budget constraint is simplified to include a non-distortionary lump-sum tax. Though it may be an appealing academic benchmark, it is largely unrealistic since the role played by lump-sum taxation is very limited.

content. The model is thus silent to other roles of the Government, for instance as employer or investor. If Government purchases includes more spending on law enforcement, road buildings or other public stock with likely future effects, these are not considered. As Hall (2009) clarifies, it is not the case that effects operating through externalities are unimportant, but simply that the fiscal stimulus has to be undertaken as an experiment on a limited and controlled macroeconomic environment. It is beyond the scope of this paper to define externalities' effects conditional on different fiscal policies. Note also that the model does not feature unemployment benefits explicitly, since labour market details are reduced to the minimum and, therefore, unemployment developments are not explicitly modelled.

3.5 The rest of the world

By assumption the rest of the world (RoW) corresponds to the rest of the monetary union, and therefore the nominal effective exchange rate is irrevocably set to unity, as all trade and financial flows are in the same currency.

Regarding financial flows, it is assumed that changes in the net foreign asset/debt position of the domestic economy have no impact on foreign macroeconomic aggregates and therefore on monetary policy decisions. As for trade flows, the demand for imports by domestic distributors results from the dividend maximisation problem presented in section 3.3 and reflects demand conditions and competitiveness. Concerning exports, let $Y_t^{A*}(f^*)$ be the good demanded by a continuum $f^* \in [0,1]$ of importers located abroad. This good is assumed to result from the assembling of a domestic exported good $X_t(f^*)$ and an intermediate tradable good $Z_t^{T*}(f^*)$ produced by foreign manufacturers. The production process is given by the following CES technology:

$$Y_t^{A*}(f^*) = \left((1 - \alpha^*)^{\frac{1}{\xi^*}} \left(Z_t^{T*}(f^*) \right)^{\frac{\xi^* - 1}{\xi^*}} + (\alpha^*)^{\frac{1}{\xi^*}} \left(X_t(f^*) \right)^{\frac{\xi^* - 1}{\xi^*}} \right)^{\frac{\xi^*}{\xi^* - 1}}$$
(23)

where ξ^* is the elasticity of substitution between foreign tradable goods and home exports and α^* is the foreign economy bias parameter.

Each foreign distributor will set the demand for the export good produced in the SOE and for the tradable goods produced in his country that minimises the cost of producing the desired quantity of assembled good, subject to the technology constraint imposed by (23). Aggregating across importers and export good varieties, the demand for exports is:

$$X_t = \alpha^* \left(\frac{P_t^X}{P_t^{T*}}\right)^{-\xi^*} Y_t^{A*}$$
(24)

where P_t^X is the price of the exported good charged by domestic distributors, P_t^{T*} is the price of the foreign tradable good and Y_t^{A*} is aggregate production of the foreign assembled good. It should be noted that this equation is highly relevant to render the model dynamically stable, namely due to a large elasticity to real exchange rate movements. The model

operates *de facto* like a real model (or a fully credible fixed nominal exchange rate model), since domestic price levels are pinned down by the external constraint that uniquely sets the real exchange rate in the steady state. Like the remaining foreign variables, both P_t^{T*} and Y_t^{A*} are assumed to be independent of domestic developments.

Finally, some comments should be made concerning the external environment of *PES-SOA*. Firstly, though restricting the RoW to the rest of the monetary union may be a limiting assumption for the purpose of analysis in many euro area SOE, it does not seem very stringent for fiscal policy analysis and allows for minimising the dimension of the external block of the model. More specifically, under this assumption one does not need to explicitly model interactions between the euro area and the world excluding the euro area. Obviously, this breakdown becomes clearly relevant in case one wants to assess the impact on the domestic economy of shocks originated abroad, in particular if a high share of external trade in goods and assets is done with countries outside the euro area. Secondly, while a country's exports in a multi-country model are endogenously determined by imports demand of their trading partners, in a SOE model foreign economy developments influence the domestic economy significantly, but are not influenced by domestic economy developments (Adolfson et al. 2007). Therefore, it seems reasonable to assume that foreign demand and prices are exogenous, with endogenous movements in exports being simply determined by real exchange rate fluctuations.

3.6 Market clearing conditions and GDP definitions

The model relies on a set of equilibrium conditions, which ensure that all markets clear in each and every period.

In the labour market, overall labour supply by households must equal overall labour demand by manufacturers:

$$L_t^{\mathcal{A}} + L_t^{\mathcal{B}} = U_t^{\mathcal{T}} + U_t^{\mathcal{N}} \tag{25}$$

In the intermediate goods market, the output produced by each type of manufacturer must meet demand by distributors and cover price adjustment and fixed costs:

$$Z_t^{\mathcal{T}} = Z_t^{\mathcal{TC}} + Z_t^{\mathcal{TI}} + Z_t^{\mathcal{TG}} + Z_t^{\mathcal{TX}} + \Gamma_t^{P\mathcal{T}} + T_t \omega^{\mathcal{T}}$$
(26)

$$Z_t^{\mathcal{N}} = Z_t^{\mathcal{NC}} + Z_t^{\mathcal{NI}} + Z_t^{\mathcal{NG}} + Z_t^{\mathcal{NX}} + \Gamma_t^{\mathcal{PN}} + T_t \omega^{\mathcal{N}}$$
(27)

In the final goods market, the output supplied by each type of distributor must meet

demand by its respective costumers and cover adjustment and fixed costs:

$$Y_t^{\mathcal{C}} = C_t^{\mathcal{A}} + C_t^{\mathcal{B}} + \Gamma_t^{P\mathcal{C}} + T_t \omega^{\mathcal{C}}$$
⁽²⁸⁾

$$Y_t^{\mathcal{I}} = I_t^{\mathcal{T}} + I_t^{\mathcal{N}} + \Gamma_t^{\mathcal{T}\mathcal{I}} + \Gamma_t^{\mathcal{N}\mathcal{I}} + \Gamma_t^{P\mathcal{I}} + T_t\omega^{\mathcal{I}}$$
(29)

$$Y_t^{\mathcal{G}} = G_t + \Gamma_t^{P\mathcal{G}} + T_t \omega^{\mathcal{G}} \tag{30}$$

$$Y_t^{\mathcal{X}} = X_t + \Gamma_t^{P\mathcal{X}} + T_t \omega^{\mathcal{X}}$$
(31)

In the foreign bond market, households change in asset net holdings must equal the current account:

$$B_t^* - i_{t-1}^* \Psi B_{t-1}^* = P_t^X X_t - P_t^* M_t + TRE_t$$
(32)

Finally, nominal GDP is defined as:

$$GDP_{t} = P_{t}C_{t} + P_{t}^{G}G_{t} + P_{t}^{I}I_{t} + P_{t}^{X}X_{t} - P_{t}^{*}M_{t}$$
(33)

while real GDP is defined as nominal GDP evaluated at the price levels prevailing in the initial steady state .⁹

3.7 Calibration

PESSOA was calibrated using actual data of the Portuguese economy and information from several studies on the Portuguese and euro area economies, including DSGE models. The model parameters are presented in detail in Appendix A.

The data on the Portuguese economy was mainly taken from the Banco de Portugal quarterly database (included in the 2009 Summer issue of the Economic Bulletin), and from the National Accounts data released by Statistics Portugal. These data sources were primarily used to pin down those parameters affecting the steady-state key macroeconomic ratios. As reported in Appendix A, the model matches fairly reasonably the key ratios of the Portuguese economy and delivers a plausible capital-to-output ratio.

Among the relatively large set of parameters and assumptions behind the model, it seems worth mentioning that the steady-state real GDP growth was assumed to be identical in the entire monetary union, which ensures the existence of a balanced growth path. The annual growth rate of the labour-augmenting productivity was set to 2%, which is consistent with the available estimates for the potential output growth in the euro area (Musso and Westermann 2005, Proietti and Musso 2007). This figure also seemed plausible for Portugal (Almeida and Félix 2006). Regarding inflation, the ECB inflation objective was assumed to be fully credible. Hence, the steady-state was solved under the assumption that foreign inflation stands at 2% per year. The euro area nominal interest rate in the steady state was set to 4.5% (Coenen et al. 2007). The parameters related with the Blanchard-Yaari households behaviour, namely the instant probability of death and

⁹This mimics the national accounts definition of GDP at reference year prices.

Expenditure		Revenue	
Govt. Consumption + GFCF	+0.36	Labour income tax	-0.29
Targeted transfers to HH	+0.09	Consumption tax	-0.05
Transfers to firms	+0.08	Corporate income tax	-0.08
		SS contributions	-0.05
Fiscal balance	-1.00		

(as a % of steady-state GDP)

Source: authors calculations using OECD (2009).

the decay in productivity over the lifetime were calibrated as in Kumhof, Muir, Mursula and Laxton (2010). The elasticities of substitution in the production functions of manufacturers and distributors, the parameters governing the wage and price markups, the adjustment costs, and the fiscal rule parameters were calibrated using Kumhof, Muir, Mursula and Laxton (2010), Coenen et al. (2007) and estimates for Portugal, whenever they were available.

4 Macroeconomic effects of alternative exit strategies

This section is focused on the macroeconomic effects of fiscal stimulus under alternative exit strategies. The evaluation is conducted by a set of fiscal policy simulations using the model presented in Section 3. The simulations are based on a specific fiscal stimulus package (henceforth, the benchmark package) and rely on the assumptions of perfect foresight, full credibility of the fiscal authority and no lags between the announcement and programme implementation dates. It is also assumed from the outset that a specific exit strategy is announced contemporaneously to the implementation of the benchmark package and that all stimulus are temporary.¹⁰

The benchmark package is based on fiscal stimulus measures of developed economies reported in OECD (2009). The stimulus is made of expenditure and revenue-based measures. The benchmark package corresponds to a re-scaling of the average figures reported by a number of countries (Table 2). The fiscal block of the model is detailed enough to account for all instruments reported in Table 2, with the exception of transfers to firms. Thus, we assume that transfers to firms can be treated as an *ad-valorem* subsidy and, therefore, the overall amount of corporate income tax cut plus transfers to firms was fed into the model through the corporate income tax. The benchmark package was implemented as a set of shocks in average tax rates and on Government expenditure levels.

The exit strategies considered herein can be split in two steps. The first step is the reversal of the fiscal stimulus. The implementation of a temporary fiscal expansion is in line with the literature that argues that a successful stimulus must be temporary, timely and

¹⁰Permanent shocks, alternative fiscal stimulus, implementation lags and credibility issues are discussed in Almeida, Castro, Félix and Maria (2010).

targeted (the so-called TTT requirement) and that permanent fiscal expansions, based for instance on a permanent increase of Government expenditures, may bring about undesirable macroeconomic consequences over the medium run.¹¹ In the benchmark simulation, the reversal of the fiscal stimulus is assumed to occur after four quarters and the fiscal expansion is fully financed by debt issuance during a period of two years.¹²

The second step of the exit strategy is the consolidation process, which is of key importance in this study. In the benchmark simulations, the consolidation starts in the first quarter of the third year, and corresponds to a temporary tax increase and/or an expenditure cut. In the presence of a stimulus, the exit period only ends when the economy returns to the initial steady state (and therefore the public debt ratio returns to the prestimulus level).

In the benchmark simulations, the first step of the exit strategy is always the same, i.e. the benchmark package presented in Table 2 is reversed after four quarters. The second step, however, is grounded on alternative fiscal instruments. This scheme allows us to evaluate the impact of alternative exit strategies in terms of the most adequate instrument to ground the consolidation process.

Figure 4 illustrates these two stages. Taking the steady-state as a baseline in which all fiscal instruments are at \mathfrak{F} , t_0 represents the announcement and implementation date of the fiscal stimulus programme.¹³ On this date, \mathfrak{F} increases by Δ , which corresponds to the size of benchmark fiscal package, implemented with several instruments and implying an increase in fiscal deficit of 1% of the initial steady-state GDP. The fiscal package is fully financed by resorting to debt issuance as of t_0 . The second relevant date is t_1 when the fiscal stimulus ceases and, therefore, all fiscal instruments that were used to implement the stimulus are reverted to their steady-state level, but the deficit originated by the stimulus keeps on being financed through public debt issuance. This represents the first step of the exit strategy. Finally, the fiscal consolidation starts in t_2 , which represents the beginning of the second step of the exit strategy. As presented in Section 3, from then onwards at least one fiscal instrument adjusts endogenously to ensure that public debt reverts to the target level and, more generally, all variables return to their initial steady state. The outcome from alternative instruments is presented in subsection 4.1.

In subsection 4.2, the benchmark simulations are expanded so as to implement a sensitivity analysis focused on the duration of the stimulus, timing and the aggressiveness of the consolidation process. More specifically, we consider, on the one hand, the possibility of a weaker consolidation effort (the "low effort" simulation). On the other hand, a

¹¹Almeida, Castro, Félix and Maria (2010) obtains similar results for the the case of a SOE operating in a monetary union.

¹²In practice, the fully financing of the fiscal stimulus by resorting to debt issuance during a two years period is achieved by switching off the fiscal rule during that period. The fiscal rule is switched on as consolidation period starts. One should be aware, that switching off the fiscal rule might rise issues related with the so-called time-inconsistency of optimal plans (Barro and Gordon 1983, Kydland and Prescott 1977). However, the discussion of the role of discretion is beyond the scope of this study. Nevertheless, conclusions would be qualitatively similar in case fiscal policy rule is switched on.

¹³Recall that there are no implementation lags, i.e. there is no interval of time between the announcement and the implementation of the stimulus.

Figure 4: A temporary fiscal stimulus based on a benchmark package



Notes: t_0 is the date when the fiscal stimulus is announced and implemented, and when the fiscal policy rule is deactivated; t_1 is the ending date of the stimulus; \mathfrak{I}^* represents a steady-state fiscal stance, created by all fiscal instruments, before the stimulus; Δ is the actual stimulus (it corresponds to a benchmark package that implies an increase in the fiscal deficit of 1% of steady-state GDP); t_2 corresponds to the starting date of the consolidation period in the benchmark scenario, defined as a time when the fiscal policy rule is again fully operational. In all experiments, the time span between t_0 and t_1 , or t_1 and t_2 is assumed to be 4 quarters. After t_2 , the fiscal rule may be more or less sensitive to deviations from steady-state figures. Finally, t_3 is an alternative date to start the consolidation period.

more protracted stimulus and a delayed consolidation will also be investigated (the "protracted" simulation). In both cases, the consolidation period is based on Government expenditure cuts. The low effort scenario differs from the benchmark by a less aggressive policy towards deviations from the debt target. Using Figure 4, this implies that fiscal consolidation starts in t_2 , as in the benchmark scenario, but is completed later then in the benchmark case. The low effort is implemented by lowering parameter d_2 in equation (22).

The protracted scenario corresponds to an extension of the stimulus for one year, and a delay of one year in the beginning of the consolidation period. This means that the stimulus is extended up to t_2 and that consolidation starts in t_3 . For comparison purposes, the sensitiveness of the fiscal rule to business cycle fluctuations of the tax bases, assessed by parameter d_1 in equation (22), remains unchanged in this scenario.

4.1 Alternative fiscal instruments to complete the exit strategy

In this subsection, we assess the impact of alternative instruments in the fiscal consolidation after the implementation of the benchmark package presented above. We start by discussing the impact multipliers, which are the most commonly used measure to assess the relevance of a fiscal stimulus (Blanchard and Perotti 2002, Canova and Pappa 2007). We then focus on medium-run impacts, including the evolution of the "Present value multiplier" (PVM) for the main economic aggregates (Mountford and Uhlig 2009). The PVM has already been used in the context of general equilibrium models (Leeper et al. 2009) and corresponds herein to the present discounted value of the impact of a 1 per cent fiscal stimulus on selected variables, where the discount rate reflects economic agent valuation of current and future events.¹⁴

The impact multipliers under alternative fiscal instruments, defined as the average impact in the year in which the stimulus is implemented, are reported in Table 3. The results suggest that the impact multipliers on real GDP and expenditure components are largely similar across all instrument used for the consolidation. This outcome reflects essentially that the composition of the benchmark stimulus package and the timing of the exit are identical. The impact on GDP, private consumption and imports is consistently positive, whereas the effect in private investment and exports is always negative. This implies that a fiscal stimulus may be used to boost GDP or consumption over one year under any exit strategy, at the cost of a partial crowding-out of investment and exports. The impact multiplier is significantly below unity, reflecting the composition of the benchmark package and the leakages associated to each component of the stimulus.¹⁵ The proximity of all results implies that the impact multipliers are insufficient to discriminate between alternative fiscal policy instruments to ground the consolidation process. Recall that such process is assumed to start two years after the beginning of the stimulus and one year after the first step of the exit strategy, which is simply characterized by the reversal of the fiscal stimulus.

The impact of a fiscal stimulus package, even in the temporary case, goes well beyond the short run. The necessary consolidation period is not finished with the reversal of the stimulus, implying that the assessment of the macroeconomic impacts over the medium run are also relevant. The impulse response functions and the PVM over a period of ten years are depicted in Figures 5 and 6. The first conclusion that can be drawn is that the relatively similar macroeconomic effects over the short run, namely on the first year, become rather different over the medium run. The analysis of these differences can therefore be used to evaluate the fiscal instruments.

The adjustment path of selected macroeconomic variables over the reported horizon puts in evidence that alternative fiscal consolidation strategies do yield different impacts in real GDP, hours, private consumption, investment and exports, while impacts in imports are somewhat closer. Exit strategies based on tax rate hikes lead to a more protracted period of below-steady-state real GDP, private consumption and investment, hours and exports, while exit strategies based on transfers or Government consumption cuts limit these impacts (Figure 5). The PVM also conveys the idea that exit strategies based on Government consumption and transfer cuts stand out with more positive medium-run impacts in real GDP, as opposed to strategies based on labour income tax rate hikes, which depict negative PVM from the third year onwards, or consumption taxes, which become negative after the seventh year (Figure 6). In the case of private consumption and hours

¹⁴A brief description of the methodology behind the PVM is presented in Appendix B.

¹⁵The degree of leakages associated with each fiscal stimulus was assessed in Almeida, Castro, Félix and Maria (2010).

	$ au_l$	$ au_c$	G	Trf
GDP	0.55	0.58	0.59	0.58
Consumption	0.71	0.78	0.77	0.76
Investment	-0.23	-0.22	-0.24	-0.19
Exports	-0.25	-0.27	-0.25	-0.25
Imports	0.38	0.40	0.41	0.41
Hours	0.75	0.78	0.79	0.78
Real wage rate	0.24	0.30	0.29	0.29
Real exchange rate	-0.10	-0.11	-0.10	-0.10
Inflation (in p.p.)	0.00	0.01	0.00	0.00
NFA (as a % of SS GDP)	0.14	-0.03	0.11	-0.09
Public debt (as a % of SS GDP)	0.26	0.39	0.27	0.45
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 Table 3: Impact multipliers under alternative exit strategies

 (deviation from steady-state)

**Notes:** NFA and Public debt deviations are in percentage points. The remaining variables are in percentage. Higher real exchange rate implies depreciation. The fiscal instruments are labour income taxes  $(\tau_l)$ ; taxes on consumption goods  $(\tau_c)$ ; Government consumption (G); and transfers (Trf).

worked, the PVM suggests that results based on Government consumption and transfer cuts are also qualitatively similar to those obtained for real GDP; nevertheless, strategies based on Government consumption cuts depict higher PVM than transfers regarding the impact on private consumption, whereas the opposite occurs in the case of hours worked. Figure 6 also indicates that strategies based on Government consumption cuts end up producing positive PVM in private investment and exports, as opposed to the remaining strategies. In the case of transfers cuts, the relative worse performance of exports and private investment in terms of the PVM vanishes as the time horizon increases.

The different macroeconomic impacts of alternative fiscal instruments are conditional on the amount of distortion implied by each instrument during the second step of the exit strategy, i.e, during the consolidation process. The labour income tax is the most distortionary instrument, while transfers (since they are distributed in a lump-sum fashion to all households) and government consumption are the least, not affecting their inter/intratemporal decisions.

Finally, the impact on imports and net foreign asset position of all alternative fiscal instruments is rather limited, against a background where exchange rate fluctuations are not sizeable. Nevertheless, one may point out that exit strategies based on labour income tax rate hikes, lead to an increase in tradable goods inflation and to a small real exchange rate appreciation, thereby deteriorating international competitiveness, whereas the opposite applies to Government consumption cuts.



Figure 5: Alternative fiscal instruments behind the exit strategy (deviation from steady-state)

**Note**: Inflation, NFA and Public debt deviations are in percentage points. The remaining variables are in percentage. Higher real exchange rate implies depreciation. **Source**: authors calculations using *PESSOA*.

On the nominal side, all exit strategies, but the one based on labour income tax, do yield a marginal negative impact on inflation prospects and a slight real exchange rate depreciation in the third year, when the consolidation starts. In case a consumption tax rate increase is used to consolidate, the direct impact in consumer prices leads to higher inflation, which does not fully translate into lower competitiveness, since it is only partly reflected in wage inflation and therefore on final goods prices and real exchange rate developments.



#### Figure 6: Present value multipliers

(in percentage)

**Source**: authors calculations using *PESSOA*.

In general, exit strategies based on Government consumption cuts seems to dominate the remaining options. This fiscal instrument was also found by Almeida, Castro, Félix and Maria (2010) to be the one with the highest impact multiplier (close to unity). This reflects the fact that the production of the Government consumption good employs resources that would otherwise be available for the private sector, creating demand side pressures. Hence, any reduction of demand side pressures promotes a real exchange rate depreciation and benefits the international competitiveness of domestic firms. This effect stimulates production and factor demand and offsets, over the medium-run, the recessionary impacts of the fiscal consolidation. It should be noted that high trade elasticities is a usual feature of SOEs (and a key variable to ensure a sustainable NFA position of a SOE engaged in a monetary union). The results also reveal a decline in the real wage rate when the fiscal policy rule is switched on, which is rapidly reverted, and an increase in firm dividends and in the rental rate of capital, leading to a higher desired capital stock level that pulls up investment over the simulation horizon. Finally, the evolution of private consumption reflects essentially limited income effects from the consolidation, related with higher dividend income prospects, which offsets the slight increase in real interest rate implied by inflation developments in a context of unchanged nominal interest rate.

Turning to exit strategies based on cuts in lump-sum transfers, the impacts in the macroeconomic scenario bear several similarities with those reported for Government consumption cuts. However, the consolidation of public debt affects the economy through different transmission channels than those operating in the case of Government consumption cuts. A cut in transfers hits the households budget constraint directly, creating pure negative income and wealth effects. This induces an increase in labour supply, which is particularly strong in the case of liquidity constrained households, that cannot smooth out the cut in transfers by trading in assets. The outward shift in the labour supply curve implies *ceteris paribus* that households will demand a lower wage for the same amount of supplied labour. Therefore, labour becomes cheaper than capital in relative terms and firms' marginal costs decline. The impact in the relative price of labour motivates the more rapid increase in hours and the less buoyant private investment than in the Government consumption cuts case, despite a smaller increase in output (real GDP). In addition, the slight gain in international competitiveness is the driver of the exports increase and of the decline in the import content. On the nominal side, the slight decline in inflation and the real exchange rate depreciation reflect mainly developments in firms' marginal costs over the simulation horizon, despite improved demand conditions.

In turn, exit strategies based on tax increases imply a protracted decline of ouput, private consumption and investment and hours to below steady-state levels over the medium run (Figure 5). The results also present strong support that exit strategies based on labour income tax hikes are the most penalising for real GDP, private consumption and investment and hours, since this tax is the most distortionary, affecting consumption/leisure allocation of both asset holders and liquidity constrained households. On the contrary, the consumption tax is far less distortionary of the consumption/leisure allocation, affecting essentially the intertemporal consumption allocation of asset holders. Liquidity constrained households are simply affected by wealth effects arising from the decline in the real income, stemming from price developments.

Despite being very similar in many aspects, a raise in the labour income tax rate or in the consumption tax rate include remarkable differences in many aspects. In particular, these taxes have different impacts on the magnitude of the consumption and inflation developments and on the real wage rate paid by intermediate goods producers against the steady-state figures. Consumption tax rate changes affects the economy through the price transmission channel, reducing the real value of households wealth and, therefore, their consumption over the consolidation period. However, the decline in wealth induces households to supply more labour in order to cushion the impact of the negative wealth effect in consumption, particularly in the case of liquidity constrained households that are not able to perform consumption smoothing by trading in assets. This explains the smaller decline in hours worked than in the case of the labour income tax rise.

A labour income tax rise affects directly the consumption/leisure allocation, shifting *ceteris paribus* the labour supply curve inwards. This means that households supply less hours for the same real wage and, in this context, real wages need to increase to keep hours worked at a proper level, inducing an increase in firms marginal costs. This is passed to final prices, leading to above steady-state inflation and to a real exchange rate appreciation, with impacts in competitiveness and trade, that affect demand prospects in the medium-run. The strong negative impact in households wealth yields a decline in private consumption, which coupled with the real exchange rate appreciation leads to

lower demand prospects, inducing a decline in the desired capital stock and in private investment.

A policy implication that can be derived from the previous analysis is that exit strategies based on expenditure cuts seem to outperform the remaining options. Given this implication, the rest of the article restricts the analysis to a consolidation period solely based on Government consumption cuts.

#### 4.2 Alternative timings to complete the exit strategy

To assess the importance of alternative timings to complete the exit strategy, two alternative scenarios will be implemented: (i) a weaker fiscal consolidation effort; and (ii) a protracted stimulus and delayed consolidation. These scenarios will be called "low effort" and "protacted" scenarios, respectively. As previously, all simulations are conducted under the assumption of full credibility of the fiscal authorities, the benchmark package remains unchanged, and all exit strategies are announced contemporaneously to the implementation of the fiscal stimulus programme. However, the consolidation process is fully based on Government expenditure cuts, which seemed to be a somewhat dominant exit strategy in the previous subsection. The outcome of both scenarios will be confronted with the results of the exit strategy based on Government consumption cuts (the "reference" scenario), obtained in subsection 4.1.

The low effort scenario differs from the one considered in the previous subsection by considering that the fiscal consolidation process can be prolonged in time. The protracted scenario corresponds to a stimulus that is prolonged for two years and that the second step of the exit strategy only occurs in the very beginning of the fourth year (a one year delay in comparison with the reference case).¹⁶

The impact multipliers for the alternative scenarios are presented in Table 4. The results suggest that the short-run impacts are largely independent of alternative timings to complete the exit strategy. Private investment is the variable that shows some differences in relative terms. Its sensitiveness reflects essentially the impact of exit timings in demand prospects over the medium term, and the importance of forward-looking elements in investment decisions resulting from capital stock adjustments (which are subject to adjustment costs).

As in the previous section, the assessment changes as the analysis is focused on macroeconomic impacts over longer time periods. This impact is depicted in Figure 7 and the PVMs are presented in Figure 8. In comparison with the reference scenario, all agents of the economy adapted their optimal behaviour, as expected, to the new fiscal policy function, which includes a less sensitive response when debt deviates from target, or to the new fiscal stimulus, which is implemented over a longer period (although still temporary).

Contrary to the reference scenario, the low effort strategy does not yield a real exchange

¹⁶Technically, the low effort scenario corresponds to changing parameter  $d_2$  of equation (22) from the benchmark calibration of 0.1 to virtually zero; in the protracted scenario, the fiscal rule parameters remains unchanged.

	Reference	Low effort	Protracted
GDP	0.59	0.60	0.55
Consumption	0.77	0.80	0.78
Investment	-0.24	-0.21	-0.43
Exports	-0.25	-0.29	-0.31
Imports	0.41	0.43	0.36
Hours	0.79	0.79	0.73
Real wages rate	0.29	0.31	0.31
Real exchange rate	-0.10	-0.12	-0.12
Inflation (in p.p.)	0.00	0.02	0.03
NFA (as a $\%$ of SS GDP)	0.11	0.11	0.13
Public debt (as a % of SS GDP)	0.27	0.26	0.26
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 Table 4: Impact multipliers for alternative exit timings (deviation from steady-state)

**Note:** Inflation, NFA and Public debt deviations are in percentage points. The remaining variables are in percentage. Higher real exchange rate implies depreciation.

Source: authors calculations using PESSOA.

rate depreciation over the medium-run. This implies that the impacts of a consolidation process based on Government consumption cuts on trade variables (and in production) cease to be in place. Liquidity constrained households are less affected than in the reference scenario, since the fiscal authorities actions, which are allowed to trade in assets, somehow compensate the effects that can emerge due to their impossibility to smooth consumption. In this sense, a prolonged adjustment limits the volatility of consumption and economic activity and might well be beneficial for liquidity constrained households. The smoothing of the fiscal adjustment is made at the cost of a higher crowding-out of investment, a larger and more persistent public debt stock increase, extending in this simulation beyond the ten-years horizon, and also a deteriorating net foreign asset position. One should however be aware that if the fiscal authorities do not enjoy perfect credibility, the situation might be less benign, the risk premium of the economy may rise and the balance of costs and benefits just presented might well be changed for the worse (Almeida, Castro, Félix and Maria 2010). The results support therefore the conclusion that the announcement of a promptly and timely exit strategy, to be completed over a relatively short period of time, may circumvent eventual adverse effects from limited credibility.

In the case of the protracted stimulus and delayed consolidation scenario, the results point to a stronger positive impact in real GDP in the second and third years, in comparison with the reference scenario. This is due to the fact that Government consumption cuts only occur from the fourth year onwards, and explains the lower level of real GDP in that year in comparison with the remaining scenarios. The delay of the negative impacts in real GDP, hours and private consumption reflects essentially the mechanism described above,



Figure 7: Fiscal stimulus and the impact of alternative exit timings (deviation from steady-state)

**Notes**: Inflation, NFA and Public debt deviations are in percentage points. The remaining variables are in percentage. Higher real exchange rate implies depreciation. **Source**: authors calculations using *PESSOA*.

which is largely based on the impact of the fiscal consolidation in liquidity constrained households, since they cannot smooth their consumption. In addition, the delayed scenario has less benign impacts in real exchange rate and private investment developments, reflecting the impact of a more protracted appreciation during the fiscal stimulus period. However, the reverse occurs in the consolidation period, since the stimulus is on aggregate twice as large as in the reference scenario, implying that the amount of debt to consolidate is also twice as large, but the consolidation effort is the same, in the sense of being





Source: authors calculations using PESSOA.

close to the steady-state position in the tenth year. This implies stronger Government consumption cuts that will lead to a stronger decline in real GDP, hours and consumption (as the fiscal consolidation starts) and to a sharper real wage adjustment (and, hence, to a sizeable real exchange rate depreciation). Although the increase in public debt is much higher than in the reference scenario, since the stimulus is in place during two years (instead of one year, as in the reference scenario), the impact in private consumption is not since asset holder smooth their consumption by resorting to asset trade; conversely, liquidity constrained households consumption profile is much more bumpy, leading to a more erratic profile in private consumption and hours than in the reference scenario. If the fiscal authorities do not enjoy full credibility, the spike in public debt levels may also backfire the initial objectives behind the fiscal stimulus, namely if the risk premium increases (Almeida, Castro, Félix and Maria 2010). The results also support the conclusion that a promptly and timely exit strategy seems to be a desirable policy option.

The PVMs reveal that if the Government is basically concerned with medium run impacts then real GDP and imports do not change significantly across alternative exit timings. The protracted scenario reveals a larger medium-run positive impact in private consumption and hours, while yielding a negative impact in private investment. The low effort scenario is far less benign, since it does not have a visibly different impact even over the medium-run in private consumption or hours worked and crowds out visibly private investment and exports, since the real exchange rate does not depreciate over the consolidation period. The main policy implication we can draw from alternative timings to complete the exit strategy is that, if the Government enjoys full credibility, there are no significant differences in terms of real GDP impacts. The effects in final demand composition might nevertheless be non-negligible. For instance, weak consolidation strategies tend to limit real exchange rate depreciation associated to Government consumption cuts and, therefore, crowding out exports and investment significantly. In addition, it leads to a deterioration in the fiscal balance and in the current account, giving rise to twin deficits, and to a deteriorating public debt and net foreign asset position. In regular operating conditions, these might well be second order effects, however, it might trigger a rise in the interest rate risk premium in a financial distress environment, as the one reported in Figure 3. In this case, the impacts are clearly less benign (Almeida, Castro, Félix and Maria 2010). Although the protracted and delayed scenarios end up raising the same issue, it should be noted that, in the last case, these issues only arise before the second step of the exit strategy, though in more exuberant way, whereas in the case of a weak consolidation strategy this type of concerns is prolonged in time and may hamper Government credibility as time passes by.

## 5 Conclusions

The fiscal activism to cope with the deepest economic and financial crisis since the Great Depression led to major imbalances in advanced economies. Although these imbalances need to be corrected at some point in time, there is a great deal of uncertainty around the impact of exit strategies. This article addressed the case of a small-open economy, integrated in a monetary union, and investigates if there is a dominant consolidation strategy both in terms of fiscal instrument and timing, using a dynamic general equilibrium model with non-Ricardian features.

The results suggest that the impact multipliers, which are biased to focus on shortterm developments, are insufficient to discriminate among the alternatives and therefore do not convey an adequate metric. On the contrary, a medium and longer term assessment can in fact be used to shed some light on the ongoing discussion on how and when should Governments consolidate their fiscal sector position, after a demanding fiscal stimulus.

The results suggest that the macroeconomic scenario resulting from alternative exit strategies may change non-negligibly, in particular in what respects external trade variables, since real exchange rate plays a crucial role in macroeconomic adjustment in a context of fixed nominal interest and exchange rates. Conditional on a benchmark fiscal stimulus package, based on OECD data, an exit strategy based on Government consumption cuts seems in general to outperform the remaining fiscal policy options, namely those based on tax hikes on labour income or on final consumption goods, or lower transfers to households. Once the fiscal authority pre-announces a consolidation strategy based on Government consumption cuts, this fosters for instance a competitive disinflation. In turn, consolidation strategies based on tax hikes induce a real exchange appreciation that hinders international competitiveness and implies a net foreign asset deterioration. Concerning the alternative timings to complete the exit strategy, the results suggest that the impacts in the macroeconomic scenario may differ qualitatively in terms of the expenditure composition. In particular, a faster consolidation may foster exports and private investment at the cost of lower private consumption and higher volatility of demand and hours worked. The results are far less distinguishable in terms of the impact in output. It is worth mentioning that the results are conditional on full credibility of the fiscal authorities, however, if that is not the case, the impact of the a fiscal stimulus might be very limited, if any, as discussed in Almeida, Castro, Félix and Maria (2010). One must be aware that a delay in the fiscal consolidation or a weak consolidation effort that prolongs the fiscal consolidations might raise concerns on the credibility of the fiscal authorities and trigger an sovereign risk premium hike. Therefore, the economic activity impact from a fiscal stimulus, without hampering fiscal authorities credibility, is conditioned on the announcement of a promptly and timely exit strategy.

## References

- Adolfson, M., Laseén, S., Lindé, J. and Villani, M. (2007), 'Bayesian estimation of an open economy DSGE model with incomplete pass-through', *Journal of International Economics* 72, 481–511.
- Almeida, V., Castro, G. and Félix, R. M. (2009), The Portuguese economy in the European context: structure, shocks and policy, *in* 'The Portuguese economy in the context of economic, financial and monetary integration', Banco de Portugal, pp. 65–152.
- Almeida, V., Castro, G. and Félix, R. M. (2010), 'Improving competition in the nontradable goods and labour markets: the Portuguese case', *Portuguese Economic Journal, forthcoming*.
- Almeida, V., Castro, G., Félix, R. M. and Maria, J. R. (2010), Fiscal stimulus in a small euro area economy, Working Paper No. 16/2010, Banco de Portugal.
- Almeida, V. and Félix, R. (2006), Computing potential output and the output-gap for the Portuguese economy, Economic Bulletin Autumn, Banco de Portugal.
- Altig, D., Christiano, L., Eichenbaum, M. and Linde, J. (2005), Firm-specific capital, nominal rigidities and the business cycle, NBER Working Papers 11034, National Bureau of Economic Research.
- Barro, R. and Gordon, D. (1983), 'A positive teory of monetary policy in a natural rate model', Journal of Political Economy 91(4), 589–610.
- Barro, R. J. and Sala-i-Martin, X. (1995), Economic Growth, McGraw-Hill.
- Bayoumi, T. and Sgherri, S. (2006), Mr Ricardo's great adventure: Estimating fiscal multipliers in a truly intertemporal model, Working Paper No. 06/168, International Monetary Fund.
- Blanchard, O. (1985), 'Debts, deficits and finite horizons', Journal of Political Economy 93(2), 223–247.
- Blanchard, O. and Perotti, R. (2002), 'An empirical characterization of the dynamic effects of changes in government spending and taxes on output', *The Quarterly Journal of Economics* 117(4), 1329–1368.
- Buiter, W. (1988), 'Death, birth, productivity growth and debt neutrality', *The Economic Journal* **98**(391), 279–293.
- Canova, F. and Pappa, E. (2007), 'Price differentials in monetary unions: The role of fiscal shocks', The Economic Journal 117(520), 713–737.
- Caprioli, F., Rizza, P. and Tommasino, P. (2010), Optimal fiscal policy in the post-crisis world, *mimeo*.

- Castro, G. (2006), Consumption, disposable income and liquidity constraints, Economic Bulletin Summer, Banco de Portugal.
- Coenen, G., McAdam, P. and Straub, R. (2007), Tax reform and labour-market performance in the euro area: a simulation-based analysis using the new area-wide model, Working Paper No. 747, European Central Bank.
- Coenen, G., Mohr, M. and Straub, R. (2008), 'Fiscal consolidation in the euro area: Longrun benefits and short-run costs', *Economic Modelling* 25(5), 912–932.
- Corsetti, G., Meier, A. and Müller, G. (2009), Fiscal stimulus with spending reversals, Discussion Paper No. 7302, Centre for Economic and Policy Research.
- EC (2009), Quarterly report on the euro area, An update of WEO projections Volume 8, No 4, European Comission.
- Erceg, C. J., Henderson, D. W. and Levin, A. T. (2000), 'Optimal monetary policy with staggered wage and price contracts', *Journal of Monetary Economics* **46**(2), 281–313.
- Fagan, G., Gaspar, V. and Pereira, A. (2004), Macroeconomic adjustment to structural change, in G. Szapary and J. von Hagen, eds, 'Monetary strategies for joining the euro', Edward Elgar, pp. 168–217.
- Frenkel, J. and Razin, A. (1996), Fiscal Policies and Growth in the World Economy, 3 edn, The MIT Press.
- Galí, J., López-Salido, J. D. and Vallés, J. (2007), 'Understanding the effects of Government spending on consumption', *Journal of the European Economic Association* 5(1), 227–270.
- Giavazzi, F. and Pagano, M. (1988), 'The advantage of tying one's hands: EMS discipline and central bank credibility', *European Economic Review* 32, 1055–1075.
- Hall, R. E. (2009), By how much does GDP rise if the government buys more output?, Working Paper No. 15496, National Bureau of Economic Research.
- Harrison, R., Nikolov, K., Quinn, M., Ramsay, G., Scott, A. and Thomas, R. (2005), The Bank of England Quarterly Model, Bank of England.
- Høj, J., Jimenez, M., Maher, M., Nicoletti, G. and Wise, M. (2007), Product market competition in OECD countries: taking stock and moving forward, Economics Department Working Paper No. 575, Organisation for Economic Co-operation and Development.
- IMF (2010), World economic outlook update, An update of WEO projections January 26, International Monetary Fund.

- Ireland, P. (2001), 'Sticky-price models of business cycle: specification and stability', Journal of Monetary Economics 47(1), 3–18.
- Kilponen, J. and Ripatti, A. (2005), Labour and product market competition in a small open economy: Simulation results using a DGE model of the Finnish economy, Discussion Paper No. 5/2005, Bank of Finland.
- Kumhof, M., Clinton, K., Mursula, S. and Laxton, D. (2010), Budget consolidation: Shortterm pain and long-term gain, IMF Working Paper 10/163, International Monetary Fund.
- Kumhof, M. and Laxton, D. (2007), A party without a hangover? On the effects of U.S. government deficits, Working Paper No. 07/202, International Monetary Fund.
- Kumhof, M. and Laxton, D. (2009a), Chile's Structural Fiscal Surplus Rule: a modelbased evaluation, Working Paper No. 09/88, International Monetary Fund.
- Kumhof, M. and Laxton, D. (2009b), Fiscal deficits and current account deficits, Working Paper No. 09/237, International Monetary Fund.
- Kumhof, M., Muir, D., Mursula, S. and Laxton, D. (2010), The Global Integrated Monetary and Fiscal Model (GIMF) - Theoretical structure, IMF Working Paper 10/34, International Monetary Fund.
- Kydland, F. and Prescott, E. (1977), 'Rules rather than discretion: The inconsistency of optimal plans', The Journal of Political Economy 85(3), 473–492.
- Laxton, D. and Pesenti, P. (2003), 'Monetary rules for small, open, emerging economies', Journal of Monetary Economics 50(5), 1109–1146.
- Leeper, E. M., Plante, M. and Traum, N. (2009), Dynamics of fiscal financing in the United States, Working Papers No. 15160, National Bureau of Economic Research.
- Mendoza, E. (2005), Real exchange rate volatility and the price of non-tradables in suddenstop-prone economies, Working Paper No. 11691, National Bureau of Economic Research.
- Mountford, A. and Uhlig, H. (2009), 'What are the effects of fiscal policy shocks?', *Journal* of Applied Econometrics **24**(6), 960–992.
- Musso, A. and Westermann, T. (2005), Assessing potential output growth in the euro area: a growth accounting perspective, Occasional paper No. 22, European Central Bank.
- OECD (2009), Economic Outlook: June 2009, OECD.
- Proietti, T. and Musso, A. (2007), Growth accounting for the euro area: a structural approach, Working Paper No. 804, European Central Bank.

- Rotemberg, J. J. (1982), 'Monopolistic price adjustment and aggregate output', the Review of Economic Studies **49**(4), 517–531.
- Schmitt-Grohe, S. and Uribe, M. (2003), 'Closing small-open economy models', Journal of International Economics 61, 163–185.
- Smets, F. and Wouters, R. (2007), 'Shocks and frictions in US business cycles: A Bayesian DSGE approach', American Economic Review 97(3), 586–606.
- Trichet, J.-C. (2009), 'Press conference at ECB on november 5th', Press conference.
- Yaari, M. (1965), 'Uncertain lifetime, life insurance and the theory of the consumer', The Review of Economic Studies 32(2), 137–150.

## Appendices

## A Model calibration

This appendix reports in some detail the calibration of the model parameters reported in Table 1. As reported in the main text, the model matches fairly reasonably the key ratios of the Portuguese economy and delivers a plausible capital-to-output ratio by industry standards, as depicted in Table  $2.^{17}$ 

The calibration of households parameters took into consideration the fact that the model features Blanchard-Yaari overlapping generations, instead of the infinitely-lived agents framework. These parameters were therefore largely based on Fagan, Gaspar and Pereira (2004), Harrison et al. (2005) and Kumhof and Laxton (2007).  $\eta_A$  and  $\eta_B$  were calibrated so as to ensure that the elasticity of labour supply to real wage is 0.5, a value commonly found in the literature. Since the Blanchard-Yaari overlapping generations households framework allows for an endogenous determination of the net foreign asset position, the discount rate was calibrated to ensure a net foreign debt position of 60% of GDP in the steady state. The coefficient of relative risk aversion was set to calibrate the inter-temporal elasticity of substitution to 0.2, which might seem a low figure in comparison with the values typically used in infinitely-lived agents models, but is in the range of the values regularly used in models featuring Blanchard-Yaari households. The share of liquidity constrained households was set to 40%, broadly in line with the estimates for Portugal presented in Castro (2006).

Concerning the labour unions parameters, we considered a 25% steady-state wage markup, which is at the upper limit of the values usually found in the literature. Note, however, that since the labour market in Portugal is strongly regulated, one may argue that the markup could be even higher than the figures usually found in the DSGE literature. Nominal wage rigidity was calibrated to ensure that wages adjust to the new equilibrium in 6 quarters, a value slightly above euro area estimates published in Coenen et al. (2007), but still in the range usually found in the literature.

Turning to manufacturers, the depreciation rate was assumed to be identical across firms and was calibrated to get the investment-to-GDP ratio in line with the National Accounts data. As regards the production function, a standard Cobb-Douglas function between capital and labour was assumed and the distribution parameters were calibrated to match the labour income share in the National Accounts data. The steady-state price markup of tradable and non-tradable goods was calibrated using OECD product market regulation indicators and the correlation between tradable and non-tradable goods markups and product market regulation indicators found in Høj, Jimenez, Maher, Nicoletti and Wise (2007). In particular, the price markup of the non-tradable goods was set to 20%, which is at the upper bound of the range of values commonly found in the literature, but consistent with the evidence pointing to low competition in the Portuguese

 $^{^{17}\}mathrm{The}$  Portuguese National Accounts do not include figures for the capital stock.

	Parameter	Value
Monetary union parameters		
Euro area interest rate (annualised)	$i^*$	1.05
Euro area labour-augmenting prod. growth (annualised)	g	1.02
Euro area inflation target (annualised)	$\pi^*$	1.02
Euro area EoS between domestic and imported goods	ξ*	2.50
Households and Unions		
Households discount rate (annualised)	β	0.97
Intertemporal elasticity of substitution	$\frac{1}{\gamma}$	0.20
Households instant probability of death (annualised)	$1 - \dot{\theta}$	0.04
Households habit persistence	ν	0.70
Consumption share - Type $\mathcal{A}$ households	$\eta_{\mathcal{A}}$	0.74
Consumption share - Type $\mathcal{B}$ households	ηΒ	0.66
Lifetime productivity decline rate (annualised)	$1-\chi$	0.04
Share of type $\mathcal{B}$ households	$\psi$	0.40
Wage mark-up	$\frac{\sigma_U}{\sigma_U}$	1.25
Wage rigidity - Adjustment cost	$\phi_U$	200
Manufacturers		
Depreciation rate (annualised)	δ	0.09
EoS between capital and labour	$\xi_J$	0.99
Price markup - tradables	$\frac{\sigma_T}{\sigma_T - 1}$	1.10
Price markup - non-tradables	$\frac{\sigma_N}{\sigma_N}$	1.20
Capital adjustment cost	$\phi_{II}$	10
Labour adjustment cost	$\phi_{III}$	5
Price adjustment cost	$\phi_{PI}$	200
Quasi labour income share - tradables	$\alpha T$	0.56
Quasi labour income share - non-tradables	$\alpha_N$	0.60
Distributors		
EoS domestic tradable/imported good	$\xi_{AF}$	1.50
EoS assembled/non-tradable good	$\xi_F$	0.50
Price markup (domestic distributors)	$\frac{\sigma_F}{\sigma_F-1}, F \neq X$	1.05
Price markup (exporters)	$\frac{\sigma_X}{\sigma_X}$	1.03
Import content adjustment cost	$\sigma_X - 1$ $\phi_{AF}$	2
Price adjustment cost	$\phi_{PF}$	200
Government		
Labour income tax rate	$\tau_L$	0.23
Consumption tax rate	$\tau_C$	0.31
Capital income tax rate	$\tau_{K}$	0.17
Employers' social security contribution rate		0.19
Debt to GDP ratio (annualised)		0.53
Fiscal stance parameter	$\begin{vmatrix} gap \\ d_1 \end{vmatrix}$	1.00
Speed adjustment towards the target debt ratio parameter	$d_2$	0.10

## Appendix - Table 1: Main parameters

	Data	Model
Expenditure (as a $\%$ of GDP)		
Private consumption	0.64	0.61
Government consumption and GFCF	0.22	0.21
Private investment	0.21	0.21
Exports	0.29	0.29
Imports	0.37	0.33
Labour income share (as a % of overall income)	0.57	0.56
Tradable goods	0.54	0.54
Non-tradable goods	0.58	0.58
Capital-output ratio (as a % of output)	NA	2.34
Tradable goods	NA	2.53
Non-tradable goods	NA	2.21
Government (as a % of GDP)		
Debt stock	0.57	0.53
Fiscal balance	-0.07	-0.02
Overall revenues	0.38	0.39
Overall expenditure	0.45	0.41
External account (as a % of GDP)		
Net foreign assets	-0.60	-0.60
Current account	-0.06	-0.02
Trade balance	-0.08	-0.04

## Appendix - Table 2: Steady-state key ratios

non-tradable goods market. As for real rigidities, capital adjustment costs were calibrated so as to ensure plausible impulse responses in terms of investment volatility. Regarding nominal rigidities, price growth adjustment costs were calibrated to match average adjustment time spans, in line with what is suggested in the literature. In particular, we impose that the adjustment of prices in the non-tradable goods sector is slightly slower than in the tradable goods sector, reflecting the fact that fiercer competition and lower markups imply lower price stickiness.

We now consider distributors parameters. In the assemblage stage, the elasticity of substitution between domestic tradable goods and imports was taken to be identical across distributors and set above unity, as in most of the literature on open economy DSGE models (see for instance Coenen et al. (2007), Harrison et al. (2005), Erceg et al. (2000) or Kumhof, Muir, Mursula and Laxton (2010)); on the other hand, in the distribution stage, assembled goods (which are basically a composite tradable good) and non-tradable goods were assumed to feature a low substitutability as in Mendoza (2005) and Kumhof, Muir, Mursula and Laxton (2010). The distribution parameters of the production function in each stage were calibrated to match the National Accounts import content and nontradable goods content of each type of final good. The degree of monopolistic competition among distributors was assumed to be lower than among manufacturers, with the steadystate markup being set to 5%, except in the case of exporters, where fiercer competition is likely to determine a lower markup. In terms of price stickiness, it was assumed that prices take 2 quarters to fully adjust for all distributors except exporters, whose prices are assumed to adjust faster. Real rigidities related to the import content adjustment costs were set to ensure a smooth adjustment of import contents to real exchange rate fluctuations.

The steady-state tax rates were calibrated to match the average revenue-to-GDP ratios observed in the data. The same applies to EU transfers and to expenditure components (government consumption and investment and government transfers). The parameters of the fiscal policy rule were calibrated to ensure a smooth tax adjustment. The target debt-to-GDP ratio in the steady state was set to 53%, implying a corresponding fiscal balance-to-GDP ratio of -2.1%.¹⁸

¹⁸The values assumed for the debt-to-GDP target and the implied fiscal balance can be questioned in view of the medium term objective that has been set by the European Commission for Portugal (a structural budget balance of -0.5%, implying a debt-to-GDP ratio close to 12%). However, since in the historical period that was used to calibrate the model the debt-to-GDP ratio averaged 57%, it does not seem reasonable to calibrate it to match a remarkably different figure.

## **B** Present value multipliers

The present value multiplier (PVM) is computed following the proposal by Mountford and Uhlig (2009) that has already been used in the context of general equilibrium models (Leeper et al. 2009). For any variable of interest, the assessment delivered by the present value multiplier up to period k can be expressed as:

$$PVM(k) = \frac{\sum_{j=0}^{k} (\beta\theta)^{j} \hat{Y}_{t+j}}{E_t \sum_{j=0}^{k} (\beta\theta)^{j} \hat{sg}_{t+j}}$$
(34)

where  $\hat{Y}_t$  refers to deviation from steady-state of variable Y in period t,  $\hat{sg}_t$  refers to deviation from steady-state of fiscal balance-to-GDP ratio in period t and  $\beta\theta$  stands for the household discount factor  $\beta$  adjusted by  $\theta$ , the degree of myopia. Typical candidates for Y can be, for instance, GDP or private consumption.

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