Should euro area countries cut taxes on labour or capital in order to boost their growth?*

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July 2017, WP 634

Abstract

The large imbalances within euro area have led to renew interest in tax policies that could reduce labour costs and thus improve competitiveness and growth. In this paper, we consider whether it would be more growth-enhancing for euro area countries to, instead, use capital income tax cuts. To address this issue, we focus on the open-economy dimension and make the simplifying assumption of complete insurance markets. Using a DSGE model calibrated for France within the euro area, we show that the increase in output resulting from tax cuts on capital income would indeed be higher than the increase in output resulting from tax cuts on labour, both in the short and long run. Importantly, the strong response of output to capital income tax cuts appears to be partly explained by the particularly high level of capital income taxes in France. Moreover, such tax cuts would be less efficient if they were expected to be only temporary. Finally, we illustrate our main points through a recent fiscal package implemented in France, which combines labour and capital income tax cuts. After briefly assessing this package, we find that investment and real output would have been more strongly boosted in the medium run if this package had been focused to a larger extent on reductions in capital income taxes.

Keywords: Fiscal reforms, taxes, government spending, DSGE model

JEL classification: E62, E63, F42

* We would like to thank François Langot, Daniel Belchior, participants of the Banque de France seminar and those of the T2M 2017 conference for useful comments and suggestions.

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NON-TECHNICAL SUMMARY

Since the launch of the euro, internal imbalances have been a strong feature of the euro area. In the absence of exchange rate adjustment, some international institutions have recommended cutting labour taxes, for example through a shift toward the consumption tax, for improving competitiveness, employment and growth in countries which suffer from current account deficits (e.g. IMF and European Commission).

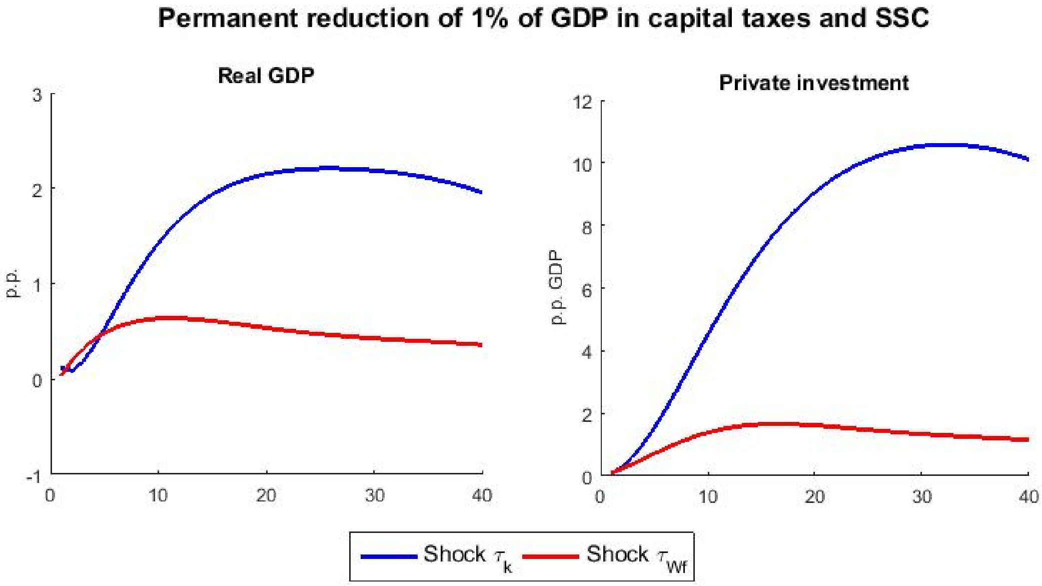
In this paper, we consider whether it would be more growth-enhancing for euro area countries to use capital income tax cuts rather than labour tax cuts. In contrast with the literature on optimal taxation, we adopt here a positive approach, where we just try to assess what DSGE models with usual frictions can tell us about the impact of such taxes on key macroeconomic variables, instead of looking at their optimal level with respect to welfare. We also choose to focus on the open-economy dimension and to leave for further research the analysis of such effects for incomplete insurance-market economies.

The contribution of this paper is twofold. In a first stage, we provide simple intuitions about the different impact of these two instruments on economic growth by using a simple Real Business Cycle (RBC) model. Indeed, we demonstrate the stronger long-run effect on output for permanent reductions in capital income taxes. Moreover, this effect is non-linear: the size of this effect increases with the level of capital income tax from which the cut is implemented. Second, we refine this quantitative analysis by building a larger DSGE model with more realistic features and calibrated for France within the euro area. Against this backdrop, we show that permanent shocks on capital income taxes have a stronger impact on output both in the short and long run. This conclusion is reinforced for France, given the high level of capital income taxation compared to the rest of the euro area. Still, reductions in capital income taxes would be less efficient if they are only temporary, or alternatively if their implementation is perceived as imperfectly credible.

We also illustrate these points by taking into account a package of fiscal reforms implemented in France since 2013: the “Credit d'Impôt pour la Compétitivité et l'Emploi” (CICE), which was subsequently incorporated into a broader Responsibility and Solidarity Pact (“Pacte de Responsabilité et Solidarité” - PRS) in January 2015. Roughly speaking, these reforms involve reductions in labour and capital income taxes, financed by tax hikes on consumption and decreases in government spending. We first provide an assessment of this package as it was implemented. Then we show that it would have raised investment and output by a larger amount if the tax cuts had been more focused on capital income. With such an alternative package, employment would have fallen somewhat in the short run (due to a degree of substitution in capital for labour) but would have risen more in the medium run given the higher increase in output.

For these quantitative simulations, we build a DSGE model with the following features. First, its core incorporates the main frictions necessary for obtaining realistic impulse responses. Second, the French economy is modeled as an open-economy which trades with the rest of the euro area (REA) and an exogenous rest of the world, so as to take account of the effect of competitiveness gains. Third, the reduced weight of France within the monetary policy matters for the real interest rate reaction and its impact on investment dynamics. Fourth, we distinguish between public investment and public

consumption to account for a potential negative impact of governments' investment cuts on the supply side of the economy.



Les pays de la zone euro devraient-ils réduire les taxes sur le travail ou le capital afin de stimuler leur croissance?

RÉSUMÉ

Les grands déséquilibres au sein de la zone euro ont entraîné un nouvel intérêt pour les politiques fiscales qui pourraient réduire les coûts du travail et ainsi améliorer la compétitivité et la croissance. Dans ce document, nous considérons s'il serait plus favorable à la croissance des pays de la zone euro, de réduire l'impôt sur le revenu du capital. Pour résoudre ce problème, nous nous concentrons sur la dimension d'économie ouverte et nous simplifions l'hypothèse de marchés d'assurance complets. En utilisant un modèle DSGE calibré pour la France dans la zone euro, nous montrons que l'augmentation de la production résultant des réductions d'impôt sur le revenu du capital serait en effet supérieure à l'augmentation de la production résultant des réductions d'impôt sur le travail, à court et à long terme. Il est important de noter que la forte réponse de la production aux réductions d'impôt sur le revenu du capital semble s'expliquer en partie par le niveau particulièrement élevé des impôts sur le revenu du capital en France. En outre, ces réductions d'impôt seraient moins efficaces s'ils n'étaient que temporaires. Enfin, nous illustrons nos principaux points grâce à un récent paquet fiscal mis en place en France, qui combine les réductions d'impôt sur le revenu du travail et du capital. Après avoir brièvement évalué ce paquet, nous constatons que l'investissement et la production réelle auraient été fortement renforcés à moyen terme si ce paquet avait été davantage axé sur les réductions des impôts sur le revenu du capital.

Mots-clés : Réformes budgétaires, taxes, dépenses publiques, modèle DSGE

1 Introduction

Since the launch of the euro, internal imbalances have been a strong feature of the euro area. In the absence of exchange rate adjustments, some international institutions have recommended cutting labour taxes (notably through a shift towards the consumption tax) in order to improve competitiveness, employment and growth in countries suffering from current account deficits (e.g. IMF, 2014, and European Commission, 2013). In practice, some governments implemented such tax reforms, e.g. Germany in 2006, while others have simultaneously reduced taxes on labour and on capital income, e.g. France in 2013. So far, the debate about the design of tax reforms has mainly focused on the effect of labour tax cuts and on the degree to which they target low wages [1].

In this paper, we consider whether it would be more growth-enhancing for euro area countries to use capital income cuts rather than labour tax cuts. More precisely, we consider two alternative schemes for tax alleviation: cutting on capital income tax, for both corporate income and capital owned by households; and reducing employers' social contributions, with a more direct impact on labour costs. In contrast with the literature pioneered by Chamley (1986) and Judd (1985) on capital income optimal taxation, we adopt a positive approach: we try to assess what DSGE models with usual frictions can tell us about the impact of such taxes on key macroeconomic variables, instead of looking at their optimal level with respect to welfare. We focus on the open-economy dimension and leave for further research the analysis of such effects for incomplete insurance-market economies[2].

The contribution of this paper is twofold. In a first stage, we provide simple intuitions about the different impact of these two instruments on economic growth by using a simple Real Business Cycle (RBC) model. Indeed, we demonstrate the stronger long-run effect on output for permanent reductions in capital income taxes. Moreover, this effect is non-linear: the size of this effect increases with the level of capital income tax from which the cut is implemented. Second, we refine this quantitative analysis by building a larger DSGE model with more realistic features[3] and calibrated for France within the euro area. France is chosen as an example of a euro area country with current account deficits that recently

[1]See for example Cahuc and Carcillo (2014) for a study related to this targeting issue of cuts on labour income tax. Berson et al. (2016) have recently applied a general equilibrium approach to this targeting issue. Previously, several other studies had more generally studied the impact of fiscal shifts from the labour income tax to the consumption tax, e.g. Langot et al. (2015), Fève et al. (2010), Fahri et al. (2014) or Lipinska and von Thadden (2012). An exception is a recent paper of Bussière et al. (2017), who also considered cuts of capital income tax, but this paper is focused on fiscal shocks in the United States, a country with a flexible exchange rate contrary to euro area countries.

[2]In a closed-economy framework, the role of incomplete markets for tax multipliers has been studied in Heathcote (2005).

[3]These features include the open economy dimension of euro area countries, the role of monetary policy, the calibration of a detailed fiscal block, the presence of non-Ricardian households and the usual set of real/nominal frictions.

experienced labour and capital income tax alleviation. Against this backdrop, we show that permanent shocks on capital income taxes have a stronger impact on output both in the short and long run. This conclusion is reinforced for France, given the high level of capital income taxation compared to the rest of the euro area. Still, reductions in capital income taxes would be less efficient if they are only temporary, or alternatively if their implementation is perceived as imperfectly credible.

We also illustrate these points by taking into account a package of fiscal reforms implemented in France since 2013: the Credit d'Impôt pour la Compétitivité et l'Emploi (CICE), which was subsequently incorporated into a broader Responsibility and Solidarity Pact ("Pacte de Responsabilité et Solidarité" – PRS) in January 2015. Roughly speaking, these reforms involve reductions in labour and capital income taxes, financed by tax hikes on consumption and decreases in government spending. We first provide an assessment of this package as it was implemented. Then we show that it would have raised investment and output by a larger amount if the tax cuts had been more focused on capital income. With such an alternative package, employment would have fallen somewhat in the short run (due to a degree of substitution in capital for labour) but would have risen more in the medium run given the higher increase in output.

The DSGE model we build to address these issues, called the FRance in Euro Area Model (FREAM), has the following features. First, its core is similar to that of Smets and Wouters (2003), which incorporates the main frictions necessary for obtaining realistic impulse responses. Second, the French economy is modeled as an open-economy which trades with the rest of the euro area (REA) and an exogenous rest of the world, so as to take account of the effect of competitiveness gains. Third, the reduced weight of France within the monetary policy matters for the real interest rate reaction and its impact on investment dynamics. Fourth, we distinguish between public investment and public consumption to account for a potential negative impact of governments' investment cuts on the supply side of the economy.

This model is close to NAWM, a 2-country model of the euro area and the United States, developed at the ECB by Coenen, McAdam and Straub (2008). However, it allows to distinguish France within the euro area. In this sense, it is very similar to EAGLE (Euro Area and GLobal Economy)[4], which also builds on NAWM. FREAM is nevertheless simpler than EAGLE in two ways. First, EAGLE consists of four endogenous blocks (Germany, the rest of the euro area, the US and the rest of the world) instead of two endogenous ones (France, the rest of the euro area) and an exogenous rest of the world for FREAM. Secondly, EAGLE features tradable and non-tradable intermediate goods instead of only tradable intermediate goods in the case of FREAM. This lightened structure for FREAM makes it easier to understand the effects resulting from the interactions between regions.

[4] See Gomes et al. (2012) for a presentation of EAGLE.

This paper is structured as follows. After providing simple intuitions about the long-run impact of capital and labour taxes in a simple RBC model (Section 2), we will briefly present a more detailed DSGE framework for studying the effect of such taxes in euro area countries (Section 3). Then, we present the simulations results obtained with this model for standard shocks (Section 4). Finally, we apply our framework to the analysis of fiscal reforms implemented in France since 2013 (Section 5) and we then conclude (Section 6).

2 Some first insights from the steady state of a RBC model

Before turning to a richer DSGE framework it is useful to illustrate two of the main points of this paper within a simple RBC model. These points are: 1) variations in the taxation of capital incomes have a higher impact on output than those in the taxation of labour for firms; 2) the existence of non-linearities in the taxation of capital. More precisely, we consider the steady-state of a model whose basic components are a utility function $u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \frac{n^{1+\zeta}}{1+\zeta}$, a Cobb-Douglas production function, a nil depreciation and three taxes. For simplifying the following conditions, we assume $\sigma = 1$. The resulting first-order and market-clearing conditions are:

- Euler condition: $1/\beta = (1-\tau^K)\alpha k^{\alpha-1} n^{1-\alpha} + 1$
- Labour-market equilibrium: $n^{\zeta} c = \frac{(1-\alpha)k^{\alpha} n^{-\alpha}}{1+\tau^{W_f}}$
- Clearing condition & production function: $c = y = (k/n)^{\alpha}\, n$
- Budget constraint of govt: $0 = \tau^k \alpha k^{\alpha} n^{1-\alpha} + \tau^{W_f} \frac{(1-\alpha)k^{\alpha} n^{1-\alpha}}{1+\tau_{wf}} + T$

with c aggregate consumption, n total employment, ζ the inverse of the Frisch elasticity of labour-supply, β the discount factor, τ^K the tax on capital income, α the elasticity of production with respect to capital, k the stock of capital, τ^{W_f} the tax on labour paid by employers, y aggregate output and T lump-sum taxes.

Aggregate output can be related both to τ_k (through capital intensity) and to τ^{W_f} (through labour). This implies:
$y = \varphi^{\alpha} \left(1-\tau^K\right)^{\frac{\alpha}{1-\alpha}} \mu \left(1+\tau^{W_f}\right)^{-\frac{1}{\zeta+1}}$

with $\varphi = \left(\frac{\alpha}{1/\beta - 1}\right)^{\frac{1}{1-\alpha}}$ and $\mu = (1-\alpha)^{\frac{1}{\zeta+1}}$.

The long-run output multipliers to shocks (of -1pp of output) on τ^{W_f} and τ^K are, respectively:

- $M_{\tau^{W_f}} = -\frac{1+\tau^{W_f}}{1-\alpha}\frac{d\log y}{d\tau^{W_f}} = \frac{1}{(1-\alpha)(\zeta+1)}$
- $M_{\tau^K} = -\frac{1}{\alpha}\frac{d\log y}{d\tau^K} = \frac{1}{1-\alpha}\frac{1}{1-\tau^K}$

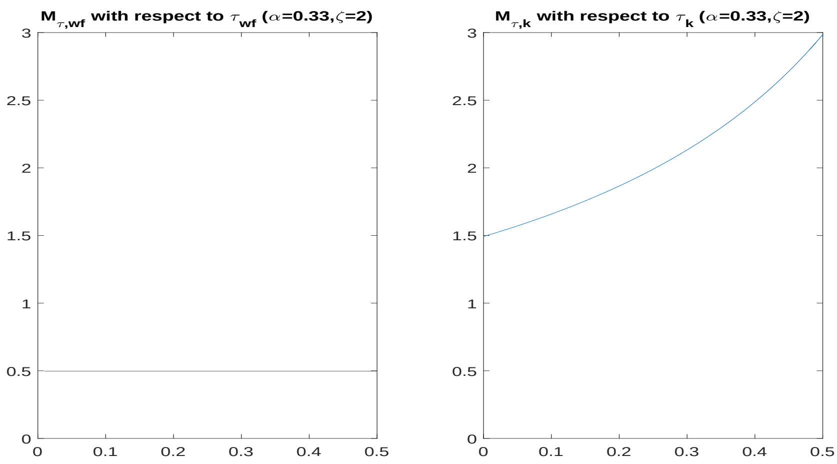
The first difference between these two multipliers is that the multiplier related to τ^K is always larger than that related to τ^{W_f}. On the one hand, the Frisch elasticity of labour supply $1/\zeta$ is crucial for the multiplier of τ^{W_f}: the larger this elasticity, the larger the multiplier; with an infinite elasticity, we obtain the same multiplier as that of τ^K. On the other hand, even if we had not set the inter-temporal elasticity of substitution σ at 1, this parameter would not matter for the equilibrium of the capital market (Euler condition)[5]: since we are at the steady-state, the ratio of marginal utilities of consumption is always equal to 1. Hence, this elasticity does not influence the response of capital intensity to shocks on τ^K.

The second difference between these two multipliers is that the multiplier related to τ^K *does* depend on the actual rate of capital taxation, whereas the multiplier related to τ^{W_f} *does not* depend on the actual rate of labour taxation for employers. Moreover, the multiplier related to τ^K is a positive function of the actual rate of capital taxation. Hence, the higher the level of capital taxation, the larger the increase in output resulting from a reduction in τ^K. Figure 1 gives a numerical illustration for standard values of α and ζ.

The left panel of Figure 1 delivers the long-run multipliers of a decrease (representing 1pp of output) of τ^{W_f}. These multipliers are equal to 0.5, irrespective of the level of τ^{W_f} from which the decrease is implemented. The right panel of Figure 1 provides the long-run multipliers of a reduction (still representing 1pp of output) of τ^K. In this case, whatever the level of taxation, the multipliers are higher than those of reductions in τ^{W_f}. Moreover, these multipliers are increasing (in absolute value) in the level of τ^K from which the reduction is implemented. For instance, the multiplier is equal to 1.7 when the initial level of τ^K is 10%, whereas it amounts to 3 for an initial level of τ^K at 50%. An interesting comparison, which we will consider in more depth below, lies between the value of the multiplier of τ^K for France and for the Rest of the Euro Area (REA). In France, τ^K is around 36%. This implies a long-run multiplier of τ^K equal to 2.35. In the REA, τ^K amounts to 27% on average. This entails a long-run multiplier of τ^K equal to 2.

Figure 1: Capital and labour tax multipliers as a function of tax-rate levels

[5]If we had not set at 1 this inter-temporal elasticity of substitution, it would still appear in the equation of the labour-market equilibrium, but it would not qualitatively change our two results at least for reasonable values (between 1 and 2).



3 FREAM: a multi-country DSGE approach of fiscal policy

This section presents the main features lying at the core of FREAM, a model for the French economy in the context of the euro area. We particularly highlight those aspects with a meaningful role for fiscal policy, on which our analysis focuses. Given that FREAM largely builds on the version of NAWM developed by Coenen et al. (2008), the full model and its derivation are detailed in the Appendix (Section A).

3.1 Brief description of FREAM

FREAM is a multi-country DSGE comprising two symmetric regions, France and the REA, trading both goods and government bonds between them and with an exogenous rest of the world (RoW, indexed with an asterisk *). In each region, there are four types of economic agents: households, firms, a fiscal authority and a monetary authority.

Households are shared between Ricardian households, who have access to financial markets and own capital, and Non-Ricardian ones who can only hold money and consume their current income in each period. There are two subsets of firms: producers of tradable differentiated intermediate goods who operate on monopolistically competitive markets with sticky prices, and producers of non-tradable goods who trade these goods on competitive markets with flexible prices. The government raises taxes and provides public spending with a fiscal policy rule ensuring long-run sustainability. The central bank sets the nominal interest rate for the euro area as a whole (France and REA are in a monetary union and share the same monetary policy), following a standard Taylor-type rule [6].

3.2 Inclusion of fiscal shocks in the model

In order to better capture the effects on the economy of the different public spending instruments, we split the public demand into public consumption (G_t) and investment ($I_{G,t}$). The main difference between these two components lies in the assumption that public investment is productive and, therefore, enhances the production function of private firms. In contrast, public consumption affects aggregate demand without impacting on the private sector.

The budget constraint of the fiscal authority will, therefore, reflects the purchases of the two aforementioned public goods. In addition, the government makes social transfers (TR_t), issues bonds to refinance its debt ($R_t^{-1}B_{t+1} - B_t$) and earns seigniorage on money holdings ($M_t - M_{t-1}$). In order to finance public spending, the government raises taxes on consumption (τ_t^C), incomes stemming from capital (τ_t^K) and labour (τ_t^N) and social security contributions from employers ($\tau_t^{W_f}$) and workers ($\tau_t^{W_h}$). In what follows, we will focus on shocks on τ_t^K and $\tau_t^{W_f}$. The period-by-period budget constraint then has the following form:

$$\begin{aligned} P_{G,t}G_t + P_{I_G,t}I_{G,t} + TR_t + B_t + M_{t-1} = \\ \tau_t^C P_{C,t}C_t + (\tau_t^N + \tau_t^{W_h}) \left(\int_0^{1-\omega} W_{i,t}N_{i,t}di + \int_{1-\omega}^1 W_{j,t}N_{j,t}dj \right) + \\ \tau_t^{W_f} W_t N_t + \tau_t^K (R_{K,t}u_t - (\Gamma_u(u_t) + \delta)P_{I,t})K_t + \tau_t^D D_t + T_t + R_t^{-1}B_{t+1} + M_t \end{aligned}$$

A fiscal rule is assumed to stabilise the government debt-to-output ratio towards the desired target B_Y as depicted in the following equation.

$$\tau_t^N = \phi_{B_Y} \left(\frac{B_t}{P_Y Y} - B_Y \right)$$

We set the tax rate on labour income (τ^N) as the instrument that allows the debt ratio to stabilise in the long run at its target value. Furthermore, we assume that labour income taxes react to the change in the debt ratio with a 10-year lag, so as to isolate the short-run responses to shocks on budgetary variables from the fiscal rule in short and medium run. In order to ensure comparability across the figures, the size of standard shocks is set to 1 per cent of GDP. Since we are dealing with tax rates in our simulations, the shock is calculated

[6] This implies that the exchange rate is constant within the euro area

in such a way that the initial change in the particular tax revenue is equal to a 1 per cent of the initial steady state GDP, thus considering the size of the tax base.

Our model is calibrated so as to reproduce the main macroeconomic aggregates observed in recent years for the three blocks of countries in FREAM. Because of the nature of our work, we devote special attention to the indicators that reproduce fiscal aggregates by compiling observed data. This strategy is presented in more detail in Section B of the Appendix.

4 Simulation results for standard shocks

In this section, we use FREAM to asses the effect on the economy for three standard scenarios involving capital and labour tax alleviation. We notably run simulations for shocks on τ_t^K and $\tau_t^{W_f}$ in three cases: 1) permanent shocks with the baseline calibration; 2) transitory shocks ; 3) and a permanent shock on τ_t^K with a lower initial level in France.

4.1 Permanent reduction of capital and labour taxes

In this subsection we describe the main results of a permanent reduction of 1pp of GDP in τ_t^K and $\tau_t^{W_f}$. We contrast the potential benefits of each tax cut with a special focus on the dynamics of real output, employment and private investment. We analyse the impact of both policies over the medium term, i.e. for a time horizon of 4 years over which the measures are fully implemented. We also assess the impact of the measures over the long term, i.e. for a time horizon of 10 years over which the variables subject to adjustment costs have the time to converge.

Figure 2 suggests that both scenarios significantly foster output growth, employment and private investment in the long run. Nonetheless, we also demonstrate that the way fiscal stimuli are implemented is crucial to determine the final outcome and the macroeconomic objective that is sought. Indeed, and in accordance with the results of Section 2, a permanent cut in taxes on capital income generates much larger positive long-run responses of output and private investment than a permanent cut in firms' social security contributions[7]. A reduction in capital income taxes, however, is likely to be a less desirable choice in terms of labour in the short and medium run, especially for those households with no ability to participate in asset markets.

[7] Qualitatively, we would get similar results when implementing simultaneous shocks in France and in the rest of the euro area. The response of output and investment would also be larger for cuts of the capital income tax than for those of the tax on labour. This is also the case when we use different values for the parameters α_G and η. Results are available upon request.

When analysing the impact of the capital income tax shock (blue lines in Figure 2), a substantial rise in private investment is observed. Recall that due to the standard assumption of adjustment costs on the rate of growth of private investment, its level depends on the discounted sum of all expected future values of Tobin's Q. In the first periods, Tobin's Q declines since there is a jump in the real interest rate. The rise in this rate results from the fall in inflation (tax reductions imply a decrease in firms' marginal costs) while the nominal interest rate is constant, given that it is determined at the euro area level as a whole. Subsequently, however, higher (after tax) returns on capital entail a large and persistent increase in Tobin's Q which more than offsets its initial decline over private investment.

The substantial rise in private investment more than offsets the fall in private consumption, which implies an overall increase in real output. Private consumption decreases since the real interest rate jumps. At the same time, a decrease in τ^K makes capital more attractive and then generates a subsequent reallocation of production inputs from labour to capital. This produces a lower labour demand and thus a reduced level of employment in the short to medium run. In the long term, nevertheless, the fall in τ^K, by significantly fostering real output, raises labour demand and employment.

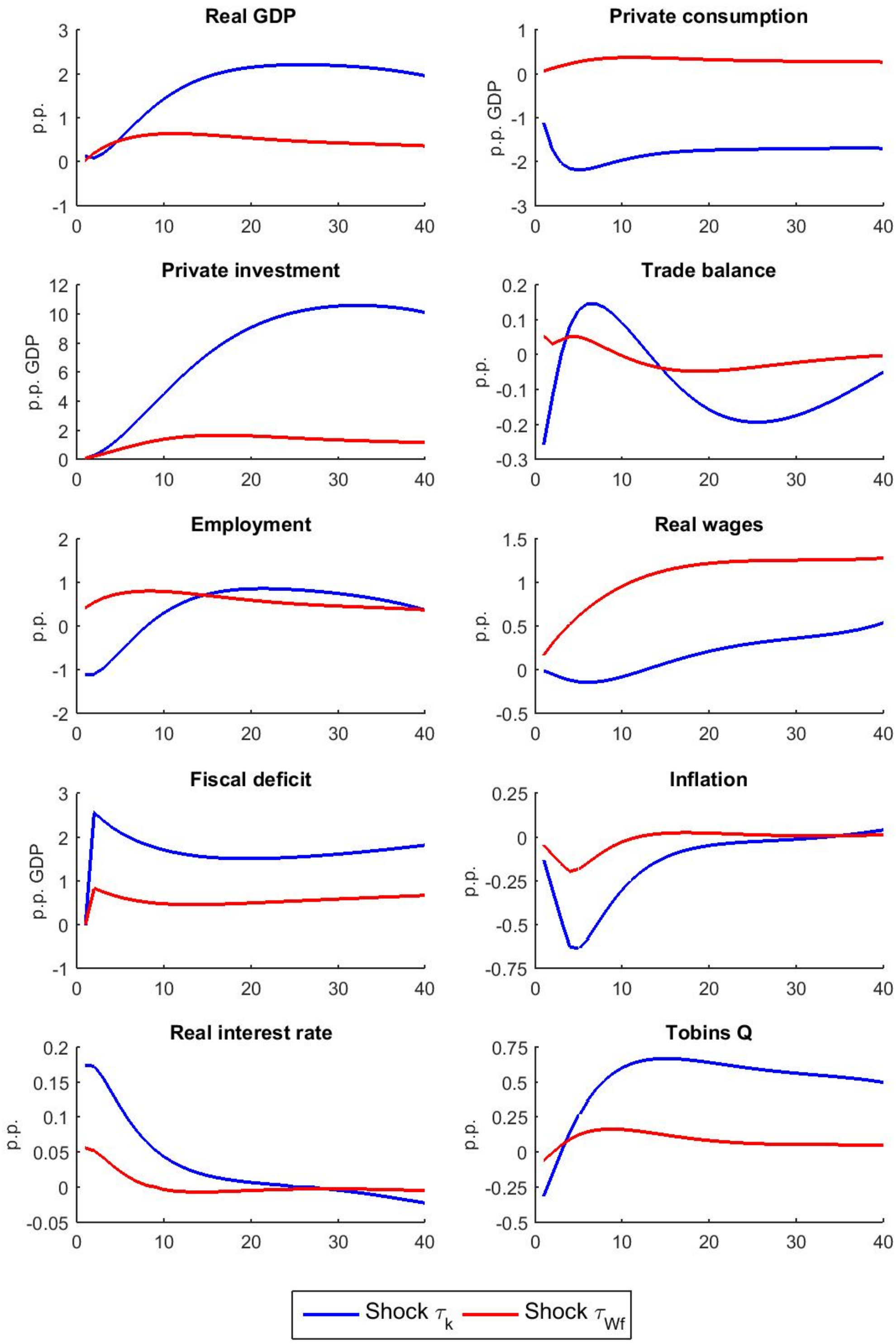
Turning to the trade balance, the fall in τ^K implies a decrease in marginal costs and thus in export prices. French terms-of-trade therefore deteriorate, which creates an initial deficit of the trade balance. As time passes, the fall in export prices improves competitiveness, leading foreign countries to substitute French goods for their own domestic goods. Moreover, the terms-of-trade of these countries improve, entailing a positive wealth-effect which generates an increase in foreign aggregate demand and then in French exports. The competitiveness and wealth effects explain why the trade balance gradually displays a surplus. In the long run, however, the large increase in French aggregate demand (mainly due to private investment) turns into an increase in imports, which cancels out both the competitiveness and wealth effects on the trade balance.

Consider now the shock on labour tax (red lines in Figure 2). The decrease in τ^{W_f} generates an increase in labour demand which results in a persistent increase in both employment and real wages. This, in turn, enhances permanent income and therefore private consumption. This increase in private consumption (as well as in exports) somewhat raises expected returns on capital, Tobin's Q and private investment. The rise in this latter variable is nevertheless much smaller than for a reduction in the capital income tax. Overall, and consistent with what we found in Section 2, the increase in real output is also much lower than in the case of a cut in τ^K.

At the same time, the impact of a lower τ^{W_f} on firms' marginal costs is partly offset by the increase in real wages. Hence, inflation declines to a lower extent than for a reduction in τ^K. The same reasoning applies to export prices, so that the deterioration in French terms-of-trade is less pronounced. On the other hand, the competitiveness and wealth effects are also lower than in the case of a shock on τ^K. All this explains why the movements in the trade balance are less pronounced.

To sum up, a permanent reduction in τ^K is particularly well suited to foster private investment, real output and even employment in the long run. Alternatively, a permanent cut in τ^{W_f} seems the required policy to implement in order to raise employment (notably in the medium run), real wages and, to a lesser extent, private consumption.

Figure 2: Permanent reduction of 1% of GDP in capital taxes and SSC (France, deviation from steady state)



4.2 Transitory reduction in capital and labour taxes

In the last subsection, we focused our attention on permanent shocks on τ^K and τ^{W_f}. We now consider transitory shocks on these taxes. Indeed, the red lines in Figure 3 and 4 show the responses of reductions in τ^K and τ^{W_f}, respectively (still amounting to 1pp of GDP), which last for 10 years. These taxes then revert back instantly to their initial values. For the sake of comparison, we reproduce (blue lines) the responses of permanent shocks computed in Figure 2. It is worth noting that in the literature, transitory shocks are also meant to represent imperfect credibility of government in implementing tax cuts. Under this alternative interpretation, the government announces a permanent reduction in taxes (and effectively enforces it) but private agents believe that this tax cut will last only ten years.

Figure 3: Permanent and transitory reductions in τ^{W_f} of 1% of GDP (France, deviation from steady state)

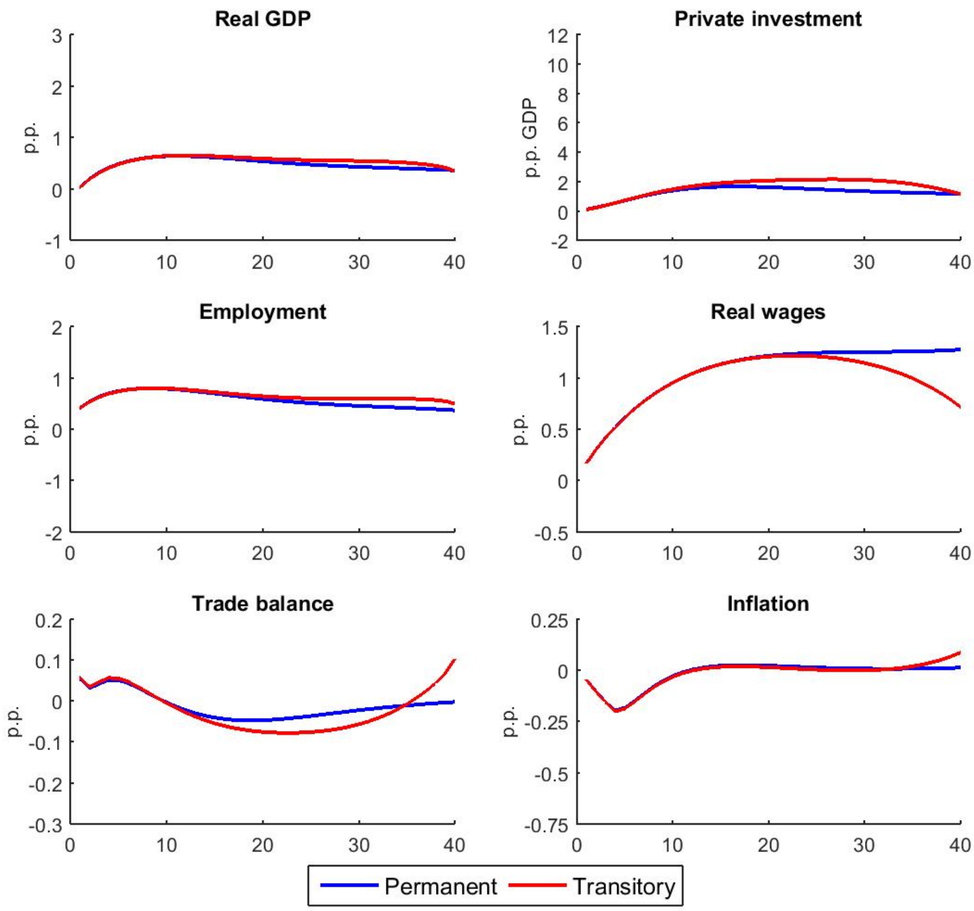
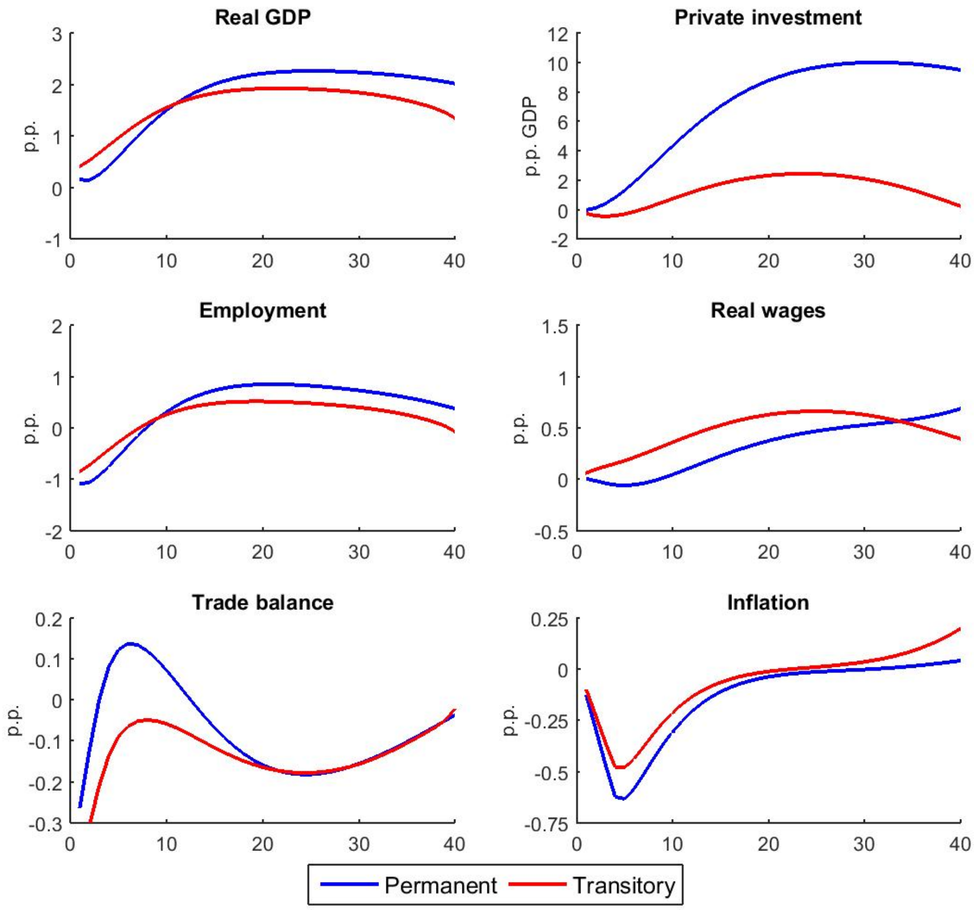


Figure 3 makes clear that the response of the main variables is quite independent from the duration of the cut in τ^{W_f}. In other words, the impact of reductions in the taxation of

Figure 4: Permanent and transitory reductions in τ^K of 1% of GDP (France, deviation from steady state)



labour for firms does not depend on the credibility of the government in implementing this tax cut.

On the other hand, Figure 4 stresses that the duration of the shock in τ^K, or the credibility of the government to enforce this tax cut permanently, is critical: the impact of the permanent tax reduction (full credibility) is much higher than the impact of the transitory tax reduction (imperfect credibility), most notably for investment and real output. This is probably related to the change in the steady state that occurs in the former case.

Indeed, the permanent reduction in τ^K is financed by an increase in τ^N, through the fiscal rule. However, τ^K is more distortive than τ^N, which implies a change in the steady state. Expectations of this change by private agents could lead them to amplify their response in the short run. This could explain the large difference with the transitory tax cut, for which the steady state is obviously unchanged. At the same time, the permanent reduction in τ^{W_f} is also financed by a rise in τ^N. But τ^{W_f} and τ^N have the same degree of distortion, which leaves the steady state unchanged. Hence, the steady state remains the same for a permanent as well as for a transitory reduction in τ^{W_f}. This could explain the relative similarity in the responses to reductions of different durations in this tax.

4.3 Non-linearity in the taxation of capital: an assessment with FREAM

We have shown in Section 2, within the steady-state representation of a simple RBC model, that the long-run multipliers of variations in the taxation of capital incomes depend on the taxation level from which these variations are implemented. This stands in sharp contrast with the taxation of labour for firms, for which the long-run multipliers are independent from the actual level of taxation. In order to provide a more precise picture of the non-linearities in capital taxation, notably in the short-run, we now illustrate the impact of variations in this taxation with FREAM.

Figure 5: Permanent reduction of 1% of GDP for different initial values of τ^K (France, deviation from steady state)

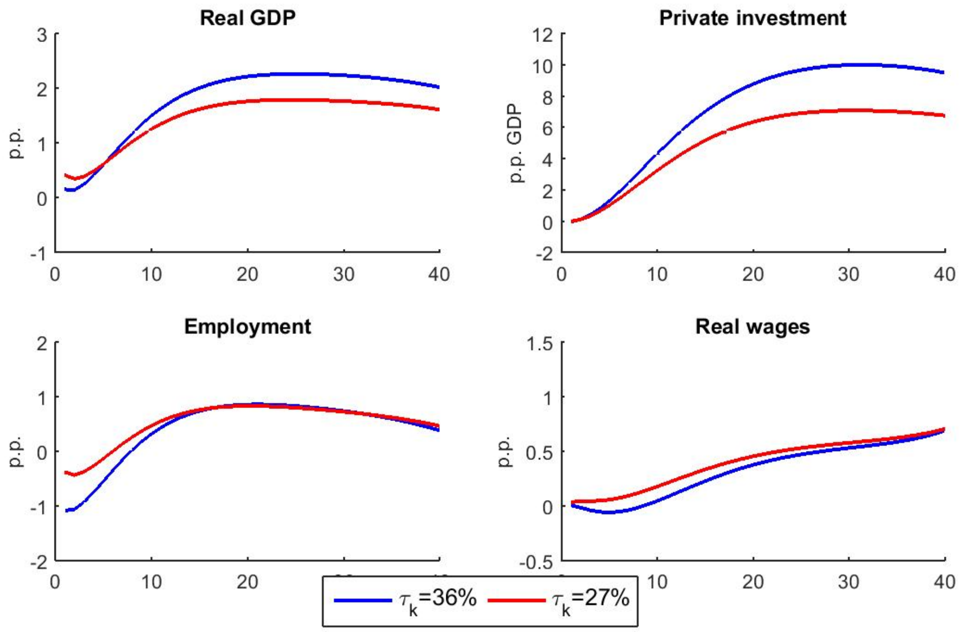


Figure 5 delivers the responses of real output, investment, employment and real wages to a permanent reduction in capital taxation (amounting to 1pp of GDP) for France. The blue line represents these responses for an initial capital tax rate of 36%, which is the actual rate in France. The responses are the same as the ones we generated in Figure 2. At the peak, private investment rises by 10%, employment by 0.8% and real output by 2.3%. The red line represents the responses if France had the same capital income taxation as in the REA, namely 27%. In this counter-factual case, private investment would rise by 7%, employment by 0.55% and real output by 1.7%.

Consistent with the findings of Section 2, the impact of a reduction in τ^K is larger when this rate is high. The results of Figure 5 therefore extend those of Section 2 in our richer model and we see that the non-linearity also matters in the short-run. Moreover, the stronger impact is particularly striking for private investment, since this variable is directly impacted by the variations in τ^K.

5 An application: the assessment of the CICE-Responsibility and Solidarity Pact

In what follows, we consider the instruments involved in a recent fiscal package implemented in France: the Crédit d'Impôt pour la Compétitivité et l'Emploi (CICE), launched in 2013, and thereafter included in the broader Pacte de Responsabilité et de Solidarité (PRS). Our interest in analysing these fiscal reforms stems from the fact that they involve a reduction in labour taxes and capital income taxes at the same time. Their official aim is to boost real output growth, competitiveness and job creations. We will first provide a brief assessment of this package. Then, we will show that if the tax reductions contained in the CICE had been directed entirely towards capital income taxes, the whole package would have achieved its objectives more successfully.

Strictly speaking, the CICE constitutes a tax credit against capital income taxes, which is computed as a share of the gross payroll. It should therefore be simulated as a reduction in τ_t^K. However, the classification of the CICE is not a clear-cut issue. Because of its design (as a share of total gross payroll), we could also interpret it as a cut of labour taxes. This is why many assessments of this package consider that it mainly corresponds to a reduction in $\tau_t^{W_f}$. Here, in our "baseline" scenario, we assume that the amount involved in the CICE corresponds to reductions in equal shares of both labour and capital income taxes. Conversely, in our "alternative" scenario, we simulated the counter-factual case, where the whole amount of the CICE would have been devoted to cuts in capital income taxes.

In addition, the PRS involves a clear reduction in the social security contributions of employers and in capital income taxes. Moreover, a "solidarity" component decreases personal income taxes paid by low-income households. The cost of the whole CICE-PRS is expected to be financed by cuts in public spending, by a new environmental tax, and by increases in the VAT rates. Official announcements point to public expenditure cuts of EUR 50 billion for the 2014-17 period.

In order to focus the analysis only on the impact of cuts of labour and capital income taxes, our simulations (for both our "baseline" and "alternative" scenarios) do not include the aforementioned financing measures[8]. Results are displayed in Figure 6.

[8]The simulation results incorporating financing measures are available upon request.

Table 1: CICE-PRS measures (cumulated EUR billion)

		2014	2015	2016	2017
Expansionary measures	SSC employers ($\tau_t^{W_f}$)	0.0	-5.5	-8.6	-9.6
	SSC households ($\tau_t^{W_h}$)	-1.3	-2.9	-4.9	-4.9
	Corporate income tax (τ_t^K)	0.0	-1.0	-4.0	-9.5
	CICE tax credit[a] ($\tau_t^{W_f}$, τ_t^K)	-10.2	-17.3	-18.5	-19.3
Recessionary measures	VAT and ecological taxes (τ_t^C)	6.2	9.9	12.7	13.8
	Gov. consumption (G_t)	-3.0	-9.5	-13.7	-18.2
	Transfers (TR_t)	-1.3	-4.0	-3.2	-3.3
	Public investment ($I_{G,t}$)	-1.1	-3.4	-6.4	-8.1

Source: Banque de France calculations.

[a] In the "baseline" scenario, the CICE tax credit is assigned in equal shares (50%) to $\tau_t^{W_f}$ and τ_t^K.

In the "alternative" case we assume that the whole amount of the CICE (100%) is assigned to τ_t^K.

Figure 6 shows that in the medium run, the CICE-PRS enhances real output, private investment and employment. With respect to the initial steady state, the three target variables show an improvement at the end of the period of about 2%, 9% and 0.7%, respectively. This expansionary effect on real output is mainly driven by the contribution of the shock on capital taxes (green bars in figure Figure 6). In the short run, however, results are more balanced. Indeed, the application of the CICE-PRS triggers an immediate decline in employment of nearly 0.4%, which is absorbed in the following periods once activity recovers. Moreover, there is a mild decline in real output, due to the fall in private consumption.

The short-run fall in employment can be explained as follows. Cuts in τ_t^K and $\tau_t^{W_f}$ (represented by the green and yellow bars in Figure 6) imply a substitution-effect regarding the other productive factor. In spite of the fact that the two initial shocks correspond to similar amounts in level, there is a whole substitution of capital for labour because of the difference in the tax base. In fact, since the tax base of τ_t^K is smaller than that for $\tau_t^{W_f}$, a similar shock in level translates into a higher decrease in the tax rate. In the long run, however, the reduction in τ_t^K fosters real output, which drives labour demand and employment up.

Foreign trade does not contribute to output growth in the long term although it has a positive impact in the first two years of implementation. The main driver behind this trend is the cut in capital income taxes. After an improvement in French competitiveness (embodied by the fall of inflation) in the first years, the strong increase in domestic demand (mainly through private investment) generates a trade deficit in the medium run.

Figure 6: Effect of the CICE-PRS "baseline" scenario, by shock contribution (France, deviation from steady state)

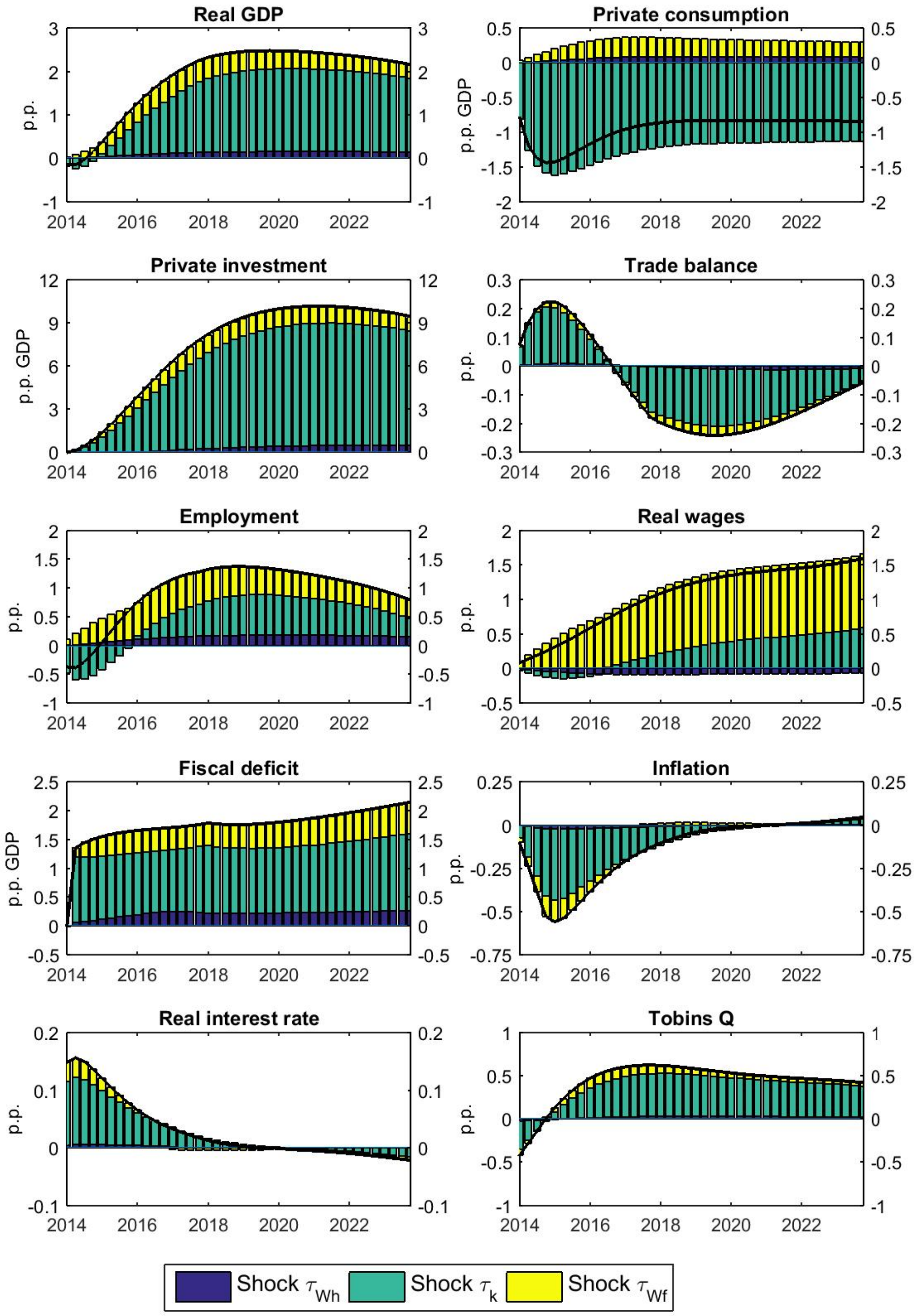
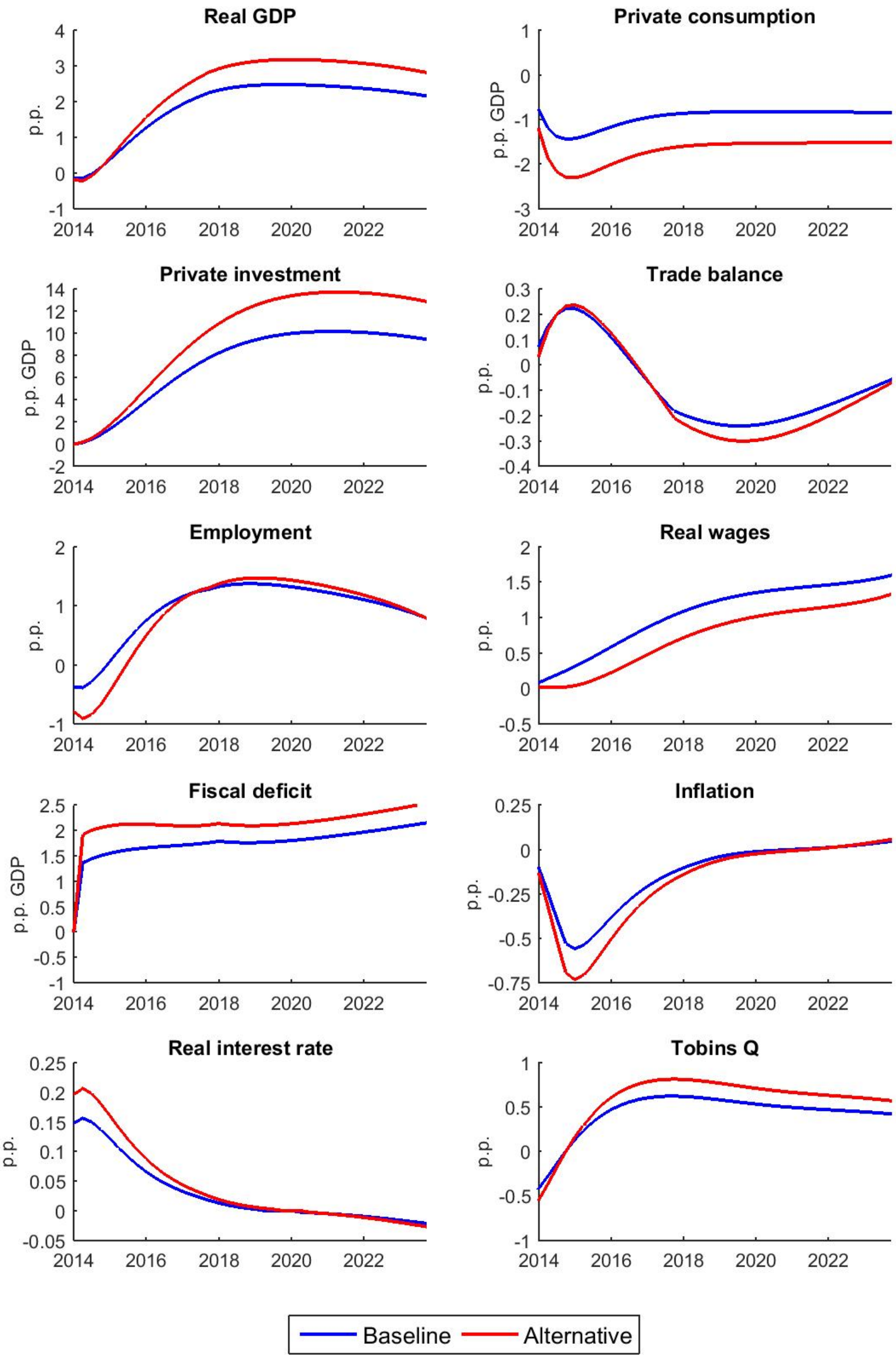


Figure 7: Effect of the CICE-PRS ("baseline" and "alternative" scenarios) (France, deviation from steady state)



The red lines of Figure 7 illustrate the results of our "alternative" scenario, which would have been obtained if the total amount devoted to the CICE had been concentrated on reductions in τ_t^K. For the sake of comparison, the results of our "baseline" scenario, for which the amount involved in the CICE is shared equally between reductions in $\tau_t^{W_f}$ and reductions in τ_t^K, are also restated (blue lines).

Consistent with what we found in Section 4, the increase in private investment related to the "alternative" scenario would have been larger than that in the "baseline" scenario. Similarly, in the medium run, the rise in real output and in employment would also have been higher for the "alternative" case. Conversely, in the short run, the decline in employment would have been more pronounced with this scenario. Hence, a package more targeted towards cuts in capital income taxation would have improved private investment, real output and employment in the medium run to a larger extent, but at the expense of a deeper contraction of employment in the short run.

6 Conclusion

In this paper, we have shown (both for the short and the long run) that the basic ranking of tax multipliers of a RBC model is unchanged in a richer model of a euro area country that shares a common currency with the rest of the euro area: cuts in capital income tax have more powerful effects on real output than cuts in labour taxes for firms. Still, cuts in capital income taxes have detrimental effects on employment in the short and medium run. We have also stressed that the advantage of such tax reductions would be attenuated if the initial level of the tax rate was not as high as the French level, or if these tax reductions were expected to be only temporary. We finally assessed the impact of a recent fiscal package that was recently implemented in France, which combines both types of tax cuts, and argued that this package would have more substantially raised real output and employment in the medium run if the tax reductions had been more concentrated upon capital income.

For further research, the main issue would be to analyse how these results would be changed in a model that allows for incomplete insurance-markets. As such an assumption should matter greatly for consumption dynamics, it would be interesting to analyse its implications for the positive issues that we have looked at in this paper.

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Appendix

A The full model

In what follows, we focus on the exposition of the French block. The REA block displays some marginal differences that are described at the end of this section, as well as the exogenous rest of the world.

A.1 Households

There are two types of households: Ricardians and non-Ricardians. The members of the Ricardian households I, indexed by $i \in [0, 1-\omega]$, have access to financial markets, accumulate capital and hold money for transaction purposes. The members of the Non-Ricardian household J, indexed by $j \in [1-\omega, 1]$, have no access to financial nor physical assets, but hold money. The members of both type of households supply differentiated labour services and set wages in monopolistically competitive labour markets.

A.1.1 Ricardian households

Each member i of Ricardian households I maximises its lifetime utility by choosing purchases of consumption $C_{i,t}$ and investment goods $I_{i,t}$, the next period's physical capital stock $K_{i,t+1}$, labour supply $N_{i,t}$, the intensity of the utilisation of existing capital $u_{i,t}$, next period's holdings of French ($B_{i,t}$), REA ($B_{i,t}^{REA,F}$) and RoW government bonds ($B_{i,t}^{*,F}$), and current period's holdings of money ($M_{i,t}$), by maximising the lifetime utility function:

$$E_t \left[\sum_{k=0}^{\infty} \beta^K \left(\frac{1}{1-\sigma} (C_{i,t+k} - \kappa C_{i,t+k-1})^{1-\sigma} - \frac{1}{1+\zeta} (N_{i,t+k})^{1+\zeta} \right) \right] \tag{1}$$

where β is the discount factor, σ the inverse of the intertemporal elasticity of substitution, ζ the inverse of the elasticity of labour with respect to the real wage and κ the degree of external habit formation in consumption.

Subject to the following period-by-period budget constraint:

$$\begin{aligned} (1+\tau_t^C + \Gamma_v(v_{i,t}))P_{C,t}C_{i,t} + P_{I,t}I_{i,t} + \left(\left(1 - \Gamma_{B^{EA}}(B_t^{EA,F})\right) R_t \right)^{-1} B_{i,t+1} + M_{i,t} + \Xi_{i,t} \\ + \Phi_{i,t} + \left(\left(1 - \Gamma_{B^{EA}}(B_t^{EA,F})\right) R_t^{REA} \right)^{-1} B_{i,t+1}^{REA,F} + \left(\left(1 - \Gamma_{B^*}(B_t^{*,F})\right) R_t^* \right)^{-1} S_t^* B_{i,t+1}^{*,F} \\ = (1-\tau_t^N - \tau_t^{W_h})W_{i,t}N_{i,t} + (1-\tau_t^K)(R_{K,t}u_{i,t} - \Gamma_u(u_{i,t})P_{I,t})K_{i,t} + \\ \tau_t^K \delta P_{I,t} K_{i,t} + (1-\tau_t^D)D_{i,t} + TR_{i,t} - T_{i,t} + B_{i,t} + B_{i,t}^{REA,F} + S_t^* B_{i,t}^{*,F} + M_{i,t-1} \end{aligned} \tag{2}$$

where $P_{C,t}$ and $P_{I,t}$ are the prices of a unit of private consumption and investment goods, respectively. R_t, R_t^{REA} and R_t^* denote the risk-less returns on domestic, REA and RoW government bonds, respectively. RoW bonds are denominated in foreign currency and their domestic value thus depends on the nominal exchange rate S_t^*. $W_{i,t}$ is the wage rate, $R_{k,t}$ is the rental rate for the capital services rent to firms, $u_{i,t}K_{i,t}$ and $D_{i,t}$ are the dividends received from holding firms.

Transaction costs should be paid for the purchases of the consumption good. This cost is denoted by $\Gamma_v(v_{i,t})$ and depends on consumption-based velocity $v_{i,t} = \frac{(1+\tau_t^C)P_{C,t}C_{i,t}}{M_{i,t}}$. At the same time, $\Gamma_{B^{EA}}(B_t^{EA,F})$ and $\Gamma_{B^*}(B_t^{*,F})$ are financial intermediation premia that should be paid when purchasing European (i.e. French or REA) and RoW bonds, respectively. Those premia are rebated in a lump-sum manner through $\Xi_{i,t}$. Varying the capital utilisation is subject to a proportional cost $\Gamma_u(u_{i,t})$.

On the fiscal side, τ_t^C represents the consumption tax rate, τ_t^N the wage income tax, τ_t^K the tax on rental capital income and τ_t^D the tax on dividend income. $\tau_t^{W_h}$ is the household member's contribution to social security. $TR_{i,t}$ and $T_{i,t}$ are transferred received and lump-sum taxes paid, respectively.

It is assumed that household members hold state-contingent securities, $\Phi_{i,t}$, which are traded amongst members and provide insurance against individual wage-income risk. This allows household members to choose the same allocation in equilibrium.

Finally, the capital stock evolves according to the following law of motion:

$$K_{i,t+1} = (1-\delta)K_{i,t} + (1-\Gamma_I(\frac{I_{i,t}}{I_{i,t-1}}))I_{i,t} \tag{3}$$

where δ is the depreciation rate and $\Gamma_I(\frac{I_{i,t}}{I_{i,t-1}})$ is the adjustment cost.

Choice of allocations Defining as $\frac{\Lambda_{i,t}}{P_{C,t}}$ and $\frac{\Lambda_{i,t}}{Q_{i,t}}$ the Lagrange multipliers associated with the budget constraint (2) and the capital accumulation (3), the first-order conditions for maximising the household member's lifetime utility function (1) with respect to $C_{i,t}$, $I_{i,t}$, $K_{i,t+1}$, $u_{i,t}$, $B_{i,t+1}$, $B_{i,t+1}^{REA,F}$, $B_{i,t+1}^{*,F}$ and $M_{i,t}$ are given by:

$$\lambda_{i,t} = \frac{(C_{i,t} - \kappa C_{I,t-1})^{-\sigma}}{1+\tau_t^C + \Gamma_v(v_{i,t}) + \Gamma_v'(v_{i,t})v_{i,t}} \tag{4}$$

$$\frac{P_{I,t}}{P_{C,t}} = Q_{i,t}(1-\Gamma_I(\frac{I_{i,t}}{I_{i,t-1}}) - \Gamma_I'(\frac{I_{i,t}}{I_{i,t-1}})I_{i,t}) + \beta E_t\left[\frac{\lambda_{i,t+1}}{\lambda_{i,t}}Q_{i,t+1}\Gamma_I'(\frac{I_{i,t+1}}{I_{i,t}})\frac{I_{i,t}^2}{I_{i,t-1}}\right] \tag{5}$$

$$Q_{i,t} = \beta E_t[\frac{\lambda_{i,t+1}}{\lambda_{i,t}}((1-\delta)Q_{i,t+1} + (1-\tau_{t+1}^K)\frac{R_{K,t+1}}{P_{C,t+1}}u_{i,t+1} + (\tau_{t+1}^K\delta - (1-\tau_{t+1}^K)\Gamma_u(u_{i,t+1}))\frac{P_{I,t+1}}{P_{C,t+1}})] \tag{6}$$

$$R_{K,t} = \Gamma_u^{'}(u_{i,t})P_{I,t} \tag{7}$$

$$\beta(1 - \Gamma_B^{EA}(B_t^{EA,F}))R_t E_t \left[\frac{\Lambda_{i,t+1}}{\Lambda_{i,t}} \frac{P_{C,t}}{P_{C,t+1}}\right] = 1 \tag{8}$$

$$\beta(1 - \Gamma_{B^{EA}}(B_t^{EA,F}))R_t^{REA} E_t \left[\frac{\Lambda_{i,t+1}}{\Lambda_{i,t}} \frac{P_{C,t}}{P_{C,t+1}}\right] = 1 \tag{9}$$

$$\beta(1 - \Gamma_{B^*}(B_t^{*,F}))R_t^* E_t \left[\frac{\Lambda_{i,t+1}}{\Lambda_{i,t}} \frac{P_{C,t}}{P_{C,t+1}} \frac{S_{t+1}^*}{S_t^*}\right] = 1 \tag{10}$$

$$\beta E_t \left[\frac{\Lambda_{i,t+1}}{\Lambda_{i,t}} \frac{P_{C,t}}{P_{C,t+1}}\right] = 1 - \Gamma_v^{'}(v_{i,t})v_{i,t}^2 \tag{11}$$

$\Lambda_{i,t}$ and $Q_{i,t}$ therefore represent the marginal utility of consumption and Tobin's Q, respectively. Note that combining equations (8) and (9) implies $R_t = R_t^{REA}$, which means that France and REA share the same monetary policy.

Wage setting The household members act as price setters in monopolistically competitive labour markets. Wages for the differentiated labour services, $W_{i,t}$, are assumed to be determined in a Calvo (1983) fashion. Each period, members receive permission to optimally reset their nominal wage with probability $1 - \xi_I$. All members receiving this permission choose the same wage rate $\tilde{W}_{I,t} = \tilde{W}_{i,t}$. The rest of the members can adjust the wage rate according to the following indexation scheme:

$$W_{i,t} = \left(\frac{P_{C,t-1}}{P_{C,t-2}}\right)^{\chi_I} \pi_C^{1-\chi_I} W_{i,t-1} \tag{12}$$

where χ_I is an indexation parameter.

Those members resetting their wage are assumed to maximise lifetime utility (1) subject to the indexation scheme (12) and the demand for their labour services. We obtain the following first-order condition:

$$E_t[\sum_{k=0}^{\infty}(\xi_I\beta)^K(\Lambda_{i,t+k}(1-\tau_{t+k}^N-\tau_{t+k}^{W_h})\frac{\tilde{W}_{I,t}}{P_{C,t+k}}\left(\frac{P_{C,t+k-1}}{P_{C,t-1}}\right)^{\chi_I}\pi_C^{(1-\chi_I)k}-\frac{\eta_I}{\eta_I - 1}(N_{i,t+k})^{\zeta})N_{i,t+k}] = 0 \tag{13}$$

Hence, wages are set so as to equate the household members´ discounted sum of expected after-tax marginal revenues (expressed in consumption-based utility terms) to the discounted sum of expected marginal cost (expressed in terms of marginal disutility of labour). Note that in the absence of wage staggering ($\xi_I = 0$), the factor $\frac{\eta_I}{\eta_I - 1}$represents the markup of the real after-tax wage over the marginal rate of substitution between consumption and leisure.

A.1.2 Non-Ricardian households

The members of the Non-Ricardian household J are not able to buy bonds and accumulate capital, but they can hold money. They choose purchases of the consumption good and holdings of money by maximising their lifetime utility function, subject to the following budget constraint:

$$(1+\tau_t^C+\Gamma_v(v_{j,t}))P_{C,t}C_{j,t}+M_{j,t}=(1-\tau_t^N-\tau_t^{W_h})W_{j,t}N_{j,t}+TR_{j,t}-T_{j,t}+M_{j,t-1}+\Phi_{j,t}$$

The first-order condition with respect to $C_{j,t}$ and $M_{j,t}$ are given by:

$$\lambda_{j,t}=\frac{(C_{j,t}-\kappa C_{J,t-1})^{-\sigma}}{1+\tau_t^C+\Gamma_v(v_{j,t})+\Gamma_v'(v_{j,t})v_{j,t}} \tag{14}$$

$$\beta E_t\left[\frac{\Lambda_{j,t+1}}{\Lambda_{j,t}}\frac{P_{C,t}}{P_{C,t+1}}\right]=1-\Gamma_v'(v_{j,t})v_{j,t}^2 \tag{15}$$

Wages are set in a similar manner as for household I. The first-order condition for the wage-setting decision is therefore the same as equation (13).

A.2 Firms

There are two types of firms: a continuum of monopolistically competitive firms that produce tradable differentiated intermediate goods and a set of representative firms that combine the purchases of domestic and imported intermediate goods and transform them into final goods.

A.2.1 Intermediate-good firms

Each intermediate-good firm $f\in[0,1]$ produces a differentiated output using the following production function:

$$Y_{f,t}=max[z_tK_{f,t}^{\alpha}K_{G,t}^{\alpha_G}N_{f,t}^{1-\alpha-\alpha_G}-\psi,0] \tag{16}$$

where the firm uses as inputs private capital services $K_{f,t}$, rented from the members of household I in fully competitive markets, public capital $K_{G,t}$, provided by the fiscal authority and an index of differentiated labour services $N_{f,t}$, supplied in monopolistically competitive markets. The total-factor productivity, z_t, is identical across firms and evolves over time according to an exogenous serially correlated process $ln(z_t)=(1-\rho_z)z+\rho_z ln(z_{t-1})+\epsilon_{z,t}$, where z is the steady-state level of productivity. ψ represents fixed cost of production. Public capital follows the same law of motion as private capital.

$$K_{G,t+1}=(1-\delta)K_{G,t}+(1-\Gamma_{I_G}(\frac{I_{G,t}}{I_{G,t-1}}))I_{G,t} \tag{17}$$

Capital and labour demand To determine its demand for private capital and labour, the firm minimises total input cost $R_{K,t}K_{f,t} + (1+\tau_t^{W_f})W_t N_{f,t}$ subject to the technology constraint (16) and taking $R_{K,t}$ and W_t as given. Here, $\tau_t^{W_f}$ represents the firm's contribution to social security. We denote by $MC_{f,t}$ the Lagrange multiplier associated to the technology constraint, which represents the nominal marginal cost. Given that all firms face the same problem and constraint, we have $MC_{f,t} = MC_t$. By merging the first-order condition with respect to capital and labour, we find the following expression:

$$MC_t^{1-\alpha_G} = \frac{1}{z_t^{1-\alpha_G} K_{G,t}^{\alpha_G} \alpha^{\alpha}(1-\alpha-\alpha_G)^{1-\alpha-\alpha_G}} (R_{K,t})^{\alpha}((1+\tau_t^{W_f})W_t)^{1-\alpha-\alpha_G} \tag{18}$$

The labour used by firm f is assumed to be a composite of two household-specific bundles of labour services, $N_{f,t}^I$ and $N_{f,t}^J$. Then:

$$N_{f,t} = ((1-\omega)^{\frac{1}{\eta}}(N_{f,t}^I)^{1-\frac{1}{\eta}} + \omega^{\frac{1}{\eta}}(N_{f,t}^J)^{1-\frac{1}{\eta}})^{\frac{\eta}{(\eta-1)}} \tag{19}$$

where the parameter η represents the intratemporal elasticity of substitution between the two household-specific bundles of labour services.

Next, the firm chooses the combination of $N_{f,t}^I$ and $N_{f,t}^J$ that minimises $W_{I,t}N_{f,t}^I + W_{J,t}N_{f,t}^J$, subject to (19), and taking wages as given. This gives the following demand functions for $N_{f,t}^I$ and $N_{f,t}^J$:

$$N_{f,t}^I = (1-\omega)\left(\frac{W_{I,t}}{W_t}\right)^{-\eta} N_{f,t}, \qquad N_{f,t}^J = (1-\omega)\left(\frac{W_{J,t}}{W_t}\right)^{-\eta} N_{f,t} \tag{20}$$

where W_t is the aggregate nominal wage index.

Price setting Each intermediate-good firm sells its good in both domestic and foreign markets under monopolistically competition and charges different prices at home and abroad. In both markets, we assume a price-setting scheme à la Calvo (1983) such that a firm receives a permission to reset its price for the output sold in the domestic and the foreign market with a probabilities $1-\xi_H$ and $1-\xi_X$, respectively. We denote by $P_{H,f,t}$ the domestic price of good f and by $P_{X,f,t}$ its foreign price denominated in foreign currency. Since all firms that reset prices choose the same price, we obtain $P_{H,t} = P_{H,f,t}$ and $P_{X,t} = P_{X,f,t}$. The rest of the firms can nevertheless adjust their prices according to the following schemes:

$$P_{H,f,t} = \left(\frac{P_{H,t-1}}{P_{H,t-2}}\right)^{\chi_H} \pi_H^{1-\chi_H} P_{H,f,t-1}, \qquad P_{X,f,t} = \left(\frac{P_{X,t-1}}{P_{X,t-2}}\right)^{\chi_X} \pi_X^{1-\chi_X} P_{X,f,t-1} \tag{21}$$

where χ_H and χ_X are indexation parameters.

Each firm resetting its domestic and/or foreign price in period t maximises the discounted sum of its expected nominal profits:

$$E_t\left[\sum_{k=0}^{\infty}\Lambda_{I,t,t+k}(\xi_H^K D_{H,f,t+k}+\xi_X^K D_{X,f,t+k})\right]=0 \tag{22}$$

subject to price-indexation (21) and taking as given domestic and foreign demand for its differentiated good, $H_{f,t}$ and $X_{f,t}$. Here, $D_{H,f,t+k}=P_{H,f,t}H_{f,t}-MC_tH_{f,t}$ and $D_{X,f,t+k}=S_tP_{X,f,t}X_{f,t}-MC_tX_{f,t}$ are period-t nominal profits (net of fixed costs) yielded in domestic and foreign markets, respectively They are distributed as dividends to the household I. Finally, $\Lambda_{I,t,t+k}$ is the firm's discount rate.

The first-order condition characterising the firm's optimal price decision for its output sold domestically is:

$$E_t\left[\sum_{k=0}^{\infty}\xi_H^K\Lambda_{I,t,t+k}\left(\tilde{P}_{H,t}\left(\frac{P_{H,t+k-1}}{P_{H,t-1}}\right)^{\chi_H}\pi_H^{(1-\chi_H)k}-\frac{\theta}{\theta-1}MC_{t+k}\right)H_{f,t+k}\right]=0 \tag{23}$$

This expression states that re-optimised prices are set so as to equate the firm's discounted sum of both expected revenues and marginal costs. Note that in the absence of price staggering ($\xi_H=0$), the factor $\frac{\theta}{\theta-1}$ represents the markup of the price charged in domestic markets over nominal marginal cost.

Export prices of $H=France$ towards $CO=REA,RoW$, with local currency pricing, are chosen as domestic prices with a Calvo scheme. Export prices are endogenous for France and REA, but not for RoW.

$$\frac{\widetilde{P}_{IM,t}^{CO,H}}{P_{IM,t}^{CO,H}}=\frac{\theta}{\theta-1}\frac{f_{X,t}^{H,CO}}{g_{X,t}^{H,CO}} \tag{24}$$

$$f_{X,t}^{H,CO}=MC_t\frac{s^{CO}}{s^H}IM_t^{CO,H}+\beta\xi_XE_t\left[\frac{\Lambda_{I,t+1}}{\Lambda_{I,t}}\left(\frac{\Pi_{IM,t+1}^{CO,H}}{\left(\Pi_{IM,t}^{CO,H}\right)^{\chi_X}\overline{\Pi}^{1-\chi_X}}\right)^{\theta}f_{X,t+1}^{H,CO}\right] \tag{25}$$

$$g_{X,t}^{H,CO}=S_t^{H,CO}P_{IM,t}^{CO,H}\frac{s^{CO}}{s^H}IM_t^{CO,H}+\beta\xi_XE_t\left[\frac{\Lambda_{I,t+1}}{\Lambda_{I,t}}\left(\frac{\Pi_{IM,t+1}^{CO,H}}{\left(\Pi_{IM,t}^{CO,H}\right)^{\chi_X}\overline{\Pi}^{1-\chi_X}}\right)^{\theta}f_{X,t+1}^{H,CO}\right] \tag{26}$$

$$P_{IM,t}^{CO,H}=\left[\xi_X\left(\left(\Pi_{IM,t-1}^{CO,H}\right)^{\chi_X}\overline{\Pi}^{1-\chi_X}P_{IM,t-1}^{CO,H}\right)^{1-\theta}+(1-\xi_X)\left(\widetilde{P}_{IM,t}^{CO,H}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{27}$$

A.2.2 Final-good firms

The representative firm producing the non-tradable final good for private consumption, Q_t^C, combines purchases of a bundle of domestically produced intermediate goods, H_t^C, with purchases of a bundle of imported foreign intermediate goods, IM_t^C, using the following CES technology:

$$Q_t^C = \left[\nu_C^{\frac{1}{\mu_C}} \left(H_t^C\right)^{\frac{\mu_C - 1}{\mu_C}} + (1-\nu_C)^{\frac{1}{\mu_C}} \left(IM_t^C\right)^{\frac{\mu_C - 1}{\mu_C}}\right]^{\frac{\mu_C}{\mu_C - 1}} \tag{28}$$

where the parameter μ_C represents the intertemporal elasticity of substitution between the distinct bundles of domestic and foreign intermediate goods, while ν_C measures the home bias in the production of the consumption good. The bundle of imported foreign intermediate goods, IM_t^C, is given by:

$$IM_t^C = \left[\sum_{CO \neq H} \left(\nu_{IMC}^{H,CO}\right)^{\frac{1}{\mu_{IMC}}} \left(IM_t^{C,CO}\left(1 - \Gamma_{IM^C}\left(\frac{IM_t^{C,CO}}{Q_t^C}\right)\right)\right)^{\frac{\mu_{IMC}-1}{\mu_{IMC}}}\right]^{\frac{\mu_{IMC}}{\mu_{IMC}-1}} \tag{29}$$

where $IM_t^{C,CO}$ is the bundle of imported intermediate goods from country (region) $CO = REA, RoW$, while $\Gamma_{IM^C}\left(\frac{IM_t^{C,CO}}{Q_t^C}\right)$ is the cost incurred by the consumption-good firm when varying the use of bundle of imported intermediate goods from CO in producing the consumption good.

The consumption-good firm chooses the combination of the domestic and foreign intermediate-good bundles H_t^C and IM_t^C, that minimises $P_{H,t}H_t^C + P_{IM,t}IM_t^C$, subject to (28) and taking price indexes $P_{H,t}$ and $P_{IM,t}$ as given. This gives the following demand functions:

$$H_t^C = \nu_{C,t}\left(\frac{P_{H,t}}{P_{C,t}}\right)^{-\mu_C} Q_t^C \tag{30}$$

$$IM_t^{C,CO} = \nu_{IMC}^{H,CO}\left(\frac{P_{IM,t}^{H,CO}}{P_{IM,t}^C \Gamma_{IM^C}^{\dagger}\left(IM_t^{C,CO}/Q_t^C\right)}\right)^{-\mu_{IMC}} \frac{IM_t^C}{1 - \Gamma_{IM^C}\left(\frac{IM_t^{C,CO}}{Q_t^C}\right)} \tag{31}$$

where $\Gamma_{IM^C}^{\dagger}\left(IM_t^{C,CO}/Q_t^C\right) = 1 - \Gamma_{IM^C}\left(IM_t^{C,CO}/Q_t^C\right) - \left(\Gamma_{IM^C}\left(IM_t^{C,CO}/Q_t^C\right)\right)' IM_t^C$.

The implied cost-minimising price of consumption and imports are:

$$P_{C,t} = \left[\nu_C\left(P_{H,t}\right)^{1-\mu_C} + (1-\nu_C)\left(P_{IM,t}^C\right)^{1-\mu_C}\right]^{\frac{\mu_C}{\mu_C - 1}} \tag{32}$$

$$P^C_{IM,t} = \left[\sum_{CO \neq H} \nu^{H,CO}_{IMC} \left(\frac{P^{H,CO}_{IM,t}}{\Gamma^{\dagger}_{IM^C}\left(IM^{C,CO}_t / Q^C_t\right)} \right)^{1-\mu_{IMC}} \right]^{\frac{1}{1-\mu_{IMC}}} \tag{33}$$

The representative firm producing the non-tradable final private investment good Q^I_t, as well as the optimal demand for the domestic and foreign intermediate-good bundles H^I_t and IM^I_t and prices $P_{C,t}$ and $P^C_{IM,t}$, are defined or derived in a manner analogous to that for the consumption good.

Conversely, the non-tradable final public consumption Q^G_t and public investment goods $Q^{I_G}_t$ are assumed to be made only by domestic intermediate goods. This means that $Q^G_t = H^G_t$ and $Q^{I_G}_t = H^{I_G}_t$ while the prices of a unit of the public consumption and investment goods are $P_{G,t} = P_{I_G,t} = P_{H,t}$.

Aggregating across the four final-good firms, we obtain the following identities:

$$H_t = H^C_t + H^I_t + H^G_t + H^{I_G}_t \tag{34}$$

$$IM_t = IM^C_t + IM^I_t \tag{35}$$

A.3 Fiscal and monetary authorities

The fiscal authority purchases the final public consumption good G_t and the public investment good $I_{G,t}$, makes transfer payments, TR_t, issues bonds to refinance its debt, B_t, earns seignoriage on money holdings, M_{t-1}, and raise taxes described above. The fiscal authority's period-by-period budget constraint as therefore the following form:

$$\begin{aligned} P_{G,t}G_t + P_{I_G,t}I_{G,t} + TR_t + M_{t-1} = \\ \tau^C_t P_{C,t}C_t + (\tau^N_t + \tau^{W_h}_t)\left(\int_0^{1-\omega} W_{i,t}N_{i,t}di + \int_{1-\omega}^1 W_{j,t}N_{j,t}dj\right) \\ +\tau^{W_f}_t W_t N_t + \tau^K_t (R_{K,t}u_t - (\Gamma_u(u_t) + \delta)P_{I,t})K_t + \tau^D_t D_t + T_t + R^{-1}_t B_{t+1} + M_t \end{aligned} \tag{36}$$

where all quantities, except labour services and wages, are expressed in per-capita terms.

The fiscal authority's purchases of the final public consumption and investment goods, as well as transfers, are specified as a fraction of steady-state nominal output. Therefore we have: $g_t = \frac{P_{G,t}G_t}{P_Y Y}$, $ig_t = \frac{P_{I_G,t}I_{G,t}}{P_Y Y}$ and $tr_t = \frac{TR_t}{P_Y Y}$. Those ratios are assumed to follow a serially correlated process.

The long-run stabilisation of public debt is ensured through a fiscal rule, operating on labour taxes:

$$\tau_t^N = \phi_{B_Y}\left(\frac{B_t}{P_Y Y} - B_Y\right) \tag{37}$$

where B_Y is the fiscal authority´s target for the ratio of government debt to output.

The monetary authority is assumed to follow a Taylor-type interest-rate rule specified in terms of annual consumer-price inflation and quarterly output growth:

$$R_t^4 = \phi_R R_{t-1}^4 + (1-\phi_R)\left[R^4 + \phi_\pi\left(\frac{P_{C,t}}{P_{C,t-4}} - \pi\right)\right] + \phi_{g_Y}\left(\frac{Y_t}{Y_{t-1}} - g_Y\right) + \epsilon_{R,t} \tag{38}$$

where $R^4 = \beta^{-4}\pi$ is the equilibrium nominal interest rate, π the inflation target and g_Y the (gross) rate in steady state, assumed to equal one. The term $\epsilon_{R,t}$ represents a serially uncorrelated monetary policy shock.

A.4 Specification of the rest of the Euro Area and the rest of the world

A.4.1 Rest of the Euro Area

Unlike French households, the households in REA buy only REA and RoW bonds. The household budget constraint for REA is:

$$\begin{aligned}
(1+\tau_{REA,t}^C + \Gamma_v(v_{i,t}^{REA}))P_{C,t}^{REA}C_{i,t}^{REA} + P_{I,t}^{REA}I_{i,t}^{REA} + \\
R_{REA,t}{}^{-1}B_{i,t+1}{}^{EA,REA} + R^*{}_t^{-1}B_{i,t+1}^{*,REA} + M_{i,t}^{REA} + \Xi_{i,t}^{REA} + \Phi_{i,t}^{REA} \\
= (1-\tau_{REA,t}^N - \tau_{REA,t}^{W_h})W_{i,t}^{REA}N_{i,t}^{REA} + (1-\tau_{REA,t}^K)(R_{K,t}^{REA}u_{i,t}^{REA} - \Gamma_u(u_{i,t}^{REA})P_{I,t}^{REA})K_{i,t}^{REA} \\
+\tau_{REA,t}^K\delta_{REA}P_{I,t}^{REA}K_{i,t}^{REA} + (1-\tau_{REA,t}^D)D_{i,t}^{REA} + TR_{i,t}^{REA} - T_{i,t}^{REA} + B_{i,t}^{EA,REA} + B_{i,t}^{*,REA} + M_{i,t-1}^{REA}
\end{aligned}$$

Being the two FOC for bonds:

$$\beta R_{REA,t}E_t\left[\frac{\Lambda_{i,t+1}^{REA}}{\Lambda_{i,t}^{REA}}\frac{P_{C,t}^{REA}}{P_{C,t+1}^{REA}}\right] = 1, \qquad \beta(1-\Gamma_{B^*}(B_t^{*,REA}))R_t^*E_t\left[\frac{\Lambda_{i,t+1}^{REA}}{\Lambda_{i,t}^{REA}}\frac{P_{C,t}^{REA}}{P_{C,t+1}^{REA}}\frac{S_{t+1}^*}{S_t^*}\right] = 1$$

Finally, REA holdings of internationally traded bonds evolve according to:

$$\begin{aligned}
R^*{}_{t-1}^{-1}B_t^{*,REA} + R_{F,t-1}^{-1}\frac{RER_{REAFR,t-1}}{RER_{REA,t-1}}B_t^{EA,REA} \\
= B_{t-1}^{*,REA} + \frac{RER_{REAFR,t-2}}{RER_{REA,t-2}}B_{t-1}^{EA,REA} + RER_{REA,t-1}^{-1}TB_{REA,t-1}^*
\end{aligned}$$

A.4.2 Exogenous rest of the world

Exogenous variables, like foreign demand Y^*, foreign prices P_Y^*, and foreign interest rate R^* follow a serially correlated process. Contrary to Christoffel, Coenen and Warne (2008), we do neither include oil prices nor foreign export prices $P_X^{c,*}$ as exogenous variables. The foreign interest rate R^* is in the UIP condition, for determining the exchange rate $S_t^{*,CO}$.

We do not distinguish consumption from investment goods and only define total imports IM_t^*. Foreign prices P_Y^* intervene in import demand IM_t^* through the relative price P_{IM}^*/P_Y^*:

$$
\begin{aligned}
IM_t^* &= (1-\nu_t^*)\left(\frac{P_{IM,t}^*}{P_{Y,t}^*}\right)^{-\mu^*} Y_t^* \\
IM_t^{*,CO} &= \nu_{IM}^{*,CO}\left(\frac{P_{IM,t}^{*,CO}}{P_{IM,t}\Gamma_{IM}^{\dagger}\left(IM_t^{*,CO}/Y_t^*\right)}\right)^{-\mu_{IM}^*} \frac{IM_t^*}{1-\Gamma_{IM}\left(\frac{IM_t^{*,CO}}{Y_t^*}\right)} \\
P_{IM,t}^* &= \left[\sum_{CO\neq H}\nu_{IM}^{*,CO}\left(\frac{P_{IM,t}^{*,CO}}{\Gamma_{IM}^{\dagger}\left(IM_t^{*,CO}/Y_t^*\right)}\right)^{1-\mu_{IM}^*}\right]^{\frac{1}{1-\mu_{IM}^*}}
\end{aligned}
$$

They also intervene in export prices of the rest of the world through a Calvo scheme driven by marginal costs, which we can deduce from foreign prices through the equation $P_{Y,t}^* = \frac{\theta^*}{\theta^*-1} MC_t^*$.

As a first-order approximation, we also assume that the marginal utility of consumption $\Lambda_{I,t}^*$ of RoW is constant, which makes it possible to replace by one its growth factor in recursive Calvo equations[9].

Finally, the accumulation equations for RoW is:

$$
R_{t-1}^{*-1} B_t^* = B_{t-1}^* + RER_t^{*-1} TB_{t-1}^*
$$

A.5 Aggregation and aggregate resource constraint

A.5.1 Aggregation

Per-capita quantities All variables, except labour services which are differentiated across household members, are expressed in per-capita terms. Hence, the aggregate quantity of household member-specific variable $X_{h,t}$ is given by $X_t = \int_0^1 X_{h,t} dh = (1-\omega)X_{i,t} + \omega X_{j,t}$, since all members of each household choose identical allocations in equilibrium.

[9] As CCW (2008) look at the log-linearized model, they don't need to model $\Lambda_{I,t}^*$.

Aggregate wage and price dynamics Given that the members of household I set their wages according to equations (12) and (13), the wage index evolves according to:

$$W_{I,t} = \left((1-\xi_I)(\tilde{W}_{I,t})^{1-\eta_I} + \xi_I \left(\left(\frac{P_{C,t-1}}{P_{C,t-2}} \right)^{\chi_I} \pi_C^{1-\chi_I} W_{I,t-1} \right)^{1-\eta_I} \right)^{\frac{1}{1-\eta_I}} \tag{39}$$

A similar equation holds for the index of the wage contracts set by the members of household J. Given that the intermediate-good firms f set their prices according to equations (21) and (22), the aggregate price index $P_{H,t}$ evolves according to:

$$P_{H,t} = \left((1-\xi_H)(\tilde{P}_{I,t})^{1-\theta} + \xi_H \left(\left(\frac{P_{H,t-1}}{P_{H,t-2}} \right)^{\chi_H} \pi_H^{1-\chi_H} P_{H,t-1} \right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{40}$$

A similar equation holds for the aggregate index of price contracts set for the differentiated goods set abroad.

A.5.2 Aggregate resource constraint and net foreign assets

The market clearing condition implies the following aggregate resource constraint:

$$P_{Y,t}Y_t = P_{C,t}(C_t + \Gamma_{v,t}) + P_{I,t}(I_t + \Gamma_u(u_t)K_t) + P_{G,t}G_t + TB_t \tag{41}$$

where TB_t is the trade balance of $H = France$ defined as:

$$TB_t = \sum_{CO \neq H} \frac{s^{CO}}{s^H} S_t^{H,CO} P_{X,t}^{H,CO} IM_t^{CO,H} - \sum_{CO \neq H} P_{IM,t}^{H,CO} IM_t^{H,CO} \tag{42}$$

The accumulation equation for the foreign debt is given by:

$$\left(R_{t-1}^*\right)^{-1} B_t^{*,F} + R_{REA,t-1}^{-1} RER_{F,t-1}^{-1} B_t^{EA,F} = B_{t-1}^{*,F} + RER_{F,t-2}^{-1} B_{t-1}^{EA,F} + RER_{F,t-1}^{-1} TB_{t-1} \tag{43}$$

B Calibration and parameters of the model

B.1 An overview of fiscal parameters in FREAM

Tables 2 to 5 in this section, summarise the details regarding the calibration of the structural parameters of the FREAM. We first set the different values reproducing long-run averages of aggregate data over the period 1995-2011. These parameters include the ratios of the various expenditure categories over GDP and monetary and fiscal aggregates. They have been calibrated using mainly information from national accounts, balance of payments and government statements data collected by the OECD, Eurostat and the World Bank. Government parameters are presented in table 2. The calibrated values of steady state parameters are summarised in table 3.

Because of the nature of our work, we devote special attention to the indicators that reproduce fiscal aggregates. Government spending is obtained by simply dividing the corresponding expenditure category over output. As regards the calibration of tax rates, we follow the procedure developed in Mendoza et al. (1994). Indeed, these rates are computed by identifying the revenue raised by different taxes and dividing their value by its corresponding tax base in national accounts. By applying this method, estimates of effective tax rates are obtained for all categories available in FREAM. These ratios are summarised in table 2 for the home (France) and foreign countries (Rest of the Euro Area), respectively.

Table 2: Fiscal Policy: baseline parameter calibration

	France	Rest of Euro Area
Expenditure items (GDP ratios)		
Government debt ($\bar{B}_Y$)	2.60	2.40
Government consumption (G)	0.24	0.19
Government transfers (TR)	0.21	0.21
Public investment (I_G)	0.03	0.03
Revenue items (effective rates)		
Consumption tax (τ^C)	0.18	0.16
Capital income tax* (τ^K)	0.36	0.27
Labour income tax (τ^N)	0.13	0.15
Social security contributions employers (τ^{W_f})	0.29	0.19
Social security contributions households (τ^{W_h})	0.17	0.16

*Dividend and capital income taxes are presented together in the simulations.

B.2 Remaining parameters

The remaining parameters (including notably the labour supply elasticity, the degrees of price and wage stickiness as well as the interest-rate response coefficients of the Taylor rule) are calibrated using consensus values from the literature[10]. We also use the same functional forms and values for the various adjustment costs as described in the aforementioned paper. For the output elasticity to public capital, we use the lower value 0.05 chosen by Leeper, Walker and Yang (2010), the other one being equal to 0.1. These parameters are summarised in tables 4 and 5.

[10] This last set of parameters corresponds to Table B.2 in Coenen et al. (2008)

Table 3: Steady-State National Accounts

	FRA	REA	RoW
Domestic demand			
Private consumption	55.0	56.1	
Private investment	15.8	18.3	
Public consumption	23.8	19.4	
Trade			
Imports (total)	26.2	22.6	4.7
Imports of consumption goods	18.0	15.3	3.0
Of which coming from:			
FRA	0.0	1.9	0.4
REA	9.6	0.0	2.6
RoW	8.4	13.5	0.0
Imports of investment goods	8.2	7.2	1.7
Of which coming from:			
FRA	0.0	0.8	0.2
REA	4.4	0.0	1.5
RoW	3.8	6.4	0.0
Monetary authorities			
Money to consumption ratio	1.1	1.2	
Inflation target ($\bar{\Pi}^4$)	1.02	1.02	
Interest rate inertia (ϕ_R)	0.95	0.95	
Interest rate sensitivity to inflation gap (ϕ_Π)	2.00	2.00	

Note: FRA = France; REA = Rest of Euro Area; RoW = Rest of the World

Recall that we distinguish three blocks of countries: France, the Rest of the euro Area (REA) and the Rest of the World (RoW). REA steady-state ratios are constructed as the weighted average of Austria, Belgium, Finland, Greece, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. Given the fact that the country coverage normally differs among different databases, we normally calibrate RoW aggregates as the countries that do not belong to the other two blocks of economies. However, the exogenous RoW block considers fewer values to be calibrated.

The statistical information used to estimate the different expenditure categories over GDP is based on yearly data. The main sources are the OECD National Accounts database for France and the REA blocks and the World Bank collection of World Development Indicators for RoW aggregates. GDP and the main components of the expenditure approach (final consumption, investment and total imports) are considered.

In the context of a three blocks of countries setup, we also calibrate the steady-state trade linkages. The shares of imports in private consumption and investment between the three blocks of countries are obtained from the Eurostat database on trade by end-use category (BEC classification). Since the database covers only Euro area economies, the trade linkages for rest of the countries are obtained by mirroring exports flows.

The objective is to provide categories which can be aligned with the basic classes of the System of National Accounts (SNA): capital, intermediate and consumer goods. However, since the classification is not completely consistent with the theoretical structure of the model, some adjustments were made. The model allows imported intermediate goods only for the production of final consumption and investment goods. This means that imported intermediate inputs should be split within the other two aggregates. Accordingly, imported intermediate inputs and unclassified items were assigned to the remaining two categories according to their respective weight on production.

The second adjustment made to the trade matrix is to account for the fact that there are no international linkages within a specific block of countries, as in the case of REA and RoW aggregates. The approach was to impose a restriction of zero trade for every type of good within each block of economies. Then, the corresponding amount was also discounted from total imports.

Money aggregates are calibrated by using financial balance sheets of national accounts compiled by the OECD, which record the stocks of financial assets held by institutional sectors. We consider as measure of money in the balance sheets, the item currency and deposits, which includes currency, transferable deposits and other deposits (AF2) and we retain the item households and non-profit institutions serving households as institutional sector. Finally, the ratio is computed by dividing money by private consumption.

The parameter values of depreciation rates were indirectly determined for matching investment rates. These figures were corroborated (when the data was available) with the resulting ratios of fixed capital consumption to capital stock of fixed assets for the economy as a whole. This information is available in the OECD national accounts dataset. We assume the same depreciation rates for public and private capital.

Table 4: Households and Firms Behaviour

	FRA	REA
Households		
Country size	0.045	0.164
Discount factor (β)	0.993	0.993
Intertemporal elasticity of substitution (σ^{-1})	1.00	1.00
Inverse of the Frisch elasticity of labor (ζ)	2.00	2.00
Habit persistence (κ)	0.60	0.60
Share of J-type households (ω)	0.25	0.25
Depreciation rate (δ)	0.010	0.016
Intermediate-good firms		
Bias towards private capital (α)	0.34	0.30
Bias towards public capital (α_G)	0.05	0.05
Substitution btw. I-type and J-type labor (η)	6.00	6.00
Final consumption-good firms		
Substitution btw. home and foreign consumption goods (μ_C)	1.50	1.50
Bias towards home goods (ν_C)	0.64	0.76
Final investment-good firms		
Substitution btw. home and foreign investment goods (μ_I)	1.50	1.50
Bias towards home goods (ν_I)	0.43	0.63

Note: FRA = France; REA = Rest of Euro Area

Table 5: Real and Nominal Rigidities

	FRA	REA
Adjustment and transaction costs		
Imports of consumption goods (γ_{IM^C})	2.50	2.50
Imports of investment goods (γ_{IM^I})	0.00	0.00
Capital utilisation (γ_{u1})*	0.02	0.03
Capital utilisation (γ_{u2})	0.01	0.01
Investment (γ_I)	3.00	3.00
Transaction cost function ($\gamma_{\Upsilon 1}$)*	0.20	0.25
Transaction cost function ($\gamma_{\Upsilon 2}$)	0.15	0.15
Intermediation cost function (γ_{B*})	0.01	0.01
Calvo parameters		
Wages - households I and J (ξ_I and ξ_J)	0.75	0.75
Prices - domestic (ξ_H)	0.90	0.90
Prices - exports (ξ_X)	0.30	0.30
Degree of indexation		
Wages - households I and J (χ_I and χ_J)	0.75	0.75
Prices - domestic (χ_H)	0.50	0.50
Prices - exports (χ_X)	0.50	0.50
Price and wage markups (Implied elasticities of substitution)		
Prices (θ)	6.0	6.0
Wages ($\eta_I = \eta_J$)	6.0	6.0

Note: FRA = France; REA = Rest of Euro Area