Fiscal multipliers in a small euro area economy: How big can they get in crisis times?

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Abstract

Using PESSOA, a DSGE model for a small euro area economy, we analyze the size of fiscal multipliers associated with a large fiscal consolidation in “normal times” and in “crisis times.” The crisis times scenario embodies a temporary increase in nominal rigidities and in financial frictions, purportedly better reflecting the underlying economic environment during the “Great Recession.” Results show that impact multipliers are around 50–70 percent larger in crisis times for expenditure-based fiscal consolidations. A government consumption-based adjustment yields the highest impact multiplier (1.8 in crisis times vis-à-vis 1.2 in normal times). Revenue-based fiscal consolidations are also more recessive in crisis times, though the differences against normal times are less pronounced.

JEL Classification: E62, F41, H62

Keywords: Fiscal multipliers, crisis, DSGE model, euro area, monetary union, small open economy

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1 Introduction

The large contractionary effects of fiscal consolidation across the globe during the “Great Recession” triggered the debate about the true size of fiscal multipliers in times of crisis. In a recent article, Blanchard and Leigh (2013) argue that fiscal multipliers associated with planned fiscal consolidations during the Great Recession are larger than those embodied in regular forecasting exercises by policy institutions. On the opposite direction, the authors find no evidence of systematic forecast errors related to planned fiscal policy changes in the pre-crisis period. This evidence suggests that fiscal multipliers may be substantially larger during severe downturns.

Recent empirical work, based on nonlinear approaches, has already stressed the possibility of an asymmetric response of output to fiscal shocks, with several authors recognizing that fiscal multipliers are highly dependent on the underlying macroeconomic conditions and on the business cycle position (e.g. Auerbach and Gorodnichenko 2010, 2012, Baum, Poplawski-Ribeiro, and Weber 2012, Corsetti, Meier, and Müller 2012). Earlier empirical models based on linear approaches may have therefore underestimated the effects of government policies on output in recessions and overestimated it in expansions (Auerbach and Gorodnichenko 2012).

Using PESSOA, a DSGE model for a small euro-area economy featuring overlapping generations, non-Ricardian agents, and financial frictions, we evaluate the size of short-run fiscal multipliers for a large fiscal consolidation performed under a severe financial turmoil coupled with stronger nominal rigidities—a state of the world termed “crisis times.” Results are put in a comparative perspective against the same fiscal adjustment when performed in more tranquil times, or what we term “normal times.”

A financial turmoil may severely amplify the effects of fiscal shocks, as expected bankruptcy costs can increase dramatically during such periods and force financial intermediaries to raise credit spreads more markedly (Levin, Natalucci, and Zakrajsek 2004). Firms are therefore forced to severely cut back on investment after a fiscal adjustment performed in turbulent times in order to rebalance their balance sheets. The associated decline in demand and the concomitant increase in bankruptcies pushes the external finance premium substantially upwards, positively impacting leverage and placing firms in a more vulnerable financial position vis-à-vis the same fiscal adjustment performed in normal times. The interaction between financial and real variables has received an increased attention in the context of the Great Recession, as this was the first episode in recent history to have been triggered by disturbances in the financial system, namely in mature economies (Ozkan and Unsal 2012).¹

¹Until the inception of the recent international crisis, the assumption that financial markets are complete and efficient seemed a reasonable approximation, at least in well-developed financial systems Roger and Vlcek (2012). Del Negro and Schorfheide (2012), for instance, estimate modified versions of the Smets and Wouters model and report empirical evidence suggesting that a significant fraction of the pre-crisis period can be more accurately forecasted by excluding financial frictions. On the opposite direction, other studies (e.g. Fornari and Stracca 2013, Villa 2013) show that financial shocks may play also an important role in explaining economic outcomes under normal economic conditions.
Nominal wages may be rapid to adjust upwards, but are slow to adjust downwards. Firms may simply prefer not to cut wages in order to prevent an increase in shirking, as postulated in the seminal paper by Shapiro and Stiglitz (1984). Additionally, labor market institutions in most economies attach an intrinsic value to the preservation of nominal wage income, namely by setting minimum nominal wage levels, requiring nominal wage cuts to be subject to a mutual agreement between employers and employees, or even imposing collective wage agreements that hamper wage cuts. Hence, during expansions, fiscal shocks are more likely to be absorbed by nominal adjustments, as inflationary pressures tend to be swiftly channeled to nominal wages. In downturns, when nominal wages are pressured down, stickiness emerges, and fiscal shocks tend to originate real adjustments, namely through cuts in the employment level (Shimer 2012).

Prices may also respond asymmetrically to the state of the economy. In particular, positive price adjustments that occur tend to be larger than negative price adjustments. With trend inflation, firms that face a shock implying a decline in desired relative prices may simply let inflation do much of the work, thus avoiding to pay adjustment costs on price changes. By contrast, a positive shock encourages price changes, as it creates a large gap between desired relative prices—which increase—and actual relative prices—which decline due to trend inflation (Ball and Mankiw 1994). The adjustment is therefore shifted from the nominal to the real side in an event of a negative demand shock, since prices are sticky on the downside, but the opposite holds in the case of a positive demand shock. Additionally, the financial nature of the Great Recession is likely to affect price-setting behavior in a non-trivial manner, since firms with weaker balance sheets may need to increase prices, or to adjust prices slower than usual, in order to raise enough internal funds to honor the debt service (Gilchrist et al. 2013). Hence, the aggregate price level tends to become stickier, and price dynamics attenuated, in response to contractionary demand shocks.

Our analysis differs from the existing literature in at least three key directions. First, the model is designed and calibrated for a small open economy integrated in a monetary union, in contrast with most DSGE models that address the size of fiscal multipliers. Hence, fiscal shocks do not generate any response from the monetary authority. Second, we analyze the size of fiscal multipliers associated with a credible fiscal consolidation that leads to a large permanent decline in the debt-to-GDP ratio in the long run, in line with policy decisions that are nowadays binding most advanced economies. On the opposite direction, most literature on the size of fiscal multipliers focuses on fiscal shocks that do not permanently affect the long run debt ratio. In the overlapping generations framework herein considered, the shift in the debt target severely limits wealth effects of lower debt to current generations, since the benefits of the fiscal adjustment—in the form of future lower labor taxes—will be mostly collected by yet-to-be born generations. Hence, our

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2 This is somewhat similar to the more standard case of an economy wherein the nominal interest rate binds at the zero-lower bound and fiscal shocks are transmitted in full to output (Eggertsson 2009, Christiano, Eichenbaum, and Rebelo 2011), or of an economy wherein the monetary authority accommodates fiscal shocks (Freedman et al. 2009).
exercise purportedly yields larger short-run fiscal multipliers, even in tranquil times, when compared with other studies. Third, the financial turmoil is brought into the model through a temporary increase in the operational costs of financial intermediaries, a proxy for the degree of financial frictions. While the link between the existence of financial frictions and fiscal policies has already been addressed in a few studies (e.g. Fernández-Villaverde 2010, Anderson et al. 2013), the link between the severity of those frictions and fiscal policies is a novel topic.

In normal times, fiscal shocks are implemented directly over the baseline steady state. In crisis times, fiscal shocks are implemented over a set of other shocks designed to capture a financial turmoil coupled with stronger nominal rigidities. Specifically, our crisis times scenario comprises a temporary shock to the degree of financial frictions, a wage rigidity shock, and price rigidities shocks embracing all sectors, in an attempt to grasp some features of the Great Recession. Fiscal multipliers are computed as the additional effect brought about by fiscal shocks vis-à-vis the crisis times scenario. The fiscal consolidation process assumes a decline in the debt-to-GDP ratio of 25 percentage points in the long run in all simulations.

Results suggest that impact fiscal multipliers can increase around 50–70 percent in crisis times for expenditure-based fiscal consolidations, and around 10–35 percent for revenue-based ones, vis-à-vis normal times. A government consumption-based fiscal consolidation yields the highest impact multiplier, of approximately 1.8 in crisis times, as opposed to a value slightly above 1 in normal times. One-year ahead multipliers are also substantially larger in periods of crisis, particularly for expenditure-based fiscal consolidations. Revenue-based consolidations are also more recessive in crisis times, though the differences against normal times are less pronounced. This is to a great extent explained by distinct price dynamics—depending on the fiscal instrument—that trigger different macroeconomic impacts. In general, fiscal instruments that generate stronger downward inflationary pressures, such as those mostly depressing aggregate demand, have their short-run multipliers further magnified in crisis times.

This article is structured as follows. Section 2 briefly reviews selected literature. Section 3 shortly describes the model. Section 4 presents and analyzes fiscal multipliers under a fiscal consolidation process. Section 5 concludes.

2 Selected literature overview

The literature on the size of fiscal multipliers is extensive and controversial, in both theoretical and empirical grounds. The controversy stems from the fact that there is no such thing as “a fiscal multiplier.” In empirical studies, the size of the multiplier depends on the identification strategy, the country or group of countries considered, the time horizon, and the empirical model. The economic cycle, the type of fiscal instrument, the duration of the fiscal consolidation process, or even the credibility of fiscal measures adopted play also a key role. The size of the multiplier is highly dependent on whether taxes, government ex-
penditures, transfers, or some combination of these, are used, whether the fiscal package is deemed as temporary or permanent, or whether it implies some sort of fiscal consolidation with a permanent effect on government debt. It is therefore not surprising that empirical studies present a vast range of fiscal multipliers, which can hardly be compared with one another. Whereas authors that find low fiscal multipliers emphasize the role of Ricardian agents or market completeness, those that advocate larger fiscal multipliers stress the role of rule-of-thumb or hand-to-mouth households, non-Ricardian behavior, finite lifetimes, or nominal rigidities.

A great number of empirical studies (e.g. Barro 1981, Hall 1986, Perotti 2005, Barro and Redlick 2011) typically places the government spending multiplier within the 0.5–1 range, though other studies (e.g. Ramey and Shapiro 1998, Blanchard and Perotti 2002, Beetsma, Giuliodori, and Klaassen 2008, Beetsma and Giuliodori 2011, Ramey 2011b) suggest a higher interval, between 0.8–1.5.3 Tax multipliers are addressed, inter alia, by Favero and Giavazzi (2012) and Perotti (2012), the former concluding in favor of a tax multiplier below one, and the latter in favor of a tax multiplier in the 1–1.5 range. These results contrast with those in Romer and Romer (2010), who estimate a tax multiplier comprised between 2.5 and 3. Chahrour, Schmitt-Grohe, and Uribe (2012) suggest that such contrasting results are explained by distinct estimation strategies, as different models identify different tax shocks. Ilzetzki, Mendoza, and Végh (2010) find that fiscal multipliers tend to be very small in the short run, but they are substantially larger, and potentially well above one, in the medium and long run.

In the theoretical front, most New-Keynesian models have been unable to generate multipliers substantially larger than one. This fact is explained to a great extent by several neoclassic features that are embodied in those models, namely the Ricardian behavior of households and the crowding-out effect of private consumption and investment, which contribute to partially offset the traditional Keynesian multiplier (e.g. Aiyagari, Christiano, and Eichenbaum 1992, Baxter and King 1993, Ramey and Shapiro 1998, Burnside, Eichenbaum, and Fisher 2004, Cogan et al. 2010).

In a recent article, Blanchard and Leigh (2013) argue that fiscal multipliers associated with planned fiscal consolidations during the Great Recession are about 0.7 to 1 percentage points larger than those embodied in regular forecasting exercises by policy institutions, but find no evidence of systematic forecast errors for the pre-crisis period. This study, alongside with the large contractionary effects of fiscal consolidation across the globe that are being observed, triggered the debate about the true size of fiscal multipliers in times of crisis, suggesting that they can therefore depend on the business cycle position of the economy.

The prevalence of state-contingent fiscal multipliers has already been addressed in a few studies, in both theoretical and empirical grounds. Using an empirical approach, Corsetti, Meier, and Müller (2012) find that the government consumption multiplier depends on the

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3See Hall (2009), Ramey (2011a), and Spilimbergo, Schindler, and Symansky (2009) for an overview of the literature.
underlying economic conditions (such as the exchange rate regime, public indebtedness and the health of the financial system), being unusually high during a financial crisis. Auerbach and Gorodnichenko (2012) and Shoag (2010) attest that fiscal multipliers are larger when labor markets have slack, a fact that can be associated with a recessionary regime. Earlier empirical models based on linear features may have therefore underestimated the effects of government consumption on output in recessions and overestimated it in expansions (Auerbach and Gorodnichenko 2012).

Though DSGE models are mostly state independent, and thus unable to generate endogenously fiscal multipliers that are state contingent, recent theoretical work (Christiano, Eichenbaum, and Rebelo 2011, Woodford 2011) has put forward a potential explanation for the dependence of fiscal multipliers on the cyclical position of the economy. If the nominal interest rate binds at the zero bound, the crowding-out effects of government spending over private consumption and private investment are reduced or even eliminated, and the fiscal multiplier can therefore take larger values, possibly larger than 2. This compares with a multiplier below 1 when monetary policy is governed by a Taylor rule at positive interest rates. Galí, López-Salido, and Vallés (2007) were also able to generate government spending multipliers as high as 2 only if the share of rule-of-thumb consumers is sufficiently large and employment is demand determined.

This article further explores the negative association between the size of fiscal multipliers and the state of the economy. In the crisis times state, financial frictions become temporarily more severe and nominal rigidities become stronger. It is relatively consensual that the Great Recession cannot be dissociated from credit market frictions (Gertler and Kiyotaki 2010, Ozkan and Unsal 2012). Fernández-Villaverde (2010) conclude that financial frictions play an important role on the response of output to fiscal shocks, though the authors do not analyze how this response changes with the degree of financial frictions, which purportedly increased during the Great Recession.

There is some evidence suggesting that nominal wages may be rapid to adjust upwards, but are slow to adjust downwards (Shoag 2010, Auerbach and Gorodnichenko 2012). The effects are more severe if wage inflation is close to zero, since firms may prefer not to cut wages in the event of a severe downturn that places a downward pressure on them. For instance, Daly, Hobijn, and Lucking (2012) reports evidence suggesting that employers in

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5Several other studies address the sensibility of fiscal multipliers to the underlying economic conditions or to the degree of development in financial markets, though the business cycle position is often neglected (e.g. Ilzetzki, Mendoza, and Végh 2010, Corsetti, Kuester, and Müller 2011, Favero, Giavazzi, and Perego 2011, Nakamura and Steinsson 2011).

6Some regime switching DSGE models have recently been developed (e.g. Kim and Nelson 1999, Liu and Muntaz 2011, Liu, Waggoner, and Zha 2011), but they focus solely on different regimes in shock variances or policy variables (such as the inflation target).

7See also Monacelli and Perotti (2008).

8Several authors attest that financial frictions can substantial improve the adherence of macroeconomic models to facts. For instance, Merola and Sutherland (2012) conclude that introducing the financial accelerator mechanism à la Bernanke, Gertler, and Gilchrist (1999) can substantially improve the Smets and Wouters (2003, 2007) model, allowing it to capture much of the historical developments in the US financial markets that led to the financial crisis.
the United States might have preferred to keep wages fixed rather than cutting pay during the crisis. For Europe, the percentage of firms that implemented nominal wage freezes in the 2002–06 period is substantially higher than the percentage of firms imposing nominal wage cuts (Fabiani et al. 2010). Hence, when nominal wage changes approach zero, firms seem to adopt alternative mechanisms to reduce costs, such as cuts in employment, rather than implementing outright wage cuts. This naturally shifts a portion of the adjustment from the nominal side to the real side of the economy (Shimer 2012). Labor market institutions play a key role in this outcome, namely by setting minimum nominal wage levels or requiring nominal wage cuts to be subject to a mutual agreement between employers and employees. Collective wage agreements, particularly in societies where unions play an important role in wage setting, are also a source of downward wage rigidity (Babecký et al. 2010, Messina et al. 2010, Druant et al. 2012).

Prices may also react asymmetrically to shocks, as postulated by Ball and Mankiw (1994). Positive shocks create a larger gap between desired and actual relative prices than negative shocks do, since trend inflation causes the relative prices to decline between adjustments. Hence, when facing a negative shock, firms may simply let trend inflation adjust relative prices downwards, thus avoiding to pay adjustment costs over outright price changes. By contrast, firms are more willing to pay the adjustment cost and change prices in the event of a positive shock, as the desired relative price increases but the actual relative price is declining due to trend inflation. Hence, positive price adjustments that occur are larger than negative price adjustments. Gilchrist et al. (2013) put forward a different argument, suggesting that price changes may be conditional on firms’ financial positions. While firms with stronger financial positions are able to lower prices, firms with weaker balance sheets may need to increase prices in order to raise enough internal funds to honor the debt service. Hence, price dynamics become attenuated in response to contractionary demand shocks. On the empirical front, Abbritti and Fahr (2013) show that the distributions of wage and of price inflation are positively skewed, and interpret this as evidence of downward rigidity. The authors show, in addition, that explicitly taking into account this asymmetry in a New-Keynesian DSGE model strongly improves the fit to the observed skewness of labor market variables and the relative length of expansions and contractions in the output and employment cycles.

3 A model for a small euro area economy

PESSOA is a New-Keynesian DSGE model for a monetarily-integrated small open economy. It features a multi-sectoral production structure, non-Ricardian characteristics, imperfect market competition, and a number of nominal and real rigidities that allow for realistic short-run dynamics and create room for welfare improving stabilization policies. In addition, the model contemplates financial frictions à la Bernanke, Gertler, and Gilchrist

Schmitt-Grohé and Uribe (2013) have also stressed the role played by persistent downward nominal wage rigidities in the economic adjustment during the Great Recession.
(1999), whereby financial shocks are transmitted and propagated to the real economy. This latter mechanism is particularly important for the study of the magnitude of fiscal multipliers in the context of a financial crisis, such as the Great Recession, since it may amplify the effects of fiscal shocks.

In PESSOA, monetary policy is set by the monetary union authority, viz the European Central Bank. The rest of the monetary union is immune to domestic shocks, a consequence of the small-open economy assumption. Hence, developments in euro area interest rates are orthogonal to domestic developments, as in Adolfson et al. (2007), and domestic interest rates can only deviate from the monetary union’s reference rate by a risk premium. In addition, the nominal exchange rate vis-à-vis the rest of the monetary union is irrevocably set to unity. For tractability, trade and financial flows are restricted to monetary union countries.

The economy is composed by nine types of agents: households, labor unions, capital goods producers, entrepreneurs, banks, intermediate goods producers (manufacturers), final goods producers (distributors), the government, and foreign agents (the rest of the monetary union). Figure 1 depicts the interactions between agents in PESSOA.

The rest of the section briefly reviews the main features of the model and the environment wherein each type of agent makes decisions. Additional details and the model’s complete analytical solution can be found in Almeida et al. (2013a).

3.1 Households

Households evolve according to the overlapping generations scheme first proposed in Blanchard (1985). They are subject to stochastic finite lifetimes and face an identical and constant probability of death, independent of age. Population is constant, implying that in each period the number of newborn households equals the number of households that die. The overlapping generations framework is linked to a life insurance scheme along the lines in Yaari (1965), which ensures net wealth transfers from succumbing households to those that survive. Households rent labor services to a labor union, receiving in return a productivity adjusted wage rate, over which they pay a labor income tax. Labor productivity is assumed to decay over lifetime at a constant rate, roughly mimicking the life-cycle income profile.

Two types of households coexist in the model: asset holders, who are able to smooth consumption over their lifetime by trading assets; and hand-to-mouth households (à la Galí, López-Salido, and Vallés 2007), who have no access to asset markets and therefore consume all their income in each and every period. Both household types derive utility from consumption and leisure, according to a constant relative risk aversion utility function. It should be stressed that households discount future events at a higher rate vis-à-vis the market, as they face a positive probability of death.

The probability of death can be also interpreted as the degree of “myopia” (Blanchard 1985, Frenkel and Razin 1996, Harrison et al. 2005, Bayoumi and Sgherri 2006). In other words, the future is seen as a period of lesser economic relevance.
Asset holders have four sources of income. First, they are remunerated for labor services rented to labor unions. Second, they receive dividends from firms and transfers from both the government and abroad. Third, they earn interest on their bond holdings. Besides foreign bonds, there are two types of domestic bonds: those issued by the national government and those issued by banks, which act as financial intermediaries by lending to entrepreneurs. Finally, asset holders receive a remuneration for financial services in the bankruptcy monitoring of firms, an activity which they perform at the request of financial intermediaries. On the expenditure side, asset holders buy consumption goods and pay consumption and labor income taxes. The difference between expenditures and income is reflected in changes in their net asset position. Hand-to-mouth households consume in each and every period their current income, given by the after-tax wage income plus all transfers from both the government and abroad. They receive no dividends from firms.

Contrary to most general equilibrium models on small open economies, PESSOA has intrinsic non-Ricardian features. Asset holders are not indifferent as to financing government expenditure with tax levies or debt issuance (i.e. future taxes); in fact, they strongly prefer debt financing, since future taxes will be charged largely on yet-to-be born generations (Buiter 1988). Part of the debt held by current generations can therefore be used to finance private consumption during their lifetime, instead of being used to face future...
tax liabilities. Non-Ricardian effects are magnified by the life-cycle income profile, which shifts the proneness of agents towards paying taxes later, when labor income is lower, rather than sooner. Additionally, the prevalence of distortionary taxation on household consumption, labor, and capital income implies a preference for tax smoothing so as to minimize the intertemporal value of the deadweight loss, something that is achieved by managing the time path of debt, thus implying a deviation from the Ricardian Equivalence. The lack of access to asset markets by hand-to-mouth households is an additional non-Ricardian feature of the model.

It is well known that breaking the Ricardian equivalence is important to generate realistic private consumption responses to government expenditure shocks (Blanchard 1985, Galí, López-Salido, and Vallés 2007). The stochastic finite lifetime framework may generate sizeable wealth effects from public debt issuance, which are absent in the infinitely-lived agent framework (Frenkel and Razin 1996, Kumhof and Laxton 2009). In addition, the stochastic finite lifetime framework allows the endogenous determination of the net foreign asset position of the economy in the steady state, since finite lifetimes limit the amount of assets/debt that households can accumulate (Harrison et al. 2005). This generates a positive correlation between public debt and the net foreign debt position, representing thus an appealing feature for the simulation of permanent fiscal shocks.

The utility maximization problem delivers a condition for each type of household that yields their optimal consumption-labor allocation and a consumption function that depends on current income, in the case of hand-to-mouth households, or on human and financial wealth, in the case of asset holders. Human wealth corresponds to the present discounted value of labor, transfers, and dividend income accruing in the future, while financial wealth corresponds to current domestic and foreign asset holdings. An interest rate parity condition resulting from portfolio optimization of asset holders defines the equilibrium in the bonds market. This no-arbitrage condition implies that the wedge between domestic and foreign interest rates corresponds to the risk premium for holding domestic assets.

3.2 Labor unions

Labor unions hire labor services from households and sell them to manufacturers operating in the intermediate goods market. Labor unions are perfectly competitive in the input market and monopolistically competitive in the output market—they charge a markup to manufacturers, therefore creating a wedge between the wage paid by these firms and the wage received by households. Market power arises from the fact that labor unions supply differentiated, imperfectly substitutable labor services. This modeling strategy—widely used in DSGE models—implies that households are rewarded for labor services in excess of

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11On the contrary, in the infinitely-lived agents model, the steady-state net foreign asset position is pinned down exogenously (Schmitt-Grohe and Uribe 2003), implying that changes in the steady-state public debt are fully offset by changes in private savings, being therefore uncorrelated with net foreign debt. The link between fiscal consolidation and the current account balance has been assessed in IMF (2011).
their marginal rate of substitution between consumption and leisure. That is, they receive a wage premium from labor unions, corresponding to the markup, which does not affect their consumption-leisure choice. Labor unions face adjustment costs on wage changes in order to mimic the dynamics of sticky wage growth. The optimality condition resulting from their optimization problem yields a pricing rule, mapping wages paid to households to wages charged to manufacturers.

### 3.3 Firms

#### 3.3.1 The non-financial sector: Manufacturers, distributors, and capital goods producers

The model’s non-financial block includes manufacturers, distributors, and capital goods producers.

Manufacturers combine capital, rented from entrepreneurs (capital goods producers in the model version with no financial frictions), with labor services, hired from labor unions, to produce an intermediate good, which is thereafter sold to distributors. There are two types of manufacturers: those producing tradable goods, and those producing nontradable goods. Manufacturers are perfectly competitive in the input market and monopolistically competitive in the output market, charging a markup over the marginal cost to distributors. The production process is based on a constant elasticity of substitution production function with labor augmenting technology. Inflation persistence and sluggish adjustment of hours worked are obtained through quadratic adjustment costs. Manufacturers pay social security taxes on their payroll and capital income taxes on profits. After-tax profits are distributed to asset holders in the form of dividends. The manufacturers’ optimality conditions yield a pricing rule mapping the price charged to distributors to the marginal cost, a labor demand function, and a capital demand function.

Distributors produce four types of differentiated final goods, each acquired by a unique type of costumer: consumption goods are acquired by households, investment goods by capital goods producers, government consumption goods by the government, and export goods by foreign distributors. Final goods are produced in a two stage process, according to a constant elasticity of substitution production technology. In the first stage, distributors obtain assembled goods by combining domestic tradable goods with imported goods. This stage determines the demand for imports of the domestic economy. In the second stage, distributors combine assembled goods with domestic nontradable goods, obtaining the final good. Analogously to manufacturers, distributors are perfectly competitive in the input market and monopolistically competitive in the output market, charging a markup over the marginal cost to final costumers, and face price adjustment costs that generate inflation persistence. They pay capital income taxes on profits and distribute dividends to asset holders. Distributors’ optimality conditions yield a demand for domestic tradable intermediate goods, domestic nontradable intermediate goods, and imported goods, and a pricing rule mapping the price charged to final costumers to the marginal cost.
Capital goods producers are the exclusive producers of capital in this economy. Before each production cycle, they buy the undepreciated capital stock from entrepreneurs (manufacturers in the model version with no financial frictions), combining it with investment goods bought from distributors, to produce new installed capital, which is thereafter sold to entrepreneurs (manufacturers). Capital goods producers face quadratic adjustment costs when changing investment levels and are assumed to operate in a perfectly competitive environment in both input and output markets. Their optimality condition yields a pricing rule, linking the price of capital (the price charged to entrepreneurs/manufacturers) to the cost of investment goods (the price paid to investment goods distributors).

3.3.2 The financial sector: Entrepreneurs and banks

The baseline model includes a financial transmission mechanism along the lines of Bernanke, Gertler, and Gilchrist (1999) and Christiano, Motto, and Rostagno (2010), whereby financial frictions affect the after-tax return on capital and therefore capital demand. The structure is based on Kumhof et al. (2010). Both normal times and crisis times are assumed to be characterized by financial frictions.

The financial sector is composed of two agents, entrepreneurs and banks. At the end of each period, entrepreneurs buy the new capital stock from capital goods producers, and rent it, partially or entirely, to manufacturers, for usage in the production process. They do not have access to sufficient internal funds to finance desired capital purchases, but can cover the funding gap by borrowing from banks. Each entrepreneur faces an idiosyncratic shock that changes the value of the capital stock after the balance sheet composition has been decided. If hit by a severe shock, the value of capital collapses, and the entrepreneur may be forced to declare bankruptcy, handing over the firm to the bank. Contrarily, if hit by a propitious shock, the value of entrepreneur’s capital rises, and her net worth increases as a result. The idiosyncratic risk is assumed to follow a lognormal distribution, and therefore some percentage of entrepreneurs goes bankrupt in each period. To ensure that the mass of entrepreneurs is kept constant through time, the same fraction of entrepreneurs is assumed to start a new business in the next period.

Entrepreneurs face two key decisions. First, they select the degree of leverage that maximizes the value of the firm, together with capital purchases. As net worth is taken as given, capital purchases directly determine the balance sheet composition and therefore leverage. In turn, the degree of leverage determines the relative risk of the firm and thus the probability of default. If leverage is low, the entrepreneur is able to face more adverse shocks, since losses are absorbed by net worth; if leverage is high, even small shocks to the firm value can have large implications in bankruptcy prospects. Consequently, as capital and leverage increase, so does the risks faced by financial intermediaries and therefore the cost of external finance.

Second, they must select the capital utilization rate that maximizes the present discounted value of after-tax profits related with the capital renting activity. Entrepreneurs may alter the fraction of capital that is rented to manufacturers by managing capital
utilization, rather than by changing the capital stock that they buy from capital goods producers. The extent to which changing capital utilization is preferred to changing the capital stock depends on their relative costs. The optimality condition associated with capital utilization pins down the real rental rate of capital. Entrepreneurs pay a capital income tax on their profits. A fraction of net profits is kept in the firm as retained earnings, while the rest is distributed to asset holders as dividends.

Banks operate in a perfectly competitive environment, thus making zero ex-ante and ex-post profits at all times. They are pure financial intermediaries, with the sole mission of borrowing funds from asset holders and lending to entrepreneurs. If the entrepreneur goes bankrupt, the bank must pay monitoring costs (to asset holders) to be able to recover the value of the firm. Monitoring costs include all bankruptcy costs, such as auditing costs, asset liquidation or business interruption effects. Since capital acquisitions are risky, so are the loans of banks, who therefore charge a spread over the risk free rate to cover for bankruptcy losses. The existence of identical a priori expectations on the idiosyncratic shock implies that the credit spread is identical for all entrepreneurs. Even though individual loans are risky, the aggregate portfolio of banks is risk free, since each bank is assumed to lend to many entrepreneurs, thus recovering through the credit spread what is lost to bankrupt entrepreneurs. In addition, the contract celebrated between the entrepreneur and the bank features a menu of state contingent interest rates, to be applied in all potential states of the world. Hence, if the economy is hit by a severe shock that increases the number of firms in financial distress or leads to larger bankruptcy losses, banks are able to charge higher interest rates on existing contracts, such that they still break-even ex-post. Households loans are therefore risk free at all times, and thus they lend to banks at the risk free rate.

The financial accelerator mechanism magnifies economic fluctuations, by creating an additional channel through which shocks are transmitted and propagated to the real economy. For instance, any shock originating a decrease in the price of capital increases also the number of entrepreneurs in financial distress and reduces the value of net worth for those that survive. As risk increases, so does the credit spread. With lower internal funds and higher borrowing costs, entrepreneurs acquire less physical capital. Investment is reduced, magnifying the fall in output and employment. The model therefore implies, realistically, a countercyclical credit spread, and procyclical consumption, investment, inflation, and employment, for aggregate demand shocks.

3.4 The government

The government buys consumption goods from distributors and performs lump-sum transfers across households. These activities are financed through tax levies on wage income, capital income, and households’ consumption, and also through transfers from the euro area. The government may also issue one-period bonds to finance expenditures, paying an interest rate on public debt which is not necessarily equal to the monetary union’s interest rate due to the existence of an exogenous country risk premium on domestic bonds.
Taxes on wage income—henceforth referred to as labor taxes—include the labor income tax paid by employees and the payroll tax paid by manufacturers. The government’s budget constraint is

$$B_t = i_{t-1} B_{t-1} + P_t^G G_t + TRG_t - RV_t$$

where $B_t$ denotes government bonds at time $t$, $i_t$ is the domestic interest rate, $P_t^G G_t$ is the nominal value of government purchases, $TRG_t$ are lump-sum transfers, and finally, $RV_t$ represents total government revenues. These are

$$RV_t = \sum \tau^x_t \cdot (\text{tax base}^x_t) + TRE_t$$

where $\tau^x_t$ is the tax rate levied on tax base$^x_t$—households’ consumption, employees’ labor income, manufacturers’ payroll, and firms’ capital income—at time $t$ and $TRE_t$ are transfers from abroad. We assume that all government debt is held by domestic asset holders, i.e. there is full home bias (markets are incomplete). Households can, however, borrow in international debt markets to buy domestic government bonds. Public debt allows the government to postpone tax levies required to finance public expenditure. This has a nontrivial impact on households’ decisions, since part of the public debt is taken as net wealth by asset holders, which are non-Ricardian.

A fiscal rule, ensuring that debt follows a nonexplosive path, links the government surplus-to-GDP ratio to a pre-determined target. Hence, deviations from that target are followed by tax adjustments or changes in public expenditure in order to restore long-run government debt to a sustainable path. The fiscal rule implies that at least one fiscal instrument adjusts endogenously. A common option relies on using the labor income tax rate as the endogenous fiscal policy instrument (Harrison et al. 2005, Kilponen and Ripatti 2006, Kumhof and Laxton 2007, Kumhof et al. 2010), though other possibilities—such as other tax rates, lump-sum transfers to households, government consumption or some combination of these—are also possible.

Although the above-mentioned fiscal block is suited to implement several fiscal simulations, the model remains a simplification of reality. Government consumption and investment are assumed to generate no externalities, therefore not affecting the marginal utility of consumption and leisure, or the firms’ productivity level. The only tangible impact of government consumption is on the demand conditions for a specific type of final good, which is particularly intensive in nontradable intermediate goods and has a low import content. The model is thus silent on other roles played by the government, in particular as a large-scale employer and investor, or on externalities associated with alternative fiscal policies. Notice also that the model does not feature unemployment benefits, since the breakdown between heads and hours per head, and hence unemployment, is not explicitly modeled.
3.5 The rest of the world

In *PESSOA*, the rest of the world corresponds to the rest of the monetary union, and thus the nominal effective exchange rate is irrevocably set to unity. The domestic economy interacts with the foreign economy *via* the goods market and the financial market. In the goods market, domestic distributors buy imported goods from abroad to be used in the production of final goods. Likewise for foreign distributors, who buy export goods from domestic distributors. More specifically, the representative foreign distributor produces final goods by assembling domestic exports (*i.e.* foreign imports) and intermediate goods produced by foreign manufacturers. Foreign distributors are assumed to be identical to domestic ones and they face therefore a similar optimization problem. Domestic exports are essentially determined by the foreign distributors’ imports demand, which, in turn, depends on price competitiveness and on foreign demand conditions. These are determined by economic activity in the rest of the world, which is immune to domestic developments.

The demand condition for domestic exports is fundamental to render the model dynamically stable. In particular, a large real exchange rate elasticity of exports is required. The model operates like a fixed nominal exchange rate model under perfect credibility, in which domestic price levels are pinned down by the external constraint that uniquely sets the real exchange rate in the steady state.\(^{12}\) Moreover, the trade balance reflects final demand conditions and competitiveness of the domestic economy *vis-à-vis* the rest of the monetary union. All foreign variables, as well as monetary policy, are assumed to be unaffected by domestic developments.

In the international financial market, asset holders can trade assets to smooth out consumption. The small open economy approach implies that changes in the domestic net foreign asset position have negligible impacts on euro area aggregates and therefore on monetary policy decisions.

3.6 Market clearing conditions and GDP definition

The model is closed by a set of conditions imposing market clearing for each and every period. In the labor market, the wage received by households, the price charged by unions for labor services, and equilibrium labor, are jointly determined by the households’ labor supply, the unions’ pricing rule, and manufacturers’ labor demand.

In the financial sector, total physical capital and its price follow from the equilibrium between the supply and the demand for capital, the former being decided by capital goods producers and the latter by entrepreneurs (manufacturers in the model version with no financial frictions). The stock of capital that is actually used by manufacturers in the production process may however differ from the total physical capital, since entrepreneurs set the fraction of the capital stock that is actually rented to manufacturers. The real rental

\(^{12}\)In the standard small open economy model, monetary policy is actively managed and the adjustment of real interest rate supplements the real exchange rate in rendering the model dynamically stable. In a small open economy within a monetary union, real interest rate dynamics tend to amplify demand driven business cycle fluctuations, due to the absence of the monetary policy’s stabilization role.
rate of capital and the fraction of utilized capital result from the equilibrium between the manufacturers’ demand and the entrepreneurs’ supply of capital.

In the intermediate goods market, the price of tradable and nontradable goods follows from the equilibrium between manufacturers’ supply and distributors’ demand. The final goods price is determined by the equilibrium between the output produced by distributors and customers’ demand.

Nominal GDP is defined as the sum of expenditure components, viz consumption, investment, government spending, and net exports. In a frictionless international financial environment, financial flows are fully determined by national saving decisions at the prevailing interest rate, implying that changes in net foreign asset holdings must be identical to the current account balance.

3.7 Calibration

PESSOA is calibrated to match Portuguese data. Besides historical data, calibration is based on information from studies on the Portuguese and euro-area economies. Further details can be found in the appendix.

4 Fiscal consolidation multipliers

This section evaluates the size of fiscal multipliers in normal times and in crisis times for a large fiscal consolidation. Each multiplier reflects the percentage change in real GDP against the initial steady state, conditional on fiscal shocks that correspond in all cases to a permanent decrease in the fiscal deficit of one percent of ex-ante GDP. It must be stressed that the multipliers computed herein are not directly comparable with the remaining literature, since we specifically assume a large and permanent fiscal adjustment impacting the long-run debt-to-GDP ratio, in line with policy decisions that are nowadays binding most advanced economies. The vast majority of studies on the subject focus either on temporary or permanent fiscal shocks with no change in the debt target. In the latter case, the adjustment triggers a change in a second fiscal instrument that is able to generate positive wealth effects in the short run. Contrarily, the large shift in the debt target in our exercise, alongside with the overlapping generations framework, limits wealth effects to current generations, since the benefits of the adjustment driven by future changes in the endogenous fiscal instrument will be mostly collected by yet-to-be-born generations. In addition, monetary policy is exogenous in our model, due to the small-open economy assumption.

We analyze the size of fiscal multipliers for four types of fiscal instruments: government consumption and transfers to households on the expenditure side, and consumption and labor income taxes on the revenue side. In normal times, fiscal shocks are implemented over the initial steady state. In crisis times, fiscal shocks are implemented over a set of other shocks—designed to capture a financial turmoil coupled with stronger nominal rigidities—that pulled the economy out of the initial steady state. In this latter case,
fiscal consolidation multipliers are computed as the additional effect brought about by fiscal shocks *vis-à-vis* the crisis times scenario.

We generate a financial turmoil by implementing a temporary increase in the degree of financial frictions, captured through banks’ operational costs. The shock is calibrated such that the leverage ratio increases around 15 percent on impact, a value below the 23 percent increase registered in the euro area between 2000–07 and 2008–11, and well below the 60 percent increase registered in the same time frame on average across peripheral countries (Portugal, Spain, Greece, Italy and Ireland).\(^{13}\)

Simultaneously, we assume that the financial turmoil triggered stronger nominal wage and price rigidities. Shaping nominal rigidities’ shocks to match observed data is not straightforward, since to our best knowledge no study properly addresses how the Great Recession impacts the size of nominal adjustments. We proceed by approximating the Rotemberg (1982a) pricing embodied in our model to that of a model with Calvo (1983) pricing, along the lines in Rotemberg (1982b, 1996). The implicit duration of price contracts is then increased by roughly 1.5 quarters across all sectors (intermediate and final goods sectors), coming close to the upper empirical range usually found in the literature.\(^{14}\) To our best knowledge, no study addresses how the Great Recession might have affected the average duration of wage adjustments. Since our modeling strategy assumes that labor unions are perfectly competitive in the input market and monopolistically competitive in the output market, the wage received by households can be decomposed into a base wage—determined under perfect competition and thus fully flexible—and a wage premium—which corresponds to the labor unions’ markup and is subject to rigidities. The nominal wage rigidity shock affects only the wage premia, which is set to 25 percent over the base wage in the steady state. We opt to increase the duration of wage premia adjustments by roughly 3 quarters. This amounts to say that the average duration of wage contracts is increased by less than one quarter, and thus wages tend to adjust slightly slower. Both the financial shock and wage and price rigidities are assumed to face a level shift until the third year—the time span of our exercise—and to decay thereafter, reaching an half-life around the fourth year.\(^{15}\)

The fiscal consolidation process considered herein consists in a permanent change in each one of the aforementioned fiscal instruments, with the objective of achieving a reduction of 25 percentage points in the government debt-to-GDP ratio in the long run. The permanent fiscal shock corresponds to 1 percent of the initial steady-state GDP. As fiscal

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\(^{13}\)In the Euro Area, the leverage ratio, measured as the ratio between liabilities and equity, increased from an average value around 68 percent in the 2000–07 period to 84 percent in the 2008-11 period. In peripheral countries the increase in leverage is more severe. In the same time span, Greece experienced an increase in leverage around 140 percent, Spain around 60 percent, and Ireland around 50 percent. In Portugal and Italy the increase was 25 and 18 percent, respectively (source: Eurostat and authors own calculations).

\(^{14}\)Several authors place the average duration of price spells between 3 to 5 quarters for the Euro Area (e.g. Dhynes et al. 2006, Dixon and Kara 2010). The average duration of price contracts for the United States is slightly smaller, around 2 to 3 quarters (Christiano, Eichenbaum, and Evans 2005, Coenen, Levin, and Christoffel 2007, Smets and Wouters 2007).

\(^{15}\)The autoregressive parameters play a minor role in the size of fiscal multipliers, with an effect below 0.1. Multipliers are mostly driven by the size of fiscal shocks until the third year.
consolidation leads to a lower level of government debt, interests outlays will decrease, providing the government with a fiscal buffer that is used to reduce government debt in the first 20 years. Thereafter, the government uses that additional fiscal buffer to reduce labor income taxes, so that the government debt-to-GDP ratio smoothly converges to the new target level. This is implemented by switching on the fiscal rule 20 years after the shock.\textsuperscript{16} Hence, lower labor income taxes will mostly benefit yet-to-be-born generations. Simulations assume perfect foresight, full credibility of fiscal authorities, and no implementation lags.

The analysis presented herein focuses only on short-run fiscal multipliers, namely on the impact of different fiscal consolidation strategies over the first 3 years. For the long-run effects of fiscal consolidation in a small euro area economy, see Almeida et al. (2013b).

4.1 Fiscal consolidation multipliers in “normal times”

Table 1 presents the fiscal consolidation multipliers in normal times, for the first three years. Results suggest that fiscal multipliers differ across instruments and time horizons, and that financial frictions play a non-negligible role, as in Fernández-Villaverde (2010).

All fiscal tightening measures have a negative effect on GDP in the first year. Fiscal multipliers in the first year range from an annual average of 0.6–0.7, in the cases of a decline in transfers or an increase in taxes, to 1.2, in the case of a decrease in government consumption.\textsuperscript{17} Government consumption feeds directly into aggregate demand, thus having a direct effect on output, whereas transfers or taxes operate mainly through current income and wealth, originating non-negligible leakages that are reflected into lower multiplicative effects on domestic output. From the second year onwards, the size of government expenditure multipliers is substantially reduced, as opposed to those associated with tax increases. Taxes, and in particular labor income taxes, affect incentives and decision-making, originating distortions that impact output negatively and more persistently.

Financial frictions contribute between 20 and 30 percent for expenditure-based fiscal multipliers in the first year. In the second and third years, financial frictions magnify the GDP response to fiscal shocks only if government consumption is used as instrument, and dampen the expansionary effects of a cut in transfers. Financial frictions play a lesser role in tax-based fiscal consolidations.

As monetary policy is exogenous, the effects on aggregate demand of a fiscal consolidation process are amplified by real interest rate developments. That is, a fiscal consolidation originating a downward pressure on inflation leads to a larger increase in real interest rates \textit{vis-à-vis} an economy where the monetary authority responds to demand conditions through a cut in nominal interest rates. Asset holders face a larger negative wealth effect in the former case, as well as larger incentives to substitute current for future consump-

\textsuperscript{16}Switching on the fiscal rule at an earlier date leads to slightly lower fiscal multipliers, since asset holders would benefit from lower taxes sooner, and their consumption would thus be less affected. We chose to switch on the fiscal rule in a very distant future so that future fiscal policies play a negligible role in short-run fiscal multipliers.

\textsuperscript{17}Details for the first year fiscal multiplier are reported in Tables B.1 and B.2 in the appendix.
<table>
<thead>
<tr>
<th>Fiscal multipliers in normal times</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decrease in government consumption</strong></td>
<td>-1.2</td>
<td>-0.4</td>
<td>-0.5</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline effect</td>
<td>-0.9</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Financial frictions contribution</td>
<td>-0.2</td>
<td>-0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td><strong>Decrease in lump-sum transfers</strong></td>
<td>-0.7</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline effect</td>
<td>-0.5</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Financial frictions contribution</td>
<td>-0.1</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td><strong>Increase in labor taxes</strong></td>
<td>-0.7</td>
<td>-0.8</td>
<td>-0.8</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline effect</td>
<td>-0.7</td>
<td>-0.8</td>
<td>-0.8</td>
</tr>
<tr>
<td>Financial frictions contribution</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Increase in consumption tax rate</strong></td>
<td>-0.6</td>
<td>-0.5</td>
<td>-0.5</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline effect</td>
<td>-0.6</td>
<td>-0.4</td>
<td>-0.4</td>
</tr>
<tr>
<td>Financial frictions contribution</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Notes: Fiscal multipliers consider a permanent shock in each fiscal instrument corresponding to 1 percent of the initial steady-state GDP. The baseline effect corresponds to the multiplier of the model with no financial frictions. All figures represent annual averages. Values are rounded to 1 decimal place.

The impacts of fiscal policy on private consumption and output are magnified by the absence of monetary accommodation. However, as inflation decreases against the initial steady-state level, so does the relative price of exported goods. The real exchange rate therefore depreciates. Besides shifting resources from the nontradable to the tradable sector, this expansionary effect partly offsets the impact of the rise in real interest rates.

Besides the direct effect in aggregate demand, a government consumption-based fiscal consolidation decreases the demand for intermediate goods, particularly nontradable goods, which are labor intensive. Labor demand and hours worked therefore decrease, as do real wages. This translates into a significant decline in households’ current income and wealth and, consequently, in private consumption of both hand-to-mouth consumers and asset holders. The lower marginal costs of intermediate goods originate a domestic price decrease, and therefore a significant real exchange rate depreciation. Price competitiveness gains are reflected into higher exports, partly offsetting the decline in both government consumption and private consumption, mainly after the first year. This type of consolidation has thus the largest impact on output in the first year, but the effects display little persistence. The cut in government consumption releases resources that can be allocated to other sectors, particularly to the tradable sector, where employment, capital, and production increase.
A decline in transfers to households operates directly via disposable income and wealth. Hand-to-mouth households are affected and become more willing to accept lower wages as they need to cope with lower income. Likewise for asset holders, who face a reduction in human wealth. Private consumption is thus negatively affected. Moreover, labor supply shifts outwards, leading to a decline in real wages, as well as in the manufacturer’s marginal cost. Manufacturers therefore substitute capital for labor, given the change in inputs’ relative prices, but they face also a reduction in intermediate goods’ demand, which negatively affects the demand for both inputs. As a result, the number of hours worked in the economy is roughly unchanged in the first year, but the real wage falls sharply. Inflation decreases and the real exchange rate depreciates, thereby fostering exports. Competitiveness gains offset the negative output effects of the decline in transfers, particularly after the first year. In the second and third years, output has already recovered and fiscal multipliers become slightly positive, in sharp contrast with other policy options, though the composition of GDP has changed: exports are now higher vis-à-vis the initial steady state, whereas private consumption is lower.¹⁸

By affecting the households’ marginal rate of substitution, higher labor income taxes trigger a substitution effect from consumption to leisure, therefore originating a decrease in labor supply. Higher payroll taxes, in turn, induce manufacturers to substitute away from labor towards capital. In addition, as aggregate demand falls, so does the demand for both factors of production. Wages, net of payroll taxes, end up decreasing slightly (as opposed to gross wages, which increase due to payroll taxes), and employment falls sharply. Households’ disposable income and wealth therefore decline, leading to a reduction in private consumption. Capital also declines, despite the substitution effect, and investment is thus hampered. Contrarily to an expenditure-based fiscal consolidation, labor income taxes distort decision-making by changing the consumption-labor allocation, and have thus protracted effects on the supply side. As a result, inflation remains roughly unchanged and the economy experiences no price competitiveness gains. Output therefore faces a protracted decline, which is magnified in the second year, a fact explained by several real rigidities that originate smooth adjustments of both employment and capital. That is, adjustment costs on the real side prevent a swifter adjustment of output to the new demand conditions.

The fiscal multiplier of consumption taxes in the first year is similar to that of labor income taxes, though it propagates through the economy differently. A hike in the consumption tax rate reduces the real value of households’ wealth, and therefore private consumption. The wealth effect induces households to supply more labor, ceteris paribus. However, as demand falls, so does the manufacturers’ demand for both labor and capital. The new labor market equilibrium yields a decline in hours worked—though in a lesser extent vis-à-vis a labor tax-based fiscal consolidation—as well as a sharp decline in real wages. That is, a consumption tax-based fiscal consolidation originates larger nom-

¹⁸In PESSOA, a cut in transfers shifts labor supply. In practice, however, transfers are to some extent targeted to pensioners, who do not actively supply labor. This feature is not captured by the model and may impose important limitations to labor supply impacts.
inal adjustments and smaller real adjustments in the labor market as compared with a labor tax-based one. In addition, even though a hike in the consumption tax rate generates inflation, the relative price of exported goods declines, since they are not subject to consumption taxes. The economy therefore experiences some price competitiveness gains, which attenuate the negative output effects of fiscal consolidation and eliminate the magnification effect that is present from the second year onwards in the case of an increase in labor income taxes. Price competitiveness gains are however insufficient to revert the negative output effects in the medium term, as opposed to the outcome of an expenditure-based adjustment.

Financial frictions create an additional mechanism through which shocks are transmitted and propagated to the real economy. Lower government consumption reduces the demand for capital and thereby the price of capital, particularly in the nontradable goods sector. In addition, the real costs of external finance increase, since the lower inflationary pressures push the real interest rate upwards. Net worth declines and leverage increases as a result. Entrepreneurial projects become riskier, as entrepreneurs face a higher probability of financial distress, and banks demand larger credit spreads in order to break-even, to cover for higher expected losses. Entrepreneurial firms start therefore a deleveraging process, whereby capital demand and investment are reduced while they rebuild lost net worth. This decline in investment originates an additional channel through which the fiscal consolidation process affects output, and explains the amplification effect associated with financial frictions. As it takes several years to rebuild lost net worth, financial frictions generate more persistent effects. The mechanism is similar for a transfers-based fiscal consolidation, even though the amplification effect is weaker in this case, since transfers operate through households’ disposable income and wealth, implying a smaller fall in demand and thus in the price of capital.

Financial frictions have a modest effect on the size of fiscal multipliers for a revenue-based fiscal consolidation, though the explanation is different depending on the fiscal instrument. For a labor tax-based fiscal consolidation, there is a persistent substitution effect from labor towards capital, explained by the payroll tax increase. The price of capital decreases only slightly, and the decline in net worth is thus not sufficient to generate a strong amplification effect, though it leads to a slight downfall in investment. Private consumption is also affected, as asset holders face a negative wealth effect following the decrease in entrepreneurs’ dividends.

A higher consumption tax rate increases inflation, thus originating a strong decline in real interest rates. This mitigates the increase in the credit spread and therefore in the external finance premium paid by entrepreneurs. Net worth is less affected as compared with expenditure-based fiscal consolidations, despite the decline in the price of capital, and investment is therefore less hindered by the need to rebuild lost net worth.

All in all, the output effects of an expenditure-based fiscal tightening are short lived, as opposed to those arising from a revenue-based one, which display a larger persistency. The former generates a stronger downward pressure on inflation, promoting stronger improve-
ments in international price competitiveness vis-à-vis the latter. These price competitiveness gains offset the recessive impact of fiscal consolidation from the second year onwards. On the opposite direction, by distorting decisions, a tax based fiscal consolidation implies a protracted decline in output, private consumption, and investment.

4.2 Fiscal consolidation multipliers in “crisis times”

Fiscal consolidation multipliers in crisis times for the first three years are depicted in Figure 2. To ease comparisons, normal times multipliers are also presented. Table 2 shows the individual impacts of more severe financial frictions and stronger nominal rigidities on the size of the multiplier. Specifically, the multiplier in crisis times can be decomposed into the baseline effect in normal times and the marginal impacts driven by more severe financial frictions and by stronger nominal rigidities.

In the first year, the average GDP effects of expenditure cuts are substantially larger during crisis times vis-à-vis normal times. A government consumption-based fiscal consolidation has an impact on GDP around 50 percent higher if carried out in a period of crisis, with the multiplier increasing from 1.2 to 1.8. For transfers, the fiscal multiplier increases around 70 percent, from 0.7 to 1.1. Crisis periods affect also revenue-based fiscal multipliers, though to a lesser extent. The effects settle around 0.1 for a labor tax-based consolidation, and around 0.2 for a consumption tax–based one. One-year ahead fiscal multipliers are also negatively affected in periods of crisis. Two-year ahead fiscal multipliers do not exhibit substantial differences between normal times and crisis times.

More severe financial frictions amplify the size of fiscal multipliers, particularly for expenditure-based consolidations. The effects in the first year range from nearly 0, in the case of a labor tax-based fiscal consolidation, to 0.2, in the case of a government consumption-based one. Intuitively, the increase in agency costs implied by more severe financial frictions trigger larger bankruptcy losses and thus larger credit spreads. With more expensive credit, entrepreneurs cut back on capital acquisitions further, implying a stronger fall in the price of capital, alongside with net worth. The additional slump in investment magnifies the output response to the fiscal shock. In addition, the larger fall in net worth contributes to foster the persistence of the shock, as investment will be more hindered while net worth reverts to the initial steady-state level vis-à-vis the scenario with baseline financial frictions.

The effects of financial frictions are stronger the larger is the initial decline in the price of capital, which occurs in expenditure-based fiscal consolidations. An increase in labor income taxes triggers a substitution effect towards capital, preventing a strong decline in its price. Net worth is thus nearly unaffected, and the marginal effect of financial frictions on the labor income tax fiscal multiplier is thus negligible. For a consumption tax-based fiscal consolidation, the substitution effect is weaker and the amplification mechanism of credit markets is therefore stronger when compared with a labor income tax increase.

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19 A detailed decomposition of the average output effects in the first year is provided in Tables C.1 to C.3, in the appendix.
Figure 2: Fiscal multipliers in normal and crisis times
(percentage deviation from initial steady-state)

<table>
<thead>
<tr>
<th>Year</th>
<th>Government Consumption (G)</th>
<th>Transfers (TRG)</th>
<th>Labor taxes ($\tau_L + \tau_{SP}$)</th>
<th>Consumption tax ($\tau_C$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td><img src="graph1.png" alt="Graph" /></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd year</td>
<td><img src="graph2.png" alt="Graph" /></td>
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<td></td>
</tr>
<tr>
<td>3rd year</td>
<td><img src="graph3.png" alt="Graph" /></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Fiscal multipliers consider a permanent shock in each fiscal instrument corresponding to 1 percent of the initial steady-state GDP. Tax rates $\tau_L$ and $\tau_{SP}$ correspond to employee’s labor income and manufacturers’ payroll, respectively.
Table 2: Fiscal multipliers in crisis times
(percentage deviation from initial steady state)

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decrease in government consumption</strong></td>
<td>-1.8</td>
<td>-1.0</td>
<td>-0.6</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiplier in normal times</td>
<td>-1.2</td>
<td>-0.4</td>
<td>-0.5</td>
</tr>
<tr>
<td>More severe financial frictions</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Stronger nominal rigidities</td>
<td>-0.3</td>
<td>-0.3</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Decrease in lump-sum transfers</strong></td>
<td>-1.1</td>
<td>-0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiplier in normal times</td>
<td>-0.7</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>More severe financial frictions</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Stronger nominal rigidities</td>
<td>-0.3</td>
<td>-0.2</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Increase in labor taxes</strong></td>
<td>-0.8</td>
<td>-0.9</td>
<td>-0.9</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiplier in normal times</td>
<td>-0.7</td>
<td>-0.8</td>
<td>-0.8</td>
</tr>
<tr>
<td>More severe financial frictions</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Stronger nominal rigidities</td>
<td>0.0</td>
<td>-0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Increase in consumption tax rate</strong></td>
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<td>-0.6</td>
<td>-0.6</td>
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<tr>
<td>of which:</td>
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<tr>
<td>Multiplier in normal times</td>
<td>-0.6</td>
<td>-0.5</td>
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</tr>
<tr>
<td>More severe financial frictions</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Stronger nominal rigidities</td>
<td>-0.1</td>
<td>-0.1</td>
<td>0.0</td>
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</table>

Notes: Fiscal multipliers consider a permanent shock in each fiscal instrument corresponding to 1 percent of the initial steady-state GDP. All figures represent annual averages. Values are rounded to 1 decimal place.

Stronger wage and price rigidities lead also to important increases in the size of fiscal multipliers in the first year, particularly for expenditure-based fiscal consolidations: from nearly 1.2 in normal times to 1.5 in crisis times for a decrease in government consumption, and from 0.7 to 1 for a cut in transfers. As previously mentioned, an expenditure-based fiscal consolidation originates a strong downward pressure on both domestic inflation and output. However, stronger nominal rigidities increase the costs of adjusting from the nominal side versus the real side, and firms therefore decide to perform a larger share of the adjustment via quantities, rather than via prices. As a result, price competitiveness gains take longer to be transmitted in full to the economy. The decline in output is therefore amplified in the first and second years after the shock, as opposed to prices, which present a more staggered adjustment. By the same token, the decline in prices is also more persistent when nominal rigidities are more important, and thus households experience larger increases in real current income and wealth around the third year. Price competitiveness gains are also larger in this time frame. The effects on output following the fiscal consolidation process are therefore reversed in the third year.

A labor tax-based fiscal consolidation has both strong demand and supply side effects,
leaving inflation nearly unchanged. Stronger nominal rigidities have therefore no effect on firms’ decisions, and consequently on the size of the fiscal multiplier. Nominal adjustments for a consumption tax-based fiscal consolidation are more important. Though higher consumption taxes generate inflation, the growth rate of prices, when measured at constant tax rates, declines. Stronger nominal rigidities affect therefore the rate at which prices and wages adjust, thus impacting the fiscal multiplier. The mechanism is similar to the one described above for an expenditure-based fiscal consolidation, though the effects at work are substantially weaker.

5 Concluding remarks

Using \textit{PESSOA}—a DSGE model for a small euro area economy—we evaluate how big fiscal multipliers for a large fiscal consolidation process can get in crisis times. The crisis times scenario is introduced through a set of temporary shocks to the degree of financial frictions and to the extent of nominal rigidities. These shocks purportedly better reflect the underlying economic environment during severe slumps that have been triggered by disturbances in the financial system, such as during the Great Recession. Results show that impact multipliers increase in periods of crisis, though the effects are more significant for expenditure-based fiscal consolidations. The impact government consumption multiplier, in particular, increases from 1.2 in normal times, to around 1.8 in crisis times. The effects are also more persistent during crisis. Impact multipliers would become even larger if one had considered a more severe financial turmoil, possibly closer to the more extreme events experienced by several countries in peripheral Europe in the context of financial fragmentation in the euro area.

Fiscal instruments that generate larger downward inflationary pressures, such as those related to expenditure cuts, have their impact multipliers further magnified in crisis times. In this case, more severe financial frictions lead to larger declines in the price of capital, and therefore in net worth. Consequently, firms are forced to cut back on investment further in order to rebalance their financial position, which results in lower net capital accumulation. Stronger nominal rigidities prevent swift adjustments in the price level, thus shifting the adjustment from the nominal side to the real side. On the opposite direction, fiscal multipliers for revenue-based fiscal consolidations do not exhibit substantial increases in periods of crisis, as the fiscal adjustment triggers a substitution effect towards capital, preventing a substantial fall in its price, and low disinflationary pressures suppress the effects of stronger nominal rigidities.

Crisis times multipliers converge to normal times multipliers in the third year as the influence of more severe financial frictions and stronger nominal rigidities in the transmission of fiscal shocks fades out. Moreover, results confirm that expenditure-based fiscal consolidations deliver a faster recovery than revenue-based ones, in both normal and crisis times (see also Almeida et al. 2013b). Specifically, GDP recovers from the second year onwards in expenditure-based fiscal consolidations, regardless of the state of the economy.
while revenue-based consolidations yield a protracted decline in GDP.

The results presented herein confirm that fiscal multipliers are largely conditional on the state of the economy, and suggest that fiscal policies should take into account the relative impacts of each fiscal instrument on output when designing and implementing large fiscal consolidations in crisis times.
References


Dixson, Huw and Engin Kara. 2010. “Can We Explain Inflation Persistence in a Way that Is Consistent with the Microevidence on Nominal Rigidity?” *Journal of Money, Credit and Banking* 42 (1):151–170.


Appendices

A Calibration

PESSOA is calibrated to match data for the Portuguese and euro-area economies. Some parameters are exogenously set by taking into consideration common options in the literature, available historical data, or empirical evidence. Others are endogenously determined within the model, with the objective of matching desired features, for instance the consumption- or investment-to-GDP ratios.

The annual growth rate of the labor-augmenting productivity is set to 2 percent, which is a plausible estimate for potential output growth in both Portugal and the euro area (Almeida and Félix 2006, Musso and Westermann 2005, Proietti and Musso 2007). Steady-state inflation stands at 2 percent per year and the euro area nominal interest rate at 4.5 percent (Coenen, McAdam, and Straub 2007). Steady-state tax rates, transfers from the rest of the euro area, government consumption, and government transfers are calibrated to match actual data.

Households parameters are largely based on Fagan, Gaspar, and Pereira (2004), Harrison et al. (2005), Kumhof and Laxton (2007) and Kumhof et al. (2010). Consumption shares are calibrated to ensure a unitary elasticity of labor supply to real wage. The instant probability of death and the productivity decay rate are assumed to be identical, implying an average lifetime and an expected working life of 25 years. The share of hand-to-mouth households is broadly in line with the estimates for Portugal presented in Castro (2006).

The depreciation rate of capital is calibrated by taking into account actual data on the investment-to-GDP ratio. The unitary elasticity of substitution between capital and labor in the production function takes into account the actual labor income share. The steady-state price markup of tradable and non-tradable goods is calibrated using OECD product market regulation indicators, as well as the correlation between tradable and non-tradable goods markups and product market regulation indicators found in Høj et al. (2007). The elasticity of substitution between domestic tradable goods and imported goods is assumed to be identical across firms and set above unity (Coenen, McAdam, and Straub 2007, Harrison et al. 2005, Erceg, Henderson, and Levin 2000, Kumhof et al. 2010). The degree of monopolistic competition amongst distributors is lower than among manufacturers.

The leverage ratio of entrepreneurs, the probability of default, and the return on capital—assumed identical for the tradable and non-tradable sectors—are approximated with aggregate Portuguese historical features. The leverage ratio is 100 percent. The same value is used in Bernanke, Gertler, and Gilchrist (1999) and Kumhof et al. (2010). The probability of default—8 percent—is relatively close to the exit rates reported in Mata, Antunes, and Portugal (2010), and in line with the value found in Kumhof et al. (2010). The loan rate spread of 175 basis points is close to the average value for the 2000-07 period.

Further details on the calibration can be found in Almeida et al. (2013a). Castro et al. (2013) places a special focus on the calibration of the financial sector.
### Normal times: macroeconomic impacts in the first year

**Table B.1: Selected impacts without financial frictions**

<table>
<thead>
<tr>
<th></th>
<th>Decrease in government consumption</th>
<th>Decrease in lump-sum transfers</th>
<th>Increase in labor taxes</th>
<th>Increase in consumption tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-0.9</td>
<td>-0.5</td>
<td>-0.7</td>
<td>-0.6</td>
</tr>
<tr>
<td>Private consumption</td>
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<td>-1.9</td>
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<td>-1.4</td>
</tr>
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<td>Government consumption</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Private investment</td>
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<td>-0.3</td>
<td>-0.6</td>
<td>-0.4</td>
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<tr>
<td>Exports</td>
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<td>1.4</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Imports</td>
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<td>-0.9</td>
<td>-0.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>Hours</td>
<td>-1.1</td>
<td>-0.2</td>
<td>-0.7</td>
<td>-0.5</td>
</tr>
<tr>
<td>Real wage</td>
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<td>-1.2</td>
<td>-0.3</td>
<td>-1.8</td>
</tr>
<tr>
<td>Real exchange rate</td>
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<td>0.5</td>
<td>0.1</td>
<td>0.2</td>
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**Table B.2: Selected impacts with financial frictions**

<table>
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<tr>
<th></th>
<th>Decrease in government consumption</th>
<th>Decrease in lump-sum transfers</th>
<th>Increase in labor taxes</th>
<th>Increase in consumption tax rate</th>
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</thead>
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</tr>
<tr>
<td>Private consumption</td>
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<td>-1.9</td>
<td>-1.3</td>
<td>-1.5</td>
</tr>
<tr>
<td>Government consumption</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Private investment</td>
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<td>-1.6</td>
<td>-0.8</td>
<td>-0.9</td>
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<tr>
<td>Exports</td>
<td>1.3</td>
<td>1.5</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Imports</td>
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<td>-1.2</td>
<td>-0.7</td>
<td>-0.9</td>
</tr>
<tr>
<td>Hours</td>
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<td>-0.4</td>
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<td>-0.6</td>
</tr>
<tr>
<td>Real wage</td>
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<td>-0.3</td>
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<tr>
<td>Real exchange rate</td>
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<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Notes:** Reported outcomes in Tables B.1 and B.2 refer to percentage deviations from the initial steady state. Fiscal multipliers consider a permanent shock in each fiscal instrument corresponding to 1 percent of the initial steady-state GDP. An increase in the real exchange rate implies a depreciation. Values are rounded to 1 decimal place.
C  Crisis times: macroeconomic impacts in the first year

Table C.1: Selected impacts—Adding more severe financial frictions

<table>
<thead>
<tr>
<th></th>
<th>Decrease in government lump-sum transfers</th>
<th>Decrease in consumption</th>
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<td>-0.6</td>
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<tr>
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</table>

Table C.2: Selected impacts—Adding stronger nominal rigidities

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<th>Decrease in government lump-sum transfers</th>
<th>Decrease in consumption</th>
<th>Increase in labor taxes</th>
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<td>GDP</td>
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<td>-0.7</td>
<td>-0.8</td>
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<td>Private consumption</td>
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<td>-1.4</td>
<td>-1.6</td>
</tr>
<tr>
<td>Government consumption</td>
<td>-4.3</td>
<td>0.0</td>
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</tr>
<tr>
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<td>Exports</td>
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<td>-0.9</td>
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<td>-0.8</td>
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</table>

Table C.3: Selected impacts in crisis times—Adding more severe financial frictions and stronger nominal rigidities

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<th></th>
<th>Decrease in government lump-sum transfers</th>
<th>Decrease in consumption</th>
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<tr>
<td>Government consumption</td>
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<td>0.0</td>
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<td>0.4</td>
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</table>

Notes: Reported outcomes in Tables C.1 to C.3 refer to percentage deviations from the initial steady state. Fiscal multipliers consider a permanent shock in each fiscal instrument corresponding to 1 percent of the initial steady-state GDP. An increase in the real exchange rate implies a depreciation. Values are rounded to 1 decimal place.