The interaction between labor tax wedge and structural reforms in Italy

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Wednesday 21st May, 2014

Abstract

We present a quantitative analysis of Italian fiscal policy to investigate the interactions between tax shifting and various structural reforms, using the Prometeia DSGE model. We consider a specific topic of Italian fiscal policy debate: a cut in the labor tax wedge and its optimum coverage, and quantitative assessment of the effects of labor and product market reforms. We find that cutting the labor tax wedge could give a strong impulse to the economy, increasing GDP and employment levels; however, the associated budget balance constraint could have a major effect on results depending on the fiscal instrument employed to balance the budget. Therefore, a tax shift is preferred to a cut in public spending on goods and services. Structural reforms can boost economic performance by cutting labor and product market markups which are the form of market rigidities we focus on. These reforms simultaneously could affect GDP and employment with increasing gains. The best payoff comes from an expansion in public spending which, under simultaneous fiscal and structural reforms, is preferable to a tax shift from labor to indirect and property taxes.

1 Introduction

The importance of structural reforms is well known and has been a constant in the economic policy recommendations of international economic institutions in the last years (OECD [2013]). The onset of the recent Great Recession emphasized the risk of policy makers being distracted from such reforms, and economic policy debate concentrated mainly on the degree of compatibility of structural reforms with the increasing need for fiscal consolidation. It is commonly believed that an economic crisis provides the right incentives for national economic system reform. In this context, the goal of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG) is to make European Monetary Union more resilient to crisis through the application of stringent general criteria for budget deficits, structural deficits, and the debt-to-GDP ratio. This requires that European countries with low potential growth and high public debt should reform their economic systems definitively in order to improve economic performance and meet the TSGC criteria. For Italy, the OECD recommendations (OECD [2014]) for structural reform include a set of labor market, education system and tax structure reforms[1]. Moreover, the OECD study recognizes the importance of already implemented reforms[2]. In general, given the fiscal consolidation requirements, it is useful to rank structural reforms following performance and harmfulness criteria. Theoretically the reform prioritization has been studied. Cournède et al. [2013a] and Cournède et al. [2013b] rank fiscal instruments for OECD countries based on their harmful effects. They suggest starting with the implementation of reforms to subsidies, pensions, property taxes, personal income taxes, and introducing education, childcare, family expenditure, social security contributions, public investment and consumption taxes only if absolutely necessary. Thus, to achieve short-medium and long run consolidation goals, the OECD countries could use less harmful instruments. Countries such as Japan and the US need to impose more harmful reforms to fully adjust given their starting macroeconomic imbalances and long-run equity and growth needs. Italy is positioned in the best group for short-term equity and growth; long run projections are not provided. The OECD study identifies instruments that would achieve short and medium run goals for Italy: subsidies,

[1]They include: 1) rebalancing of protection, from jobs to workers' income, by decreasing job protection of workers under certain types of contracts and improving the social safety net; 2) increased equity and efficiency in education in order to get more value for money from the education system and improve the chances of the low-skilled; 3) increased efficiency of the tax structure by simplifying the tax code, fighting tax evasion and, when the fiscal situation permits, reducing the tax wedge on low-wage labor; 4) reducing the barriers to competition through stronger law enforcement at all levels of government, reduced public ownership, and delays in civil courts; 5) reducing the risk of persistent unemployment and accelerating return to work by enhancing active labor market policies.

[2]These reforms concern new regulations for networked industries, increased powers for the competition authority, and liberalization of shop opening hours. However, further efforts are required to ensure effective implementation of mandatory conciliation in labor disputes and universal unemployment benefits (to be phased in by 2017).

pensions, other property taxes, unemployment benefits, personal income, corporate income taxes, environmental taxes, recurrent taxes, taxes on immovable property, other government in kind consumption. Bouthevillian and Dufrénot [2013] argue that the one-size-fits-all approach to growth-friendly fiscal consolidation is not best practice. European emerging countries are more sensitive to measures of direct taxation than the most advanced countries. Moreover, indirect taxation could have harmful effects on growth rates in the European emerging countries. Increased human capital expenditure stimulates growth in low-growth countries, while welfare and sovereign spending are efficient for economies that grow rapidly. The question of how heterogeneous growth patterns in the euro area are shaped by fiscal policy measures compared to structural reforms, is crucial and requires assessment (at least qualitatively) of the interaction between these two policy instruments. In general, the main structural reforms advocated in the literature are labor and product market reforms and their outcomes can depend on the time span and institutional framework. These reforms usually are modeled such that they imply a reduction in the bargaining power of economic agents, and thereby affect real wages and relative prices in the economy. Cacciatore et al. [2012] argue that structural reforms can affect payoffs depending on membership of a monetary union or not. Within a monetary union expectations about lower prices could increase real interest rates and decrease consumption and output in the short run. Structural reforms are aimed at long run benefits. Barnes et al. [2011] evaluate the impact of policy reforms in terms of GDP per capita in a review of a range of empirical studies mostly conducted by the OECD. Barnes et al. [2011] provide an accounting framework of reduced-form equations that explain the sub-components of per capita GDP. They find that the largest per capita GDP gains in the long run seem to come from reforms to education, strengthening competition in product markets, reducing the level and duration of unemployment benefits, tax wedge cuts and less strict employment protection legislation. Overall, one-fifth of long-run impact comes from product market deregulation, and one-fifth from reforms to the average tax wedge. Other significant gains come from increased human capital and lower unemployment benefits. The exercise suggests that some groups of countries have distinct sets of policy priorities. For example, in Italy the labor tax wedge could be reduced to achieve an impact on GDP per capita equal to 8.4 percent. Hobza and Mourre [2010] provide some stylized and illustrative results for the broad benefits of some types of policy measures envisaged under the so called European Commission's Europe 2020 program for EU countries. They demonstrate the effects of fiscal consolidation on its own, and in combination with structural reforms, proposing different scenarios. The structural reform scenarios suggest that progress in implementing structural reforms under the main priority areas of EU2020 could generate significant gains in terms of increasing output and employment. In particular, GDP could increase from around 1.3 percent up to 6.8 percent depending on the boldness of the reform plan. The contribution to GDP of product market reforms would go from 0.9 percent to 3.3 percent, while the contribution of labor market reforms

would go from 0.4 percent to 2.9 percent. Product market reforms could have a negative impact on the labor market of between -0.1 percent and 0.1 percent, while labor market reforms could have a positive impact of 0.6 percent up to 4.3 percent. While the long run consequences of structural reforms have been investigated extensively, short-run analysis could be misleading. Cacciatore et al. [2012] explore the short-term effects of labor and product market reforms by applying a dynamic general equilibrium model with endogenous producer entry and labor market search and matching frictions. They find that it takes time for reforms to pay off, typically two years. This is partly because their benefits materialize through the gradual processes of firm entry and increased hiring, while reform-driven layoffs are immediate. Moreover, even though all reforms stimulate GDP in the short run, some, such as job protection reforms and product market reforms, result in temporary increases in unemployment. Implementing simultaneous labor and product market reforms helps to minimize such transition costs. It should be noted that the short-term dynamics of the economy in the aftermath of product market reform is smoother in more flexible labor markets but the long-term gains from product market reforms are smaller. Likewise, the long-run gains from labor market reforms are smaller in more flexible product markets. The substitutability *versus* complementarity between labor and product reforms and unilateral *versus* simultaneous reforms in the European Union are investigated in Gomes et al. [2011]. Gomes and colleagues find that the effects of individual reforms are more or less additive. In particular, given that the increase in labor demand more than counterbalances the increase in labor supply, real wages increase. The labor demand effect is associated with reform to the services sector; the supply effect is associated with reform to the labor market. This result is related to a general point about the "optimal timing" of reforms made by Blanchard and Giavazzi [2003], who argue that structural reforms should generally start with the service sector because the ensuing increase in real wages helps to generate support for subsequent reforms in the labor market. Gavilán et al. [2011] use a large overlapping generations model of a small open economy featuring imperfect competition in the labor and product markets. They use the model to analyze the macroeconomic behavior of the Spanish economy after the crisis. They point to the trade-off faced by tighter fiscal policies which may reduce the output losses induced by the crisis in the medium-term, but at the expense of a mild output loss in the years immediately after the crisis. Structural reforms do not result in this kind of trade-off: they can contribute to reducing output losses in the short- and medium-term while inducing a positive long-run effect on the level of output. Bouis and Duval [2011] examines the impact on potential GDP over a 5 to 10-year horizon of structural reforms in product and labor markets, relying on existing OECD empirical studies. Both reforms raise productivity growth, although the effects are estimated to be smaller for labor market than for product market reforms. In particular, for Italy, the estimated multifactor productivity gains from product market reform are found to be around 3 percent and 7 percent over a 5-year and 10-year horizon respectively, and from employment

protection legislation are around 0.5 percent over a 10-year horizon. The estimated increase in employment rates from labor tax wedge cuts is close to 2 percentage points for Italy in the long-run. In general, the overall potential GDP gain for the average OECD country from undertaking the full range of reforms to the labor and product markets could be close to 10 percent for a 10-year horizon, indicating the presence of ample room for structural reforms to offset the permanent GDP losses from the recent crisis. Currently, Italy is facing important economic challenges such as recovery of financial market confidence through rapid fiscal consolidation, and better prospects for medium-term growth through the implementation of structural reforms. Using the European Commission's QUEST III model for R&D, adapted to Italy, Annicchiarico et al. [2012] find that structural reforms are likely to bring about sizeable gains in output, consumption, employment, and net foreign assets. However, these gains may be affected by fiscal consolidation intensity. The analysis covers a product and a labor market reform that includes lower price and wage markups and a shift from labor to consumption taxation. Labor market reforms are responsible for a large payoff from output and employment in the short run. Annicchiarico et al. [2012] find that under a fiscal consolidation package equivalent to 6 percent of GDP, the effects of structural changes may be mitigated. However, the positive effects of structural reforms support fiscal consolidation via decreasing the public debt-to-GDP ratio in the ex ante budget neutral scenarios. Average annual output growth rate gain over a ten-year time horizon is found to be equal to 0.6 percent under the assumption that Italy will manage to halve the gap with the EU best performers in several areas of interventions, in five years. Reducing the gap by one-third would imply an average annual gain of 0.4 percent, while fully closing the gap would increase average growth by up to 1 percent. Lusinyan and Muir [2013] use the IMF's Global Integrated Monetary and Fiscal model (GIMF) to analyze the role of structural and fiscal reforms in Italy, aimed at strengthening competition in the product market and making the labor market more efficient and inclusive, supported by growth-friendly fiscal reforms. They find positive effects on GDP in the long-run from both product and labor market reforms, and payoffs from their simultaneous implementation. In considering fiscal reforms, they take account, in a deficit-neutral way, of a reduction in the labor tax wedge and an increase in infrastructure spending. In particular, they allow for a shift from direct to indirect taxes (lowering both labor and corporate taxes, offset by broadening the VAT base) and a shift from transfers to productive, well-targeted infrastructure investment. Increasing competition in tradable and non-tradable sectors could increase output by 4.0 percent in 5 years and 7.7 percent in the long run. The reduction in labor taxes initially raises GDP relative to the baseline by 0.5 percent, and by up to 2 percent in the long run. By combining fiscal reforms with product and labor market reforms, real GDP in Italy could increase by about 8.5 percent after 5 years and almost 22 percent in the long run. They find also that these effects would be stronger if the remaining euro area economies carried out contemporaneous similar reforms. Forni et al. [2010] assess the effects of increasing competition in the service sector

in Italy which, based on cross-country comparisons, is the OECD country with the highest markups in non-manufacturing industries. They propose a two-region (Italy and the rest of the euro area) dynamic general equilibrium model allowing for monopolistic competition in the labor, manufacturing, and service markets. They simulate the macroeconomic and spillover effects of increasing the degree of competition in the Italian services sector and find that decreasing service sector markups to the levels of the rest of the euro area increases Italian GDP by 11 percent in the long run. The literature on the topic provides a rich set of interesting results about structural reforms and fiscal consolidation, taken individually or together. Nevertheless, there is some uncertainty about the sign and the likely interactions of a reform policy mix in a context of budget balance or fiscal consolidation. In particular, we are interested in comparing the fiscal balancing of a labor tax wedge cut, realized through a cut in public spending, with a tax wedge cut realized through a shift to indirect or property taxes. We analyze a series of taxation mix to be combined with structural reforms to the labor and product markets in order to boost competition, employment, investment and growth. We apply the Prometeia DSGE model for the Italian economy (Catalano [2014]) and incorporate various tax rates including household labor income tax, VAT applied to non-durable and durable consumption, real estate tax rate, labor tax wedge, and capital revenues tax rate. Structural reforms are modeled such that they imply a reduction in price and wage markups. Fiscal reforms are implemented in a budget-neutral scenario and include cuts to taxes affecting labor costs, that is, social contributions, IRAP (Regional Tax on Productive Activities), and personal income tax (IRPEF). In order to keep constant the public deficit against a reduction in revenues coming from the labor wedge tax cuts, we consider alternative scenarios allowing for a reduction in government spending, or a tax shift from labor to consumption (through an increase in the VAT tax rate) or to real estate investment (through an increase in the TASI tax rate, i.e. the house service tax rate). We analyze the extra payoffs that might come from simultaneous structural and fiscal reforms. We find a dynamic tradeoff for the tax rates under analysis: a reduction in social contributions and IRAP tax rate produces the highest payoff in terms of real GDP in the short run, while the IRPEF tax cut results in the highest output in the long run. With respect to the alternatives fiscal coverages, the VAT increase provides the most desirable scenario as it represents a good compromise between the short- and the long-run performance of the economy, even though TASI increase performs better in the long-run. Regarding structural changes, product market reforms perform better than labor market reforms, in both the short and the long run. However, only labor market reforms lead to a permanent contraction in the unemployment rate. Moreover, if product market reforms are implemented slowly, they might cause some short-term pain in the areas of consumption and unemployment. The payoffs from a reform package including simultaneous structural and fiscal reforms are evident only in the short run. Moreover, the combination of contemporaneous IRPEF, social contributions and IRAP tax cuts with structural reforms shows that it would be preferable to

adjust public spending because an increase in public spending would benefit from higher multipliers than those from a reduction in taxation.

The paper is organized as follows: in section 2 we describe calibration and experiment setup; in section 3 and appendix A we show simulation results and section 4 concludes. We invite the interested reader to appendix B for a model detailed description.

2 Calibration and experiment design

In this section we describe the policy areas of intervention and how reforms are implemented in the DSGE model. All policy changes are supposed to be permanent, an assumption common in quantitative studies that explore the long-run effects of policy measures. Moreover, we assume all measures to be fully credible from the beginning, meaning that the announced reform path is believed immediately and fully anticipated. For the general calibration we refer to Catalano [2014]. As we show below, we build several reform scenarios concerning both fiscal and structural policy areas. The public sector is calibrated to be at 40 percent of GDP[3], the public expenditure in goods and services is set to 21 percent and the public debt is 132 percent in terms of the GDP ratio. We set marginal and mean tax rates for VAT, IRPEF, TASI and the social contribution respectively to 14.5 percent, 21 percent, 0.8 percent and 36 percent. Markup on product market is set to 20 percent close to the values in Forni et al. [2010][4]. Labor markup is equal to 20 percent setting the elasticity of substitution accordingly. We calibrate the price and wage markup reduction by 2 percentage points. This is consistent with the minimum size experiment performed in Forni et al. [2010] on price markup.

Fiscal reform scenarios To take into account the effects of a labor tax wedge cut we allow for a decrease in personal income tax (IRPEF), in social contributions and in regional taxes on productive activities (IRAP). For each fiscal instrument, we consider a tax cut such that the decrease in the relative fiscal revenue would be equal to 1 percent of nominal GDP. The simulation exercises are modeled such that the public budget is balanced and kept constant; therefore, in each experiment we allow for alternative fiscal adjustments: a reduction in public spending or an increase in VAT or TASI (house service tax or property tax), against each component of labor tax wedge simulated[5]. Moreover, in order to detect the likely payoffs stemming

[3]The percentage includes transfers to households, unemployment benefit and goods and services expenditure.

[4]Based on the estimates of Christopoulou and Vermeulen [2012] on sectoral markups, we set the Italian price markup according to the Manufacturing and Construction aggregate value which is higher than the 18 percent value estimated for the Euro area.

[5]We denote in the model (see section B) personal income tax as $\tau_{l,t}$ (IRPEF), social contributions $\tau_{l,t}$, regional taxes on productive activities $\tau_{i,t}$ (IRAP), VAT $\tau_{c,t}$ and TASI $\tau_{h,t}$.

from a fiscal reform package, we analyze the effects of simultaneous cuts in IRPEF, IRAP and social contributions[6]. Table 1 shows the percentage changes in tax rates[7].

Table 1: Fiscal reform scenarios

Experiments			
Fiscal reforms	Tax rate	Single tax change	Simultaneous tax change
Labor tax wedge cut	IRPEF	-2.7 pp	-0.9 pp
	Social contr.	-2.7 pp	-0.9 pp
	IRAP	-1.8 pp	-0.6 pp

Structural reform scenarios Structural reforms aim at enhancing competition through short- and long-run increases in output, employment and investment. Rigidities in product and labor markets imply that both prices and wages are higher than they would be under more competitive markets. This means that prices and wage may include a markup over marginal costs and over the marginal rate of substitution between consumption and leisure, respectively. Therefore, the simulation experiments take into account a reduction in markups of 2 percentage points. Lower price markups would lead to an increase in competition and to a sizable positive effect on GDP, and a lower wage markup would reduce union bargaining power, and hence real wages, increasing flexibility in the labor market and inducing smaller but not irrelevant increase in output. We allow for different speeds of reform implementation in order to account for short-term drawbacks that may occur under slow product market reforms[8]. Similar to our treatment of fiscal reforms, we analyze the interactions between labor and product market reforms combining them in a scenario with simultaneous markup changes[9].

Reform package scenario: combining fiscal and structural reforms We consider a broad scenario including three experiments that are combinations of each single tax cut with structural reforms, and a broad simulation exercise that includes simultaneous fiscal tax cuts and structural reforms. The purpose is to evaluate the interactions among policy measures and their likely dynamic tradeoffs.

[6]The size of the shock to each single tax rate is such that each instrument is simultaneously responsible for one-third of the total percentage change in GDP (1 percentage point).

[7]In order to keep the fiscal instrument unchanged we set the sensitivity parameter χ_j of $j-th$ fiscal instrument to public debt to zero in order to switch off short term dynamics on fiscal tax rates. Therefore, the effective tax rates is equal to the target level that follows the final steady state change after the shock (see section B.3).

[8]The persistence parameter of the exogenous processes used for wage and price markups are set equal to 0.002, 0.45 and 0.90 for the most immediate, medium and slowest scenarios, respectively.

[9]We move elasticities of substitution between varieties in the Retailer sector (see section B.2.3 i.e. parameters η^{ch}, η^{cd}, η^{d}, η^{k} and η^{x}).

3 Results

In this section we present the results for fiscal reforms aimed at reducing labor costs under budget-neutral scenarios, and structural reforms to both labor and product markets. These reforms, which are becoming relevant and urgent in current Italian economic debate, may contribute to reducing the competitiveness gap with the best EU performers, and restoring the sustainability of public finances. We enrich the analysis by also taking account of the likely payoffs stemming from a combination of structural reforms to labor and product markets, and evaluating the macroeconomic implications of a tax relief on labor associated with structural reforms (Table 2).

Fiscal reforms In general, a permanent decrease in the IRPEF tax rate causes an increase in disposable income that leads to a rise in consumption, investment (except in the case of a TASI tax coverage), and hence in real GDP. Similarly, a cut in social security contributions positively affects growth and improves competitiveness and exports by decreasing the cost of labor thus determining, on the one hand an increase in labor demand, and on the other hand a decrease in prices which strengthens exports and consumer purchasing power. A permanent reduction in the IRAP tax rate has only a slight positive effect on real GDP in the long-run, driven mainly by increasing employment and disposable income. Overall, an IRPEF tax cut performs better than social contributions and IRAP in terms of consumption, investment and employment, especially in the long-run (Figures 1, 2 and 3). The analysis of the GDP under different fiscal scenarios suggests that we would prefer a VAT coverage since it provides a good compromise between short- and long-run performance for each component of labor tax wedge used in the simulation exercise. Indeed, a tax shift from labor to consumption allows an increase in disposable income, thus offsetting the negative impact on consumption stemming from an increasing VAT tax rate. In general, the TASI channel performs better than VAT in the long-run, through higher employment and higher consumption but with some relevant costs in the short run in terms of real estate investment. We find no extra-payoffs from simultaneous labor tax wedge reforms involving IRPEF, social contributions and IRAP tax rate cuts (Table 2, columns c34-c36). With respect to the effect that such reforms might have on the public debt to GDP ratio in the long-run, an increase in both the VAT and TASI tax rates perform better than a reduction in public expenditure (Table 3).

In more detail, below we present the results of the different scenarios distinguishing between short and the long-run effects, in order to assess which labor tax wedge component is preferable:

1. Long Run

    - In the case of a public expenditure reduction to balance the budget, none of the instruments can be considered to be better than any other since

tax revenues multipliers are almost totally compensated for by spending multipliers (Table 2, columns c13 c16 c19, Year 20);

- In the case of a VAT or TASI tax rate increase, we have significant positive multipliers, especially for the Irpef tax cut (Table 2, columns c14 c15, Year 20).

2. Short Run

   - In the case of a public spending reduction, an Irpef tax cut leads to a negative impact on GDP in the first year (Table 2, columns c13, Year 1) while social contributions shows the highest output response (Table 2, column c16, Year 1);
   - A VAT tax increase yields a significant positive multiplier in the first year, especially for the social contributions reduction, and, with a slight difference, also for the IRAP tax cut (Table 2, columns c17 c20);
   - In the case of a TASI tax rate increase, the announcement negatively affects investment in housing and therefore aggregate demand. However, the positive effect of a reduction in labor taxation stimulates the economy by increasing consumption (Table 2, columns c15 c18 c21).

To sum up, regardless the type of fiscal coverage, we find some dynamic tradeoff between the tax rates affecting the labor costs: a reduction in social contributions and the IRAP tax rate produces the highest payoff in terms of real GDP in the short run, while an IRPEF tax cut gives the highest output in the long run. TASI tax coverage performs better than VAT in the long run, but VAT coverage represents the best compromise between the short and long runs.

Structural Reforms The purpose of product market reforms is to increase competition and stimulate growth, employment, and productivity. A permanent reduction in price markups (in both tradable and not tradable sectors) by 2 percentage points leads to an increase in exports by more than 2 percentage points, and hence in domestic production and employment. Indeed, the reduction in prices would reduce the cost of final goods to consumers and yield higher real wages which would cause a rise in disposable income in the long-run, further strengthening consumption and investment which increase by around 2.5 percentage points. However, because product market reforms take time to materialize, there is a contraction in consumption in the short run, and the slower the reform the more prolonged the reduction (Figure 4). The increase in real wage leads to an increase in the marginal cost in the short run which explains the gradual adjustment in labor demand. Increased demand for goods would stimulate production and induce firms to employ more labor and capital. In the first year after the shock, labor demand increases more than labor supply (which grows because the income effect is dominated by the substitution effect stemming from the increased opportunity cost of leisure), thus

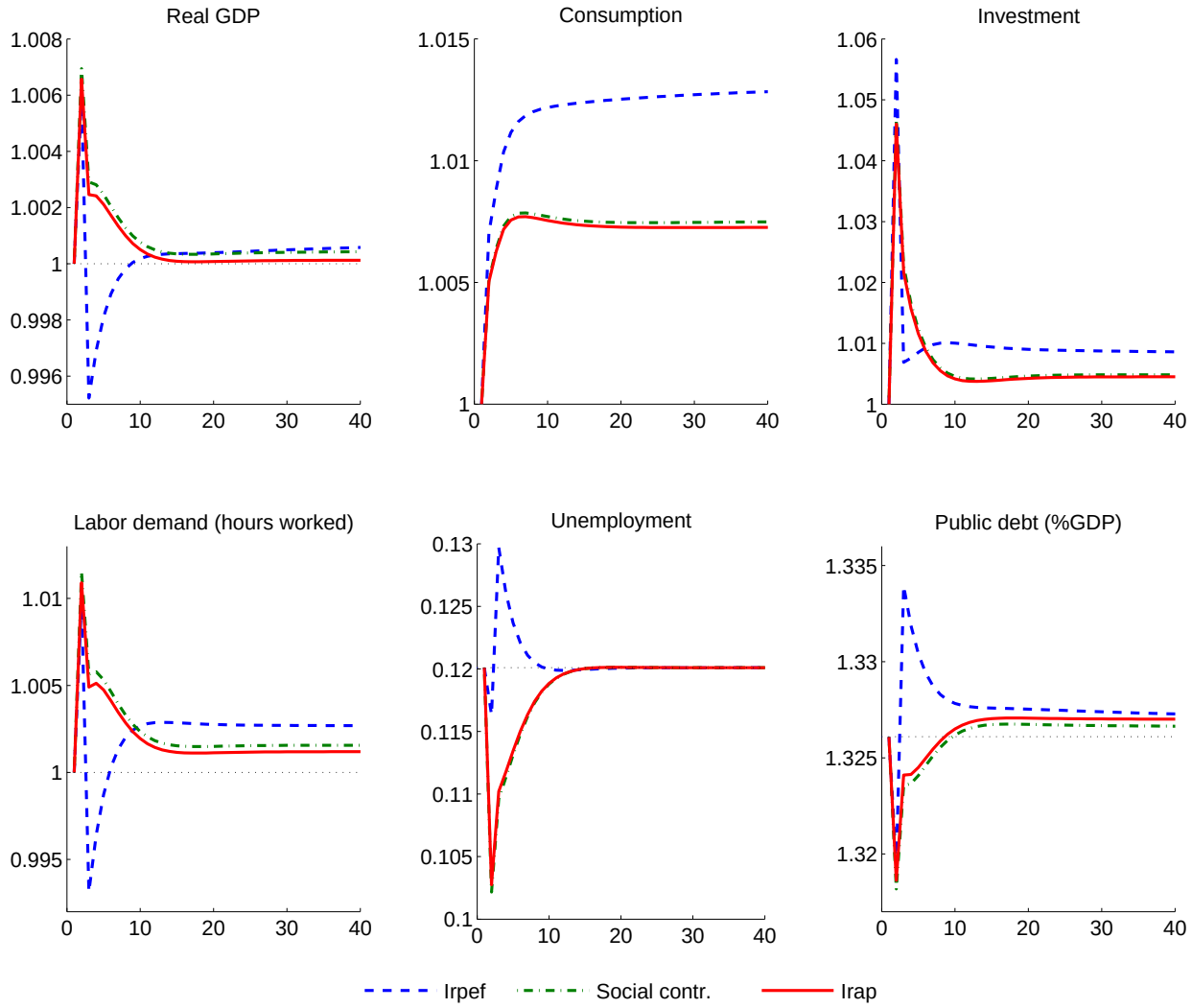

Figure 1: Fiscal reforms (adjusting government spending)

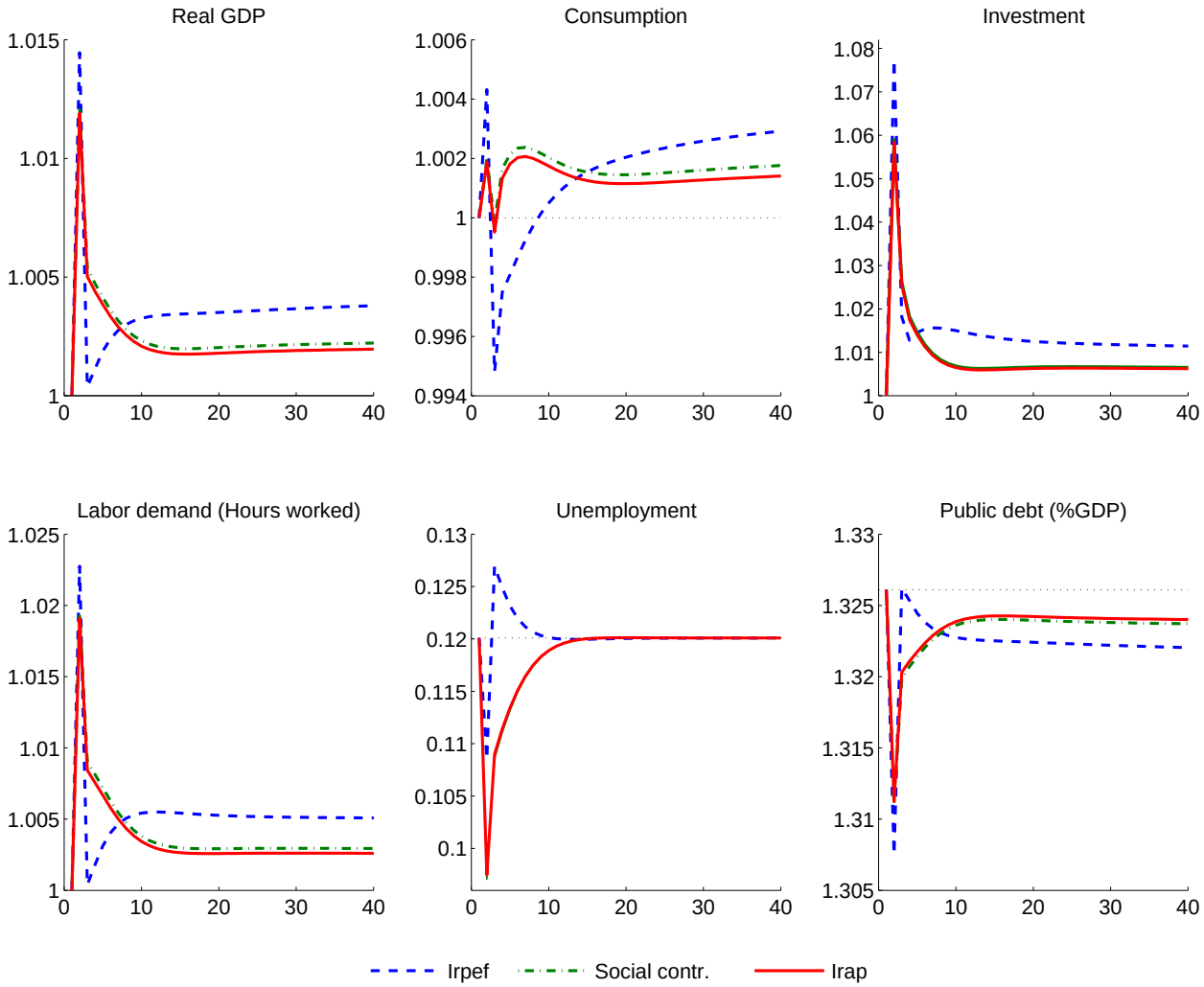

Figure 2: Fiscal reforms (adjusting VAT tax rate)

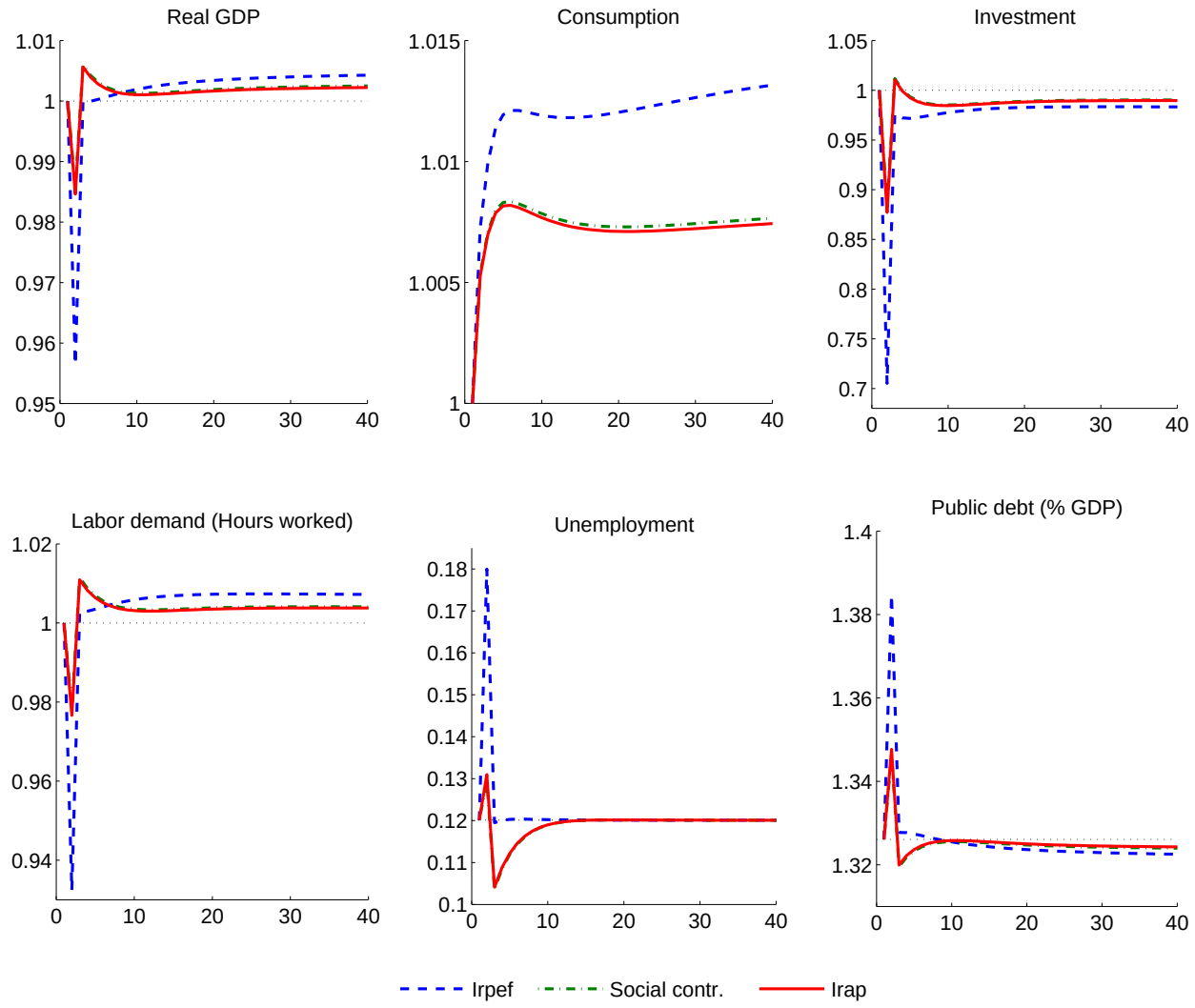

Figure 3: Fiscal reforms (adjusting TASI tax rate)

reducing the unemployment rate. Capital becomes relatively cheaper thus firms increase capital investment. In the long-run, output improves by around 2 percentage points. Figure 4 shows the behavior of labor demand and unemployment under fast, medium and slow product market reforms[10].

With respect to labor market reforms (Figure 5), a permanent reduction in the wage markup by 2 percentage points would lead to a fall in real wages and to an increase in labor demand, while labor productivity would decline slightly. Demand for capital also increases, thus investments are permanently higher by 0.5 percent. The reduction in prices, induced by a decrease in marginal costs, is less intense compared to product market reforms, therefore the positive effects on exports and consumption are more muted but not negligible[11]. With respect to consumption, despite the fall in labor income stemming from lower real wages, households benefit from increasing dividend income from firms as a result of a rise in firm profits by 0.5 percent. Overall, real GDP improves in the short run and stabilizes at the 0.5 percent higher level in the long run.

Implementing simultaneous product and labor market reforms could imply some extra-payoffs in both the short and long run. The combination of structural reforms would prevent real wages from declining permanently, as they do under labor market reforms only, and could constrain the short-run decrease in labor demand stemming from slow product market reforms. If we combine labor and product market reforms, we can evaluate the presence of likely non-linear interactions in the model. Even if not very sizable, the impact of the structural reform package on GDP is slightly higher than the sum of the single components: 2.85 percent from the combined package versus 2.83 percent, the sum of the separate product and labor market reforms (Table 2 columns c11 vs c8, Year 20).

Overall, labor market reforms perform worse than product market reforms over the entire simulation horizon. In the case of product market reforms, an acceleration of their implementation could improve short-run benefits while labor market reforms do not exhibit this behavior. With respect to public debt to GDP ratio, product market reforms perform better since they reduce the public debt to GDP ratio by four times compared with labor market reforms (2.8 vs 0.7 p.p. in Table 4).

To summarize these results, we describe the effects of reforms in the short and the long run to evaluate the more preferable structural reforms:

1. Long Run

    - Growth is fostered mainly under product market reform. Also, un-

[10]Cacciatore *et al.* (2012) state that structural reforms stimulate GDP in the short run but some imply transition costs that would increase unemployment for one or two years; this may occur in the aftermath of product market reforms because increasing real wages lead firms to lay off workers in the short run thus causing unemployment to rises for a time.

[11]The small impact of labor market reforms is confirmed empirically in the literature (e.g., Barnes and others, 2011; Bouis and Duval, 2011).

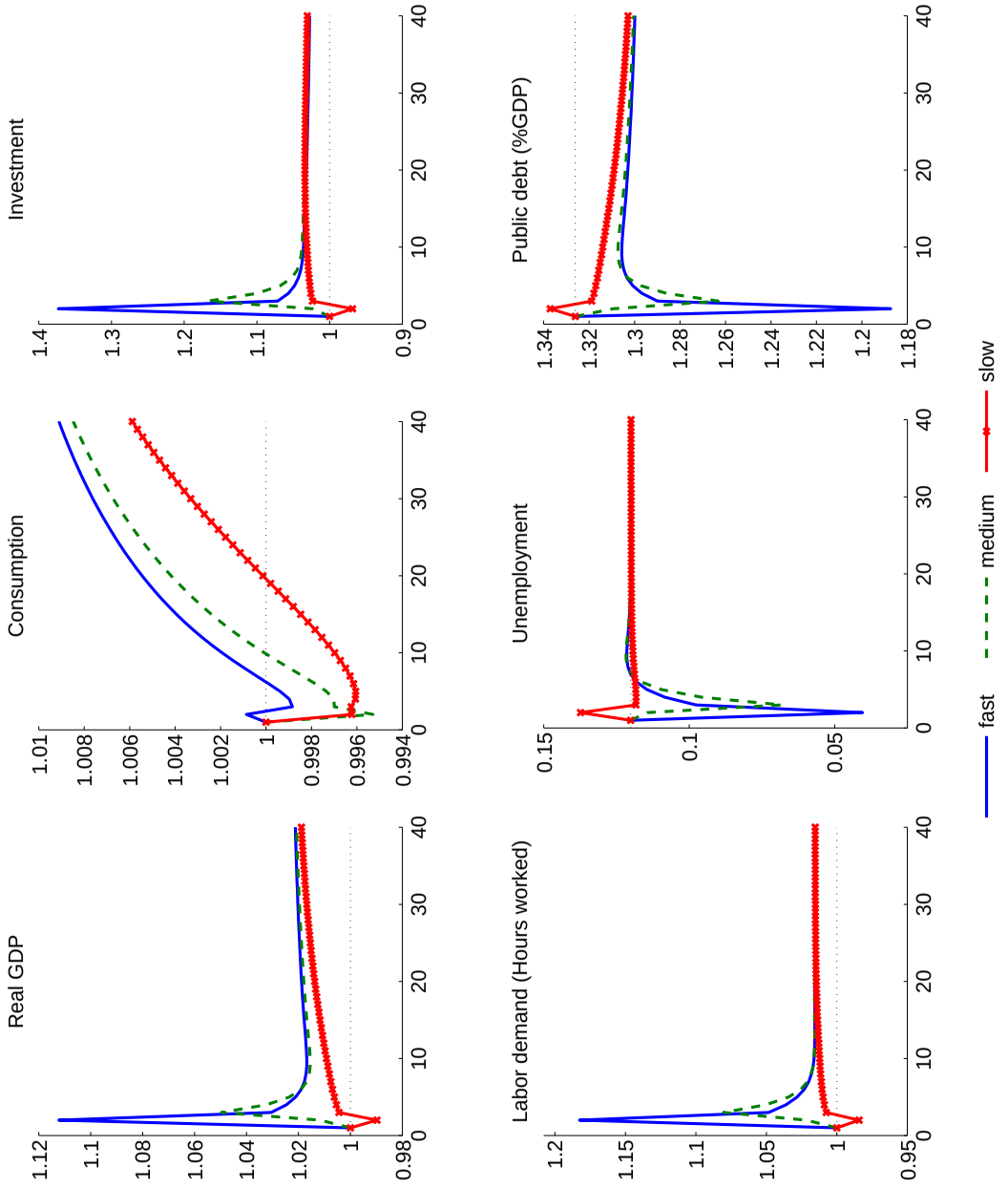

Figure 4: Product market reforms (different speed of implementation)

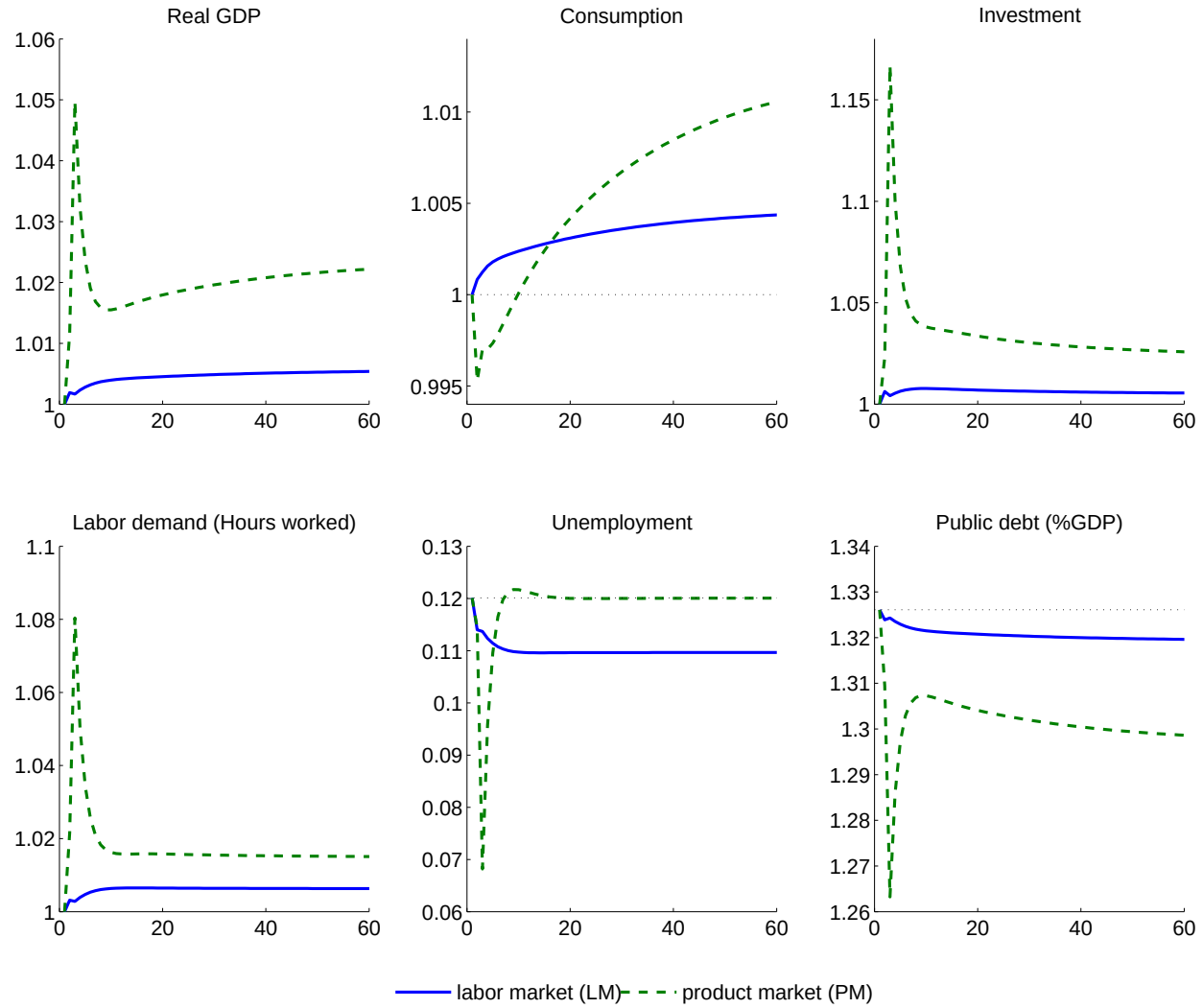

Figure 5: Product and labor market reforms

employment decreases under labor market reforms but employment increases more in the product market reforms. Similarly, fiscal consolidation in terms of lower debt to gdp ratio (Table 4) is stronger in product market reform. There seems to be some complementarities between labor and product market reforms (Table 2, column c11 vs c8).

2. Short Run

   - The speed of structural reforms matters because it could affect short run response of the economy since it occurs under product market reforms: growth could be negative at impact in the slowest case of reform implementation (Table 2, column c3). The unrealistic full and immediate product market reforms would provide enormous benefits for growth compared to labor market reforms (Table 2, column c1).

In a nutshell, product market reforms perform better than labor market reforms in both the short and the long runs. However, only labor market reforms lead to a permanent contraction in the unemployment rate. Moreover, if product market reforms are implemented slowly, they cause a longer contraction in consumption and an increase in the unemployment rate at impact. Therefore, under this scenario, combining labor and product market reforms may help to offset the negative effects that slow product market reforms have on unemployment, and labor market reforms have on real wages.

Combining structural and fiscal reforms Thus, it is not surprising that if we combine structural reforms with fiscal policies, product market reforms always perform better than labor market reforms (which constrain the expansion of aggregate demand via decreasing real wages). The extra-payoffs from a reform package including simultaneous structural and fiscal reforms distinguished by instrument (IRPEF, social contributions or IRAP) are evident only in the short run, compared with the sum of the single components (Table 2, columns c22 vs c31, c25 vs c32, and c28 vs c33). The benefits stemming from structural reforms allow for a reduction in the VAT or TASI tax rate (instead of an increase in fiscal burden) or, alternatively, an increase in government spending (instead of a reduction), depending on the type of fiscal adjustment chosen. The labor tax wedge package including simultaneous IRPEF, social contribution and IRAP tax cuts (without structural reforms) gives the tax shift from labor to TASI or VAT as the best scenarios in terms of GDP growth after the first quarter onwards (Table 2, columns c34-c36).

Thanks to structural reform payoffs the sign of coverage adjustment is the opposite than what would be in the simple fiscal reform scenario (labor tax wedge cut). This gives the opportunity to use the expansive side of public expenditure or of a tax cut in VAT or TASI. Therefore, the combination of contemporaneous IRPEF, social contributions and IRAP tax cuts with structural reforms (Table 2, columns c37-c39)

shows that, except for the first quarter after the shock, it is always preferable to adjust public spending because its increase provides benefits from higher multipliers than those from a reduction in taxation.

4 Conclusions

Current economic debate in Italy is focused on the best structural reform mix, and the interaction with fiscal consolidation needs. The literature on the topic provides numerous empirical and quantitative assessments of structural and fiscal reforms. In this paper we focus on a cut in the labor tax wedge and the optimal coverage to balance the budget. We analyzed the effects of simultaneous fiscal and structural reforms on labor and product markets. We found that a labor tax wedge cut could give a strong impulse to employment and GDP growth, but the budget balance constraint could affect the results depending on the fiscal instrument chosen to achieve fiscal balance. In line with the literature, we find that a tax shift from labor to consumption or to property, would be preferable to a reduction in public spending on goods and services. However, when we combine structural and fiscal reforms we get the highest payoff from an adjustment to public spending to balance the fiscal effects of a labor tax wedge cut. Not surprisingly, this result is driven mainly by the benefits stemming from structural reforms which allow expansion in public spending rather than a cut to it. Thus, the paper suggests that in absence of structural reforms, it is better to implement a cut in the labor tax wedge by shifting taxes from labor to consumption or, even better, to property. However, if the policy maker's aim is to boost competition, employment, and growth, it would be better to cut the labor wedge tax under a structural reform scenario, thus taking advantage of the positive effects from simultaneous fiscal and structural reforms.

A Tables

Table 2: Real GDP under different scenarios

(% deviations from the initial steady state)

Reform Scenarios				Years								column
				1				3	5	10	20	
				Q1	Q2	Q3	Q4	Q1	Q1	Q1	Q1	
Structural reforms	Product Market (PM)	fast		11,23	3,05	2,46	2,11	1,68	1,84	2,10	2,29	c1
		medium		1,16	4,97	3,23	2,35	1,55	1,75	2,06	2,28	c2
		slow		-1,02	0,44	0,54	0,62	0,92	1,30	1,85	2,23	c3
	Labour Market (LM)	fast		0,19	0,16	0,22	0,27	0,39	0,44	0,51	0,55	c4
		medium		0,19	0,17	0,23	0,28	0,40	0,45	0,51	0,55	c5
		slow		0,14	0,09	0,13	0,17	0,30	0,39	0,49	0,55	c6
	PM+LM (sum)	fast		11,41	3,21	2,68	2,38	2,07	2,29	2,61	2,85	c7
		medium		1,36	5,14	3,46	2,63	1,95	2,20	2,56	2,83	c8
		slow		-0,89	0,53	0,67	0,79	1,22	1,69	2,34	2,78	c9
	PM+LM (simultaneous)	fast		11,50	3,27	2,74	2,43	2,09	2,30	2,62	2,86	c10
		medium		1,38	5,19	3,51	2,67	1,96	2,21	2,58	2,85	c11
		slow		-0,89	0,52	0,66	0,78	1,21	1,69	2,35	2,80	c12
		Adj	Δ									
Fiscal reforms	Irpef	G	-	0,60	-0,48	-0,31	-0,19	0,02	0,04	0,06	0,07	c13
		VAT	+	1,45	0,04	0,11	0,19	0,33	0,35	0,38	0,40	c14
		TASI	+	-4,35	-0,01	0,00	0,03	0,19	0,32	0,42	0,47	c15
	Social contributions	G	-	0,69	0,29	0,28	0,25	0,08	0,03	0,04	0,05	c16
		VAT	+	1,21	0,54	0,47	0,41	0,23	0,20	0,22	0,23	c17
		TASI	+	-1,44	0,60	0,42	0,31	0,13	0,18	0,25	0,27	c18
	Irap	G	-	0,66	0,25	0,24	0,21	0,05	0,01	0,01	0,01	c19
		VAT	+	1,19	0,50	0,44	0,38	0,21	0,18	0,20	0,20	c20
		TASI	+	-1,54	0,56	0,39	0,28	0,11	0,15	0,22	0,24	c21
Structural and fiscal (simultaneous)	LM+PM+Irpef	G	+	2,07	4,65	3,16	2,44	1,95	2,22	2,60	2,88	c22
		VAT	-	1,53	4,16	2,95	2,34	1,91	2,15	2,49	2,71	c23
		TASI	-	5,27	2,88	2,35	2,09	1,96	2,21	2,51	2,68	c24
	LM+PM+Social contr	G	+	2,13	5,45	3,78	2,91	2,03	2,23	2,60	2,87	c25
		VAT	-	1,26	4,67	3,33	2,59	1,82	2,01	2,34	2,55	c26
		TASI	-	8,23	3,52	2,81	2,40	1,92	2,07	2,34	2,49	c27
	LM+PM+Irap	G	+	2,09	5,45	3,76	2,89	2,00	2,20	2,57	2,84	c28
		VAT	-	1,21	4,65	3,31	2,56	1,80	1,99	2,31	2,52	c29
		TASI	-	8,25	3,47	2,76	2,36	1,89	2,05	2,31	2,47	c30
Structural and fiscal (sum)	LM+PM+Irpef	G	+	1,95	4,66	3,16	2,44	1,97	2,24	2,62	2,91	c31
	LM+PM+Soc contr	G	+	2,05	5,43	3,75	2,88	2,02	2,23	2,61	2,88	c32
	LM+PM+Irap	G	+	2,01	5,38	3,71	2,85	2,00	2,20	2,58	2,85	c33
Simultaneous labor wedge reforms	Irpef+Social contr+Irap	G	+	0,66	0,02	0,07	0,09	0,05	0,03	0,04	0,04	c34
		VAT	-	1,30	0,37	0,35	0,33	0,26	0,24	0,27	0,28	c35
		TASI	-	-2,47	0,39	0,28	0,21	0,15	0,22	0,30	0,33	c36
Simult. labor wedge and structural reforms	Irpef+Irap+Social contr+PM+LM	G	+	2,11	5,18	3,57	2,75	2,00	2,22	2,59	2,87	c37
		VAT	-	1,36	4,50	3,20	2,50	1,85	2,05	2,39	2,60	c38
		TASI	-	7,23	3,29	2,64	2,29	1,93	2,11	2,39	2,55	c39

Table 3: Impact of a labor tax wedge cut

% deviations from the initial steady state

Variable	Year (1Q)	adj G			adj VAT			adj TASI		
		Irpef	**Soc. contr.**	**Irap**	**Irpef**	**Soc. contr.**	**Irap**	**Irpef**	**Soc. contr.**	**Irap**
Output	1	0,60	0,69	0,66	1,45	1,21	1,19	-4,35	-1,44	-1,54
	3	0,02	0,08	0,05	0,33	0,23	0,21	0,19	0,13	0,11
	5	0,04	0,03	0,01	0,35	0,20	0,18	0,32	0,18	0,15
	10	0,06	0,04	0,01	0,38	0,22	0,20	0,42	0,25	0,22
	20	0,07	0,05	0,01	0,40	0,23	0,20	0,47	0,27	0,24
Consumption	1	0,70	0,51	0,50	0,43	0,20	0,19	0,72	0,53	0,53
	3	1,22	0,77	0,75	0,05	0,20	0,17	1,19	0,79	0,77
	5	1,25	0,75	0,73	0,19	0,15	0,12	1,19	0,73	0,71
	10	1,28	0,75	0,73	0,29	0,17	0,14	1,31	0,76	0,74
	20	1,31	0,75	0,73	0,34	0,20	0,16	1,41	0,81	0,78
Investment	1	5,66	4,68	4,60	7,74	5,90	5,84	-29,48	-11,72	-12,29
	3	1,00	0,46	0,42	1,50	0,69	0,65	-2,24	-1,47	-1,54
	5	0,91	0,45	0,41	1,28	0,65	0,62	-1,77	-1,17	-1,24
	10	0,86	0,48	0,45	1,15	0,66	0,63	-1,67	-0,97	-1,03
	20	0,84	0,48	0,45	1,10	0,63	0,60	-1,74	-0,99	-1,06
Employment	1	0,98	1,15	0,49	2,27	1,95	1,91	-6,75	-2,17	-2,34
	3	0,27	0,24	0,17	0,54	0,38	0,34	0,59	0,35	0,31
	5	0,28	0,15	0,11	0,53	0,29	0,26	0,72	0,37	0,34
	10	0,27	0,16	0,12	0,51	0,29	0,26	0,73	0,41	0,38
	20	0,27	0,16	0,12	0,50	0,29	0,26	0,69	0,40	0,37
Unemployment (abs)	1	-0,38	-1,79	-1,73	-1,16	-2,31	-2,26	5,99	0,94	1,09
	3	-0,01	-0,13	-0,13	0,00	-0,13	-0,12	0,01	-0,12	-0,11
	5	-0,01	0,00	0,00	-0,01	0,00	0,00	0,00	0,01	0,01
	10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Public debt (abs)	1	-0,67	-0,79	-0,74	-1,80	-1,46	-1,44	5,68	1,97	2,09
	3	0,18	0,01	0,04	-0,32	-0,24	-0,22	-0,06	-0,05	-0,03
	5	0,15	0,07	0,10	-0,35	-0,20	-0,18	-0,21	-0,11	-0,09
	10	0,12	0,06	0,09	-0,39	-0,23	-0,20	-0,34	-0,20	-0,17
	20	0,10	0,05	0,09	-0,42	-0,24	-0,21	-0,40	-0,23	-0,20

Table 4: Impact of structural reforms

(% deviations from the initial steady state)

Variable	Year (1Q)	**Labor market (LM)**	**Product market (PM)**	**LM+PM (sum)**	**LM+PM (simultaneuous)**
Output	1	0,19	1,16	1,36	1,38
	3	0,40	1,55	1,95	1,96
	5	0,45	1,75	2,20	2,21
	10	0,51	2,06	2,56	2,58
	20	0,55	2,28	2,83	2,85
Consumption	1	0,08	-0,47	-0,39	-0,38
	3	0,24	0,01	0,25	0,25
	5	0,30	0,35	0,65	0,65
	10	0,39	0,82	1,21	1,21
	20	0,46	1,15	1,61	1,61
Investment	1	0,63	2,31	2,94	3,01
	3	0,78	3,81	4,59	4,60
	5	0,71	3,45	4,16	4,18
	10	0,61	2,86	3,47	3,48
	20	0,53	2,47	3,00	3,02
Employment	1	0,31	2,16	2,47	2,51
	3	0,64	1,62	2,26	2,27
	5	0,65	1,58	2,23	2,24
	10	0,64	1,53	2,17	2,18
	20	0,63	1,50	2,13	2,14
Unemployment (abs)	1	-0,61	-0,58	-1,19	-1,24
	3	-1,04	0,16	-0,88	-0,88
	5	-1,05	0,00	-1,05	-1,05
	10	-1,05	-0,01	-1,05	-1,05
	20	-1,04	0,00	-1,05	-1,05
Public debt (abs)	1	-0,22	-1,66	-1,88	-1,91
	3	-0,46	-1,88	-2,34	-2,35
	5	-0,52	-2,14	-2,67	-2,66
	10	-0,60	-2,54	-3,14	-3,13
	20	-0,66	-2,83	-3,49	-3,48

B The Model

The model analyzed is based on Catalano [2014]. In this paper we augment the fiscal block following Forni et al. [2010] and Manzo and Monteduro [2011] for the IRAP and social contribution implementation into the model. We take account of consumption, and financial and real assets allocations for households and firms. The model exhibits sticky nominal wages and prices, and an explicit financial intermediary sector that allows for a financial accelerator mechanism, as in Gerali et al. [2010] and Iacoviello [2005]. We introduce the labor market according to Galí [2011]. Households are modeled by a standard utility maximization problem to define the level of consumption goods (durable and nondurable) and investment in housing stock and financial assets (deposits). Financial markets play two roles: the first is to satisfy demand for funding from the domestic economy (from government and entrepreneurs); the second is to collect financial resources from foreign financial markets and domestic net savers (households). The external sector includes all foreign agents that interact with the domestic economy, such as the monetary authority, i.e. the European Central Bank which sets the monetary policy interest rate, thus monitoring the inflation gap in the euro area. Hence, the policy rate provides a benchmark for asset prices in the national and euro area financial markets. Government issues debt (financed by financial markets) and demands final goods. The model incorporates different tax rates including household labor income tax, VAT applied on non-durable and durable consumption, real estate tax rate, labor tax wedge, capital revenues tax rate.

B.1 Households

We consider an infinite horizon economy populated by a continuum of households that face two different decision problems: on the one hand, they want to maximize their expected lifetime utility subject to their budget constraints, and on the other hand, they determine their consumption of domestic and foreign goods by minimizing their total consumption expenditure.

B.1.1 Households' first stage consumption decision

Households maximizes the following lifetime utility

$$\sum_{i=0}^{\infty} \beta^{t+i} \left[U \left(C_{t+i}, H_{t+i}, L^{s}_{t+i} \right) \right], \tag{1}$$

where $0 < \beta < 1$ is the discount factor. The first argument in the utility function is a bundle of consumption goods, C_t, including imported consumption, Cm_t and home produced consumption goods, Ch_t, defined by the following Dixit-Stiglitz index aggregator:

$$C_t = \left[(1-\gamma_1)^{\frac{1}{\theta_1}} Ch_t^{1-\frac{1}{\theta_1}} + \gamma_1^{\frac{1}{\theta_1}} Cm_t^{1-\frac{1}{\theta_1}} \right]^{\frac{\theta_1}{\theta_1-1}}, \tag{2}$$

where θ_1 is the elasticity of substitution between imported and domestic consumption, and γ_1 denotes the share of foreign goods in the aggregate consumption.

The second source of utility is given by services from housing, H_t, considered as durable goods. The choice of desired housing stock reflects households' preferences over non-durables and housing services, and the user cost of housing capital, which depends on the depreciation rate, δ^h, and the domestic interest rates, Rm_t. As housing stock deteriorates each period, some expenditure will be needed to maintain it at the desired level. Moreover, individuals evaluate their labor supply, L_t^s. Thus, we have

$$U = \frac{U_{CH,t}^{1-\frac{1}{\sigma_c}} - 1}{1-\frac{1}{\sigma_c}} + \epsilon^{cd} \frac{Cd_t^{1-\frac{1}{\sigma_{cd}}}}{1-\frac{1}{\sigma_{cd}}} - \epsilon \frac{L_t^{s\,1+\omega}}{1+\omega}, \tag{3}$$

where the parameter σ_c denotes the consumer's intertemporal elasticity of consumption, σ_{cd} the intertemporal substitution of durable goods and ω the Frisch elasticity of labor supply. ϵ^{cd} and ϵ denote the scaling utility parameter of durable consumption and labor. $U_{CH,t}$ is a Constant Elasticity of Substitution (CES) subutility index defined for non-durable consumption and housing,

$$U_{CH,t} = \left[\phi^c \left(\psi^c (C_t - hC_{t-1}) \right)^{\frac{\sigma_d-1}{\sigma_d}} + (1-\phi^c) \left((1-\psi^c) H_t \right)^{\frac{\sigma_d-1}{\sigma_d}} \right]^{\frac{\sigma_d}{\sigma_d-1}},$$

where the parameters ϕ^c and ψ^c determine the shares devoted to non-durable consumption and housing, and σ_d is the elasticity of substitution between them. This ensures a certain degree of complementarity between non-durable consumption and housing.

Consumers face the following period-by-period constraints defining the dynamics for financial assets as M_t, housing as H_t, durable consumption as Cd_t

$$\begin{aligned}
M_t &= (1-\tau_l) W_t L_t^s + \Pi_t^w + \Pi_t^r + \Pi_t^b + \left(1 + R_{t-1}^m\right) M_{t-1} \\
&- (1+\tau_c) \left(P_t C_t + P_t^{cd} I_t^d \right) - P_t^{dv} I_t^h - \tau_h P dv_t H_{t-1}; && (4) \\
H_t &= I_t^h + (1-\delta^h) H_{t-1} && (5) \\
Cd_t &= I_t^d + \left(1-\delta^{cd}\right) Cd_t; && (6) \\
& && (7)
\end{aligned}$$

where R_t^m is the interest rate on deposits M_t, P_t denotes the consumer price index, $W_t L_t$ is nominal labor income,$P_t^{dv} I_t^h$ and $P_t^{cd} I_t^d$ represent nominal expenditure on

investments in housing and durable consumption, respectively. Accordingly, the parameters δ^h and δ^{cd} denote the depreciation rate on housing and durable consumption. τ_l and τ_c in equation (4) represent the respective tax rates for labor and consumption, while τ_h is the real estate tax rate. Households are shareholders, and therefore earn firm profits from wholesalers (Π_t^w), retailers (Π_t^r), banks (Π_t^b). Households determine optimally C_t, Cd_t, H_t, L_t, M_t. From the maximization problem, we get a set of dynamic intertemporal equilibrium equations describing the behavior of the variables of interest:

$$
\begin{aligned}
u_t^H &= \lambda_t P_t^{dv} - \mathrm{E}_t \beta \lambda_{t+1} P_{t+1}^{dv} \left(1 - \delta^h - \tau_{h,t+1}\right); && (8)\\
u_t^{cd} &= \lambda_t P_t^{cd} - \mathrm{E}_t \beta \lambda_{t+1} P_{t+1}^{cd} \left(1 - \delta^{cd}\right); && (9)\\
\lambda_t &= \frac{u_t^{c,h}}{(1+\tau_c) P_t} - h \frac{u_{t+1}^{c,h}}{(1+\tau_{c,t+1}) P_{t+1}}; && (10)\\
\lambda_t &= \mathrm{E}_t \lambda_{t+1} \beta \left(1 + R_t^m\right); && (11)\\
mrs_t &= \frac{\epsilon L^{s\,1+\omega}}{(1-\tau_{l,t})\lambda_t} && (12)\\
& && (13)
\end{aligned}
$$

where λ_t is the Lagrange multiplier associated with the financial asset constraint[12]. Households set their wages following the mechanism in Calvo [1983] which allows us to formulate sticky wages using analytically convenient expressions. Calvo pricing implies that, each period, only a fraction $1 - \zeta_w$ of firms is able to reset wages; all other households keep their wages unchanged with probability ζ_w. Workers reoptimize when they receive a random and exogenous signal that occurs independent of the time lapse since the last adjustment. When setting their wages, households have to be forward-looking since they know that the new wage may remain effective for some periods. Thus, they maximize the discounted utility while wages remain effective. For each household j, we denote the optimal wage in period t as $Wa_t(j)$ and the current wage as $W_t(j)$. The households maximize utility given the demand for $i-th$ labor variety

$$
L_{i,t}^s = \left(\frac{Wa_{i,t}}{W_t}\right)^{-\epsilon_w} L_t^s \tag{14}
$$

and the dynamic constraints in equation (4). Taking derivatives of expected discounted utility yields the optimal wage[13]

$$
Wa_t = \frac{E_t \sum_{\tau=0}^{\infty} \zeta_w^\tau \beta^\tau (\epsilon_w W_t^{\epsilon_w + \epsilon_w \omega} \epsilon L_t^{s\,1+\omega})}{E_t \sum_{\tau=0}^{\infty} \zeta_w^\tau \beta^\tau ((\epsilon_w - 1)(1-\tau_{l,t}) W^{\epsilon_w} L_t^s)}. \tag{15}
$$

[12]This constraint includes the constraints on housing and durable goods.

[13]We assume that the markup distortion created by monopolistic competition is eliminated by subsidy given to each firm setting the optimal price as in Lim and McNelis [2008].

Following Schmitt-Grohé and Uribe [2004], the numerator and the denominator of the optimal price can be written using a recursive framework with two auxiliary variables, A_t^{w1} and A_t^{w2}:

$$A_{w1,t} = \epsilon_w W_t^{\epsilon_w+\epsilon_w\omega} \epsilon L_t^{s\,1+\omega} + \chi_w \beta A_{w1,t+1} \tag{16}$$

$$A_{w2,t} = (\epsilon_w - 1)\lambda_t(1-\tau_{l,t}) W_t^{\epsilon_w} L_t^s + \chi_w \beta A_{w2,t+1}. \tag{17}$$

Therefore, the optimal wage becomes,

$$Wa_t = A_{w1,t}/A_{w2,t}, \tag{18}$$

and the effective wage is given by

$$W_t = \left(\zeta_w W1 - \epsilon_w + (1-\zeta_w) Wa_t^{1-\epsilon_w}\right)^{\frac{1}{1-\epsilon_w}}, \tag{19}$$

i.e. the effective wage is an average of the wage set in the previous period,W_{t-1}, and the new wage, Wa_t. Indeed, a fraction ζ_w of households is not able to reoptimize, and thus, keep the wage set in the previous period W_{t-1}, while the $1-\zeta_w$ reoptimizing firms choose in time t the optimal wage Wa_t. For $\zeta_w = 0$ (all firms are able to reoptimize their wage), the model collapses to the flexible wage model.

Given the definition of the real marginal rate of substitution and unemployment we define the latter as

$$U_t = 1 - \frac{L_t^d}{L_t^s} \tag{20}$$

where L_t^d is wholesaler producer labor demand, so the wage markup is a function of the unemployment rate[14]

$$\mu_{w,t} = \frac{\frac{W_t}{P_t}}{mrs_t} = (1-U_t)^{-\omega}. \tag{21}$$

Staggered wages combined with union market power result in labor supply and demand mismatches.

B.1.2 Households' second stage consumption decision

Consumption is aggregated by a CES function over domestically produced consumption (Ch) and imported consumption (Cm). Accordingly, total consumption expenditure by domestic households implies minimizing the following expenditure

[14]Log linearizing Equations 18 and 19 and taking equation 21 we can obtain the same New Keynesian wage Phillips Curve obtained in Galí [2011], i.e. $\pi_t^w = \beta E_t\{\pi_{t+1}^w\} - \lambda^w \omega \left(U_t - U^n\right)$

$$P_t^f Cm_t + P_t^{ch} Ch_t = P_t C_t \tag{22}$$

subject to the Dixit-Stiglitz index aggregator defined in equation (2):

$$C_t = \left[(1-\gamma_1)^{\frac{1}{\theta_1}} Ch_t^{1-\frac{1}{\theta_1}} + \gamma_1^{\frac{1}{\theta_1}} Cm_t^{1-\frac{1}{\theta_1}} \right]^{\frac{\theta_1}{\theta_1 - 1}}.$$

First order conditions yield the following demand functions for both domestic and imported goods:

$$Cm_t = \gamma_1 \left(\frac{P_t^f}{P_t} \right)^{-\theta_1} C_t, \tag{23}$$

$$Ch_t = (1-\gamma_1) \left(\frac{P_t^{ch}}{P_t} \right)^{-\theta_1} C_t, \tag{24}$$

where P_t^f denotes the price of imported goods and P_t^{ch} represents the price of domestic goods. As mentioned above, θ_1 denotes the elasticity of substitution between imported and domestic goods and γ_1 denotes the share of foreign goods in aggregate consumption, C_t.

B.1.3 Entrepreneurs

Entrepreneurs maximize intertemporal utility on consumption, Cn_t, taking account of a physical accumulation constraint with real adjustment costs, and a financial credit constraint. Formally they are characterized as rule-of-thumb consumers since the collateral constraint forces them to consume only their available income. The multiperiod program is to maximize:

$$\sum \beta_e^{t+i} E_t \frac{Cn_{t+i}^{1-\frac{1}{\sigma_n}} - 1}{1-\frac{1}{\sigma_n}} \tag{25}$$

subject to capital accumulation

$$K_t = I_t^k + (1-\delta) K_{t-1} - \frac{\psi}{2} \frac{\left(I_t^k - \delta K_{t-1} \right)^2}{K_{t-1}}, \tag{26}$$

the financial asset accumulation process

$$Nd_t = (1+R_{t-1}^n)(1-\psi_2) Nd_{t-1} + (1+\tau_c) P_t^{ch} Cn_t + qk_t I_t^k - P_t^k K_{t-1}(1-\tau_k), \tag{27}$$

and the financial credit constraint

$$Nd_t \leq \mu_2 \frac{qk_{t+1}(1-\delta) K_t}{1+R_t^n}. \tag{28}$$

Thus, entrepreneurs maximize the utility function in equation (25), where σ_n denotes the intertemporal elasticity of substitution, β_e is the entrepreneurs' discount rate, and Cn_t is the entrepreneurs' consumption. Equation (27) indicates that the enterpreneurs' debt in t, denoted by N_t, depends on the interest paid on the debt in the previous period, $(1+R^n_{t-1})(1-\psi_2)N_{t-1}$ (where R^n_t is the interest rate on loans granted from banks to entrepreneurs and ψ_2 is the default ratio associated with loans), on the nominal expenditure for consumption $P^{ch}_t Cn_t$, , and on the capital investment costs, $qk_t I^k_t$, net of the earnings from capital rent services, $P^k_t K_t$.

The first order conditions of the maximization problem give the following equations[15]:

$$1+ \ni_t = \beta_e \left(\frac{Cn_{e,t+1}}{Cn_{e,t+1}}\right)^{-1/\sigma_n} \frac{(1+\tau_{c,t})}{(1+\tau_{c,t+1})} \frac{P^{ch}_t}{P^{ch}_{t+1}} (1+R^n_t) \tag{29}$$

$$Q_{e,t} = \frac{\lambda_{e,t} q k_t}{\left(1 - \frac{\psi(I-\delta K_{e,t-1})}{K_{e,t-1}}\right)} \tag{30}$$

$$\begin{aligned} Q_{e,t} = \beta_e \left(\frac{Cn_{e,t+1}}{Cn_{e,t}} \frac{(1+\tau_{c,t})}{(1+\tau_{c,t+1})}\right)^{-1/\sigma_n} \frac{P^{ch}_t}{P^{ch}} \\ \left[P^k(1-\tau_k) + Q\,(1-\delta) + \psi \frac{(I_{e,t} - \delta K_{e,t})\,\delta}{K_{e,t}} + \psi \frac{(I_{e,t+1} - \delta K_{e,t})^2}{2K^2_{e,t}}\right] + \\ + \ni_t\, \mu_2 \frac{qk(1-\delta)}{1+R^n_t} \end{aligned} \tag{31}$$

where Q_t, λ^e_t,$\ni_t$, are respectively the Lagrange multiplier attached to the constraints in equations (26), (27), (28).

B.2 Firms

The firm sector is organized in several sub-sectors which allow us to distinguish the production of services and goods among the agents and obtain simple analytical results. Thus, as mentioned above, we distinguish the "capital aggregator" sector (which aggregates domestic and foreign capital investment goods) from entrepreneurs (providing capital rent services, see section B.1.3), wholesalers (producing intermediate goods), and retailers (producing multiple final goods), according to their economic activity responsibilities.

[15] We assume an always binding borrowing constraint and this implies that equation (28) always holds with equality.

B.2.1 Capital Aggregator

The "capital aggregator" is a specialized sector which purchases foreign produced capital investment goods, Ikm_t, at price P_t^f and domestically produced capital investment goods, Ikh_t, at price P_t^{kh}, and aggregates them into a capital composite index, Ik_t, which is sold to the entrepreneur at the price qk_t. Therefore, the problem is to maximize the profits

$$\Pi_t^k = qk_t Ik_t - P_t^{kh} Ikh_t - P_t^f Ikm_t \tag{32}$$

subject to the production function

$$Ik_t = \left[(1-\alpha_k)^{\frac{1}{\theta_2}} Ikh_t^{1-\frac{1}{\theta_2}} + \alpha_k^{\frac{1}{\theta_2}} Ikm_t^{1-\frac{1}{\theta_2}} \right]^{\frac{\theta_2}{\theta_2-1}}, \tag{33}$$

where α_k is the share of foreign capital investment goods in the production function, and θ_2 denotes the elasticity of substitution between home and foreign goods. Therefore, the capital investment demand functions are defined as follows:

$$Ikh_t = \alpha_k \left(\frac{P_t^{kh}}{qk_t} \right)^{-\theta_2} I_t^k \tag{34}$$

$$Ikm_t = (1-\alpha_k) \left(\frac{P_t^f}{qk_t} \right)^{-\theta_2} I_t^k, \tag{35}$$

where the investment goods price index is given by

$$qk_t = \left[\alpha_k Pkh_t^{1-\theta_2} + (1-\alpha_k) Pf_t^{1-\theta_2} \right]^{\frac{1}{1-\theta_2}}. \tag{36}$$

B.2.2 Wholesalers

The model includes a wholesaler setting in which the intermediate goods production function is denoted by Y_t, and the production factors, i.e. labor (L_t^d) and capital services (K_t), are employed at the wage $W_t L_t^d$ and price P^k, respectively. The production function is given by

$$Y_t = Z_t \left[\alpha_1 K_{t-1}^{\kappa} + (1-\alpha_1) \left(L_t^d \right)^{\kappa} \right]^{\frac{1}{\kappa}}, \tag{37}$$

where Z denotes the technology available to firms, α_1 is the share of capital in the production function, and κ is the elasticity of substitution between inputs in the production function. Wholesaler's profits are defined as

$$\pi = (1-\tau_{i,t})(Pw_t Y_t - Pk_t K_{t-1}) - (1+\tau_{f,t}) W_t L_t^d \tag{38}$$

where $\tau_{f,t}$ denotes the tax rate of social contributions firms have to pay and $\tau_{i,t}$ is the IRAP tax rate. The minimization problem yields the standard marginal cost value, and combining the first order conditions with respect to capital and labor, we have

$$A_t = \frac{1}{2}\left[(1-\tau_{i,t})\frac{P_t^k}{mpk_t} + (1+\tau_f)\frac{W_t}{mpl_t}\right], \tag{39}$$

with mpl and mpk denoting the marginal productivity of labor and capital respectively. Wholesalers set their prices following the mechanism of Calvo [1983] which allows us to formulate the idea that prices are sticky through analytically convenient expressions. For each firm j, we denote the optimal price in period t as $Pwa(j)$ and the current price as $Pw(j)$. Taking derivatives of profits yields the optimal price[16]

$$Pwa_t = \frac{Y_t(Pw_t)^{\zeta_e}A_t + E_t\sum_{\tau=1}^{\infty}\zeta_p^{\tau}\beta^{\tau}(A_{t+\tau}(P_{t+\tau})^{\zeta_e})Y_{t+\tau}}{Y_t(Pw_t)^{\zeta_p} + E_t\sum_{\tau=1}^{\infty}\zeta_p^{\tau}\beta^{\tau}((P_{t+\tau})^{\zeta_e})Y_{t+\tau}}, \tag{40}$$

where ζ_e denotes the elasticity of substitution between differentiated goods. The effective price is given by

$$Pw_t = \left(\zeta_p Pw_{t-1}^{1-\zeta_e} + (1-\zeta_p)Pwa_t^{1-\zeta_e}\right)^{\frac{1}{1-\zeta_e}}, \tag{41}$$

i.e. the effective price is an average of the price set in the previous period, Pw_{t-1}, and the newly set price, Pwa_t. Indeed, a fraction ζ_p of firms is not able to reoptimize, thus they keep the price set in the previous period Pw_{t-1}, while the $1-\zeta_p$ reoptimizing firms will choose in t the optimal price Pwa_t. For $\zeta_p = 0$ (all firms are able to reoptimize their price), the model collapses to the flexible price model.

B.2.3 Retailers

Retailers operate in monopolistic competitive markets and differentiate without costs wholesale goods Y_t in consumption, investment and export goods. They maximize profits

$$\Pi_t^r = P_t^{ch}\left(G_t + Ch_t + Cn_t\right) + P_t^{cd}I_t^d + Px_tX_t + P_t^{kh}Ikh_t + P_t^{dv}I_t^h - Pw_tY_t, \tag{42}$$

subject to the demand volume constraint

$$Y_t = Ch_t + Ikh_t + G_t + X_t + I_t^h + I_t^d + Cn_t, \tag{43}$$

[16]We assume that the markup distortion created by monopolistic competition is eliminated by the subsidy given to each firm setting the optimal price as in Lim and McNelis [2008].

(where G_t denotes public expenditure), and subject to the demand functions for domestic consumption ,

$$Ch_t(j) = \left(\frac{P_t^{ch}(j)}{P_t^{ch}}\right)^{-\eta^{ch}} Ch_t,$$

durable goods

$$Cd_t(j) = \left(\frac{P_t^{cd}(j)}{P_t^{cd}}\right)^{-\eta^{cd}} Cd_t,$$

investment in housing

$$I_t^h(j) = \left(\frac{P_t^{dv}(j)}{P_t^{dv}}\right)^{-\eta^{d}} I_t^h,$$

capital investment goods

$$Ikh_t(j) = \left(\frac{P_t^{kh}(j)}{P_t^{kh}}\right)^{-\eta^{k}} Ikh_t,$$

and exports

$$X_t(j) = \left(\frac{Px_t(j)}{Px_t}\right)^{-\eta^{x}} X_t.$$

The demand functions allow us to obtain first order conditions as a mark-up pricing rule over the marginal cost Pw_t:

$$P_t^{ch} = \frac{\eta^{ch}}{(\eta^{ch}-1)} Pw_t, \tag{44}$$

$$P_t^{cd} = \frac{\eta^{cd}}{(\eta^{cd}-1)} Pw_t \tag{45}$$

$$P_t^{dv} = \frac{\eta^{d}}{(\eta^{d}-1)} Pw_t \tag{46}$$

$$P_t^{kh} = \frac{\eta^{k}}{(\eta^{k}-1)} Pw_t \tag{47}$$

$$Px_t = \frac{\eta^{x}}{(\eta^{x}-1)} Pw_t \tag{48}$$

where η^{ch}, η^{cd}, η^{d}, η^{k} and η^{x} and denote the price elasticity of demand domestic goods, durable goods, investment in housing, domestically produced capital goods, and exports, respectively.

B.3 Government

Government consumes an amount of domestic goods G_t at price P_t^{ch}. Its revenue is given by the exogenous tax rates imposed on labor, consumption, return on capital of entrepreneur households, social contribution affecting wholesaler employer and real estate and IRAP i.e., τ_l, τ_c, τ_k, τ_f, τ_h and τ_i , respectively. Government borrows B_t from financial intermediaries at a rate R_t to finance its expenditure G_t which is adjusted in order to set public debt to GDP ratio b_t to its long run (target) level, b_t^{tar}. The public debt stock evolves accordingly to the following equation

$$B_t = (1+R_t)\,B_{t-1} + P_t^{ch}G_t - \tau_{k,t}Pk_tK_{t-1} - \tau_{h,t}Pdv_{t,t}H_{t-1} - \tau_{i,t}(Pw_tY_t - Pk_tK_{t-1}) - \tau_{f,t}Ld_tW_t - \tau_{l,t}W_tL_t - \tau_{c,t}\left(P_tC_t + Pch_tCn_t + Pcd_tI_t^d\right)_t \quad (49)$$

Finally, the public expenditure reaction function is given by[17]:

$$G_t := (1+R_t)\,B_{t-1} + P_t^{ch}G_t - \tau_{k,t}Pk_tK_{t-1} - \tau_{h,t}Pdv_{t,t}H_{t-1} + -\tau_{i,t}(Pw_tY_t - Pk_tK_{t-1}) - \tau_{f,t}Ld_tW_t - \tau_{l,t}W_tL_t - \tau_{c,t}\left(P_tC_t + Pch_tCn_t + Pcd_tI_t^d\right) = 0 \quad (50)$$

and the reaction function for the tax rates are:

$$\tau_{l,t} = \tau_{l,t}^{tar} + \chi_l\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (51)$$

$$\tau_{c,t} = \tau_{c,t}^{tar} + \chi_c\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (52)$$

$$\tau_{k,t} = \tau_{k,t}^{tar} + \chi_k\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (53)$$

$$\tau_{h,t} = \tau_{h,t}^{tar} + \chi_h\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (54)$$

$$\tau_{f,t} = \tau_{f,t}^{tar} + \chi_f\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (55)$$

$$\tau_{i,t} = \tau_{i,t}^{tar} + \chi_i\left(b_{t-1} - b_{t-1}^{tar}\right) \quad (56)$$

where $\chi_j < 0$ denotes the sensitivity of the fiscal instrument to public debt of $j-th$ instrument, and j^{tar} and b^{tar} denote the level of the target level for any fiscal instrument and the ratio of debt to GDP, respectively. Equation (50) ensures that public expenditure G_t must adjust to keep the deficit constant and balanced.

[17]We change the fiscal policy instrument flipping the public expenditure and TASI and VAT tax rates using accordingly equations 50 and the equations 52 and 54.

B.4 Banks

Banks collect deposits M_t from households remunerated at rate R_t^m. They lend to government the amount B_t at rate R_t and to firms the amount Nd_t at rate R_t^n, assuming that a fraction ψ_2 of firms goes bankrupt. Banks can borrow (lend) internationally from (to) other euro area countries the amount F_t^{ea} and from (to) the rest of the world the amount F_t^{rw}/S_t, where S_t is the nominal exchange rate (we assume a 2nd stage allocation choice between the rest of the world and the intra-EA foreign assets, in order to get the exchange rate as an exogenous variable). Thus, optimization is defined over bank profits:

$$\begin{aligned}\Pi_t^b = (1+R_{t-1})B_{t-1} + (1+R_{t-1}^n)(1-\psi_2)Nd_{t-1} + \\ -(1+R_{t-1}^x+\Omega_{t-1}^{ea})F_{t-1}^{ea} + \\ -(1+R_{t-1}^{\star}+\Omega_{t-1}^{rw})\frac{F_{t-1}^{rw}}{S_t} + \\ -\left(\frac{1+R_{t-1}^m}{1-\psi_1}\right)M_{t-1},\end{aligned} \tag{57}$$

where $\psi 1$ the official reserve fraction of national bank deposits, R_t^x is the monetary policy rate, $R_t^{\star}$ is the exogenous rest-of-the-world interest rate, Ω_t^{ea} and Ω_t^{rw} denote the interest rate premium (discount) which indicates the greater (lower) riskiness of the domestic bonds with respect to the euro area bonds and rest-of-the-world assets, respectively. By maximizing profits, with respect to B_t, Nd_t, M_t, F_t^{ea} and F_t^{rw} subject to the asset market equilibrium constraint

$$B_t + N_t + (\psi_1 - 1)M_t = \frac{F_t^{rw}}{S_t} + F_t^{ea}, \tag{58}$$

and combining the FOCs, allows the following conditions:

$$1 + R_t = (1+R_t^n)(1-\psi_2); \tag{59}$$

$$1 + R_t = \frac{1+R_t^m}{(1-\psi_1)}; \tag{60}$$

$$R_t = R_t^x + \Omega_t^{ea} + \Omega_t^{ea'}F_t^{ea}; \tag{61}$$

$$\frac{(1+R_t)}{S_t} = \frac{(1+R_t^{\star}+\Omega_t^{rw}+\Omega_t^{rw'}F_t^{rw})}{S_{t+1}} \tag{62}$$

$$1 + R_t = (1+R_t^n)(1-\psi_2) \tag{63}$$

$$1 + R_t = \frac{1+R_t^m}{(1-\psi_1)} \tag{64}$$

$$R_t = R_t^x + \Omega_t^{ea} + \Omega_t^{ea'} F_t^{ea} \tag{65}$$

$$\frac{(1+R_t)}{S_t} = \frac{(1+R_t^* + \Omega_t^{RW} + \Omega_t^{rw'} F_t^{rw})}{S_{t+1}}. \tag{66}$$

Therefore, on the one hand, we obtain standard no arbitrage conditions between internal and foreign interest rates: equations (59) and (60) establish no arbitrage between internal rates, R, R^m and R^n, while equations (61) and (62) allow for no arbitrage between the internal rates and the monetary policy rate R^x, and between the internal rates and the exogenous rest-of-the-world interest rate $R^\star$, respectively. The terms Ω^i and $(\Omega^{i,'} F^i)$, with $i = ea, rw$ denote the interest rate premium and marginal rate premium defined as the internal debt elastic interest rate which assures economy stability and equilibrium solution existence (as in Schmitt-Grohé and Uribe [2003]). Therefore, in equations (61) and (62), the terms $(\Omega_t^{ea} + \Omega_t^{ea'} F_t^{ea})$ and $(\Omega_t^{rw} + \Omega_t^{rw'} F_t^{rw})$ denote respectively the spread between domestic and euro area assets, and between domestic and rest-of-the-world assets. If R is higher than R^x (or $R^\star$), this means that the spread between Italian assets and euro area (or rest-of-the-world) assets is increasing, thus requiring a higher interest rate on domestic bonds. F^{ea} represents the net foreign assets position of the home country with respect to euro area countries. Similarly, F^{rw} represents the value of the assets that the home country owns abroad, in the rest of the world. Moreover, if $R_t^\star > R_t^x$, the home country will sell assets in euros and buy assets in the rest of the world, thus reducing its credit towards euro area countries (i.e. increasing F_t^{ea}) and increasing its credit towards the rest of the world (i.e. decreasing F_t^{rw}).

B.5 Domestic-foreign trade relations

International trade relations determine foreign demand for domestic goods and satisfy domestic demand for imported intermediate and consumption goods. The foreign demand for national goods, denoted by X_t, is faced by domestic retailers and is given by

$$X_{t,rw} = \alpha_{x,rw} \left[\frac{Px_{t,rw}}{\frac{Px_{t,rw}^f}{S_t}} \right]^{-\chi_{2,rw}} X_t^{rw}, \tag{67}$$

$$X_{t,ea} = \alpha_{x,ea} \left[\frac{Px_{t,ea}}{Px_{t,ea}^f} \right]^{-\chi_{2,ea}} X_t^{ea}, \tag{68}$$

where X^i, $i = ea, rw$, is the total demand from the rest of the world and the euro area countries. The ratio $\frac{Px_{t,i}}{Px_{t,i}^f}$ denotes relative prices, where $Px_{t,i}$ is the domestic price of domestically produced goods in domestic currency, $Px_{t,i}^f$ is the price of foreign produced goods in foreign currency, and S_t is the nominal exchange rate

(expressed as the price of foreign currency in terms of domestic currency). $\chi_{2,i}$ and $\alpha_{x,i}$ denote the demand elasticity to price and the demand ratio (i.e. the weight of the domestic economy in world demand), respectively.

The import sector is defined as a multitude of consumption and investment goods importers. They determine import demands within and outside the euro area proportional to consumption and investment demands from households (Cm_t) and the capital aggregator (Ikm_t). Import demand functions stem from the minimization problem of the following total expenditure on imports

$$P_t^f(j)(Cm_t(j) + Ikm_t(j)) = P_t^{f,ea}(Cm_t^{ea} + Ikm_t^{ea}) + \frac{P_t^{f,rw}}{S_t}(Cm_t^{rw} + Ikm_t^{rw}), \quad (69)$$

and are given by

$$Cm_t^h(j) = \alpha_{cm}\left(\frac{P_t^{f,h}}{P_t^f}\right)^{-\theta_4} Cm_t, \quad (70)$$

$$Ikm_t^h(j) = \alpha_{km}\left(\frac{P_t^{f,h}}{P_t^f}\right)^{-\theta_5} Ikm_t. \quad (71)$$

where $h = ea, rw$ denotes import demand from the euro area and from the rest of the world. α_{cm} and α_{km} denote import consumption and capital shares, and the parameters θ_4 and θ_5 denote the elasticity of substitution between consumption goods and investment goods, respectively.

Therefore, the domestic price of imports P_t^f is given by the weighted average of the price of imports from EA ($P_t^{f,ea}$) and the price of imports from the rest of the world ($P_t^{f,rw}$):

$$\begin{aligned} P_t^f &= \left[\frac{Cm_t(\alpha_{cm}P_t^{f,ea}(j)^{1-\theta_4} + (1-\alpha_{cm})(\frac{P_t^{f,rw}(j)}{S_t})^{1-\theta_4})}{Cm_t + Ikm_t} + \right. \\ &+ \left. \frac{Ikm_t(\alpha_{km}P_t^{f,ea}(j)^{1-\theta_5} + (1-\alpha_{km})(\frac{P_t^{f,rw}(j)}{S_t})^{1-\theta_5})}{Cm_t + Ikm_t}\right]^{\frac{1}{1-(\theta_4+\theta_5)}}. \end{aligned} \quad (72)$$

B.6 Monetary Policy

The monetary authority sets monetary policy according to a Taylor rule linking the policy rate R_t^x to the inflation gap. Thus, the European Central Bank sets the

nominal interest rate R_t^x in response to a deviation in the inflation rate evaluated at euro area union level from its long-run equilibrium level $(\hat{\pi}_t - \pi^\star)$, according to the following rule

$$R_t^x = \phi_r R_{t-1}^x + (1 - \phi_r) \left[R_t^\star + \phi_\pi (\hat{\pi}_t - \pi^\star) \right]. \tag{73}$$

With $\phi_\pi > 0$, the Taylor rule says that an increase in inflation of 1 percentage point should lead the European Central Bank to raise the policy rate by more than 1 percentage point. Therefore, the Taylor rule is a simple monetary policy rule that establishes how a central bank should react in response to developments in inflation by adjusting its interest rate policy instrument in a systematic manner. The coefficient ϕ_r is the interest rate smoothing coefficient which allows for inertial behavior in setting interest rates. The value $\phi_r > 0$ proves to be particularly important for policy analysis in models with strong expectation channels (Woodford [2003]). The actual inflation rate $\hat{\pi}_t$ is defined as

$$\hat{\pi}_t = \left[\phi \dot{p}_t + (1 - \phi) \dot{p}^f \right]. \tag{74}$$

where $\dot{p}_t$ is the Italian inflation rate and $\dot{p}^f$ is the rest of Europe inflation rate; ϕ defines the preferences of the Central Bank for Italian inflation.

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