BANCA D'ITALIA

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Temi di discussione

(Working Papers)

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October 2019

Number 1241

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The papers published in the Temi di discussione *series describe preliminary results and are made available to the public to encourage discussion and elicit comments.*

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ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

FISCAL DEVALUATION AND LABOUR MARKET FRICTIONS IN A MONETARY UNION

by Lorenzo Burlon[*], Alessandro Notarpietro[♦] and Massimiliano Pisani[♦]

Abstract

We assess the effects of a fiscal devaluation on economic and labour market conditions in a Member State of the euro area by simulating a monetary union model featuring labour markets with search and matching frictions. The fiscal authority of the Member State enacts a discretionary reduction in the social contribution rate for employers so that the corresponding revenues decrease by 1per cent of the before-shock (steady-state) nominal GDP. The measure is *ex ante* revenue neutral, because it is financed by a simultaneous discretionary increase in the consumption tax rate that generates additional *ex ante* revenues equal to 1 per cent of the before-shock GDP. The main results are as follows. First, GDP increases by 0.5 per cent, sustained by the increase in investment and net exports, while consumption decreases. Second, the unemployment rate decreases by 0.3 percentage points. Third, the trade balance improvement is equal to 0.3 per cent of GDP (the improvement in real net exports is partially offset by the deterioration in term of trade). Fourth, the results are rather robust to changes in key parameters.

JEL Classification: F32, F47, H20.
Keywords: fiscal devaluation, labor market, trade deficit, dynamic general equilibrium modeling.

Contents

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1 Introduction[1]

Fiscal devaluation is commonly defined as a (budget-neutral) discretionary reduction in the social security contribution rate for employers financed by a discretionary increase in the consumption tax rate. Higher consumption taxes increase the after-tax price of domestic and imported goods uniformly. They do not affect the price of exported goods. Moreover, in the case of domestically produced goods sold at home, lower social contributions reduce unit labour costs and, as soon as they are passed-through into product prices, the relative price of domestic goods. The implied increase in price-competitiveness vis-à-vis the trade partners of the country stimulates domestic production and, thus, economic activity. Overall, the fiscal devaluation would (a) favor exports, (b) reduce imports, (c) induce a deterioration of the terms of trade (defined as the import price-to-export price ratio), and (d) increase domestic employment, since labour costs decrease and, likely, economic activity increases. In particular, the fiscal devaluation should improve trade balance, economic activity, and employment of a country belonging to a monetary union. Thus, a country-specific devaluation could partly mimic the effects of a nominal exchange rate devaluation.

In this paper we assess the effects on employment and other main macroeconomic variables of a fiscal devaluation enacted by a country belong to a monetary union. We simulate a dynamic general equilibrium model of the euro area (EA) and the world economy. The model is new-Keynesian as it features monopolistic competition in the goods markets and nominal price rigidities. Thus, monetary policy has a non-trivial stabilization role. The EA is split into two regions, calibrated, for illustrative purposes, to Italy and rest of the EA (REA). The two regions share the monetary policy and the nominal exchange rate of the euro vis-á-vis the rest of the world (RW) currency (the RW is the third bloc of the model). Monetary policy is conducted by the EA central bank according to a Taylor rule (the EA-wide monetary policy rate reacts to EA-wide inflation and GDP).

Crucially, we build on Jacquinot et al. (2018) and assume that in each EA region there is a labour market where demand and supply can match subject to searching frictions. Thus, the setup allows us to characterize employment not only in terms of its intensive margin (number of hours worked) but also in terms of its extensive margin (number of employees).

We run the following simulations. In the benchmark scenario the fiscal authority of the considered Member State reduces, in a discretionary way, for five years the rate of social contributions

[1]We thank for useful suggestions two anonymous referees, Fabio Busetti, Nicola Curci, Pietro Rizza, Daniele Siena, and Martino Tasso. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy or the European Central Bank. All errors are ours.

for employers so that the corresponding revenues decrease by 1 per cent of the before-shock (steady-state) nominal GDP. The measure is *ex ante* revenue-neutral, because it is financed by a simultaneous five-year discretionary increase in the consumption tax rate, that generates additional *ex ante* revenues equal to 1 per cent of the before-shock nominal GDP. Thereafter, the tax rates immediately return to their initial levels. The fiscal devaluation is announced, immediately implemented, and fully credible. We also change the duration of the fiscal devaluation and assess welfare in the case of permanent fiscal devaluation. Finally, we run a sensitivity analysis by changing the values of parameters regulating nominal price rigidities, the degree of accommodation of the EA monetary policy, the values of the parameters affecting separation rate and job finding rate (i.e., matching efficiency rate and break-up rate, respectively), to change the flexibility of the labour market.

Our main results are as follows. First, the level of Home real GDP increases by 0.5 per cent (peak level), sustained by the increase in investment and net exports, while consumption decreases. Second, the unemployment rate decreases by 0.3 percentage points (pp). Third, the trade balance improvement is equal to 0.3 per cent of GDP (the improvement in real net exports is partially offset by the deterioration of the terms of trade). Fourth, results are rather robust to changes in key parameters.

To the best of our knowledge, this is the first paper that looks at the impact of fiscal devaluation on both the intensive and the extensive margin of the labour market in a model of a monetary union with extra-monetary union trade. Attinasi et al. (2018) use a New Keynesian DSGE model of a monetary union with a search and matching labour market structure and a fiscal bloc containing a wide range of taxes and disaggregated government spending to evaluate the macroeconomic and welfare effects of reducing the firms and workers labour tax rates under alternative financing instruments. Different from their model, ours also allows for trade of the monetary union with the RW. Our labour market framework is the same as in Jacquinot et al. (2018). They consider the effects of alternative labour tax reductions. Different from them, we consider the combined effects of also an increase in consumption tax. Gomes et al. (2016) evaluate the effects of a fiscal devaluation by simulating a model similar to ours. Their results are in line with ours. However, their model features only the intensive margin of the labour market. Lipinska and von Thadden (2012) develop a two-country DSGE model of a monetary union to analyze unilateral permanent shifts of the tax structure towards indirect taxes and find small long-run effects of this measure. Evidence in de Mooij and Keen (2012) suggests that in the EA the revenue-neutral shifts from employers' social contributions towards VAT could improve the trade balance in the short run in a sizable way. Empirical analysis by Franco (2011) based on Portuguese data finds that the fiscal devaluation favors price-competitiveness. The changes in

tax rates would have to be large and temporary to achieve a sharp improvement in the current account. According to Banco de Portugal (2011), a 1 per cent of GDP shift from employers' social security contributions to VAT boosts exports by 0.5 per cent in the first year and improves the trade balance by 0.6 per cent of GDP. According to Jaumotte and Sodsriwiboon (2010), raising labour productivity and moderating unit labour costs could substantially improve current account positions of EA Member States.

The paper is organized as follows. Section 2 shows the model setup, the transmission mechanism of the fiscal devaluation, and the calibration of the model. Section 3 reports the results. Section 4 concludes.

2 Model setup

In this section, we provide an overview of the model, its main features (the labour market), the transmission mechanism of the fiscal devaluation, and the model calibration.

2.1 Overview of the model

We simulate a multi-country dynamic general equilibrium model. The world economy is composed of three blocs. Two blocs, Home and rest of the EA (REA), are members of the EA which is modeled as a monetary union. The two countries have a common nominal exchange rate and a common monetary policy rate. The third bloc, representing the rest of the world (RW), has its own monetary policy rate and nominal exchange rate. The model is micro-founded and features nominal price rigidities, capital accumulation, and international trade in goods and bonds.[2]

The key feature that allows us to evaluate the impact of the fiscal devaluation on unemployment is a country-specific labour market framework, as in Jacquinot et al. (2018), with involuntary unemployment because of search and matching frictions. The labour market setup is described in the Appendix.

In each country, there are a representative household, a representative firm in each production sector, and a public sector.

The household is infinitely lived. It consumes a final good. In every period the household rents workers to domestic labour firms. At the end of the (generic) period, the representative household receives labour income (wages and unemployment benefits) from workers, dividend

[2]Similar models are the International Monetary Fund (IMF) Global Economy Model (GEM), the European Central Bank (ECB) New Area Wide Model (NAWM), and the Euro area and Global Economy model (EAGLE). On GEM, see Bayoumi et al. (2004), Laxton (2008), and Pesenti (2008); on NAWM see Warne et al. (2008); on EAGLE, Gomes et al. (2010).

income from firms, and pays taxes. The household decides the amount of consumption, which is equally shared across its members. It owns the portfolio of domestic firms and the domestic capital stock. The latter is rent to domestic firms in a competitive market.[3] The household also buys and sells two bonds: a domestic bond issued by the local public sector denominated in domestic currency; an international bond (denominated in euro) issued in zero net supply worldwide.

On the production side, firms produce final non-tradable goods and an array of intermediate tradable and non-tradable goods. There are three final non-tradable goods produced by perfectly competitive firms: a private consumption good, an investment good, and a public consumption good. Consumption and investment goods are produced using all available intermediate goods (domestic tradable goods, non-tradable goods, and imported goods), combined accordingly to a constant elasticity of substitution (CES) technology. The public consumption good is produced only with intermediate non-tradable goods.

There are many varieties of intermediate goods all of which are imperfect substitutes. Each variety is produced by a single firm under conditions of monopolistic competition. Market power implies that firms set nominal prices and charge a markup over marginal costs. Each intermediate good is produced using domestic labour and capital that are combined according to a CES technology. Intermediate goods are both sold domestically and exported. There is international price discrimination as firms set prices in the currency of the importing country (as such, markets are segmented across countries).

In the labour market there are labour firms that hire domestic workers and sell the corresponding labour services to domestic firms that produce intermediate goods. The latter pay a cost when posting a vacancy.

In the beginning of a generic period, a fixed proportion of employment relationships ends exogenously. The separated workers join the unemployed from the previous period in the searching process. Thereafter, aggregate shocks are realized, the number of matches is determined, wages are set, and production takes place. Thus, new matches become productive immediately and employment can react to shocks in the same quarter.

As for monetary policy, the central bank sets the short-term nominal interest rate according to a standard Taylor-type rule, by reacting to the domestic inflation rate (the change in the after-consumption tax consumer price index, CPI from now on) and real activity.

Fiscal policy is conducted at the regional level. Each country sets government consumption, unemployment benefits (assumed to be the same in all sectors), lump-sum taxes, labour taxes

[3]Labour and physical capital are immobile internationally.

on both firms and employees, capital income taxes, and consumption taxes.

Labour taxes are paid by households and by labour firms. As labour firms sell labour services to firms producing intermediate goods, a change in labour taxes paid by labour firms is fully and immediately passed-through into the corresponding marginal costs paid by intermediate-good firms. When simulating the fiscal devaluation, we appropriately change the consumption tax rate and the social contribution rate paid by the household and the labour firm, respectively. Public debt is stabilized through a fiscal rule that induces an endogenous adjustment of lump-sum taxes. Tax rates other than (a) those levied on consumption and (b) the social contribution rates are kept constant.

The model also features standard investment adjustment costs and external habit formation in consumption. All nominal prices of intermediate goods are sticky, because firms pay a quadratic adjustment cost à la Rotemberg (1982) when changing prices.[4] Moreover, current-period prices are indexed to a weighted average of previous-period sector-specific inflation rate and the central bank's inflation target (assumed to be constant).

2.2 Fiscal sector

Fiscal policy is set at the regional level. The government budget constraint is

$$B_{G,t} - B_{G,t-1}R_{t-1} \leq P_{N,t}C_{G,t} + TR_t - T_t, \tag{1}$$

where $B_{G,t}$ is public debt and R_{t-1} the gross interest rate paid on the beginning-of-period public debt stock. The variable $C_{G,t}$ represents government purchases of goods and services, $T_t > 0$ (< 0) are lump-sum transfers (lump-sum taxes) to households. Consistent with the empirical evidence, $C_{G,t}$ is fully biased towards the intermediate non-tradable good. Therefore, it is multiplied by the corresponding price index $P_{N,t}$.[5] Total government revenues TR_t from distortionary taxation are given by the identity

$$TR_t \equiv \tau_t^c P_t C_t + \tau_t^{wh} W_t N_t + \tau_t^{wf} W_t N_t + \tau_t^{rk} R_t^k K_{t-1}.$$

The government follows a fiscal rule defined on lump-sum transfers to bring the public debt as a percentage of domestic GDP, $b_G > 0$, in line with its long-run (steady-state) target $\bar{b}_G$ and to stabilize the change inb_G. The rule is

$$\frac{T_t}{T_{t-1}} = \left(\frac{b_{G,t}}{\bar{b}_G}\right)^{-\phi_1} \left(\frac{b_{G,t}}{b_{G,t-1}}\right)^{-\phi_2}, \tag{2}$$

[4] See Rotemberg (1982).
[5] See Corsetti and Mueller (2006).

where the parameter ϕ_1 is greater than zero ($\phi_1 > 0$), calling for a reduction (increase) in lump-sum transfer whenever the current-period short-term public debt (as a ratio to GDP) is above (below) the target or increases (decreases) over time.

2.3 Monetary policy

The EA interest rate rule is specified as follows:

$$\left(\frac{R_t}{\bar{R}}\right)^4 = \left(\frac{R_{t-1}}{\bar{R}}\right)^{4\rho_R} \left(\frac{\Pi_{EA,t,t-3}}{\bar{\Pi}^4}\right)^{(1-\rho_R)\rho_\pi} \left(\frac{GDP_{EA,t}}{GDP_{EA,t-1}}\right)^{(1-\rho_R)\rho_{GDP}} . \tag{3}$$

where R is the (quarterly) nominal interest rate, $\bar{R}$ its steady-state value, Π_{EA} is the year-on-year CPI inflation rate, $\bar{\Pi}^4$ is the central bank CPI inflation target (assumed to be constant) and GDP_{EA} is the EA gross domestic product. To capture inertia in monetary policy, we also assume that the current period policy rate reacts to its one period-lagged value. The inflation rate Π_{EA} is defined as the weighted average of two EA region-specific after-consumption tax CPI inflation rates and GDP_{EA} as the sum of the regional gross domestic products.[6] A similar rule holds in the RW.

Note that, in the EA, the region-specific inflation rates determine the region-specific real interest rates because the nominal interest rate is the same across the two regions (and set by the central bank of the monetary union).

2.4 The transmission mechanism of fiscal devaluation

Even though in a monetary union the nominal exchange rate is no longer available as a national (stabilization) policy instrument, the fiscal devaluation can still be used to favor the adjustment in the real exchange rate of a Member State when needed: (a) the increase in the consumption tax is imposed on imports of consumption goods, while the price of the domestically produced goods can benefit of declining social contributions paid by firms on labour costs; (b) lower social contributions thus have a negative effects on the prices of exported goods, favoring their price competitiveness in foreign markets.

Firms in the intermediate sector act under monopolistic competition. They set prices taking into account the demand for their brand and subject to nominal (price) rigidities à la Rotemberg (1982), i.e., firms have to pay quadratic adjustment costs to change the prices of their products. In the case of the tradable good sold domestically, the implied optimal price setting equation,

[6] Thus, there is a direct effect, through the Taylor rule, of changes in the consumption tax rate on the monetary policy rate.

reported here in a compact manner, is[7]

$$\frac{P_{H,t}}{P_t} = E_t \left(\sum_{s=t}^{\infty} MKP_{P_H,s} \frac{MC_s}{P_s} \right), \tag{4}$$

where P_H is the price of the tradable good H and P the price of consumption basket, E is the expectation operator, MKP_{P_H} is the markup on the nominal marginal cost, MC. The marginal cost depends on both labour and capital costs. Thus, it depends on the tax rate $0 \leq \tau^{wf} \leq 1$ associated with employers' social contributions. *Ceteris paribus*, a decrease in τ^{wf} induces a decrease in P_H/P adjust their prices. Thus, it would induce also a decrease in the price of domestic goods relative to the prices of foreign goods.

For the consumption tax $0 \leq \tau^c \leq 1$, we assume it is uniformly imposed on domestically (H) produced and imported (F) consumption goods. Thus, it would not change the corresponding relative prices:

$$\frac{P_{H,t}\left(1+\tau_t^c\right)}{P_t\left(1+\tau_t^C\right)} = \frac{P_{H,t}}{P_t} \tag{5}$$

$$\frac{P_{F,t}\left(1+\tau_t^c\right)}{P_t\left(1+\tau_t^c\right)} = \frac{P_{F,t}}{P_t}. \tag{6}$$

The consumption tax would also affect the inter-temporal relative price of consumption through the standard Euler equation:

$$C_t^{-\rho} = \beta E_t \left(R_t \frac{P_t}{P_{t+1}} \frac{\left(1+\tau_t^c\right)}{\left(1+\tau_{t+1}^c\right)} C_{t+1}^{-\rho} \right) \tag{7}$$

Ceteris paribus, an increase in the current value of the consumption tax would induce households to postpone consumption thereby increasing savings. Jointly with the intra-temporal substitution effect associated with the change in relative prices between domestic and imported goods, this should further contribute to reduce imports of consumption goods. The decrease in the relative price of domestic goods and the lower unit labour costs would stimulate employment. Home firms would face an increase in demand for their goods. To increase production they would increase employment, given that labour has become cheaper.

2.5 Calibration

We calibrate at quarterly frequency the blocs to Italy (Home country), REA, and RW. We set some parameters to match the great ratios and the trade matrix. The remaining parameters are similar to those reported in the calibration of models such as the GEM (Laxton and Pesenti

[7] A similar mechanism applies to goods produced in the non-tradable sector as it is assumed that social contributions paid by all firms in the economy are uniformly reduced.

2003, Pesenti 2008), the NAWM (Warne et al. 2008), and the EAGLE (Gomes et al. 2010 and Jacquinot et al. 2018).

Table 1 reports the matched great ratios and tax rates. The steady-state ratio of Home government debt over (annual) output is larger than in REA. Tax rates for Italy and REA are in line with values reported in European Commission (2018). Home labour tax rates are similar to those of the REA. Home consumption tax rate and capital tax rate are lower and higher than the corresponding REA tax rates, respectively.

Table 2 contains preference and technology parameters. We set the discount factor of households to 0.9926 (implying a steady-state annualized real interest rate of about 3 per cent). The habit persistence parameter, the intertemporal elasticity of substitution, and the Frisch elasticity are respectively set to 0.70, 1, and 0.48, respectively. The disutility from work χ is set to 2.2 as in Jacquinot et al. (2018). We set the quarterly depreciation rate of capital to 0.025, consistent with a 10 per cent annual depreciation rate.

On the production side, in the production functions of intermediate tradable and non-tradable goods the bias towards capital is set to values close to 0.5. In the final goods baskets, the degree of substitutability between domestic and imported tradables is higher than that between tradables and non-tradables, consistent with the existing literature (elasticities equal to 1.5 and 0.5, respectively). The biases towards the tradable bundle in the consumption basket are equal to 0.64, 0.35, and 0.35 in Home, REA, and RW, respectively; in the investment basket they are equal to 0.75 in each region. The weight of domestic tradable goods in the consumption and investment tradable baskets is different among countries, and is set to be consistent with multilateral import-to-GDP ratios.

The labour market calibration is reported in Table 3. We mainly follow Christoffel et al. (2009) for our calibration strategy. We set the labour services production elasticity α_H to match a labour share of around 60 per cent. The bargaining power of workers is set to the conventional value of 0.5, in line with the literature. The quarterly separation rate is equal to 5.2 per cent, 6.0 per cent and 4.8 per cent, in Home, REA and RW to match the unemployment rates for Italy and the EA.[8] The resulting matching probabilities are lower in the case of the Home region than in those of the REA and RW. Unemployment benefits are calibrated so that the replacement rate is set to 65 per cent for both regions of the EA, in line with the evidence for the EA provided by Christoffel et al. (2009), and the RW.

The markup in the Home non-tradable sector (a proxy for the services sector) is higher than the corresponding value in the REA (see Table 4). In all regions the markup in the tradables

[8] We assume that the RW has an unemployment rate similar to the REA.

sector (a proxy for the manufacturing sector) has the same value.[9]

Table 5 reports nominal and real rigidities. We set parameters of the price quadratic adjustment costs for Home and REA extra-EA exports to relatively low values. The indexation parameters on prices are equal respectively to 0.50, to get sufficiently hump-shaped response of prices. For real rigidities, we set adjustment costs on investment changes to 2.50.

Table 6 reports parameters in the monetary rules and fiscal rules. The interest rate reacts to its lagged value (inertial component of the monetary policy), annual inflation, and quarterly output growth. In the monetary union, monetary policy reacts to the EA-wide variables. For fiscal rules, *lump-sum* taxes stabilize public debt.

3 Results

In this section we report the results of the scenario analysis. The impact on the Home economy of a unilateral fiscal devaluation is considered.

The Home fiscal authority reduces the rate of employers' social contributions for five years, so that the corresponding revenues decrease by 1 per cent of the before-shock (steady-state) nominal GDP. The measure is *ex ante* revenue-neutral, because it is financed by a five-year discretionary increase in the consumption tax rate, that generates additional *ex ante* revenues equal to 1 per cent of the before-shock nominal GDP.[10] From the beginning of the sixth year the tax rates are set at their corresponding initial levels. In all simulations, starting from the sixth year, lump-sum taxes endogenously adjust, according to the Home fiscal rule, to stabilize the public debt-to-GDP ratio. The fiscal devaluation is announced, immediately implemented, and fully credible. To make the transmission mechanism clear, we disentangle the contributions of lower social contributions and higher consumption tax. We also change the duration of the fiscal devaluation and assess welfare in the case of permanent fiscal devaluation. Finally, we run a sensitivity analysis by changing the values of parameters regulating nominal price rigidities, the degree of accommodation of the EA monetary policy, the values of the parameters affecting separation rate and job finding rate (i.e., matching efficiency rate and break-up rate, respectively),

[9] The chosen values are are in line with Bayoumi et al. (2004), Faruqee et al. (2007) and Everaert and Schule (2008).

[10] The simulation of *ex ante* revenue-neutral measures is consistent with the literature. This assumption allows to hold constant everything other than changes in the stated instruments and, thus, to have a clear evaluation of the considered measures and the implied multipliers (i.e., the implied change in output and other variables of interest in correspondence of the change in the fiscal instrument equal to 1 per cent of before-shock GDP). The multipliers are the interesting results from both the academic and policy perspectives. If consumption tax revenues would change endogenously to balance the public sector balance *ex post* in every period, then it is not necessarily true that their change would be equal to 1 per cent of before-tax GDP and, thus, we could not have a direct estimate of their multiplier.

to change the flexibility of the labour market.

3.1 Home fiscal devaluation

The employers' social security contributions rate decreases from 27.0 to 24.2 per cent. The consumption tax rate increases from 18.0 to 19.6 per cent. Fig. 1 shows the effects of the fiscal devaluation on the Home variables.[11] The real marginal costs in the non-tradable and tradable sectors decrease by roughly 2.0 per cent on impact. The sudden reduction is associated with lower social contributions. Given that prices adjust in a gradual way to lower marginal costs, firms' markup increase. Before-consumption tax prices decrease in the Home region, while the corresponding after-tax consumer price index increases. Consistent with the lower prices of Home goods, the Home (before-consumption tax) real exchange rates depreciate and the Home terms of trade deteriorate.[12]

Home GDP increases by roughly 0.5 per cent at the peak.[13] Consumption decreases, because of the negative effect of higher consumption taxes. Investment increases for the following reasons: (i) the lower social contributions favor an increase in employment, that stimulates the productivity (i.e., the return) of physical capital and, thus, its accumulation; (ii) since prices are sticky, their decrease is smaller than that of marginal costs and, thus, firms' markups and profits increase; (iii) higher consumption taxes induces households to substitute investment for consumption goods, as the former are cheaper than the latter.

Home (gross) exports increase because of the improvement in international competitiveness, associated with the deterioration in Home country's international relative prices. Home (gross) imports decrease because of the negative substitution effect, that induces Home households to substitute cheaper domestic goods for the imported ones.

The nominal exchange rate of the euro slightly appreciates vis-á-vis the RW currency, because the EA central bank increases, albeit in a contained way, the policy rate following the higher after-consumption tax Home inflation and economic activity. The nominal appreciation partially counterbalances the Home-RW bilateral terms-of-trade deterioration and somehow reduces the price competitiveness gain of Home goods in the RW.

As reported in Fig. 2, Home exports towards both REA and the RW increase, because Home firms decrease the prices of their goods in all destination markets. Overall, the Home trade

[11] Spillovers to the REA and the RW are negligible. To save on space we do not report them.

[12] The Home terms of trade are defined as Home import-to-Home export prices ratio, where both prices are defined in Home currency terms. The Home real exchange rate is the foreign consumer-to-Home consumer prices ratio, where both prices are defined in Home currency terms.

[13] GDP, consumption, investment, exports, and imports are evaluated in "real terms", i.e., using prices of the initial (before-shock) steady-state equilibrium.

balance improves (as a ratio to GDP) by 0.3 per cent.

Fig.3 reports the labour market variables. Home employment increases. Specifically, total and per capita hours worked increase by 0.5 per cent and 0.4 per cent, respectively.[14] The unemployment rate decreases by 0.3pp. Matches increase as well, while the probability of finding a job and that of filling a vacancy increases and decreases, respectively. Real wages paid to the workers decrease, following the increase in consumption taxes (real wages are nominal wages deflated by the after-tax consumer price level).

3.1.1 Decrease in the social contribution rate paid by Home firms

In order to disentangle the transmission mechanism of the devaluation, Figure 4 reports results obtained when the Home fiscal authority reduces for five years the social contribution rate to generate a 1 per cent of before-tax GDP reduction in corresponding tax revenues (the same as in the fiscal devaluation scenario). The consumption tax rate is kept constant at its steady-state level. Assumptions on fiscal policy are unchanged, so that lump-sum taxes adjust from year 6 to stabilize the public debt-to-GDP ratio.

Effects on the main macroeconomic variables are larger than those in the benchmark scenario (Fig. 1–3), because this new simulation does not include the increase in the consumption tax rate, whose effects on consumption are negative. Home GDP increases by 0.6 per cent. Consumption increases more because households face a larger increase in their permanent income. Investment increases because of the higher employment, which makes physical capital more productive. The increase in investment is lower than in the case of fiscal devaluation because in the latter case the increase in consumption taxes induces households to increase savings, favoring the substitution of investment goods for consumption goods. Now, instead, there is a larger incentive for firms to substitute labour for capital, given the lower labour costs implied by lower labour taxes. Exports increase following the Home real exchange rate depreciation, due to the expansion in Home supply. Imports now increase due to the higher Home aggregate demand (taxation of consumption goods does not increase in this scenario). Home consumer price inflation decreases (both before- and after-consumption tax), because the reduction in labour taxes paid by firms reduces after-tax labour costs in the short run despite the increase in wages.

The effects on the main labour market variables are positive and larger than in the benchmark scenario. Hours worked, employees, matches, and real wages increase, consistent with the higher labour demand and economic activity. The unemployment rate decreases by 0.5pp.

[14] Total hours worked is the product of employment and per capita hours worked.

3.1.2 Increase in the Home consumption tax rate

Fig. 5 reports results in the case of a five-year increase in the Home consumption tax rate corresponding to a 1 per cent of GDP permanent increase in consumption tax revenues (the same as in the fiscal devaluation scenario). The labour tax rate is kept constant at its steady-state level.

Home GDP decreases, by 0.25 per cent. Households decrease consumption, whose price has increased because of the higher taxes. Investment decreases relative to its baseline level during the first two years, given that the lower employment (see below) makes physical capital less productive. Thereafter, it returns above the baseline, because firms newly start to accumulate capital in anticipation of future higher aggregate demand (associated with the future reduction in consumption taxes, in the beginning of the sixth year). Exports slightly increase, because firms in the Home tradable sector, following the decrease in aggregate demand, reduce the price of their goods not only domestically but also abroad (i.e., firms reduce their mark-up to protect their market shares). Home imports decrease as well, because of the lower Home aggregate demand. Consistent with the lower aggregate demand, the (before-consumption tax) price level decreases.

Moreover, firms reduce labour demand. labour market variables are negatively affected. Hours worked decrease. The number of matches decreases. The probabilities of finding a job and hiring a new worker decrease and increase, respectively. The unemployment rate increases by 0.2pp. The real wage (i.e., the nominal wage deflated by the after-tax consumer price level) decreases.

3.1.3 Duration of fiscal devaluation and welfare analysis

Fig. 6 shows the effects of a temporary fiscal devaluation, lasting for one, two, and five years (benchmark) and of a permanent devaluation.

In the very short run (first year), GDP increases slightly more in the case of a one-and two-year fiscal devaluations. Consumption decreases to a larger extent in these cases. Households have a larger incentive to substitute future for current consumption, because they anticipate its (after-consumption tax) price will decrease in the very near future (after the end of the first year). However, investment increases more in the case of one- and two-year devaluations: given that the labour cost reduction is very temporary, the incentive for firms to accumulate capital and make labour more productive in the short run is large. Exports and imports largely increase and decrease, respectively. Home and foreign households shift their aggregate demand towards Home goods, which have become cheaper, and away from REA and RW goods. Overall, in

the short run Home GDP would be roughly constant in the case of one-year fiscal devaluation, because the lower consumption would not be counterbalanced by the larger investment and net (and gross) exports. The modest impact on production would imply a negligible positive effect on hours worked, while unemployment would slightly decrease.

In the (baseline) case of a five-year devaluation consumption decreases to a smaller extent in the short run than in the case of one-and two-year devaluation, because households anticipate that consumption taxes will be higher for a more prolonged period and thus smooth consumption over time (i.e., they reduce it by less, but for more periods). Moreover, short-run consumption is sustained by the positive wealth effect of longer-lasting labour tax reduction, that favors a more prolonged and larger increase in investment and employment (households and firms anticipate the future path of capital and labour and set current consumption decisions accordingly).

Short-run consumption does not decrease in the case of permanent fiscal devaluation. The positive wealth effect, due to the permanently higher production (and, thus, income) is the dominant driving force, while the negative intertemporal substitution effect is virtually null, given the permanent and constant change in labour and consumption tax rates. Investment initially decreases and thereafter increases, since firms have a lower incentive to immediately accumulate capital. The short-run GDP increase is low.

Consistent with the GDP responses, in the short run hours worked increase more (and unemployment decreases more) in the case of temporary devaluation. The real wage decreases in the short-run, consistent with the increase in consumption taxes. It increases in the case of permanent fiscal devaluation, because of the larger current and expected future labour demand.

In the medium run the five-year devaluation has larger expansionary effects on GDP than the permanent devaluation. The former is driven by the larger substitution effect, that induce households to quickly increase aggregate demand for investment. In the case of a permanent devaluation, households and firms gradually and permanently change their allocations to the new long-run levels, without overshooting them, so to smooth out the permanent shock.

Table 7 (column "fiscal devaluation") shows the new long-run steady-state in the case of the permanent devaluation. Qualitatively, results are similar to those along the transition. As shown by the charts, the transition to the new long-run steady-state equilibrium is relatively quick. Variables achieve their corresponding new levels in a relatively short amount of time, in particular it takes between three and four years to GDP and unemployment. Lower nominal rigidities can make the transition shorter, as reported in Section 3.2.1.[15]

[15]In the new steady state the trade balance returns to zero, consistent with the assumptions, holding in steady state but not along the transitional dynamics, of constant and zero net foreign asset position of the Home region. International relative prices permanently and endogenously adjust to guarantee that these steady-state

Fig. 7 reports responses of the main Home trade variables. The short-run trade balance improves in a rather similar way across all scenario. The improvement is almost negligible in the case of the permanent devaluation. Given that economic activity and, thus, income permanently increase, households have a low incentive to lend internationally. The increase in Home aggregate supply is matched by an almost equal increase in Home aggregate demand. Consistently, international relative prices change to a small extent.

Table 7 (column "lower labour tax rate") also reports the new steady-state results under the assumption that only the social contribution rate is permanently reduced (the consumption tax rate is kept constant at its initial steady-state level). They are expansionary and larger than those obtained in the fiscal devaluation scenario. Column "higher consumption tax rate"reports the long-run results under the assumption of a permanent increase in the consumption tax rate. Effects on main macroeconomic and labour market variables are negative.[16]

Overall, results suggest that the foreseen duration of the devaluation matters, to some extent, for its short-run macroeconomic effectiveness.

Consistent with the literature (see Attinasi et al. (2018) we have also computed steady-state welfare gains/losses in the case of a permanent fiscal devaluation. They are measured in terms of how much of initial steady-state consumption (in per cent) the Home household would be willing to give up in order to be indifferent between living in the initial or in the final steady state. We have also calculated the welfare gains/losses including the transition paths from the initial to the final steady state.

When the transition is not taken into account, welfare increases by 0.012 per cent. The increase in utility associated with higher consumption more than offsets the increase in disutility associated with higher labor. When the transition is also considered, the welfare gain is lower (0.007 per cent), given that in the short run the labour increases while consumption decreases. Moreover, the negative, albeit mild, contribution of the transition suggests that temporary fiscal devaluations would have very small negative effects on welfare. However, welfare is computed by assuming that the representative household assumption holds, i.e., that there is consumption risk sharing between employed and unemployed members of the household. It cannot be excluded that, if the risk sharing assumption is relaxed, aggregate welfare could increase also in the case of temporary fiscal devaluation, as the utility of those household's member that become employed

assumptions are satisfied. Similarly, lump-sum taxes endogenously adjust, according to the Home fiscal rule, to guarantee that the public sector budget is balanced and the public debt returns to its (imposed) steady-state level.

[16]The algebraic sum of the effects of the labour tax reduction with those of the consumption tax increase are roughly equal to the effects of the fiscal devaluation. This is consistent with the absence of large non-linearities in the model.

widely increases because of higher consumption.

Overall, results suggest that fiscal devaluation could improve employment and external position of a country belonging to a monetary union.

3.2 Sensitivity analysis

We assess how results change when we implement the five-year fiscal devaluation under alternative assumptions on Home price stickiness, EA monetary policy accommodation, Home matching efficiency rate, and Home break-up rate.[17]

3.2.1 Price stickiness

Fig. 8 reports results of the devaluation under two alternative assumptions: (i) the domestic and foreign prices of the Home tradable goods are flexible; (ii) prices of Home tradable and non-tradable goods are flexible. The degree of nominal stickiness is calibrated so that prices, in Calvo (1983) terms, adjust once every two quarters.[18]

Price flexibility implies a quicker pass-through of production costs into products prices. Thus, prices immediately decrease following the lower unit labour costs, associated with lower labour taxes. When all Home prices are flexible the (before-consumption tax) Home inflation decreases more on impact, driven by the lower prices of domestic goods. Aggregate demand for consumption and investment shift towards the cheaper domestic good, favoring larger short-run positive response of GDP and negative response of (gross) imports that have quickly become expensive. Similarly, foreign demand shifts towards Home exports, that increase to a larger extent than in the case of sticky prices.

Short-run responses are larger in absolute value when all prices are flexible. If the prices of non-tradables are sticky, then the lower labour costs are partially absorbed by the markups and, thus, are not fully passed-through, in the short run, into the prices of the non-tradable goods.

The fast increase in economic activity implies that the labour market responds more in the short run. Hours worked and unemployment achieve their corresponding peak levels in a shorter amount of time than in the case of price stickiness. The real wage decreases to a lower extent

[17] Spillovers to the REA and RW are negligible. To save on space we do not report them.

[18] See Calvo (1983). The standard Calvo pricing equation, linking current inflation π_t to future expected inflation $E_t\pi_{t+1}$ and current-period marginal cost mc_t is $\pi_t = \beta E_t \pi_{t+1} + \tilde{\lambda} mc_t$, where $0 < \beta < 1$ is the discount factor and $\tilde{\lambda} \equiv (1-q)(1-\beta q)/q$ with $0 < q < 1$ being the constant probability that a firm must keep its price unchanged in any given period. The quadratic adjustment cost gives a similar (log-linearized) difference equation for inflation, but with $\tilde{\lambda} \equiv (\theta - 1)/\kappa$, where $\theta > 1$ is the elasticity of substitution among brands and $\kappa > 0$ is the parameter measuring the size of the quadratic cost. Thus, up to first order, it is possible to map the Rotemberg in the Calvo framework by equating the two definitions of $\tilde{\lambda}$ and solving the resulting equation for the unknown parameter q.

because of the larger fall in the before-consumption tax price level (that compensates for the positive effect of the increase in consumption taxes on after-tax price level).

Fig. 9 report the dynamics of the trade variables. The improvement of the trade balance is front-loaded, given that the pass-through of lower labour cost into prices of Home goods is higher. Thus, there is a larger substitution effect in favor of Home goods in the short run.

Overall, the simulations show that nominal price rigidities are key for the short-run effects of the fiscal devaluation.[19] The more flexible the prices in the short run, the larger the pass-through of labour costs into goods' prices, the more expansionary the short-run effects. To the opposite, sticky prices would imply that price markup would adjust in the short run, making the transition towards the new long-run steady-state equilibrium more gradual.

3.2.2 Monetary policy

Fig. 10 shows the effects of the Home fiscal devaluation under the assumption of the EA central bank keeping, in a credible way, the monetary policy rate at the baseline level in the initial four quarters of the simulation. The central bank resumes to follow the Taylor rule since the fifth quarter. In the charts we also report, for the sake of comparison, the results of the benchmark simulation (i.e., the central bank always follows the Taylor rule). Quantitatively, results do not greatly change, because the initial rise of the policy rate in the benchmark simulation is not very large, given the modest impact of Home inflation and economic activity on the overall EA corresponding variables (that enter the EA Taylor rule). The initial expansionary effect of the devaluation is somehow larger when the central bank does not raise the policy rate but keeps it at the baseline level. In the short run, consumption decreases to a lower extent, while investment increases more. Consistent with the relatively higher Home demand, Home imports increase slightly more. Higher Home demand also positively affects Home prices. Thus, Home exports increase to a slightly lower extent. Their dynamics is sustained by the depreciation of the euro nominal exchange rate. Different from the baseline simulation, the exchange rate now depreciates, because the EA monetary policy rate does not increase.[20] The Home trade balance is not greatly affected.

Overall, results do not greatly change when the monetary policy stance is accommodative.

[19] Long-run results are not affected, as prices are fully flexible in steady-state equilibria.

[20] The nominal exchange rate is determined by the modified uncovered interest parity condition, that links the difference between EA and RW monetary policy rate to the expected depreciation rate of the euro.

3.2.3 High separation rate and high job finding rate

Fig. 11 shows the effects of the Home fiscal devaluation under the assumption that the values of the matching efficiency rate is increased by 50 per cent, from 0.052 to 0.078 (higher than the corresponding REA value, equal to 0.06). The figure also reports the case of increasing both the matching efficiency rate and break-up rate. The latter is increased from 0.5 to 0.7, the value of the REA break-up rate.

Relative to the benchmark case, the new higher values of the considered parameters make the Home labour market more flexible. The additional expansionary effects are not extremely large. Hours worked and unemployment rates increase and decrease to a higher extent, respectively. Firms have now higher convenience in hiring. Thus, they increase labour demand relatively more, favoring wages, that increase (relative to the benchmark). The higher labour market flexibility, by favoring employment, stimulates economic activity and, thus, to some extent, GDP. The expansionary effects are somewhow larger if both the rates are simultaneously increased.[21]

Overall, results are robust to the changes in the two considered structural parameters.

4 Conclusions

We have quantitatively assessed the effects of a fiscal devaluation enacted by one Member State of the EA. We find a positive effect on GDP and employment. Exports also rise, thanks to an increase in competitiveness, and the trade balance improves. On the demand side, households' consumption declines, due to the higher consumption tax, while investment increases.

Our work can be further extended. First, it would be interesting to compare the effects of a fiscal devaluation on labour market with those obtained by structural reforms aiming at increasing the flexibility in the product and labour markets.[22] Second, intermediate goods and services could be introduced in the production function joint with capital and labour. In this case, changes in the relative prices of internationally traded goods would also have a direct and large impact on the supply side of the economy. Third, it would also be of interest to compare the effects of fiscal devaluation on employment with those of an expansionary fiscal measure based on an increase in public investment, that would affect both the demand and, through higher public capital, the supply side of the economy. Fourth, we could assess the macroeconomic effects of higher consumption tax revenues financing a reduction in taxes levied on households

[21] Responses of the trade variables do not greatly change relative to the benchmark. To save on space we do not report them. They are available upon request.

[22] For an analysis of the macroeconomic impact of reforms in the EA non-tradable sectors, see Gomes et al. (2013).

wage income, instead of taxes levied on wage payments by firms. In that case, it cannot be excluded that the implied price competitiveness gains could be lower than those reported in this paper, since higher wage income could imply a larger increase in domestic aggregate demand and thus a smaller decrease in the price of domestic goods, for a given domestic aggregate supply. The interaction of these macroeconomic effects with the assumed wage bargaining structure is worth exploring. Finally, changes in international relative prices could have a crucial role for macroeconomic stabilization when the central bank normalizes the monetary policy after having implemented non-standard monetary policy measures. We leave all these interesting topics for future research.

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Table 1: Main macroeconomic variables

	H	REA	RW
Private consumption	61.2	61.4	61.8
Public consumption	19.0	18.0	18.0
Investment	17.6	17.9	17.6
Imports	28.9	19.1	4.5
Net foreign asset position	0.0	0.0	0.0
Public debt	130.0	90.0	60.0
Consumption tax rate τ^c, τ^{c*}, τ^{c**}	0.18	0.20	0.20
Social contribution rate paid by employers τ^{wf}, τ^{wf*}, τ^{wf**}	0.27	0.25	–
Labour tax rate (households) τ^{wh}, τ^{wh*}, τ^{wh**}	0.20	0.18	0.35
Capital income tax rate τ^{rk}, τ^{rk*}, τ^{rk**}	0.32	0.30	0.30
GDP	3.3	17.5	79.2

Note: H = Home; REA = rest of the euro area; RW = rest of the world. Consumption tax rate, social contribution rate paid by employers, labor tax rate (households), and capital income tax rate: pp. GDP in per cent of world GDP. Public debt in per cent of annualized GDP. All other variables in per cent of GDP.

Table 2: Parameterisation

Parameter	H	REA	RW
Discount factor β, β^*, β^{**}	0.9926	0.9926	0.9926
Intertemporal elasticity of substitution $1/\sigma$, $1/\sigma^*$, $1/\sigma^{**}$	1.0	1.0	1.0
Inverse of Frisch elasticity of labour supply τ, τ^*, τ^{**}	2.1	2.1	2.1
Disutility of labour, χ, χ^*, χ^{**}	2.2	2.2	2.2
Habit ς, ς^*, ς^{**}	0.7	0.7	0.7
Depreciation rate of capital δ, δ^*, δ^{**}	0.025	0.025	0.025
Tradable intermediate goods			
Subst. between factors of production $\xi_T, \xi_T^*, \xi_T^{**}$	0.95	0.95	0.95
Bias towards capital $\alpha_T, \alpha_T^*, \alpha_T^{**}$	0.51	0.45	0.52
Non-tradable intermediate goods			
Subst. between factors of production $\xi_N, \xi_N^*, \xi_N^{**}$	0.95	0.95	0.95
Bias towards capital $\alpha_N, \alpha_N^*, \alpha_N^{**}$	0.51	0.45	0.52
Final consumption goods			
Subst. between domestic and imported goods $\phi_A, \phi_A^*, \phi_A^{**}$	1.50	1.50	1.50
Bias towards domestic tradable goods a_H, a_G^*, a_F^{**}	0.55	0.35	0.90
Subst. between tradables and non tradables $\rho_A, \rho_A^*, \rho_A^{**}$	0.50	0.50	0.50
Bias towards tradable goods a_T, a_T^*, a_T^{**}	0.64	0.35	0.35
Final investment goods			
Subst. between domestic and imported goods $\phi_E, \phi_E^*, \phi_E^{**}$	1.50	1.50	1.50
Bias towards domestic tradable goods $\upsilon_H, \upsilon_G^*, \upsilon_F^{**}$	0.55	0.35	0.90
Subst. between tradables and non tradables $\rho_E, \rho_E^*, \rho_E^{**}$	0.50	0.50	0.50
Bias towards tradable goods $\upsilon_T, \upsilon_T^*, \upsilon_T^{**}$	0.75	0.75	0.75

Note: H=Home; REA=rest of the euro area; RW= rest of the world. "*" refers to REA, "**" to RW.

Table 3: Labour market

	H	REA	RW
Matching efficiency, ϕ_{mat}, ϕ^{*}_{mat}, ϕ^{**}_{mat}	0.50	0.70	0.70
Matching elasticity, μ_{mat}, μ^{*}_{mat}, μ^{**}_{mat},	0.50	0.50	0.50
Bargaining power, η, η^{*}, η^{**}	0.50	0.50	0.50
Break-up rate, δ_x, δ^{*}_x, δ^{**}_x,	0.052	0.060	0.048
Vacancy posting cost, ψ, ψ^{*}, ψ^{**}	0.70	0.013	0.0001
Labour services production elasticity, α, α^{*}, α^{**}	0.60	0.60	0.60
Unemployment benefits, $uben$, $uben^{*}$, $uben^{**}$	11.4	0.76	3.23
Replacement ratio, $rrat$, $rrat^{*}$, $rrat^{**}$	0.65	0.65	0.65
Matching prob., workers, p^{W}, p^{W*}, p^{W**}	0.45	0.72	0.53
Matching prob., firms, p^{F}, p^{F*}, p^{F**}	0.56	0.68	0.92
Unemployment rate, un, un^{*}, un^{**}	10.9	8.1	8.7

Note: H = Home; REA = rest of the euro area; RW = rest of the world. Unemployment rate in per cent. "* " refers to REA, "** " to RW.

Table 4: Gross mark-up (implied elasticity of substitution)

	H	REA	RW
Tradables	1.20 ($\theta_T = 6$)	1.20 ($\theta^{*}_T = 6$)	1.20 ($\theta^{**}_T = 6$)
Nontradables	1.30 ($\theta_N = 4.44$)	1.24 ($\theta^{*}_N = 5.19$)	1.50 ($\theta^{**}_N = 3$)

Note: H = Home; REA = rest of the euro area; RW = rest of the world.

Table 5: Real and nominal adjustment costs

Parameter	H	REA	RW
Real adjustment costs			
Investment ϕ_I, ϕ_I^*, ϕ_I^{**}	2.50	2.50	2.50
Adjustment costs on bonds			
Households' private bond positions			
ϕ_{b1}, ϕ_{b1}^{**}	0.01	–	0.01
Nominal adjustment costs			
H produced tradables κ_H, κ_H^* κ_H^{**}	50	50	50
REA produced tradables κ_G, κ_G^* κ_G^{**}	50	50	50
RW produced tradables κ_F, κ_F^* κ_F^{**}	50	50	50
Non-tradables κ_N, κ_N^*, κ_N^{**}	400	400	400
Indexation			
Prices α_P, α_P^*, α_P^{**}	0.5	0.5	0.5

Note: H = Home; REA = rest of the euro area; RW = rest of the world. "* " refers to REA, "** " to RW.

Table 6: Fiscal and monetary policy rules

Parameter	H	REA	EA	RW
Fiscal policy rule				
$\phi_1, \phi_1^*, \phi_1^{**}$	1.01	1.01	-	1.01
$\phi_2, \phi_2^*, \phi_2^{**}$	1.01	1.01	-	1.01
Common monetary policy rule	-	-		
Lagged interest rate ρ_R, ρ_R^{**}	-	-	0.87	0.87
Inflation ρ_Π, ρ_Π^{**}	-	-	1.70	1.70
GDP growth $\rho_{GDP}, \rho_{GDP}^{**}$	-	-	0.10	0.10

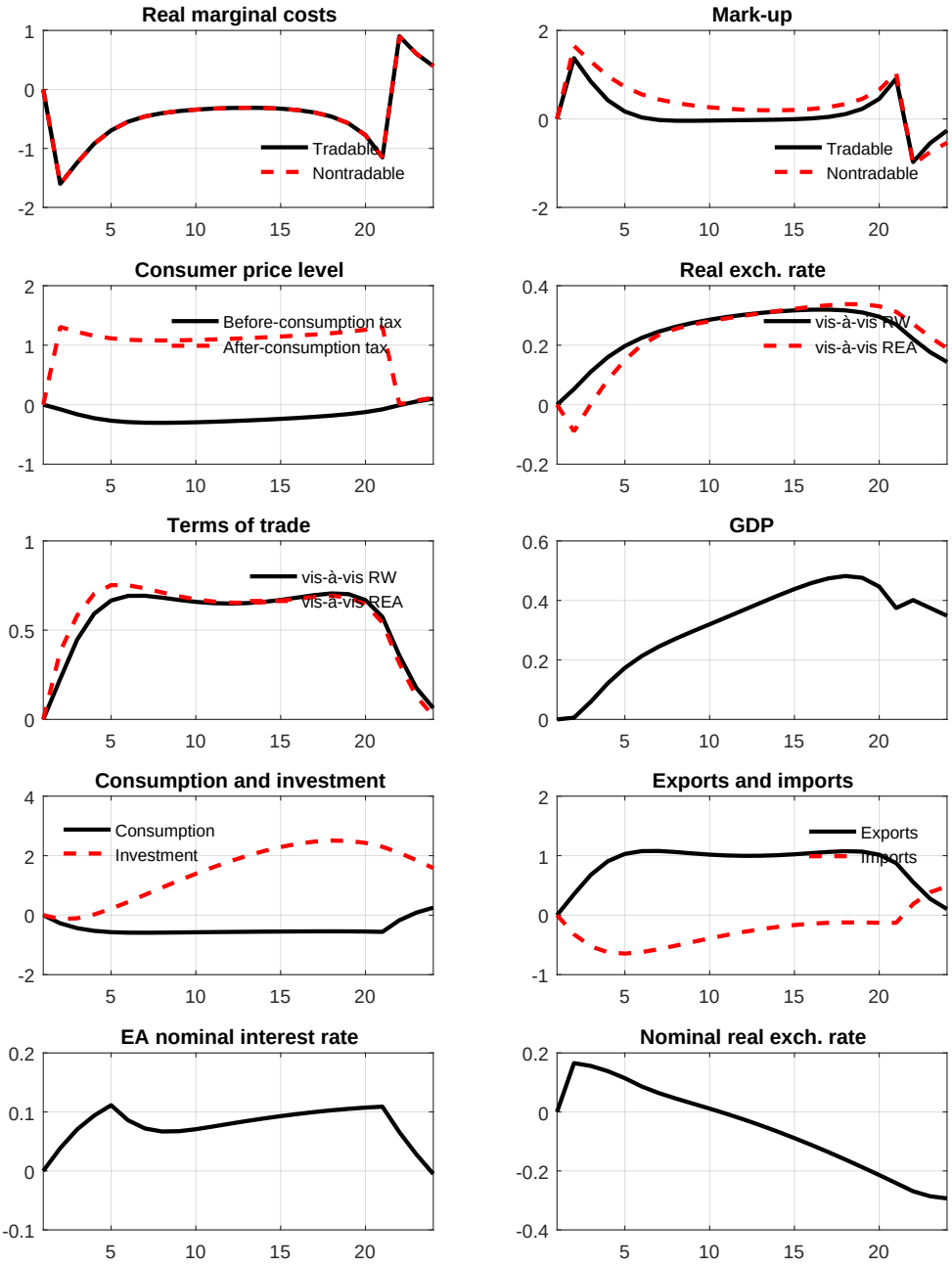
Note: H = Home; REA = rest of the euro area; EA = euro area; RW = rest of the world. "* " refers to REA, "** " to RW.

Table 7: Long-run (steady-state) effects of Home permanent fiscal devaluation. Home variables

	Fiscal devaluation	Lower social contrib. rate	Higher cons. tax rate
GDP	0.25	0.65	-0.42
Consumption	0.24	0.63	-0.41
Investment	0.17	0.45	-0.29
Exports	0.29	0.76	-0.49
Imports	0.10	0.25	-0.16
Real exch. rate vis-à-vis REA	0.12	0.32	-0.21
Real exch. rate vis-à-vis the RW	0.13	0.33	-0.22
Terms of trade vis-à-vis REA	0.19	0.51	-0.33
Terms of trade vis-à-vis RW	0.19	0.51	-0.33
Hours worked	0.38	1.00	-0.64
Hours worked per head	0.18	0.50	-0.30
Real hourly wage	0.62	1.67	-1.03
Wage income	1.00	2.69	-1.66
Unemployment rate	-0.17	-0.44	0.30

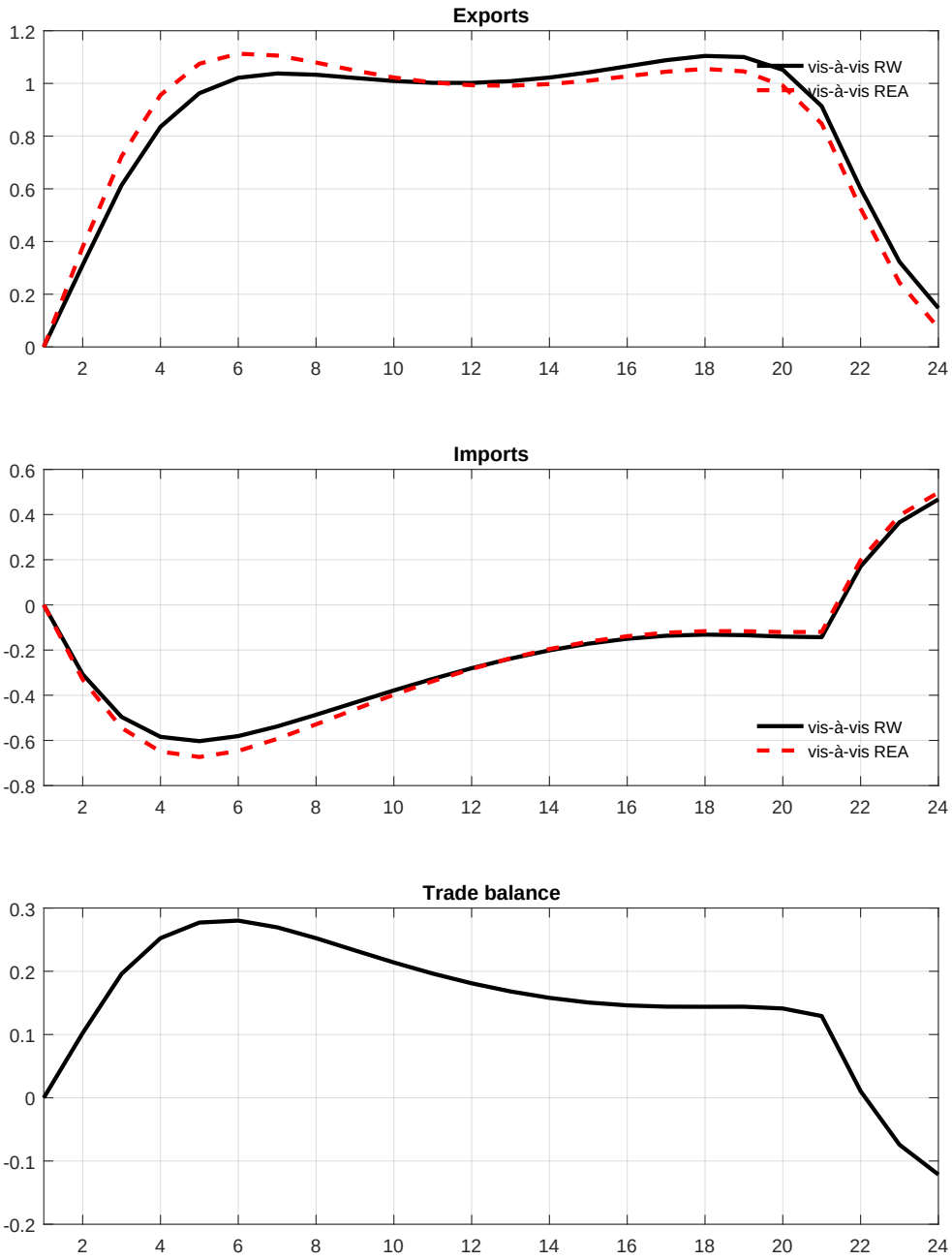
Note: per cent dev. from initial steady state. Unemployment rate: pp dev. from initial steady state. Real exchange rate: + is a depreciation; terms of trade: + is a deterioration. GDP and its components in real terms (evaluated at the initial steady-state prices).

Figure 1: Home fiscal devaluation. Home macroeconomic variables



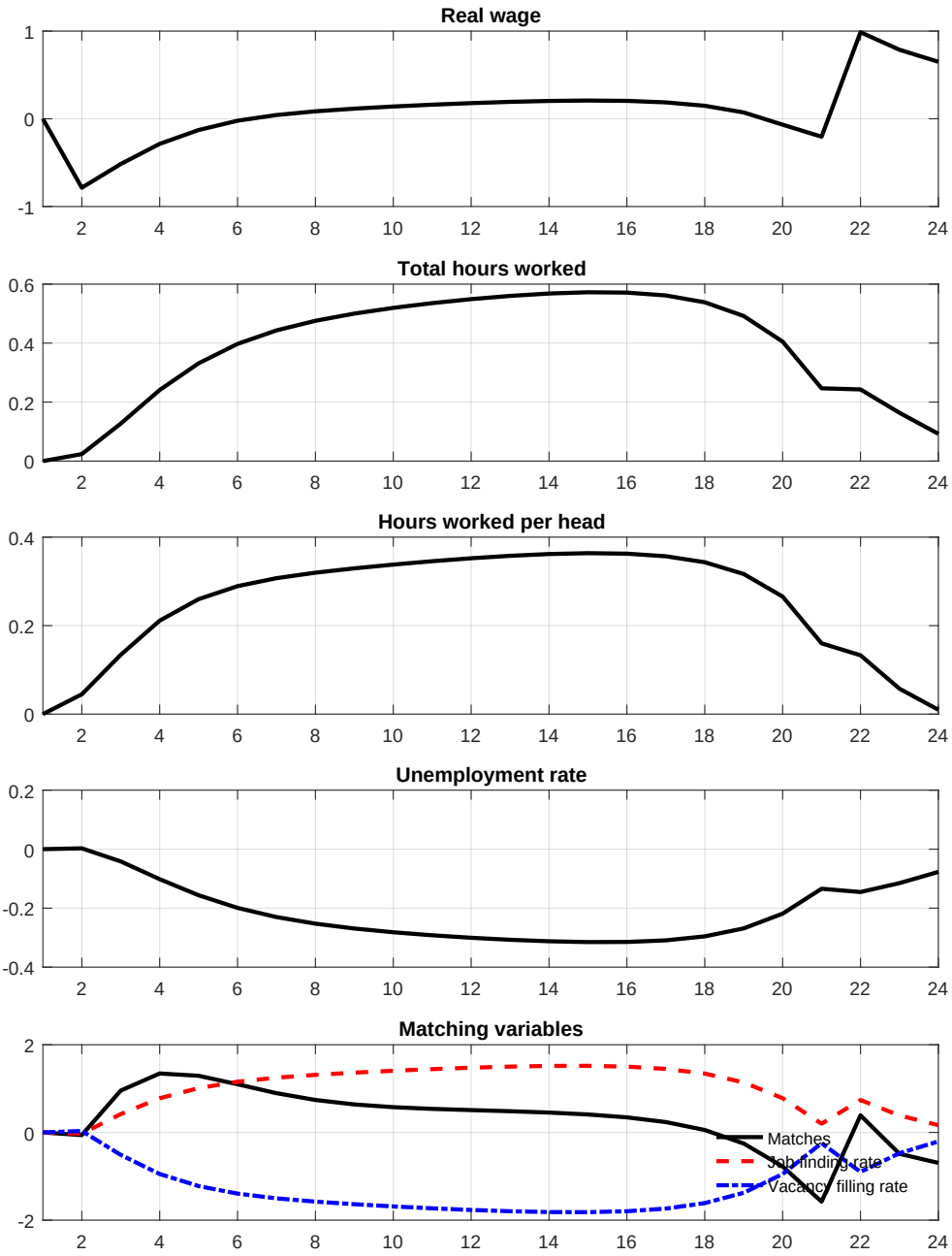
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline. GDP and its components evaluated at constant prices; real exchange rate: + is a depreciation; nominal exchange rate: + is depreciation of the euro; terms of trade: + is deterioration.

Figure 2: Home fiscal devaluation. Home trade variables



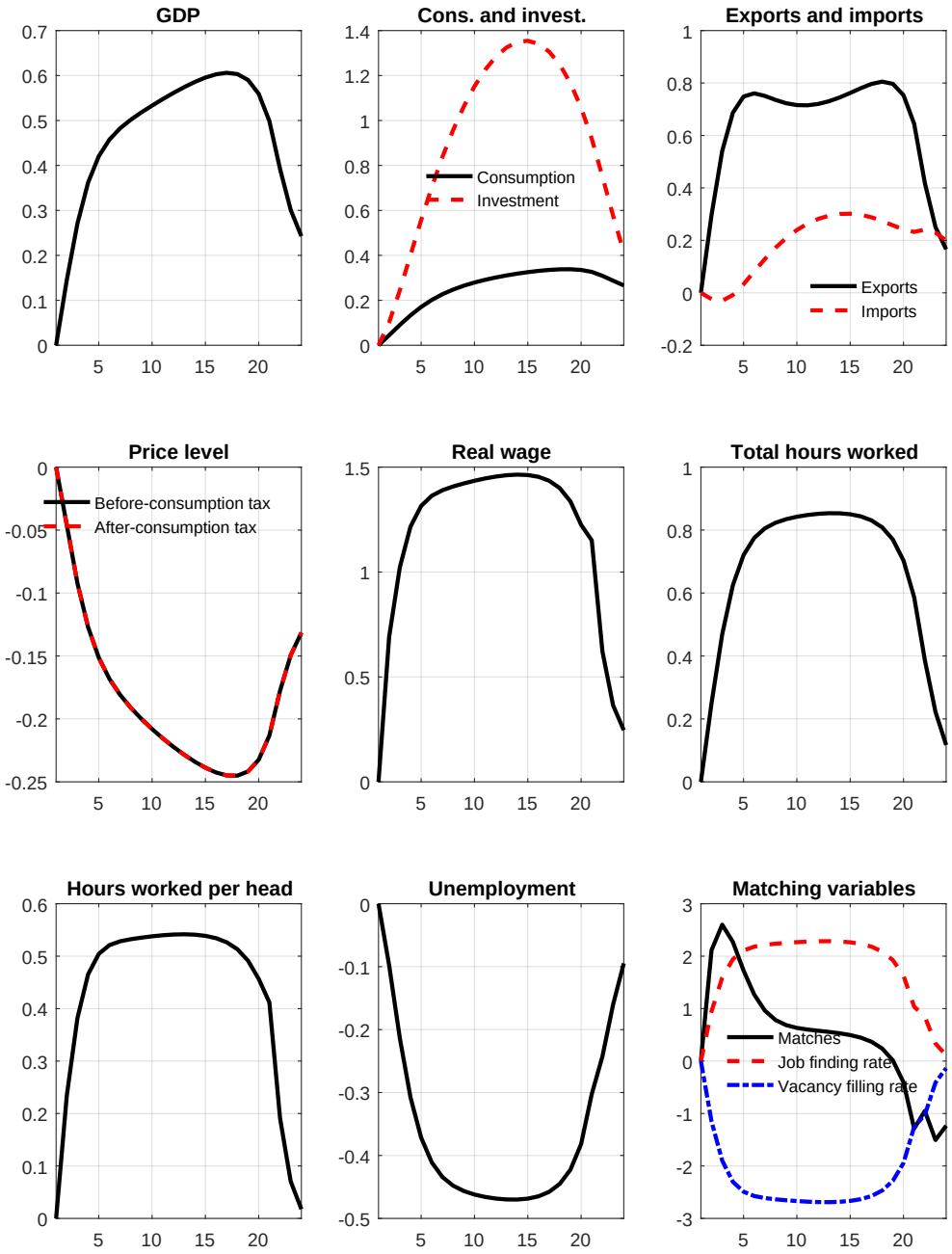
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; trade balance is reported as ratio to GDP, pp deviations from baseline. Exports and imports evaluated at constant prices.

Figure 3: Home fiscal devaluation. Home labour market variables



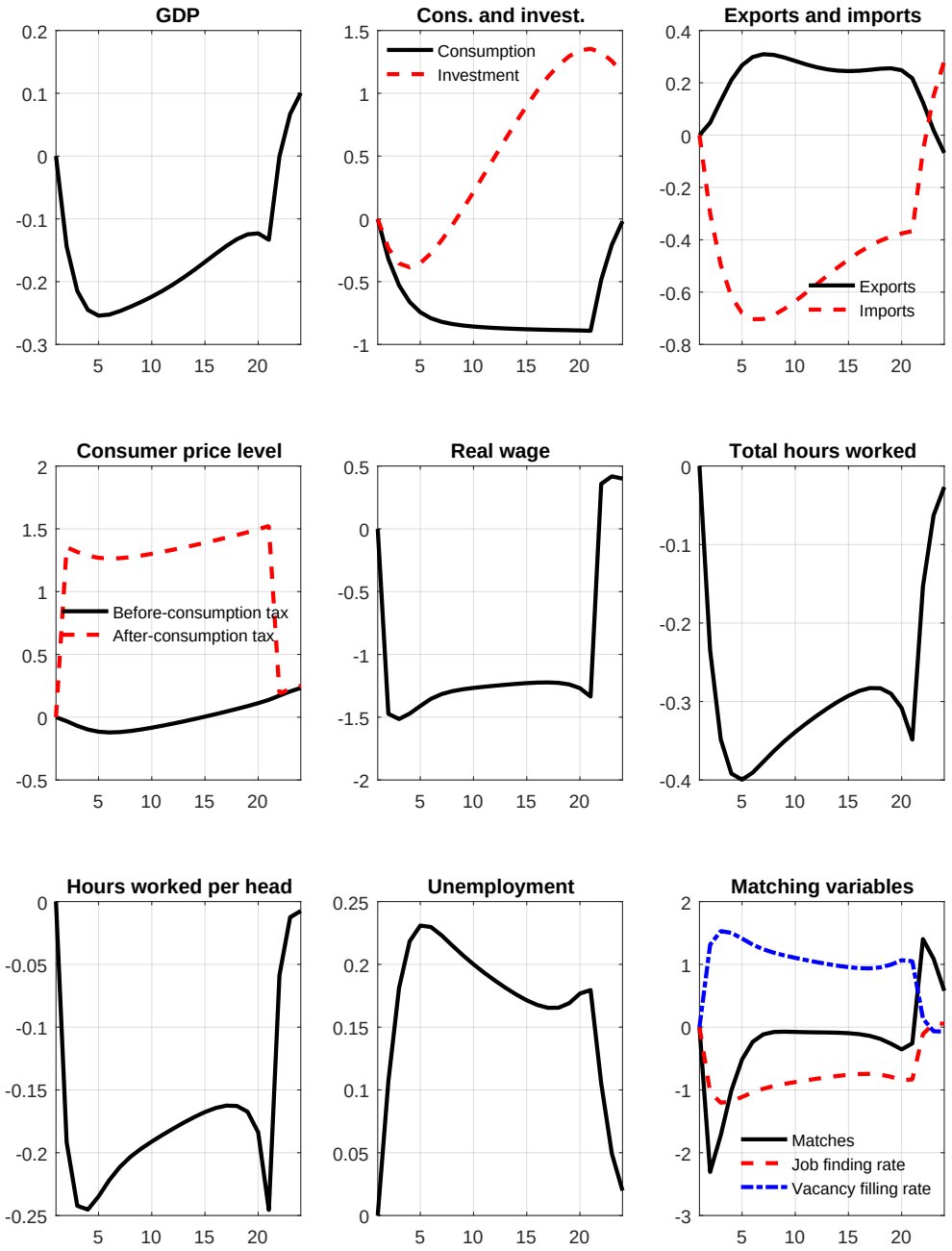
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment, job finding, and vacancy rates, pp deviations from baseline.

Figure 4: Decrease in Home social contribution rate for employers. Home variables



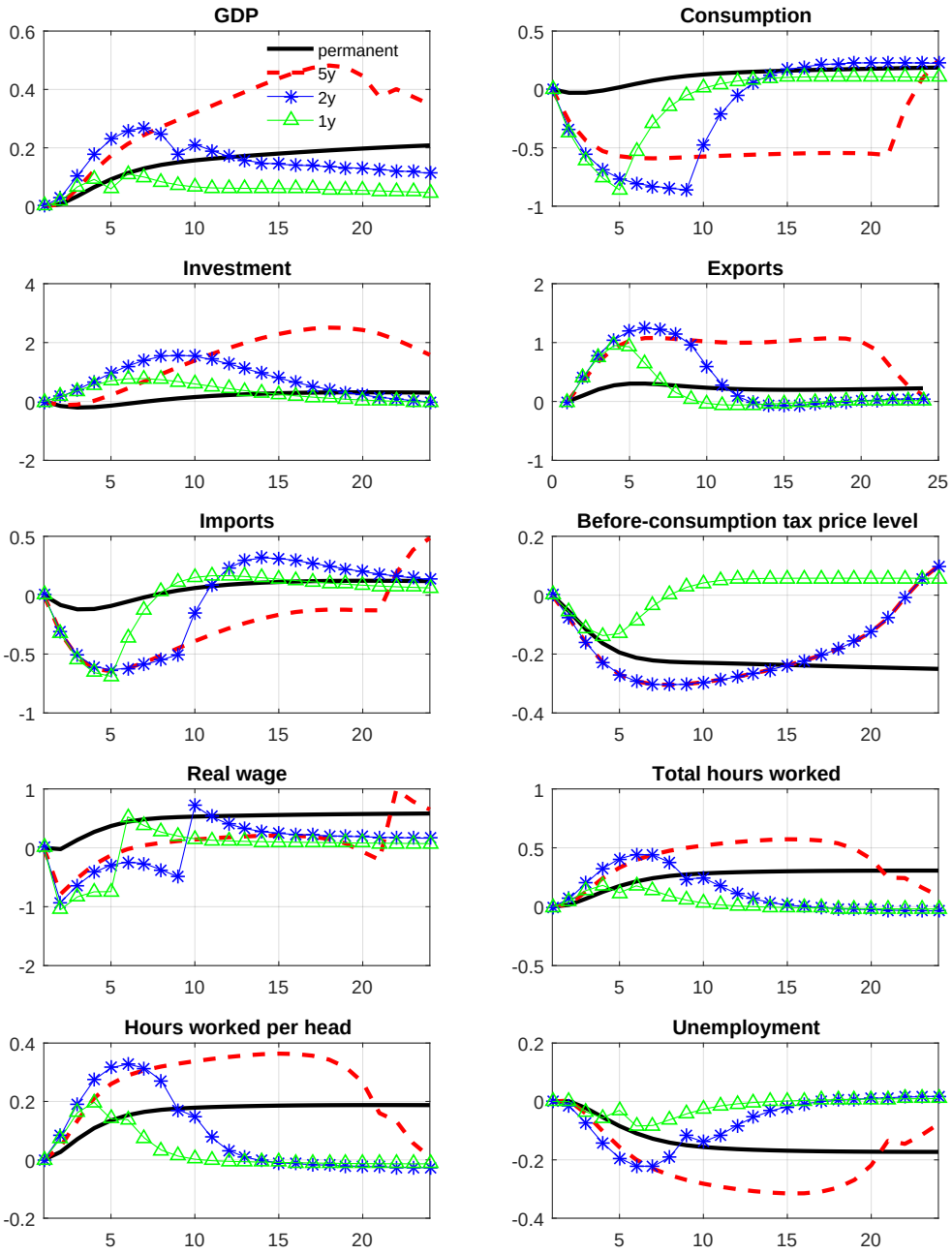
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment, job finding, and vacancy rates, pp deviations from baseline. GDP and its components evaluated at constant prices.

Figure 5: Increase in Home consumption tax. Home variables



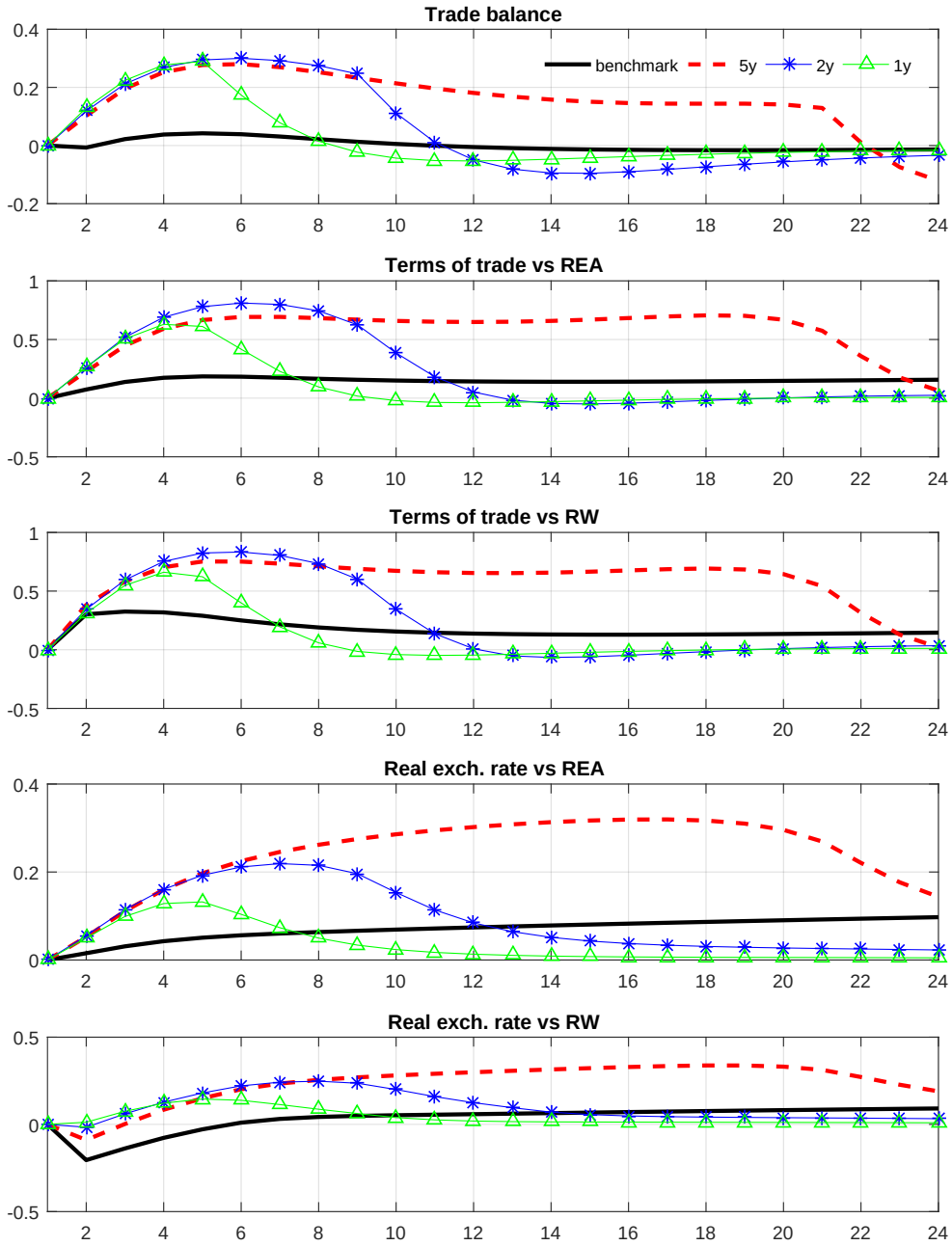
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment, job finding, and vacancy rates, pp deviations from baseline. GDP and its components evaluated at constant prices.

Figure 6: Permanent vs transitory fiscal devaluation. Home variables



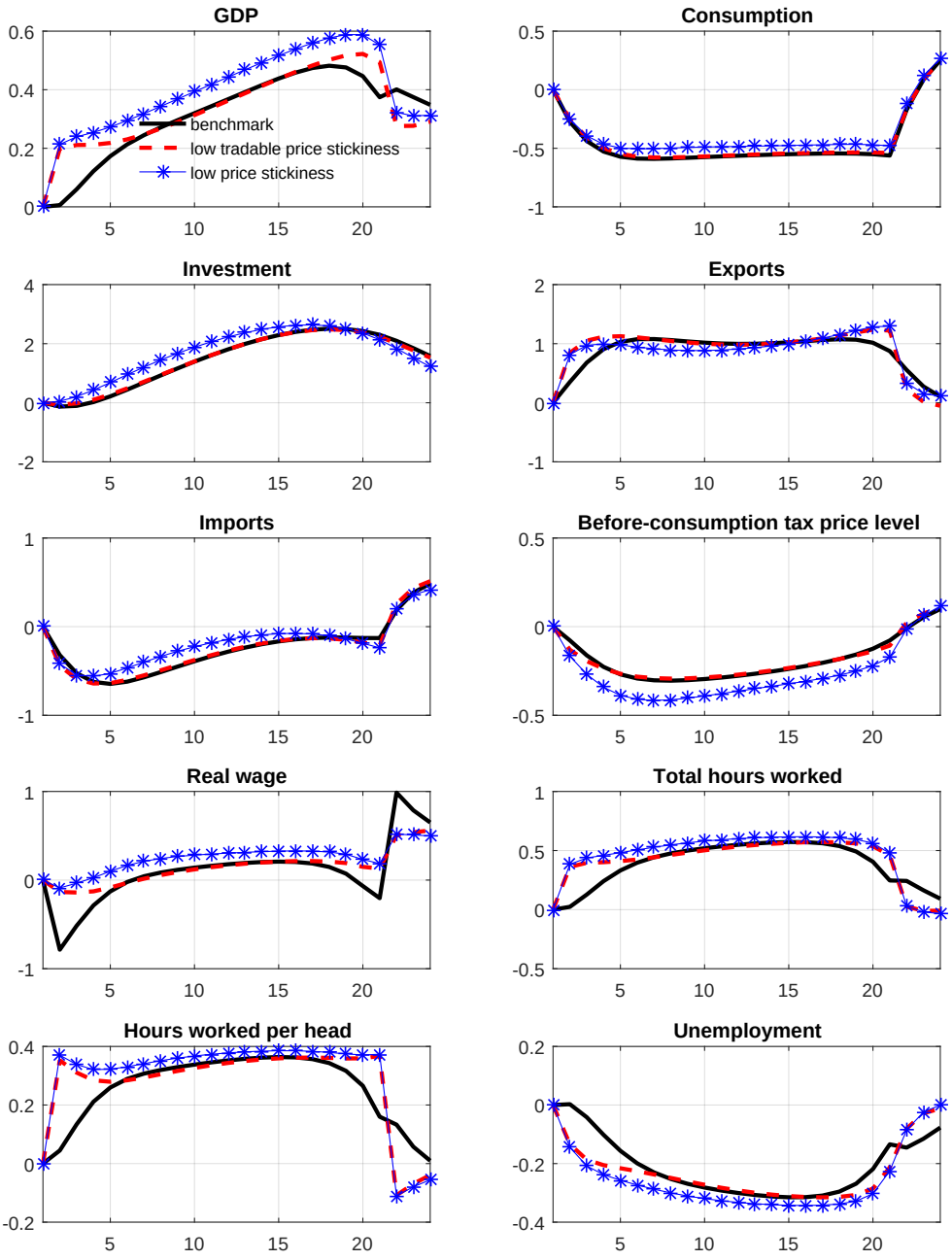
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment rate, pp deviations from baseline. GDP and its components evaluated at constant prices.

Figure 7: Permanent vs transitory fiscal devaluation. Home trade variables



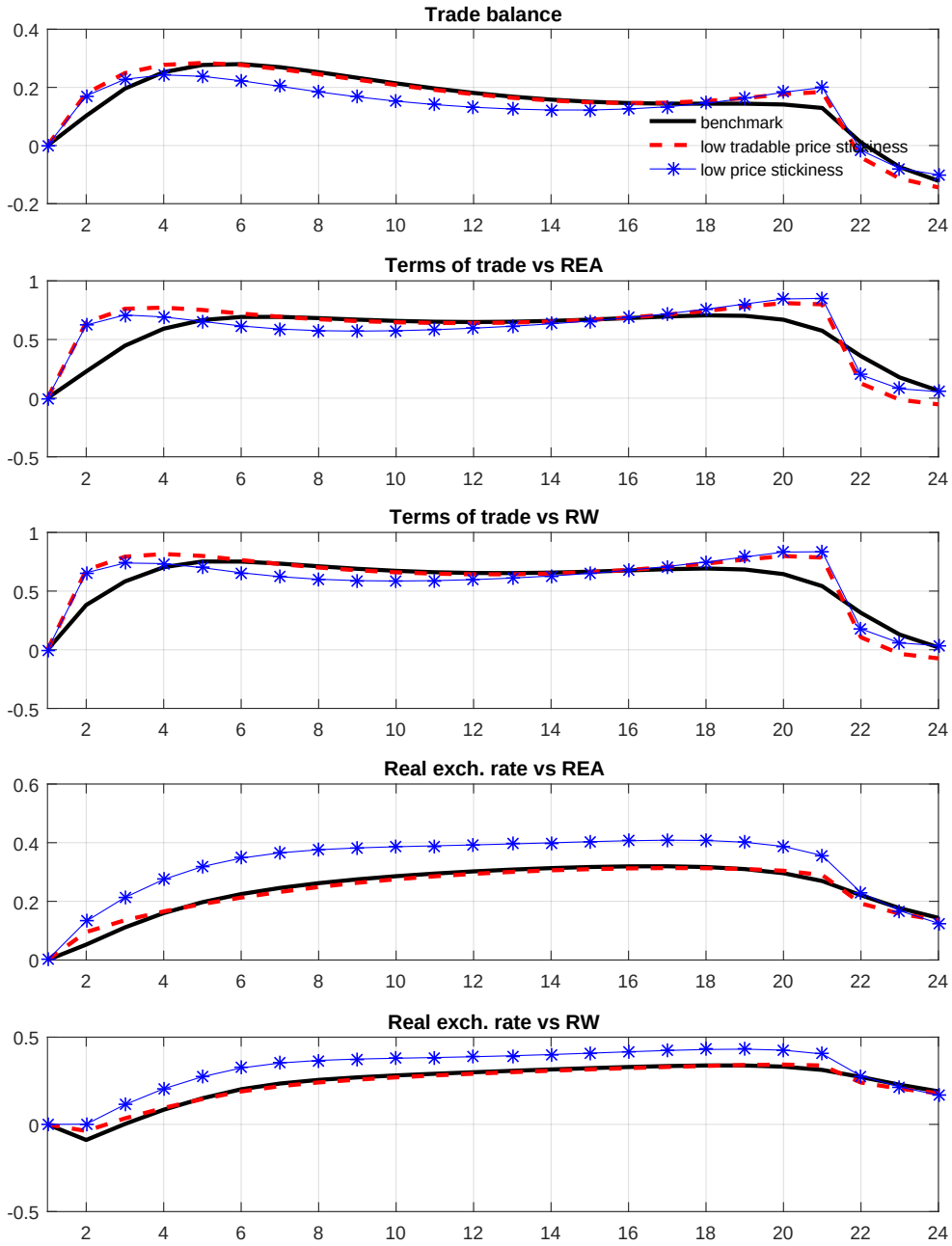
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; trade balance is reported as ratio to GDP, pp deviations from baseline. Real exchange rate: + is depreciation; terms of trade: + is deterioration.

Figure 8: Sensitivity: low Home price stickiness. Home variables



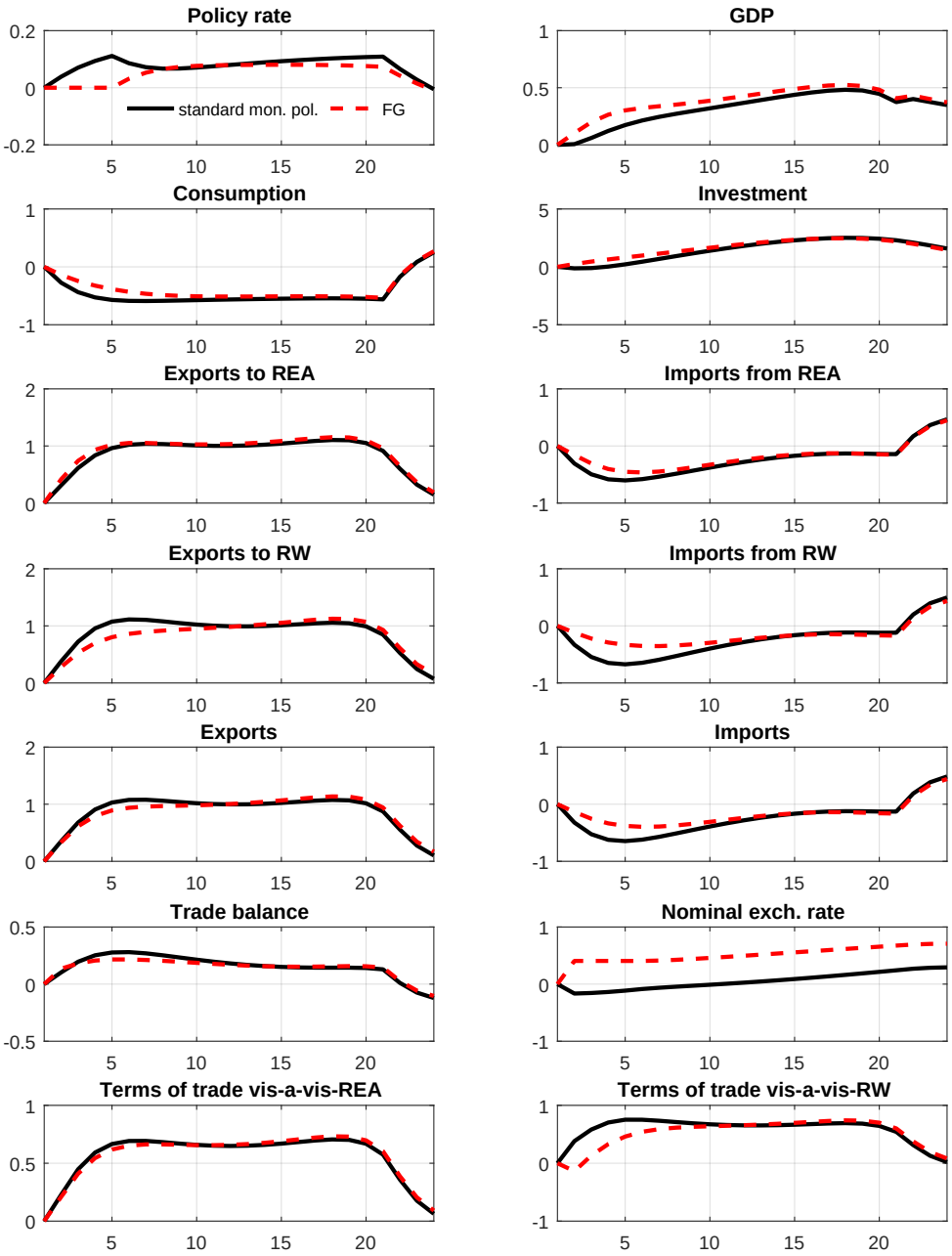
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment rate, pp deviations from baseline. GDP and its components evaluated at constant prices.

Figure 9: Sensitivity: low Home price stickiness. Home trade variables



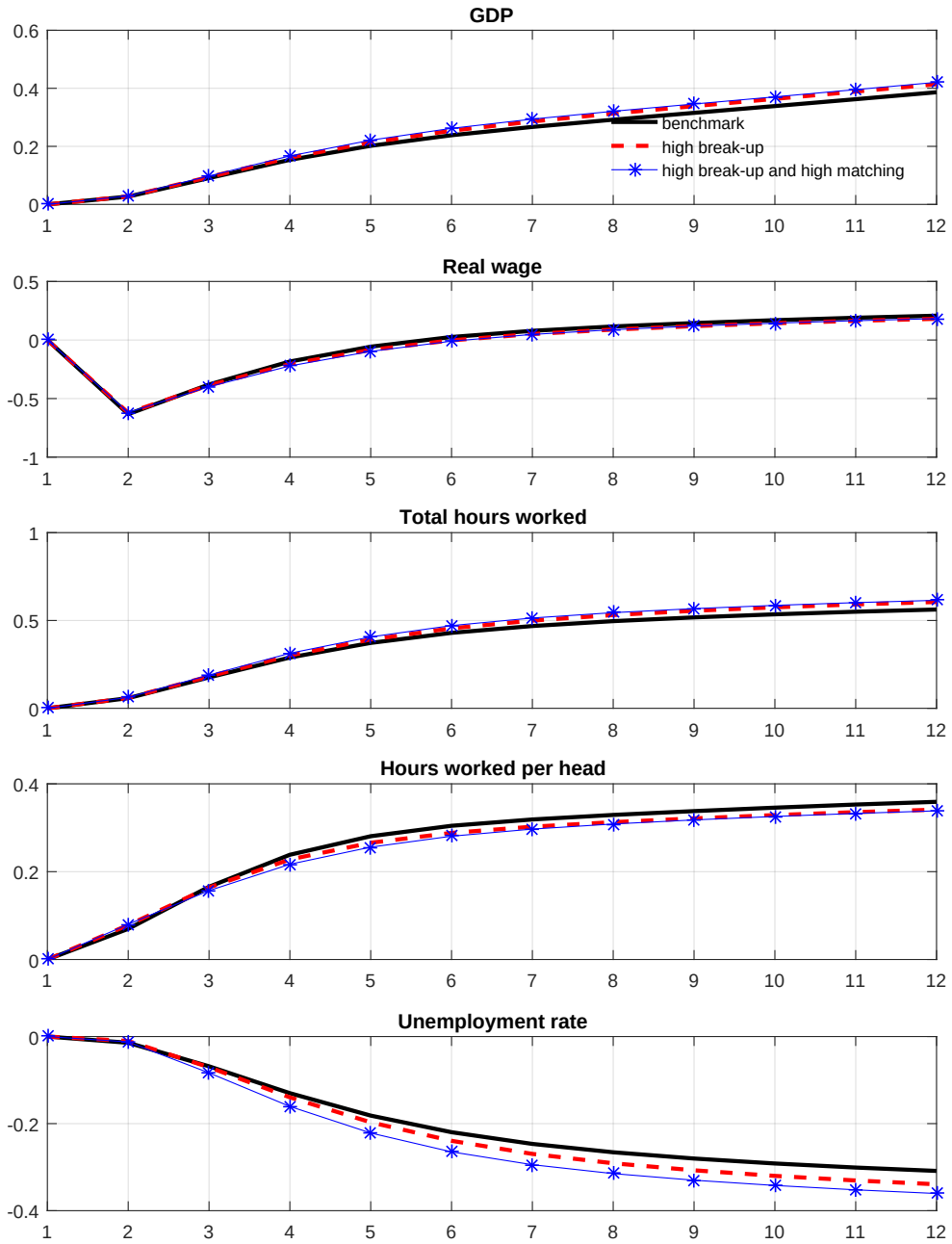
Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; trade balance is reported as ratio to GDP, pp deviations from baseline. Real exchange rate: + is depreciation: terms of trade: + is deterioration.

Figure 10: Sensitivity: EA accommodative monetary policy. Home variables



Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; trade balance is reported as ratio to GDP, pp deviations from baseline. Real exchange rate: + is depreciation; terms of trade: + is deterioration.

Figure 11: Sensitivity: High Home break-up rate and High Home matching efficiency rate. Home variables



Notes: quarters on the horizontal axis; on the vertical axis, per cent deviations from the baseline; for unemployment rate, pp deviations from baseline.

A Appendix: the labour market

There is a continuum of labour firms, each employing one worker. Labour firms enter the market by posting a vacancy and, if matched with a worker, bargain with households to determine the wage rate and sell homogeneous labour services from hired workers to firms producing intermediate goods.[23]

A.1 Matching and labour market flows

The matching process is modeled using the matching function

$$M_t^P = \phi_{mat}^P {un_t^P}^{\mu_{mat}^P} {vac_t^P}^{1-\mu_{mat}^P}, \tag{8}$$

where M_t^P is the number of matches in each period, vac_t^P the number of vacancies, un_t^P the number of unemployed workers searching for a job, $\phi_{mat}^P > 0$ the efficiency of the matching process, and $0 < \mu_{mat}^P < 1$ the elasticity of the matching function with respect to employment.

The probability for a searching worker to find a job, $p_t^{P,W}$, is

$$p_t^{P,W} \equiv \frac{M_t^P}{un_t^P} = \phi_{mat}^P \left(\frac{vac_t^P}{un_t^P}\right)^{1-\mu_{mat}^P}. \tag{9}$$

Similarly, the probability for a firm to find a worker, $p_t^{P,F}$, is

$$p_t^{P,F} \equiv \frac{M_t^P}{vac_t^P} = \phi_{mat}^P \left(\frac{vac_t^P}{un_t^P}\right)^{-\mu_{mat}^P}. \tag{10}$$

Using the above definitions of probabilities, it is possible to derive the law of motion for the number of employed workers. It is

$$\begin{aligned} nde_t^P &= (1-\delta_x^P) nde_{t-1}^P + M_t^P \\ &= (1-\delta_x^P) nde_{t-1}^P + p_t^{P,F} vac_t^P \\ &= (1-\delta_x^P) nde_{t-1}^P + p_t^{P,W} un_t^P, \end{aligned} \tag{11}$$

where it is assumed that separations occur at the beginning of the period ($0 < \delta_x^P < 1$ is the exogenous probability of becoming unemployed, i.e., the exogenous separation rate) and newly matched workers become productive within the period.[24] Similarly, the number of unemployed

[23] See Mortensen and Pissarides (1999) and Christoffel et al. (2009).

[24] Thus, there are two aggregates of employed workers. The number of employed workers *after matching has been completed*, is denoted by nde_t^P. These are workers who are in an employment relationship in the current period t. The number of employed workers *at the beginning of the period* t is smaller, and consists of workers who were employed in the previous period and have not been separated, $(1-\delta_x^P) nde_{t-1}^P$.

workers, un_t, who search for work at the beginning of the period t (i.e., the number of workers who enter the matching process), is equal to those who were unemployed at the end of the period $t-1$ after the $(t-1)$ matching has been completed, une_{t-1}, plus the newly separated workers, $\delta_x^P nde_{t-1}^P$:

$$un_t = une_{t-1} + \delta_x^P nde_{t-1}^P, \tag{12}$$

where

$$une_{t-1} = 1 - nde_{t-1}^P. \tag{13}$$

Consistently, the number une_t of unemployed at the end of the period t (after period t matching has been completed) is

$$une_t = 1 - nde_t^P. \tag{14}$$

A.2 Value functions

The value functions of households and labour firms are given by the current-period payoff and the continuation value, conditional on the probabilities of remaining in the current state or transiting to another state.

Household. In case a worker is employed she works h_t^P hours, receives a real (measured in domestic consumption units) hourly wage w_t^P and has to be compensated for the foregone leisure. In case of a break-up in the beginning of the next period, she will be unemployed, conditional on not matching successfully in the next period.

All unemployed workers search in the beginning of the next period, and can either become employed with probability $p_{t+1}^{P,W}$, or remain unemployed. Following den Haan et al. (2000), it is the household that takes the labour supply decision for its workers.

The value $E_{P,t}$ of being employed is therefore determined by the after-tax real wage income, reduced for the disutility of foregone leisure (measured in consumption units), plus the continuation value, which depends on the future employment status, transition probabilities, and the household's stochastic discount factor:

$$E_{P,t} = (1-\tau_t^{wh}) w_t^P h_t^P - \frac{\chi}{\lambda_t} \frac{h_t^{P\ 1+\zeta}}{1+\zeta} + \\ + \beta \frac{\lambda_{t+1}}{\lambda_t} \left(\delta_x^P (1 - p_{t+1}^{P,W}) U_{P,t+1} + (1 - \delta_x^P (1 - p_{t+1}^{P,W})) E_{P,t+1} \right), \tag{15}$$

where $0 < \tau_t^{wh} < 1$ is the labour tax rate paid by household on wage w_t^P, $1/\zeta$ is the Frisch labour supply elasticity, $\chi > 0$ is the weight of leisure in the utility function, $0 < \beta < 1$ is the

time discount factor, λ_t is the marginal utility of household consumption, and $\beta\lambda_{t+1}/\lambda_t$ is the household's stochastic discount factor.

The value of being unemployed is

$$U_{P,t} = u_{ben,t} + \beta\frac{\lambda_{t+1}}{\lambda_t}\left((1-p_{t+1}^{P,W})U_{P,t+1} + p_{t+1}^{P,W}E_{P,t+1}\right), \tag{16}$$

where unemployed workers receive unemployment benefits paid by the government, $u_{ben,t} \geq 0$. The value of being unemployed depends on the level of unemployment benefits, but also on the future states and probabilities of transition to those states. Unemployment benefits are assumed to be a fixed percentage $rrat > 0$ of the wage in the private sector,

$$u_{ben,t} = rrat\ w_t^P. \tag{17}$$

Labour firm. There is a continuum of labour firms. Each of them hires one worker. Labour firms sell labour services to firms in the intermediate sectors at a price x_t. To obtain labour services, they hire workers by posting vacancies. Once a worker is hired, she works h_t^P hours, which are transformed by a labour firm into labour services, $y_t^{P,h}$, according to the technology

$$y_t^{P,h} = h_t^{P\ \alpha_H},$$

where $\alpha_H > 0$. For every hour worked, a labour firm pays its worker a wage w_t^P.

The value for a labour firm of having a worker, $J_{P,t}$, is

$$J_{P,t} = x_t h_t^{P\ \alpha_H} - (1+\tau_t^{wf})w_t^P h_t^P + \beta\frac{\lambda_{t+1}}{\lambda_t}(1-\delta_x)\left(J_{P,t+1}\right). \tag{18}$$

The value of having a worker is determined by per-period profits of the labour firm, which are the difference between the revenues from selling labour services and costs of paying workers, which includes labour taxes paid by labour firms ($0 < \tau_t^{wf} < 1$ is the related tax rate). If there is no break-up of the employment relationship, the firm keeps the value of having a worker in the next period.

The value for a labour firm of having an open vacancy, $V_{P,t}$, is

$$V_{P,t} = -\psi + p_t^{P,F}J_{P,t} + \beta\frac{\lambda_{t+1}}{\lambda_t}\left((1-p_{t+1}^{P,F})V_{P,t+1}\right). \tag{19}$$

Every period, the firm has to pay a fixed cost $\psi > 0$ to search for a worker. If successful, which occurs with the probability $p_t^{P,F}$, it finds a worker and, by assumption, begins producing in the same period. If the firm does not find a worker, it remains with a vacancy. Labour firms post vacancies as long as the value of having a vacancy exceeds zero. Because entry is free, the value of

having a vacancy is driven to zero in equilibrium. Equation (19) can thus be simplified, resulting in the "free-entry condition"

$$\psi = p_t^{P,F} J_{P,t}, \tag{20}$$

which determines the number of vacancies in the model. Because the cost of having a vacancy open is fixed, and unemployment changes gradually, an increase in the value of having a worker $J_{P,t}$ induces firms to enter the labour market.

A.3 Wages and hours worked

The presence of labour market frictions implies that the wage is not equal to the marginal product of labour. Labour firms and households bargain over the surplus created by the match, taking into account their threat points (the value of having a vacancy, which is zero, and the value of being unemployed, respectively), bargaining powers, and labour taxes paid by each side in the bargaining.

We assume that wages in the private sector are determined by the Nash bargaining between labour firms and households that maximise the Nash surplus with respect to wages and hours worked. The role of the wage is to split this surplus between the labour firm and the worker. The first-order condition with respect to wages is:[25]

$$\eta(1-\tau_t^{wh})J_{P,t} = (1-\eta)(1+\tau_t^{wf})\left(E_{P,t} - U_{P,t}\right), \tag{21}$$

where $0 < \eta < 1$ is the bargaining power of households. Equation (21) implicitly determines wages in the private sector. Note that labour taxes paid by firms τ_t^f influence the bargaining of households and firms. For instance, the larger is the share of the surplus that goes to the households, the bigger is the tax base for labour taxes paid by households and hence taxes paid to the government. If the labour firm - worker pair decides to give higher share to the worker, the pair as a whole loses the amount collected by the government. Agreeing on a lower wage implies that the total surplus that can be shared is larger. In our setup, the effect is symmetric for household and firm taxes. Changes in the tax rates therefore affect not only the asset values, but also the shares of each side's surplus that the other side is able to appropriate.

Hours worked are determined as

$$\alpha_H x_t h_t^{P,\ \alpha_H - 1} = \frac{\chi h_t^{P\ \zeta}(1+\tau_t^{wf})}{\lambda_t(1-\tau_t^{wh})}, \tag{22}$$

[25] See Jacquinot et al. (2018) for the derivations of the equations.

where the marginal product for a labour firm of an additional hour of labour services sold to intermediate goods firms is equated to the disutility of the household having its workers work an additional hour (measured in consumption units). Note that the condition (22) depends on x_t (the price of labour services sold by the labour firms to intermediate-goods firms) and, thus, only indirectly, via general equilibrium effects, on wages w_t. Moreover, it depends on labour taxes. An increase in the latter implies a reduction in the number of hours worked and, therefore in the total surplus of the match between a worker and a firm.

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