

Macroeconomic effects of non-standard monetary policy measures in the euro area: the role of corporate bond purchases

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April 26, 2017

Abstract

This paper evaluates the macroeconomic effects of the Corporate Sector Purchase Programme (CSPP) implemented in the euro area (EA) by the Eurosystem. To this purpose, we calibrate and simulate a monetary-union dynamic general equilibrium model. We assume that entrepreneurs can finance their spending by issuing bonds in the domestic corporate bond market and by borrowing from domestic banks. Our results are as follows. First, the March 2016 CSPP boosts EA GDP by around 0.2% in the second year (peak level). Inflation rises too but by a smaller amount. Second, taking into account the extension of December 2016, the overall impact of the programme on GDP amounts to 0.4%. Third, the CSPP also stimulates banking activity, because the improvement in macroeconomic conditions induces a higher demand for loans from households and entrepreneurs. Fourth, the macroeconomic effectiveness of the programme is positively affected by a more gradual exit policy from the CSPP and by the duration of the forward guidance on policy rate.

Keywords: DSGE models, financial frictions, open-economy macroeconomics, non-standard monetary policy, corporate bonds, forward guidance, euro area.

JEL classifications: E43; E44; E52; E58.

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1 Introduction¹

On 8 June 2016 the Eurosystem started to purchase corporate bonds under its Corporate Sector Purchase Programme (CSPP). The CSPP was announced by the ECB's Governing Council following its meeting on 10 March, with the aim to further strengthen the pass-through of the Eurosystem's asset purchases to the financing conditions of the real economy.² Under the CSPP, the Eurosystem purchases securities issued by non-bank corporations in both primary and secondary markets.

This paper evaluates the macroeconomic effects of the CSPP. To this purpose, we simulate a large-scale New Keynesian dynamic general equilibrium model calibrated to the euro area (EA) and the rest of the world (RW). The EA is modelled as a monetary union of two regions, Home (also referred to as 'domestic economy', calibrated to Italy for illustrative purposes) and rest of the EA (REA), where Home is of medium size (its GDP being around 20% of overall EA GDP).

The model has the following crucial features.

In each EA region there are (non-financial) entrepreneurs. Entrepreneurs hold shares of domestic physical capital producers, that invest in physical capital accumulation and rent it to domestic firms. Entrepreneurs finance their spending by issuing securities to domestic households (savers) and by borrowing from the domestic banking sector. Securities and loans are imperfect substitutes. Securities are uncollateralized long-term bonds in the form of perpetuities with exponentially decaying coupons.³ Bank loans are collateralized by entrepreneurs' real estate, which is a durable good that enters the production function of regional intermediate goods. The collateralization takes the form of a loan-to-value (LTV) ratio (entrepreneurs' bank loans are proportional to the expected value of real estate).

In each EA region there is a banking sector. It collects deposits from domestic

¹The opinions expressed are those of the authors and do not reflect views of the Bank of Italy. Any remaining errors are the sole responsibility of the authors.

²The CSPP is part of the Eurosystem's Expanded Asset Purchase Programme (APP), which was announced in January 2015 by the European Central Bank and includes mostly sovereign bonds' purchases.

³This is consistent with one of the main features of the CSPP, i.e., that its eligible maturity spectrum ranges from a minimum remaining maturity of six months to a maximum remaining maturity of 30 years at the time of the purchase.

savers and lends to domestic entrepreneurs and other domestic households (borrowers). As in the case of entrepreneurs, the borrowers use real estate as collateral when demanding bank loans. The banking sector also buys domestic long-term sovereign bonds (this feature is not crucial for our results).

The presence of both bank loans and corporate bonds allows us to model and calibrate the financial structure of entrepreneurs, which represent the non-financial corporate sector in our model. It also allows us to assess the indirect effects of the CSPP on the banking sector. Moreover, we model another category of households, labeled ‘restricted’ (thus, in the model there are three different, non-overlapping types of households: savers, borrowers, and restricted). Restricted households represent non-bank financial institutions investing in particular classes of assets. In the model, they are allowed to invest in shares of capital producers and long-term sovereign bonds.

Given these features, the core of the transmission mechanism of the CSPP is as follows. The higher demand from the Eurosystem increases corporate bond prices and reduces interest rates. Thus, entrepreneurs have an incentive to issue bonds so as to finance investment in physical capital (because of their stake in capital producers) and purchases of real estate and consumption goods.

The remaining model features are in line with existing large-scale dynamic general equilibrium models of the EA, such as the ECB New Area Wide Model (see Christoffel, Coenen, and Warne 2008). In particular, we distinguish between final (nontradable) consumption and investment goods and between intermediate tradable and nontradable goods, produced according to sector-specific technologies exploiting domestic capital and labor. We also include standard nominal (price and wage) and real (consumption habit and investment adjustment costs) frictions.

The following scenarios are simulated. First, the Eurosystem credibly announces that it immediately implements purchases of corporate bonds that last for 4 quarters. This is consistent with the fact that the CSPP was announced on 10 March 2016 (we consider this as the beginning of 2016Q2 for simplicity), the purchases started on 8 June 2016 (thus, during 2016Q2), and they were intended to last until March 2017 (that is, 2017Q1 included). The amount of quarterly purchases was around €6bn in 2016Q2, €23bn in 2016Q3, €21bn in 2016Q4, and €24bn in 2017Q1 (around 0.3% of quarterly average EA GDP in the first quarter

of simulation and 1% in the following ones).⁴ We assume that the bonds are held to maturity (the latter is set to around 8 years, roughly the average maturity of non-banking corporate securities in the EA). The EA (short-term) monetary policy rate is kept constant at the baseline level for 8 quarters (forward guidance on monetary policy rate, FG). Thereafter, it follows a standard Taylor rule and reacts to EA-wide inflation and economic activity.

We run alternative scenarios. Specifically, we evaluate the role of exit policy (corporate bonds are held by the Eurosystem for an amount of time shorter than the bonds' maturity) and FG (longer or shorter than two years). In all scenarios the sequence of purchases is fully anticipated by households and firms (perfect foresight assumption).

Finally, we simulate the extension of the CSPP leg of the APP as announced on 8 December 2016 (we consider this as the beginning of 2017Q1 for simplicity). The additional purchases start after March 2017, i.e., in 2017Q2, and should last for 3 quarters until the end of 2017 (that is, 2017Q4). Hence, we assume that the extension, which we label 'CSPP2,' consists of a first quarter of simulation with zero purchases (corresponding to 2017Q1) followed by quarterly purchases equal to €24bn, that is, of the same amount as the last recorded quarter (2017Q1).

The main results are as follows. First, the March 2016 CSPP boosts EA GDP by around 0.2% in the second year (peak level). Inflation rises too but by a smaller amount. Second, taking into account the extension of December 2016, the overall impact of the programme on GDP amounts to 0.4%. Third, the CSPP also stimulates banking activity, because the improvement in macroeconomic conditions induces a higher demand for loans from households and entrepreneurs. Fourth, the macroeconomic effectiveness of the programme is positively affected by a more gradual exit policy from the CSPP and by the duration of the FG on policy rate.

There are reasons to believe that our estimates of CSPP's macroeconomic effects are a lower bound. The inclusion into the model of portfolio choices that distinguish among different classes of corporate bonds would allow to assess the indirect impact of the CSPP on less safe corporate sectors such as the high yield, whose relatively tight financial conditions are likely to indirectly benefit more from the CSPP.

⁴Check ECB (2017) for details on CSPP holdings at book value by quarter.

The paper builds upon several recent contributions. Burlon et al. (2015, 2016a, 2016b) evaluate the macroeconomic effects of the PSPP, i.e., purchases of sovereign bonds by the Eurosystem. Different from them, we focus on the CSPP, and evaluate its macroeconomic effects on the EA economy. The banking sector is akin to Gerali et al. (2010) and, more recently, to Bokan et al. (2016). Different from them, we allow entrepreneurs to finance investment by issuing also corporate bonds. To the best of our knowledge, this is the first attempt to provide an evaluation of the CSPP macroeconomic effects with a structural model of the EA.

The paper is organized as follows. Section 2 describes the main features of the model, in particular the problem of the entrepreneurs, the corporate bonds and banking sector. Section 3 describes the simulated scenarios. Section 4 reports the main results. Section 5 concludes.

2 The model

We first provide an overview of the model. Subsequently, we illustrate the crucial features for the simulations (entrepreneurs and banking sector). Finally, we report the calibration.

2.1 Overview

The model represents a world economy composed of three regions, that is, Home, REA (Home+REA=EA), and RW. The size of the world economy is normalized to one. Home, REA, and RW have sizes equal to n , n^* , and $(1 - n - n^*)$, with $n > 0$, $n^* > 0$, and $n + n^* < 1$.⁵ Home and REA share the currency and the monetary authority. The latter sets the nominal short-term interest rate according to EA-wide inflation and GDP.

The crucial features of the model are those determining its financial structure.

In both EA regions there are (i) three types of households – i.e., savers, borrowers, and restricted, (ii) the banking sector, (iii) (non-financial) entrepreneurs,

⁵For each region, size refers to the overall population and to the number of firms operating in each sector (intermediate tradable, intermediate nontradable, final nontradable, capital producer, and banking sector).

(iv) capital producers, and (v) (non-financial) firms in the wholesale and retail sectors.⁶

The (non-financial) entrepreneurs hold shares of domestic (physical) capital producers. The latter choose the optimal amounts of the (end-of-period) stock of physical capital and investment. They rent capital to domestic wholesale firms and rebate profits to entrepreneurs and restricted households according to corresponding (exogenous) shares. Entrepreneurs finance their investment in physical capital (as they hold shares of capital producers) by borrowing from domestic banks (their loans are collateralized by the owned real estate) and by issuing uncollateralized long-term “corporate” bonds in the domestic corporate bond market.

All households consume and supply labor services to domestic (non-financial) firms. Savers invest in deposits with domestic banks, internationally traded bonds, domestic short- and long-term sovereign bonds, domestic corporate bonds, domestic real estate; they hold domestic firms, other than capital producers. Borrowers get loans from the banking sector and pledge their real estate as collateral. Restricted households invest in long-term sovereign bonds and physical capital, as they hold shares of capital producers. Restricted households represent non-bank financial institutions.

The banking sector collects deposits from domestic savers, lends to domestic borrowers and entrepreneurs, and buys domestic long-term sovereign bonds.

Given that entrepreneurs issue corporate bonds, the model can be used to evaluate the macroeconomic impact of CSPP. The presence of the banking sector allows us to model entrepreneurs’ financial characteristics in a more exhaustive way and to evaluate the impact of CSPP on the banking sector conditions.

Real estate is in fixed aggregate supply. It is exchanged between entrepreneurs, savers, and borrowers, under perfect competition. It is a durable nontradable good that provides utility (housing services) to households and that entrepreneurs rent as input to domestic wholesale firms.

The remaining features of the model are rather standard and in line with New Keynesian open economy models. Households consume a final good, which is a composite of intermediate nontradable and tradable goods. The latter are

⁶There is no overlap across household types, as the set {savers, borrowers, restricted} constitutes a partition of the set of households in each region.

domestically produced or imported. All households supply differentiated labor services to domestic firms and act as wage setters in monopolistically competitive labor markets by charging a mark-up over their marginal rate of substitution between consumption and leisure.⁷

On the production side, perfectly competitive firms produce two final goods (consumption and investment goods), and intermediate goods are produced by monopolistic firms. The two final goods are sold domestically and are produced combining all available intermediate goods using a constant-elasticity-of-substitution (CES) production function. The two resulting bundles may have different composition. Intermediate tradable and nontradable goods are produced combining domestic capital, labor and real estate, that are assumed to be mobile across sectors. Intermediate tradable goods can be sold domestically and abroad. Because intermediate goods are differentiated, firms have market power and restrict output to create excess profits. We also assume that markets for tradable goods are segmented, so that firms can set a different price for each of the three markets (Home, REA, and RW). In line with other dynamic general equilibrium models of the EA, we include adjustment costs on real and nominal variables, ensuring that consumption, production, and prices react in a gradual way to a given shock. On the real side, habits and quadratic costs delay the adjustment of households consumption and investment, respectively. On the nominal side, quadratic costs make wages and prices sticky.⁸

In what follows, we report the main new equations for the Home country. Similar equations hold in the REA. Different from Home and REA, in the RW there exists only one (standard) representative household. We report other main equations in the Appendix, as they are standard for a New Keynesian model.

2.2 Entrepreneurs

There exists a continuum of entrepreneurs e having mass $0 < \lambda_E < 1$ in the Home population. The generic entrepreneur e maximizes the intertemporal utility function

⁷Following common practice in the New Keynesian literature, the assumption of cashless economy holds in the model.

⁸See Rotemberg (1982).

$$E_0 \sum_{t=0}^{\infty} \beta_E^t \frac{(C_{e,t}(e) - hC_{e,t-1})^{1-\sigma}}{(1-\sigma)}, \quad (1)$$

where E_0 denotes the expectation conditional on information set at date 0, C is consumption of (non-durable) goods, $0 < \beta_E < 1$ is the discount factor, $1/\sigma$ is the elasticity of intertemporal substitution ($\sigma > 0$). The parameter h ($0 < h < 1$) represents external habit formation in consumption.

Entrepreneurs borrow from domestic banks and issue corporate bonds in the domestic market, which are sold to savers and, when the CSPP is implemented, to the central bank of the monetary union.

The entrepreneur e gets one-period (short-term) loans from banks subject to a collateral constraint à la Kiyotaki and Moore (1997),

$$-Loan_{e,t}(e) \leq m_e E_t \left(\frac{Q_{t+1} h_t(e)}{R_t^{Loan,e}} \right), \quad (2)$$

where $Loan_e < 0$ is the bank loan, $0 \leq m_e \leq 1$ is the loan-to-value ratio, Q is the real estate price, h is the real estate (a durable good), and $R^{Loan,e}$ is the gross interest rate on loans.⁹

The entrepreneur also issues long-term corporate bonds B_{CORP} , modelled as a perpetuity paying an exponentially decaying coupon $\kappa_{CORP} \in (0, 1]$.¹⁰ The budget constraint is

$$\begin{aligned} & P_{CORP,t} B_{CORP,t}(e) - R_{CORP,t} P_{CORP,t} B_{CORP,t-1}(e) \\ & + Loan_t(e) - Loan_{t-1}(e) R_{t-1}^{Loan,e} \\ = & \Pi_t(e) + R_t^h h_{t-1}(e) - P_{c,t} C_t(e) - Q_t (h_t(e) - h_{t-1}(e)), \end{aligned} \quad (3)$$

where $\Pi_t(e)$ are revenues from ownership of domestic capital producers, R^h is the (net) return from renting real estate to domestic firms on a period-by-period basis, P_c is the consumption deflator, and $R_{CORP,t}$ is the gross yield to maturity

⁹As in Iacoviello (2005), it is assumed that entrepreneurs are more impatient than savers, i.e., their discount factor is relatively low. This guarantees that the borrowing constraint holds in the deterministic steady state and, by the continuity argument, in a neighborhood of it.

¹⁰See Woodford (2001).

on corporate bonds,

$$R_{CORP,t} = \frac{1}{P_{CORP,t}} + \kappa_{CORP}, \quad (4)$$

where P_{CORP} is the price of the corporate bond.

2.3 Capital producers

There exists a continuum of mass $0 \leq n \leq 1$ of firms that produce physical capital. Each capital producer maximizes discounted future profits. In discounting, the producer uses the stochastic discount rates of entrepreneurs and restricted households, aggregated according to the (parametric) shares ω and $(1 - \omega)$, respectively (capital producers are owned by entrepreneurs and restricted households, to whom rebate profits in a lump-sum way). Each capital producer optimally chooses the end-of-period capital K_t and investment I_t subject to the law of capital accumulation, the adjustment costs on investment, and taking all prices as given. The law of motion of capital accumulation for the generic capital producer p is

$$K_t(p) = (1 - \delta) K_{t-1}(p) + (1 - AC_t^I(p)) I_t(p), \quad (5)$$

where $0 < \delta < 1$ is the depreciation rate. The adjustment cost on investment AC_t^I is

$$AC_t^I(p) \equiv \frac{\phi_I}{2} \left(\frac{I_t(p)}{I_{t-1}(p)} - 1 \right)^2, \quad (6)$$

where $\phi_I > 0$ is a parameter. Investment is a final nontradable good, composed of intermediate tradable (domestic and imported) and nontradable goods. Capital producers buy it in the corresponding market at price P_I .¹¹ Capital producers rent existing physical capital stock $K_{t-1}(p)$ at the nominal rate R_t^K to domestic firms producing intermediate tradable and nontradable goods.

2.4 Banks

There is a banking sector both in the Home economy and in the REA economy. In each banking sector there is a continuum of commercial banks.

¹¹Because of the adjustment costs on investment, a ‘‘Tobin’s Q’’ holds.

In the Home economy, each bank $b \in [0, n]$ consists of two branches, the wholesale branch and the retail branch.¹²

The wholesale branch acts under perfect competition. It maximizes profits by taking all interest rates as given and subject to a bank capital requirement. It optimally issues deposits and equities (i.e., bank capital) to domestic savers (patient households), buys domestic long-term sovereign bonds, and makes resources available to the domestic bank retail branch.

The latter operates under monopolistic competition and makes loans to domestic borrowers and, crucially, to domestic entrepreneurs. It maximizes profits by optimally setting the interest rate on loans taking as given (i) the interest rate paid on resources it gets from the wholesale banking branch and (ii) the demand for loans from entrepreneurs and households. It also faces adjustment costs when setting the interest rate.

In what follows we initially describe the main equations of the wholesale branch and, subsequently, those of the retail branch.

2.4.1 Banks - Wholesale branch

The optimal decisions of the wholesale branch solve a profit maximization problem subject to the balance sheet constraint, the capital requirement, and taking prices and interest rates as given.

The balance sheet constraint of the generic wholesale branch b is

$$LOANS_t^{wh,s}(b) + P_{m,t}B_t^{long,bank}(b) = D_t^{bank,d}(b) + V_tK_t^{bank,s}(b), \quad (7)$$

where $LOANS_t^{wh,s} > 0$ are loans to the retail branch, $B_t^{long,bank}$ are holdings of the domestic long-term sovereign bonds (P_m is their price), $D_t^{bank,s}$ are the deposits, and $K_t^{bank,s}$ are bank equities (V is their market price).¹³

The profits are equal to

¹²We assume the same size n for the banking sector as for the region without loss of generality.

¹³The long-term sovereign bonds are formalized as perpetuities following Woodford (2001).

$$\begin{aligned}
& R_{wh,t}^{LOANS} LOANS_t^{wh,s}(b) + R_t^{long} P_{m,t} B_t^{long,bank}(b) \\
& - R_t^{DEP} D_t^{bank,d}(b) - V_t K_t^{bank,s}(b) \\
& - \frac{\phi_{LOAN}}{2} \left(LOANS_t^{wh}(b) - \overline{LOANS^{wh}} \right)^2 - \frac{\phi_D}{2} \left(D_t^{bank,d}(b) - \overline{D^{bank,d}} \right)^2 \\
& - \frac{\phi_{BK}}{2} \left(V_t K_t^{bank,s}(b) - \kappa LOANS_t^{wh} \right)^2,
\end{aligned} \tag{8}$$

where R_{wh}^{LOANS} is the (gross) interest rate on loans $LOANS^{wh,s}$ to the retail branch, R^{long} the return on sovereign bonds, R^{DEP} the gross interest rate on deposits, and V is the price of equity. The branch pays quadratic adjustment costs on loans, deposits and on the deviations of the bank capital from the capital requirement $\kappa LOANS^{wh}$ ($0 \leq \kappa \leq 1$, ϕ_{LOAN} , ϕ_D , $\phi_{BK} > 0$ are parameters, $\overline{LOANS^{wh}}$ and $\overline{D^{bank,d}}$ are the steady-state values of loans and deposits, respectively).

The wholesale branch optimally chooses deposits, equities, loans, and long-term sovereign bonds so that, at the margin, it equates the costs of the two sources of financing (deposits and capital) to each other and to the returns on the two assets (loans and sovereign bonds).

2.4.2 Banks - Retail branch

The retail branch lends to domestic entrepreneurs and domestic borrowers. It differentiates wholesale loans, $LOANS^{wh}$, at zero cost.¹⁴ The loans are then sold to households and entrepreneurs at their individual rates. The retail branch acts under monopolistic competition. It sets the interest rate on loans to maximize profits taking as given (i) the interest rate that pays to borrow from the wholesale branch and (ii) the entrepreneurs' and borrowers' demand for loans, and subject to quadratic adjustment costs on the loans' interest rate (this allows us to get a gradual adjustment of retail interest rates to a given shock).

The resulting first-order conditions imply that the interest rates on loans to entrepreneurs and households, $R_{retail}^{LOANS,entr}$ and $R_{retail}^{LOANS,bor}$ respectively, are given by a (time-varying) mark-up on the interest rate paid to the wholesale sector,

¹⁴The total amount of loans supplied to entrepreneurs and households is equal to the loans the retail branch gets from the wholesale branch.

$$R_{retail,t}^{LOANS,entr} = mkp_t^{entr} R_{wh,t}^{LOANS} \quad (9)$$

$$R_{retail,t}^{LOANS,bor} = mkp_t^{bor} R_{wh,t}^{LOANS}, \quad (10)$$

where the mark-up depends on the elasticity of substitution among differentiated loans and, in the short run, also on quadratic adjustment costs paid to change the lending rate. The implied profits are rebated to the savers, as a return on bank equity, according to the owned amount of bank capital (equities).

2.5 Restricted households

There exists a continuum of restricted households j' , having mass λ_R ($0 \leq \lambda_R < 1$ is the share of restricted households in the Home population). Their preferences are additively separable in consumption and labor effort. The generic restricted household j' receives utility from consumption $C_R(j')$ and disutility from labor $L_R(j')$. The household's expected lifetime utility is

$$E_0 \sum_{t=0}^{\infty} \beta_R^t \left[\frac{(C_{R,t}(j') - hC_{R,t-1})^{1-\sigma}}{(1-\sigma)} - \frac{L_{R,t}(j')^{1+\tau}}{1+\tau} \right], \quad (11)$$

where β_R is the discount factor ($0 < \beta_R < 1$), $1/\sigma$ is the elasticity of intertemporal substitution ($\sigma > 0$), and $1/\tau$ is the labor Frisch elasticity ($\tau > 0$). The parameter h ($0 < h < 1$) represents external habit formation in consumption. Restricted households have access only to the market of long-term sovereign bonds. The budget constraint is

$$\begin{aligned} & P_t^L B_{R,t}^L(j') - \sum_{s=1}^{\infty} \kappa^{s-1} B_{R,t-s}^L(j') \\ &= \Pi_t^{prof}(j') + W_{R,t}(j'(1 - \tau_t^l)) L_{R,t}(j') \\ & \quad - P_t(1 + \tau_t^c) C_{R,t}(j') - AC_{R,t}^W(j'), \end{aligned} \quad (12)$$

where B_R^L is the amount of long-term sovereign bonds, Π^{prof} is profit from ownership of the Home capital producers, $0 \leq \tau^c \leq 1$ is the tax rate on consumption.

Long-term sovereign bonds have price P^L and are formalized as perpetuities paying an exponentially decaying coupon $\kappa \in (0, 1]$, following Woodford (2001). Finally, households act as wage setters in a monopolistic competitive labor market. Each household j' supplies one particular type of labor services which is an imperfect substitute to services supplied by other households. In the generic period t it sets its nominal wage W_R taking into account of the labor income tax rate $0 \leq \tau^\ell \leq 1$, labor demand, and quadratic adjustment costs AC_R^W à la Rotemberg on the nominal wage $W_R(j')$:

$$AC_{R,t}^W(j') \equiv \frac{\kappa_W}{2} \left(\frac{W_{R,t}(j')/W_{R,t-1}(j')}{\Pi_{W_{R,t-1}}^{\alpha_W} \bar{\Pi}_{EA}^{1-\alpha_W}} - 1 \right)^2 W_{R,t} L_{R,t}, \quad (13)$$

where $\kappa_W > 0$ and $0 \leq \alpha_W \leq 1$ are parameters that regulate wage stickiness and indexation, respectively, the variable $\Pi_{W_{R,t}} \equiv W_{R,t}/W_{R,t-1}$ is the gross wage inflation rate, and $\bar{\Pi}_{EA}$ is the long-run gross inflation target of the EA monetary authority (assumed to be constant). The adjustment costs are proportional to the per-capita wage bill of restricted households, $W_R L_R$.¹⁵ Restricted households represent non-bank financial institutions investing in particular classes of assets, i.e., long-term sovereign bonds and shares of the capital producers.

2.6 Savers

There exists a continuum of savers, indexed by j , having mass $0 \leq \lambda_S < 1$ (λ_S is the share of savers in the Home population). The generic household has preferences separable in consumption of goods other than housing, housing services h , and labor,

$$E_0 \sum_{t=0}^{\infty} \beta_S^t \left[\frac{(C_{S,t}(j) - h C_{S,t-1})^{1-\sigma}}{(1-\sigma)} + \chi \ln(h_t(j)) - \frac{L_{S,t}(j)^{1+\tau}}{1+\tau} \right]. \quad (14)$$

The savers have access to multiple financial assets (all denominated in euro terms): the short-term (one-period) sovereign bond B^G , exchanged with the do-

¹⁵As the implied first order conditions are rather standard we do not report them to save on space. They are available upon request.

mestic government; the short-term private bond B^P , exchanged with REA savers and RW households and paying the interest rate R^P ; the long-term sovereign bond B_S^L , exchanged with domestic restricted households and the domestic government; the corporate bonds, B_{CORP}^S , issued by domestic entrepreneurs; the bank equities, $K^{bank,d}$, issued by domestic banks at price V . Thus, they have several opportunities to smooth consumption when facing a shock. The budget constraint of the generic saver j is

$$\begin{aligned}
& P_t^L B_{S,t}^L(j) - \sum_{s=1}^{\infty} \kappa^{s-1} B_{S,t-s}^L(j) \\
& + P_{CORP,t} B_{CORP,t}^S(j) - R_{CORP,t} P_{CORP,t} B_{CORP,t-1}^S(j) \\
& + B_t^G(j) - B_{t-1}^G(j) R_{t-1} \\
& + B_t^P(j) - B_{t-1}^P(j) R_{t-1}^P (1 - \phi_t) \\
& + V_t K_t^{bank,d} - V_t K_{t-1}^{bank,d} \\
& = (1 - \tau_t^\ell) W_{S,t}(j) L_{S,t}(j) + \Pi_t^P(j) + \Pi_t^{bank} K_{t-1}^{bank,d}(j) \\
& + \Pi_t^{prof}(j) - P_t (1 + \tau_t^c) C_{S,t}(j) + TR_t(j) - Q_t(h_t(j) - h_{t-1}(j)) - AC_{S,t}^W(j) \\
& - AC_{S,t}^B(j),
\end{aligned} \tag{15}$$

where the short-term government bond B^G pays the EA monetary policy rate R . The dividends $\Pi^P(j)$ and Π^{bank} are from ownership of domestic monopolistic firms and bank equity holdings, respectively.¹⁶ The term ϕ represents an exponential adjustment costs, needed to stabilize the position in the internationally traded bond.¹⁷ Π^{prof} is profit from ownership of the Home capital producers. The term TR represents lump-sum transfers from the government. Savers supply labor services under monopolistic competition and face quadratic adjustment costs AC_S^W when setting nominal wages (the cost is similar to the one paid by restricted house-

¹⁶Claims to firms' profits are not internationally tradable.

¹⁷The adjustment cost is defined as

$$\phi_B \equiv \phi_{b1} \frac{\exp(\phi_{b2}(B_t^P - \bar{B}^P)) - 1}{\exp(\phi_{b2}(B_t^P - \bar{B}^P)) + 1}, \text{ with } \phi_{b1}, \phi_{b2} > 0$$

where \bar{B}^P is the steady-state position of the representative Home saver. Both are taken as given in the maximization problem. A similar cost holds for the RW household.

holds, see eq. 13). They also pay adjustment costs AC_S^B on long-term sovereign bond holdings.¹⁸ First order conditions imply no-arbitrage conditions.¹⁹ Thus, in equilibrium the interest rates paid by the different bonds are equal to the monetary policy rate R_t , net of the spreads induced by the longer maturity and the adjustment costs.²⁰

2.7 Borrowers

There exists a continuum of households, labeled ‘borrowers,’ indexed by j'' , having mass $0 \leq \lambda_B < 1$ (λ_B is the share of borrowers in the Home population). The generic borrower has preferences separable in consumption of goods other than housing, housing services h , and labor similar to those of savers (14). The only difference is the the discount factor, which is lower for borrower than for savers (borrowers are more impatient than savers). Borrowers get one-period (short-term) loans from domestic banks subject to a collateral constraint à la Kiyotaki and Moore (1997),

$$- Loan_{borr,t}(j'') \leq m_{borr} E_t \left(\frac{Q_{t+1} h_t(j'')}{R_t^{Loan,borr}} \right), \quad (16)$$

where $Loan_{borr} < 0$ is the bank loan, $0 \leq m_{borr} \leq 1$ is the loan-to-value ratio, Q is the real estate price, h is the real estate, and $R^{Loan,borr}$ is the gross interest rate on loans.

¹⁸We assume a standard quadratic form for the adjustment cost, that is,

$$AC_{S,t}^B(j) \equiv \frac{\phi_{bL}}{2} (P_t^L B_{S,t}^L(j) - \bar{P}^L \bar{B}_S^L)^2, \text{ with } \phi_{bL} > 0,$$

where $\bar{P}^L \bar{B}_S^L$ is the (symmetric) steady-state value of the long-term sovereign bond. The adjustment cost guarantees that the bond holdings follow a stationary process and that the economy converges to the steady state.

¹⁹As the implied first order conditions are rather standard we do not report them to save on space. They are available upon request.

²⁰See Chen *et al.* (2012) for the details. Our calibration implies that households can modify their financial positions without facing relevant adjustment costs.

2.8 Monetary policy

The EA (short-term) monetary policy rate is controlled by the EA monetary authority, which keeps it constant for an announced number of periods (FG on the monetary policy rate) or sets it according to a standard Taylor rule. When the policy rate is not set according to the FG, it reverts to the Taylor rule. The latter is

$$\frac{R_t}{\bar{R}} = \left(\frac{R_{t-1}}{\bar{R}} \right)^{\rho_R} \left(\frac{\Pi_{EA,t}}{\bar{\Pi}_{EA}} \right)^{(1-\rho_R)\rho_\pi} \left(\frac{GDP_{EA,t}}{GDP_{EA,t-1}} \right)^{(1-\rho_R)\rho_{GDP}}, \quad (17)$$

where R_t is the gross monetary policy rate. The parameter ρ_R ($0 < \rho_R < 1$) captures inertia in interest rate setting, while the parameter \bar{R} represents the steady-state gross nominal policy rate. The parameters ρ_π and ρ_{GDP} are respectively the weights of EA consumer price index (CPI) inflation rate ($\Pi_{EA,t}$) (taken as a deviation from its long-run constant target $\bar{\Pi}_{EA}$) and GDP ($GDP_{EA,t}$).²¹

Finally, the EA monetary authority adopts the CSPP. It is modelled as exogenous Home and REA corporate bonds' purchases. Thus, the central bank directly intervenes in the corporate bonds markets.

The market clearing condition for the Home corporate bond is

$$\int_0^{n\lambda_S} B_{CORP,t}^S(j) dj + B_t^{CSPP} = \int_{n\lambda_S}^{n\lambda_S+n\lambda_e} B_{CORP,t}(e) de, \quad (18)$$

where the variable $B_{CORP}^S(j)$ represents the corporate bonds held by the generic household (saver) j (whose share in the population is λ_S), B^{CSPP} represents the demand for corporate bonds from the EA monetary authority, and $B_{CORP}(e)$ the corporate bonds issued by the generic entrepreneur e . A similar market clearing condition holds for the REA corporate bonds market.²²

²¹The CPI inflation rate is a geometric average of Home and REA CPI inflation rates (respectively Π_t and Π_t^*) with weight equal to the correspondent country GDP (as a share of the EA GDP). The EA GDP, $GDP_{EA,t}$, is the sum of Home and REA GDPs.

²²To keep the model parsimonious we consider, in each EA region, the overall corporate bond market. Thus, we do not distinguish between primary and secondary market.

2.9 Equilibrium

In each country the initial asset positions, preferences, and budget constraints are the same for households belonging to the same type and firms belonging to the same sector. Moreover, profits from ownership of domestic firms acting under monopolistic competition are equally shared among savers. Profits from ownership of domestic capital producers are distributed to entrepreneurs and restricted households according to the corresponding shares held by each type of agent, and are equally shared within each type. Thus, we consider the representative entrepreneur and household for each household type (restricted, savers, and borrowers). Moreover, we consider the representative capital producer and the representative firm for each sector (final nontradable, intermediate tradable, intermediate nontradable, wholesale banking branch, and retail banking branch). The implied symmetric equilibrium is a sequence of allocations and prices such that, given the initial conditions and considered monetary policy measures (the shocks affecting the model): households and firms satisfy their corresponding first order conditions; the monetary policy rules, the fiscal rules, and the government budget constraints hold; and all markets clear.

2.10 Calibration

The model is calibrated at quarterly frequency. We set some parameter values so that steady-state ratios are consistent with great ratios (average values of main variables as a ratio to GDP). For remaining parameters we resort to previous studies and estimates available in the literature.²³

Table 1 contains parameters for preferences and technology. Parameters with “*” and “**” are related to the REA and the RW, respectively. The discount factor of EA savers is set to 0.996, so that the steady-state short-term interest rate is equal to 1.6% on an annual basis. The discount factor of RW households is set to 0.996 as well. The discount factor of restricted households determines the steady-state value of the long-term interest rate and is set to 0.99, so that in steady state the interest rate on EA long-term sovereign bonds is equal to 4.1% on annualized terms. The discount factor of entrepreneurs determines the steady-state value of

²³See the New Area Wide Model (NAWM, Christoffel, Coenen and Warne 2008).

the corporate interest rate. It is set to 0.99, so that the steady-state interest rate on corporate bonds is equal to 4.1% on annualized terms. The discount factor of borrowers is set to 0.991. The loan-to-value ratio is set to 0.6 in the case of entrepreneurs (it is 0.7 in the case of borrowers).

In each region the population shares of savers, borrowers, entrepreneurs, and restricted households are set to 0.3, 0.5, 0.1, and 0.1, respectively. Given the lack of micro-evidence on those shares, we set them to get a response of investment to the (benchmark) CSPP around four times as large as the response of consumption, in line with standard business cycle facts, and at the same time to calibrate the adjustment cost on investment to a rather standard value (i.e., 7.5, as reported in Table 3), in line with Smets and Wouters (2003).²⁴

Table 2 reports gross mark-ups and the related elasticities of substitution among intermediate goods.

Table 3 reports real and nominal adjustment costs. The parameter regulating the adjustment costs paid by the entrepreneurs on deviations of corporate bond positions from steady-state levels, ϕ_{bL} , is set to 0.001 in both Home and REA. The cost paid by the Home and REA savers is set to 0.007. The parameters regulating the adjustment cost on private bond position, paid by Home savers and RW households, are set to 0.01. These parameters have been calibrated following two criteria. First, they should not greatly affect the model dynamics and yet help to stabilize it. Second, the response of the interest rate on corporate bonds to the benchmark CSPP should be in line with existing evidence for the EA.²⁵

Table 4 reports the parametrization of the systematic feedback rules followed by the fiscal and monetary authorities. The central bank of the EA targets the contemporaneous EA-wide consumer price inflation (the corresponding parameter

²⁴Moreover, the chosen calibration of restricted households allows us to get in the benchmark case results for the PSPP that are in line with Blattner and Joyce (2016). Specifically, using a small macro-finance BVAR model, they find that the ECB government bond purchases, as announced on 22 January 2015, reduced EA 10-year bond yields, on average, by around 30bps in 2015, and had a positive impact on the output gap and inflation in 2016, of the order of 0.2ppt and 0.3ppt respectively. The authors state that their estimates are likely to underestimate the overall impact of the ECB's purchases on interest rates and inflation, as they do not consider all possible transmission channels of the purchases programme. To save on space, we do not include the robustness analysis on the relative shares of the different household types. It is available upon request.

²⁵See ECB (2016) and Zaghini (2017).

is set to 1.7) and the output growth (the parameter is set to 0.1). Interest rate is set in an inertial way and hence its previous-period value enters the rule with a weight equal to 0.87. The values are identical for the corresponding parameters of the Taylor rule in the RW. For the fiscal rule, it is always lump-sum transfers to adjust to stabilize public debt.

Table 5 reports the steady-state great ratios implied by the chosen parameterization. The corporate bonds-to-(nominal annualized) GDP is set to 10% (in steady state, the bonds issued by the entrepreneurs are held by the domestic savers). The chosen value is in line with the ratio of corporate bonds to total debt of non-financial corporations in Italy and in the EA, as reported for 2015 in Banca d'Italia (2016).²⁶ The share of capital producers held by entrepreneurs is equal to 50% (and, thus, the share held by restricted households is 50% as well). The amount of bank capital (share to total loans) is equal to 10%. The banking sector loans to entrepreneurs and borrowers is equal to 72% and 36% of annualized GDP, respectively. We calibrate the duration of the corporate bonds to 8 years, in line with Zaghini (2017).²⁷ The duration of the long-term sovereign bonds is set to 8 years as well. Short-term public debt (ratio to yearly GDP) is set to 13% for Home and 8% for the REA. Long-term public debt is set to 121% and 93% of (yearly) GDP for Home and the REA.²⁸ We assume that in each country long-term sovereign bond holdings that are not in the banks' balance sheets are equally shared between savers and restricted households. The long-term sovereign bonds held by banks, as a ratio of annualized GDP, is set to 31% in both regions.

The chosen calibration yields impulse response functions to a standard monetary policy shock (+0.25 bp) for GDP and inflation in each EA region that are in line with the workhorse estimated models of the EA in the literature.²⁹

²⁶Since this ratio has been increasing over the years, in a sensitivity analysis (not reported) we assume that corporate bonds account for 5% of GDP and find no significant difference in the macroeconomic impact of the CSPP. Results are available upon request.

²⁷The quarterly duration is $\frac{R_{CORP,t}}{(R_{CORP,t} - \kappa_{CORP})}$.

²⁸Thus, total public debt as a share of GDP is 134% in Home (roughly consistent with Italian data) and 101% in REA.

²⁹See, for example, the New Area Wide Model (NAWM, Christoffel, Coenen and Warne 2008).

3 Simulated scenarios

We simulate the following scenarios. First, the Eurosystem credibly announces that it immediately implements purchases of corporate bonds that last for 4 quarters. This is consistent with the fact that the CSPP was announced on 10 March 2016 (we consider this as the beginning of 2016Q2 for simplicity), the purchases started on 8 June 2016 (thus, during 2016Q2), and they were intended to last until March 2017 (that is, 2017Q1 included). The amount of quarterly purchases was around €6bn in 2016Q2, €23bn in 2016Q3, €21bn in 2016Q4, and €24bn in 2017Q1 (around 0.3% of quarterly average EA GDP in the first quarter of simulation and 1% in the following ones).³⁰ We assume that the bonds are held to maturity. The EA (short-term) monetary policy rate is kept constant at the baseline level for 8 quarters (forward guidance on monetary policy rate, FG). Thereafter, it follows a standard Taylor rule and reacts to EA-wide inflation and economic activity. We also simulate the extension of the CSPP leg of the APP as announced on 8 December 2016 (we consider this as the beginning of 2017Q1 for simplicity). The additional purchases start after March 2017, i.e., in 2017Q2, and should last for 3 quarters until the end of 2017 (that is, 2017Q4). Hence, we assume that the extension, which we label ‘CSPP2,’ consists of a first quarter of simulation with zero purchases (corresponding to 2017Q1) followed by quarterly purchases equal to €24bn, that is, of the same amount as in the last recorded quarter (2017Q1).

We also run alternative scenarios. Specifically, we evaluate the role of exit policy (corporate bonds are held by the Eurosystem for an amount of time shorter than the bonds’ maturity) and FG (longer or shorter than two years). In all scenarios the sequence of purchases is fully anticipated by households and firms (perfect foresight assumption).

³⁰Check ECB (2017) for details on CSPP holdings at book value by quarter.

4 Results

4.1 The CSPP

Fig. 1 shows the simulated effects of the CSPP on the corporate bond market. The interest rate on corporate bonds persistently decreases (by roughly 50 bp at its trough). The size of the reduction is in line with the estimates provided by Zaghini (2017) and ECB (2016).³¹ Savers reduce their bond holdings, because they sell them to the monetary authority. Entrepreneurs initially decrease their holdings and, starting from the fourth quarter (in correspondence of the interest rate trough), persistently increase the issuance of bonds.³²

Fig. 2 illustrates the responses of the main macroeconomic variables. In both EA regions economic activity and, in a rather mild way, inflation increase. Effects are rather symmetric among the two regions. Both regions' GDP increase by around 0.2% (peak level, achieved after six quarters).

All GDP components increase. Entrepreneurs' investment benefits from the reduction in the corporate interest rates. The lower interest rates induce them to gradually issue new bonds so as to finance the increase in physical capital accumulation, real estate demand, and consumption.

The induced increase in capital accumulation makes labor and real estate more productive. Thus, firms producing intermediate tradable and nontradable goods increase demand for labor and real estate. Home exports benefit from the increase in REA aggregate demand. REA exports increase to a lower extent than Home exports do, because they are more oriented towards the RW, whose aggregate demand is not affected by the CSPP (the euro depreciates in a rather mild way vis-à-vis the RW currency).

³¹According to the results reported by ECB (2016), based on a time-series panel analysis of the determinants of corporate bond spreads estimated over the October 1999-March 2016 period, over the identified period from 10 to 24 March, 11bp of the total decline of 16bp in the spreads of EA investment-grade corporate bonds was related to the monetary policy measures announced in March, more specifically the launch of the CSPP.

³²Given that we do not distinguish between primary and secondary markets, the initial decreases reflects the sale to the monetary authority of previously issued corporate bonds held by entrepreneurs. As the price of bonds gradually decreases from the peak reached right after the announcement, entrepreneurs find more profitable to stop selling the bonds and start issuing new ones, thus exploiting the improved financing conditions established by the programme.

Fig. 3 reports the effects on labor market variables. The increase in capital accumulation makes labor more productive. Thus, firms increase labor demand. Consistently, real wages increase.

Higher capital accumulation and employment favor a persistent increase in real estate demand for production and consumption purposes by entrepreneurs and constrained households (see Fig. 4). The increase in real estate demand from entrepreneurs is gradual and achieves a peak after four quarters, when the corporate interest rate achieves its trough. Given that in each region the overall (economy-wide) stock of real estate is constant, the higher demand for real estate from borrowers and entrepreneurs is satisfied by the lower demand by savers (the latter sell the real estate to the former). The price of real estate persistently increases.

Consistently with the increase in the value of collateralizable real estate (see Eq. 2 and Eq. 16), entrepreneurs and borrowers persistently increase their demand for loans from the banks (Fig. 5). Banks finance loans by raising deposits and, to a lower extent, banking capital (the bank capital-to-loan ratio declines in a very slight way). The higher demand of deposits and capital is met by the increase in supply of funds by domestic savers. Banks match the higher demand for loans by readily increasing supply. Thus, there is only a rather mild increase in the interest rates on loans (Fig. 6). Similarly, the interest rate on deposits increases only mildly. The limited increase in interest rates is not surprising, given that the stance of the EA monetary policy is accommodative and interest rates on the financial assets are linked by no-arbitrage conditions. Banking sector equity prices and return increase, consistent with the increase in lending and increase in banks' demand for additional capital.

Overall, we find that the CSPP has expansionary effects on EA economic activity. The effects on inflation are positive but milder. The programme also benefits banking sector, by favoring the demand for loans.

4.2 Early-exit strategies from the CSPP

In the benchmark scenario we assume no reinvestment, i.e., the monetary authority holds the bonds to maturity. We compare the benchmark with two scenarios that

are different in the duration of the CSPP. In the first scenario, the monetary authority announces that it will gradually sell the bonds 2 years before they reach maturity, that is, it will hold them for only 6 years instead of 8. In the second scenario, the monetary authority announces that it will gradually sell the corporate bonds only one year before they reach maturity.³³

Fig. 7 reports the results. The main message is that the earlier the announced exit from the programme, the lower the decrease in the interest rate of corporate bonds and the less expansionary the macroeconomic effects.

In the case of exit after 6 years, the central bank supports demand for corporate bonds for a rather short amount of time. Thus, the price of the bond increases and the interest rate decreases to a smaller extent than in the benchmark. The responses of EA CPI inflation and GDP are consistent with those of the long-term interest rates. The earlier is the exit, the less pronounced is the increase in economic activity and inflation. Demand for real estate increases to a lower extent as well. The implied increase in its price is rather modest, limiting the increase of real estate value and, thus, the increase in borrowing from the banks.

In the case of exit after 7 years, the central bank supports demand for Home and REA corporate bonds for a longer amount of time than in the case of an exit after only 6 years. Thus, the prices of the bonds, which reflect current and future demand conditions, increase to a larger extent; correspondingly, the interest rate decreases to a larger extent. Entrepreneurs increase their demand for investment in physical capital and real estate relatively more. The larger increase in real estate prices further favors entrepreneurs and consumers' borrowing from the banking sector.

4.3 Duration of the forward guidance

In the benchmark simulation the EA monetary authority announces in the initial period that it will keep the short-term policy rate at the baseline level during the first two years (two-year FG). We now assess the role of this commitment by changing the announced number of periods during which the monetary policy rate

³³For an analysis of the macroeconomic effects of the early exit from the PSPP (the other leg of the APP), see Burlon et al. (2016b).

is kept constant. Specifically, we consider a first scenario with three-year FG and a second scenario with one-year FG. In all scenarios, the policy rate increases after the end of the commitment period, because the central bank returns to follow the Taylor rule and therefore increases the policy rate to stabilize macroeconomic conditions.

Fig. 8 shows the results. The interest rate on corporate bonds does not greatly change across the three scenarios, because its dynamics largely reflect the direct effects of the CSPP, which is identical in the two scenarios.

The initial increase in demand for investment and real estate favors economic activity and inflation. The later the exit from the FG, the more expansionary are these effects. The larger amplification is due to the fact that households anticipate the slower increase in the policy rate and, thus, increase their aggregate demand for consumption to a larger extent. Consistent with the larger aggregate demand, there is a larger increase in bank loans to borrowers and entrepreneurs.

Overall, in the case of three-year FG the larger increase in aggregate demand implies higher GDP growth and inflation in the first two years. The EA GDP boost is around 0.3% (peak) in the second year.

Finally, in the case of one-year FG there is a smaller increase in aggregate demand. The boost to EA GDP is around 0.1% (peak).

4.4 The CSPP extension

Fig. 9 reports the responses of interest rates on corporate bonds and real GDP to the CSPP (i) as announced in March 2016 (analyzed in the previous sections) and (ii) as prolonged in December 2016. We use calendar dates on the horizontal axis to gauge the cumulated macroeconomic consequences of the two decisions. It is assumed that in March 2016 households and firms did not anticipate the December 2016 announcement. Thus, the latter is a surprise that enters the agents' information set in December 2016. Moreover, it is assumed that in December 2016 agents expect that a 2-year FG holds. Following the announcement, the interest rate on corporate bonds drops by another 50 bp in 2017Q1.³⁴ The overall decrease

³⁴If the December 2016 announcement would have been anticipated by households and firms, the decrease in the interest rate would have materialized before December.

is equal to almost 100 bp. The 2016Q2 and 2017Q1 decreases are similar to each other. The reason is the size of the purchases, which is the same in the two announcements. The larger drop in the interest rate is an incentive for firms to further increase investment. Economic activity further increases. The EA GDP increases by slightly less than 0.4% (peak level) in the beginning of 2018. Without the programme extension, the GDP would increase by roughly 0.2%. The higher aggregate demand induces firms to increase prices. EA inflation increases by 0.1pp in 2017. The increase would be much lower without the programme extension.

Overall, the macroeconomic effects of the combination of the initial announced CSPP and its (subsequent) extension are not trivial.

5 Conclusions

This paper evaluates the macroeconomic effectiveness of the CSPP. According to our results, the CSPP favors economic activity and inflation. Moreover, it also favors the recovery of the demand for bank loans and, thus, the improvement in banking sector conditions through its expansionary effects on aggregate demand (for consumption and investment). Overall, the CSPP can contribute to restore a standard monetary policy regime, the relative small dimension of the EA corporate market notwithstanding.

Our work can be extended along several dimensions. First, investors may see the CSPP as an opportunity to cash in on their eligible holdings and move into other parts of the credit curve or different asset classes with the potential for higher returns. The inclusion into the model of portfolio choices that distinguish among different classes of corporate bonds would allow to assess the (indirect) impact of the CSPP on less safe corporate sectors such as the high yield. Related to this, one could take into account the presence of risk premia on corporate bonds' interest rates. Ajello and Tanaka (2017) for example document how the introduction of multi-period defaultable debt contracts in an otherwise standard New Keynesian DSGE model improves the fit of observed credit spreads, credit risk premia, leverage ratios, and interest rates' term structure data. Second, the CSPP favors the demand for investment from firms by improving their financial conditions. Investment could also rise because of incentives associated with lower

taxes and increase in competition. Thus, there can be interaction between the CSPP on the one hand and fiscal or structural reforms on the other. We leave these issues for future research.

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Table 1: Preferences and technology

Parameter	H	REA	RW
Savers' discount factor $\beta_S, \beta_S^*, \beta^{**}$	0.996	0.996	0.996
Restricted households' discount factor β_R, β_R^*	0.99	0.99	–
Borrowers' discount factor β_B, β_B^*	0.991	0.991	–
Entrepreneurs' discount factor β_E, β_E^*	0.99	0.99	–
Intertemporal elasticity of substitution $1/\sigma$	1.0	1.0	1.0
Habit (households and entrepreneurs) h	0.8	0.8	0.8
Inverse of Frisch elasticity of labor supply τ	2.0	2.0	2.0
Share of savers λ_S	0.3	0.3	1.0
Share of restricted households λ_R	0.1	0.1	–
Share of borrowers λ_B	0.5	0.5	–
Share of entrepreneurs λ_E	0.1	0.1	–
Entrepreneurs' loan-to-value ratio m_e	0.6	0.6	–
Borrowers' loan-to-value ratio m_{borr}	0.7	0.7	–
Depreciation rate of capital δ	0.025	0.025	0.025
<i>Tradable intermediate goods</i>			
Substitution between factors of production $\xi_T, \xi_T^*, \xi_T^{**}$	0.90	0.90	0.90
Bias towards capital $\alpha_T, \alpha_T^*, \alpha_T^{**}$	0.43	0.43	0.43
Bias towards housing $\beta_T, \beta_T^*, \beta_T^{**}$	0.05	0.05	–
<i>Nontradable intermediate goods</i>			
Substitution between factors of production $\xi_N, \xi_N^*, \xi_N^{**}$	0.90	0.90	0.90
Bias towards capital $\alpha_N, \alpha_N^*, \alpha_N^{**}$	0.43	0.43	0.43
Bias towards housing $\beta_N, \beta_N^*, \beta_N^{**}$	0.05	0.05	–
<i>Final consumption goods</i>			
Subst. btw. dom. and imported goods $\phi_A, \phi_A^*, \phi_A^{**}$	1.50	1.50	1.50
Bias towards domestic tradable goods a_H, a_F^*, a_G^{**}	0.68	0.59	0.90
Subst. btw. tradables and nontradables $\rho_A, \rho_A^*, \rho_A^{**}$	0.50	0.50	0.50
Bias towards tradable goods a_T, a_T^*, a_T^{**}	0.68	0.50	0.50
<i>Final investment goods</i>			
Subst. btw. dom. and imported goods $\phi_E, \phi_E^*, \phi_E^{**}$	1.50	1.50	1.50
Bias towards domestic tradable goods v_H, v_F^*, v_G^{**}	0.50	0.49	0.90
Subst. btw. tradables and nontradables $\rho_E, \rho_E^*, \rho_E^{**}$	0.50	0.50	0.50
Bias towards tradable goods v_T, v_T^*, v_T^{**}	0.78	0.70	0.70

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

Table 2: Gross mark-ups

Mark-ups and elasticities of substitution			
	Tradables	Nontradables	Wages
H	1.2 ($\theta_T = 6.0$)	1.33 ($\theta_N = 4.0$)	1.33 ($\psi = 4.0$)
REA	1.2 ($\theta_T^* = 6.0$)	1.33 ($\theta_N^* = 4.0$)	1.33 ($\psi^* = 4.0$)
RW	1.2 ($\theta_T^{**} = 6.0$)	1.33 ($\theta_N^{**} = 4.0$)	1.33 ($\psi^{**} = 4.0$)

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

“*” refers to REA, “**” to RW

Table 3: Real and nominal adjustment costs

Parameter	H	REA	RW
<i>Real adjustment costs</i>			
Investment $\phi_I, \phi_I^*, \phi_I^{**}$	7.50	7.50	7.50
<i>Adjustment costs on bonds</i>			
Savers' long-term sovereign bond positions ϕ_{bL}, ϕ_{bL}^*	0.0002	0.0002	–
Savers' corporate bond positions $\phi_{bS^C}, \phi_{bS^C}^*$	0.007	0.007	–
Entrepreneurs' corporate bond positions $\phi_{bE^C}, \phi_{bE^C}^*$	0.001	0.001	–
Savers' short-term private bond positions			
$\phi_{b1}, \phi_{b1}^{**}$	0.01	–	0.01
$\phi_{b2}, \phi_{b2}^{**}$	0.01	–	0.01
<i>Nominal adjustment costs</i>			
Wages $\kappa_W, \kappa_W^*, \kappa_W^{**}$	600	600	600
Home produced tradables $\kappa_H, \kappa_H^*, \kappa_H^{**}$	400	400	400
REA produced tradables $\kappa_G, \kappa_G^*, \kappa_G^{**}$	400	400	400
RW produced tradables $\kappa_F, \kappa_F^*, \kappa_F^{**}$	400	400	400
Nontradables $\kappa_N, \kappa_N^*, \kappa_N^{**}$	800	800	800

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

“* ” refers to REA, “** ” to RW

Table 4: Fiscal and monetary policy rules

Parameter	H	REA	EA	RW
<i>Fiscal policy rule</i>				
$\phi_1, \phi_1^*, \phi_1^{**}$	1.01	1.01	-	1.01
$\phi_2, \phi_2^*, \phi_2^{**}$	1.01	1.01	-	1.01
<i>Common monetary policy rule</i>				
Lagged interest rate ρ_R, ρ_R^{**}	-	-	0.92	0.92
Inflation ρ_Π, ρ_Π^{**}	-	-	1.70	1.70
GDP growth $\rho_{GDP}, \rho_{GDP}^{**}$	-	-	0.10	0.10

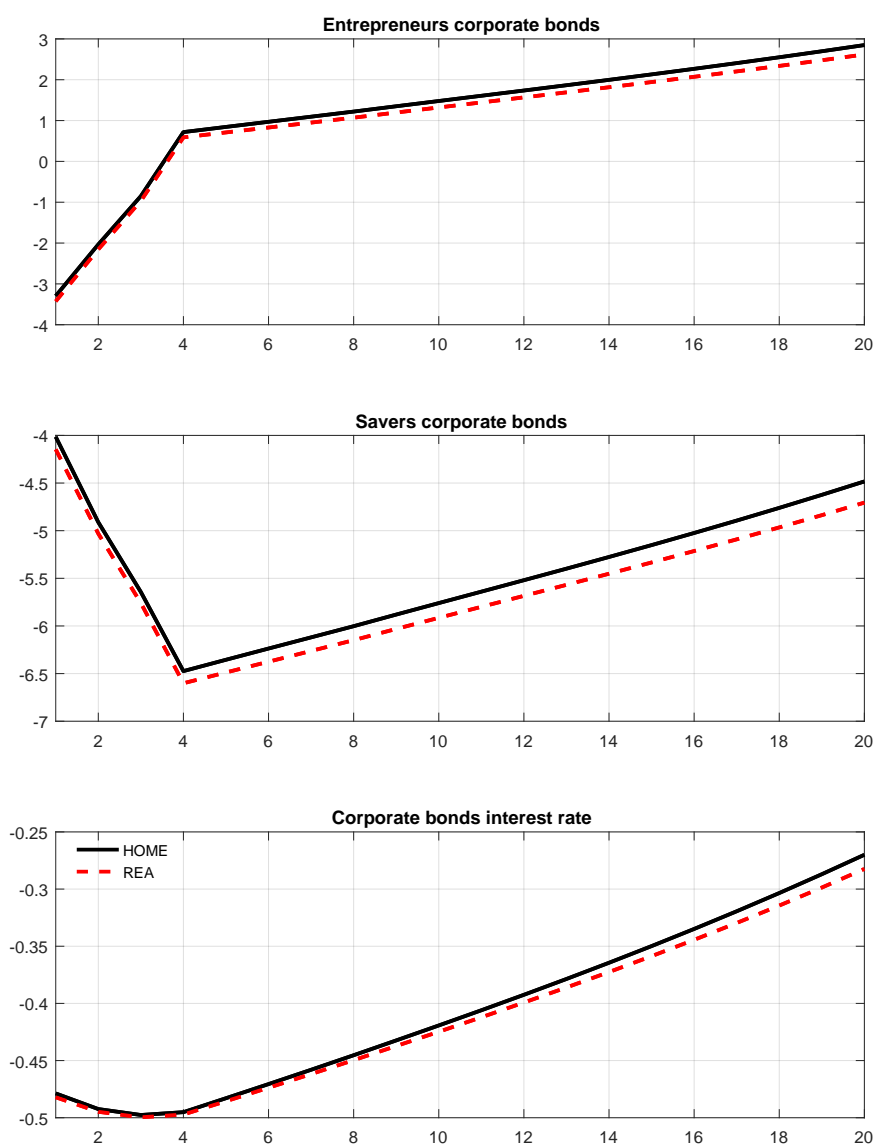
Note: H=Home; REA=rest of the euro area; EA= euro area; RW= rest of the world; “* ” refers to REA, “** ” to RW

Table 5: Main variables

	H	REA	RW
<i>Macroeconomic variables</i>			
Private consumption (% of GDP)	63.0	63.1	59.9
Public consumption (% of GDP)	20.0	20.0	20.0
Private investment (% of GDP)	14.3	14.3	17.5
Imports (% of GDP)	26.0	19.7	3.9
GDP (% of world GDP)	4.0	16.0	80.0
<i>Financial variables</i>			
Shares of capital producers held by entrepreneurs (%)	50.0	50.0	–
Corporate bonds (% of annual GDP)	10.0	10.0	–
Bank capital (% of total loans)	10.0	10.0	–
Bank loans to entrepreneurs (% of annual GDP)	71.8	71.8	–
Bank loans to borrowers (% of annual GDP)	36.0	36.0	–
Short-term public debt (% of annual GDP)	13.2	8.0	–
Long-term public debt (% of annual GDP)	121.3	93.3	–
Long-term sovereign bonds held by banks (% of annual GDP)	31.0	31.0	–
Duration corporate bonds (quarters)	32.0	32.0	–
Duration long-term sovereign bonds (quarters)	32.0	32.0	–
Net Foreign Asset Position (ratio to GDP)	0.0	0.0	0.0

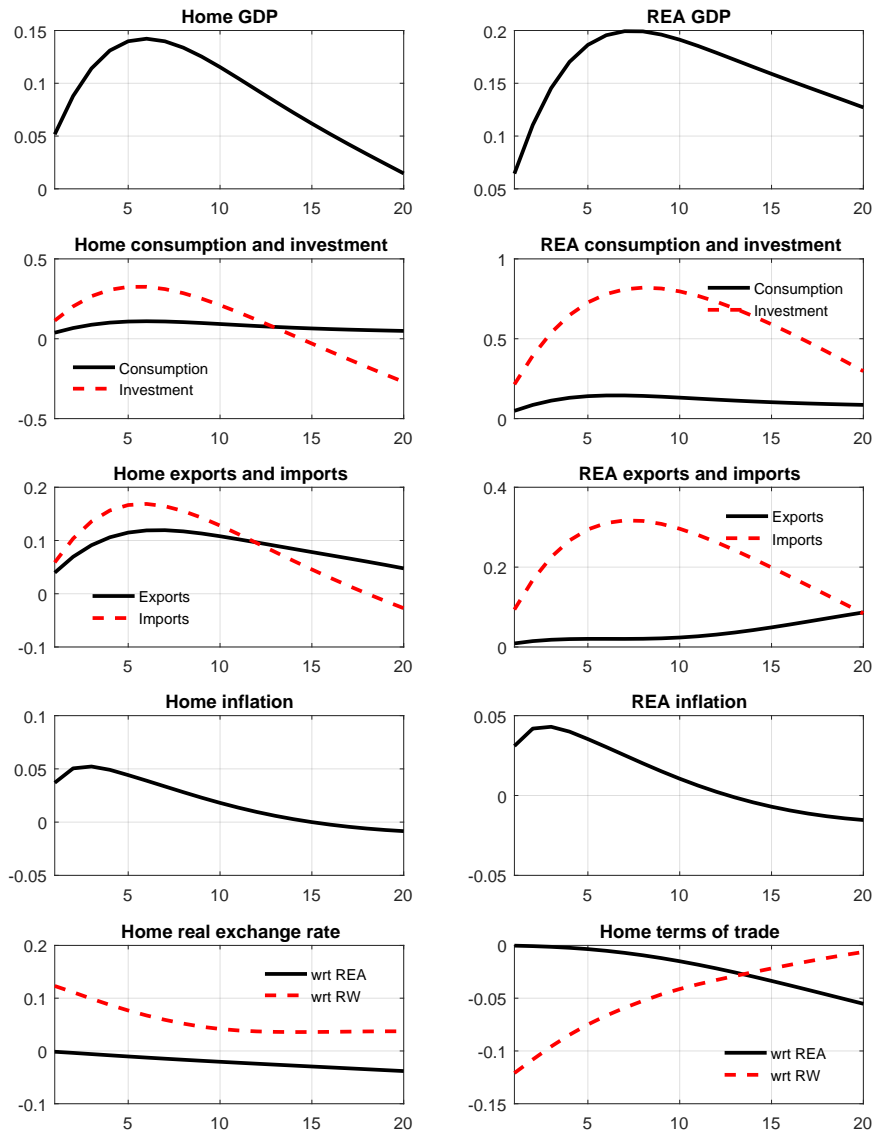
Note: H=Home; REA=rest of the euro area; RW= rest of the world.

Figure 1: Corporate bond market



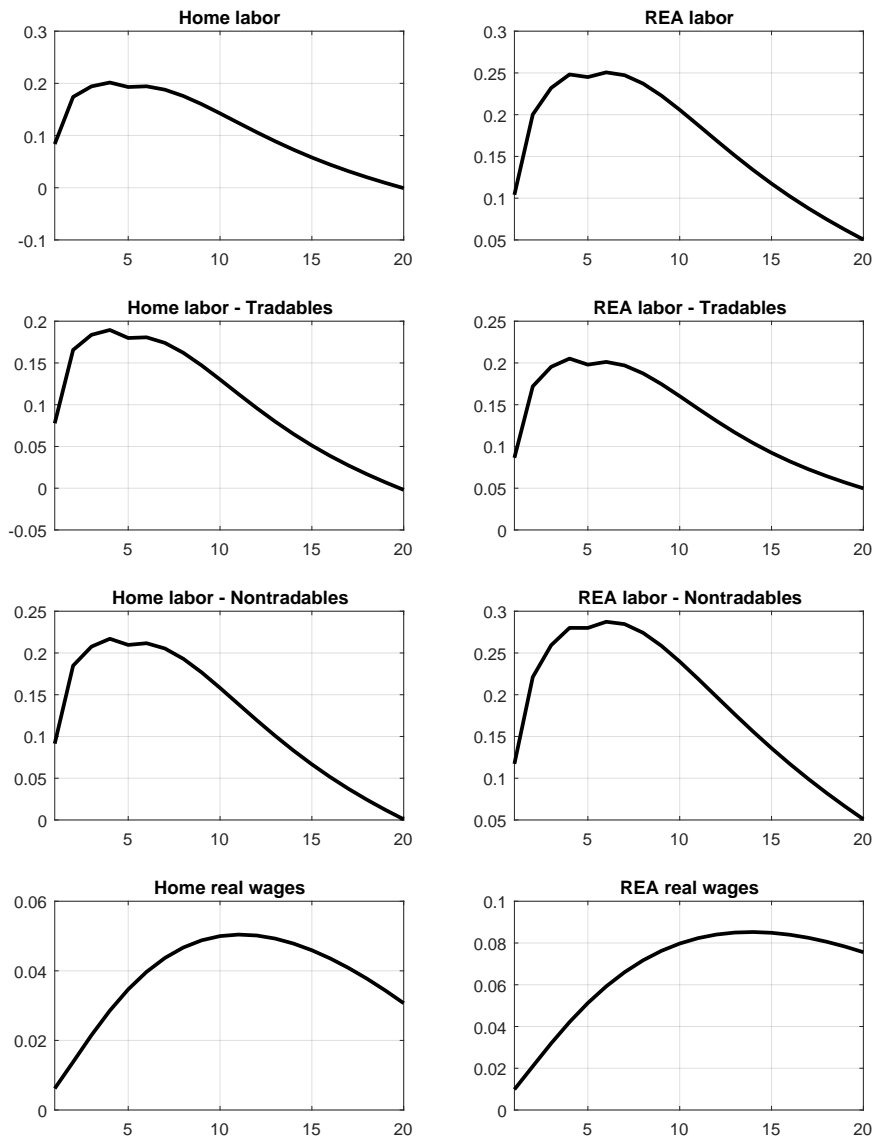
Notes: horizontal axis, quarters; GDP and its components in real terms; vertical axis, % deviations from the steady state. For nominal interest rate, annualized pp. dev.

Figure 2: Main macroeconomic variables



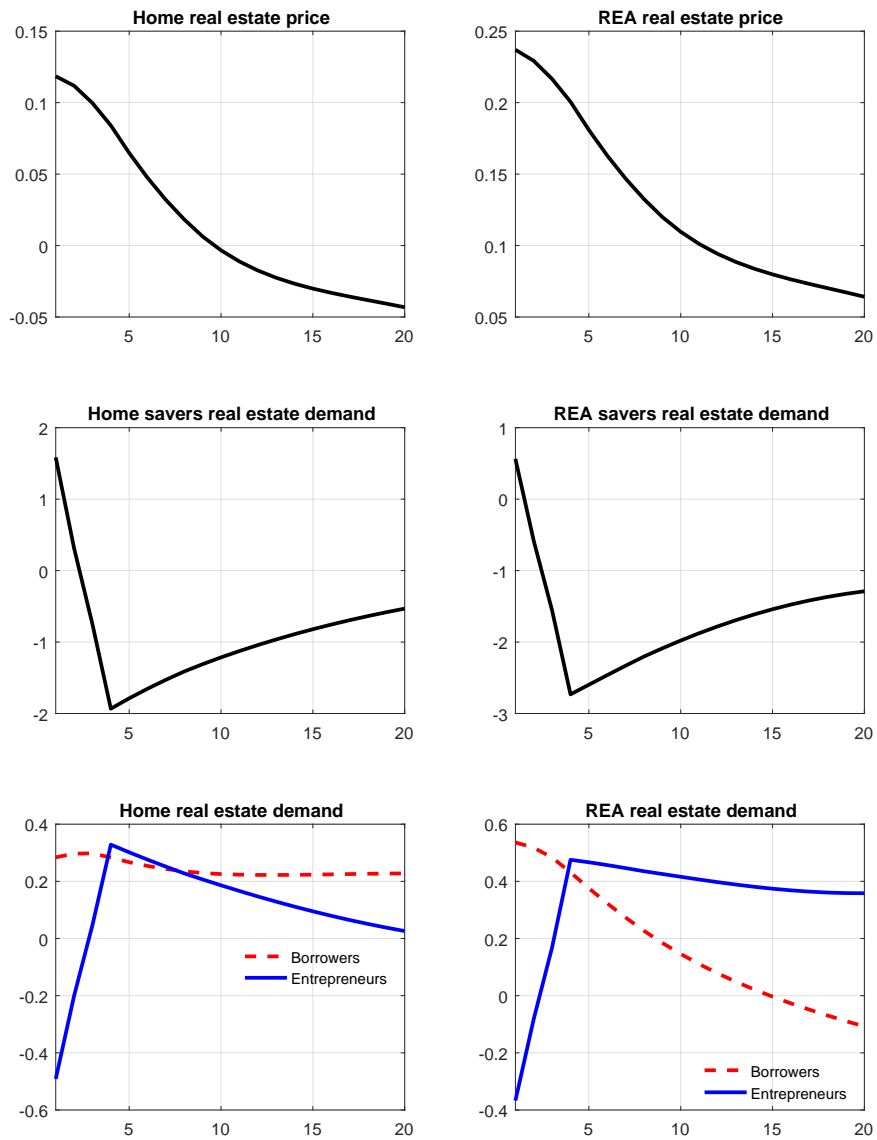
Notes: horizontal axis, quarters; vertical axis, % deviations from the steady state. For inflation, annualized pp. dev.

Figure 3: Labor market



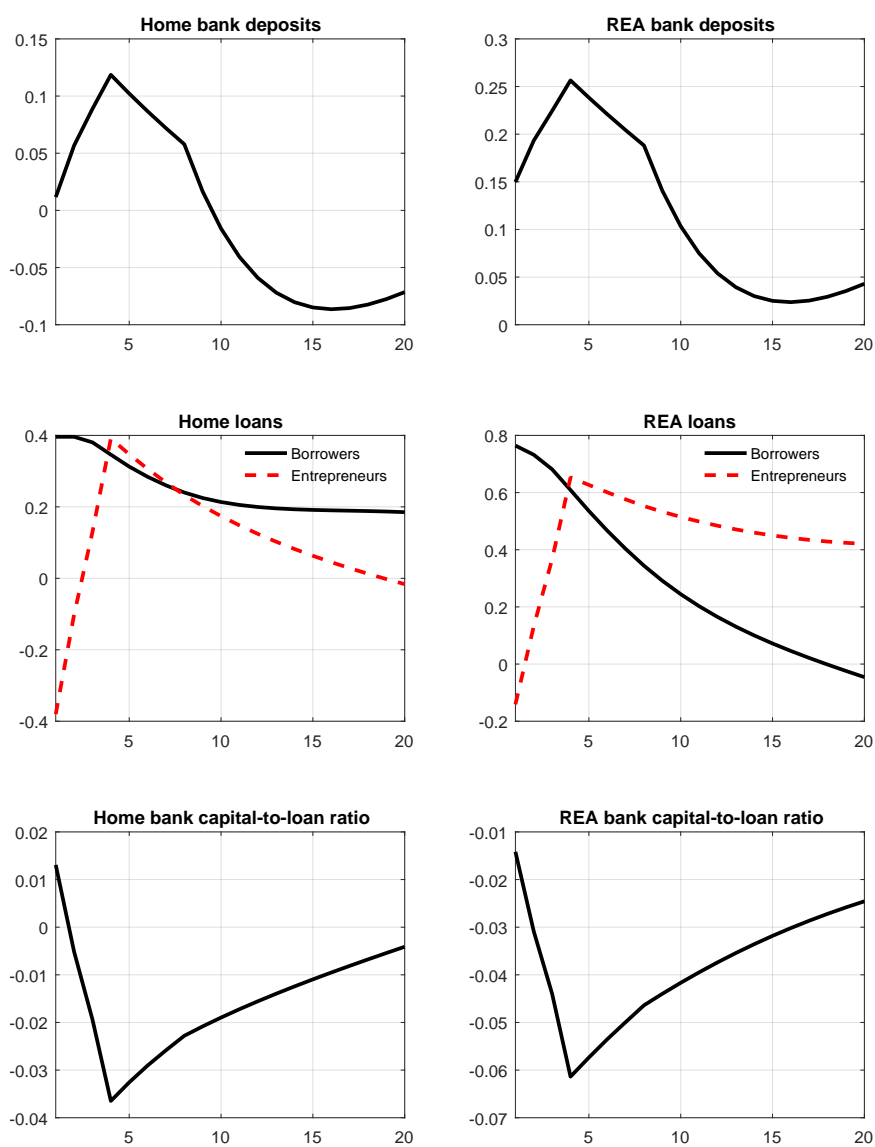
Notes: horizontal axis, quarters; vertical axis, % deviations from the steady state.

Figure 4: Real estate market



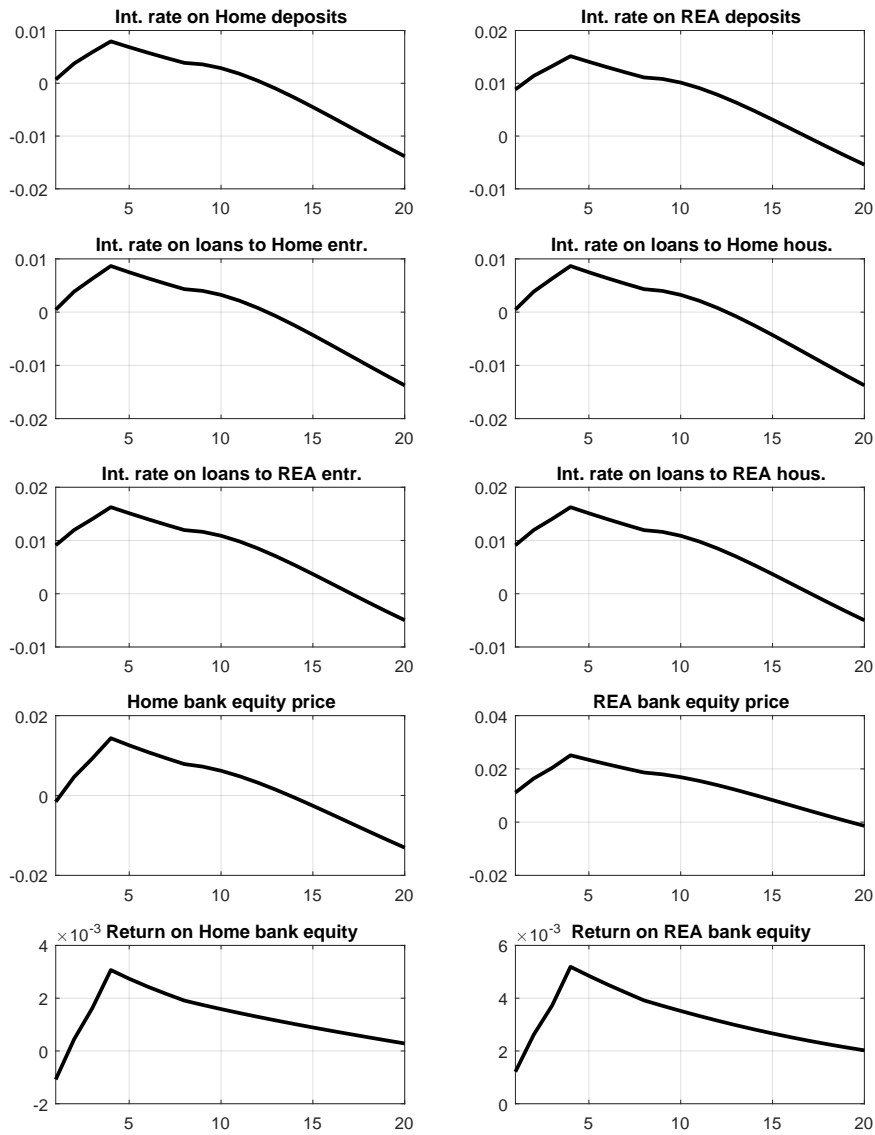
Notes: horizontal axis, quarters; vertical axis, % deviations from the steady state.

Figure 5: Banking sector: quantities



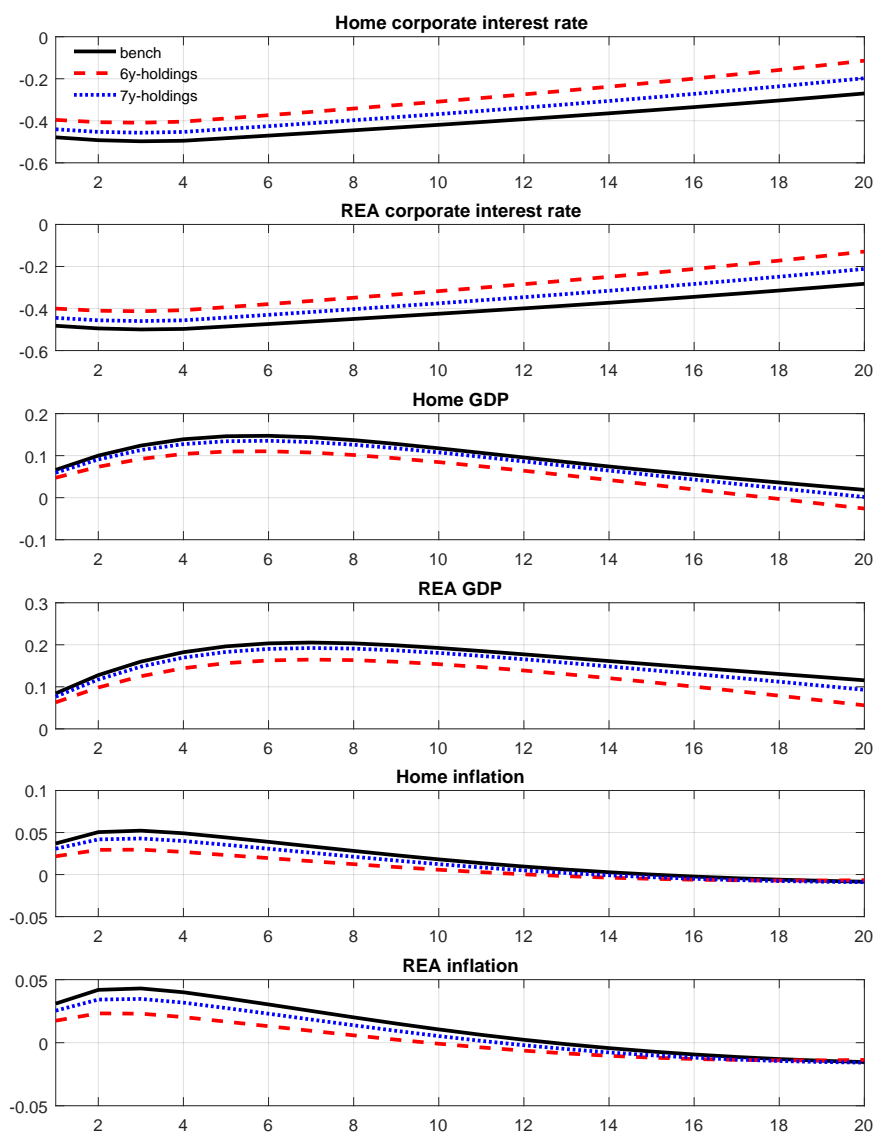
Notes: horizontal axis, quarters; vertical axis, % deviations from the steady state; for the bank capital-to-loan ratio, pp. dev.

Figure 6: Banking sector: prices



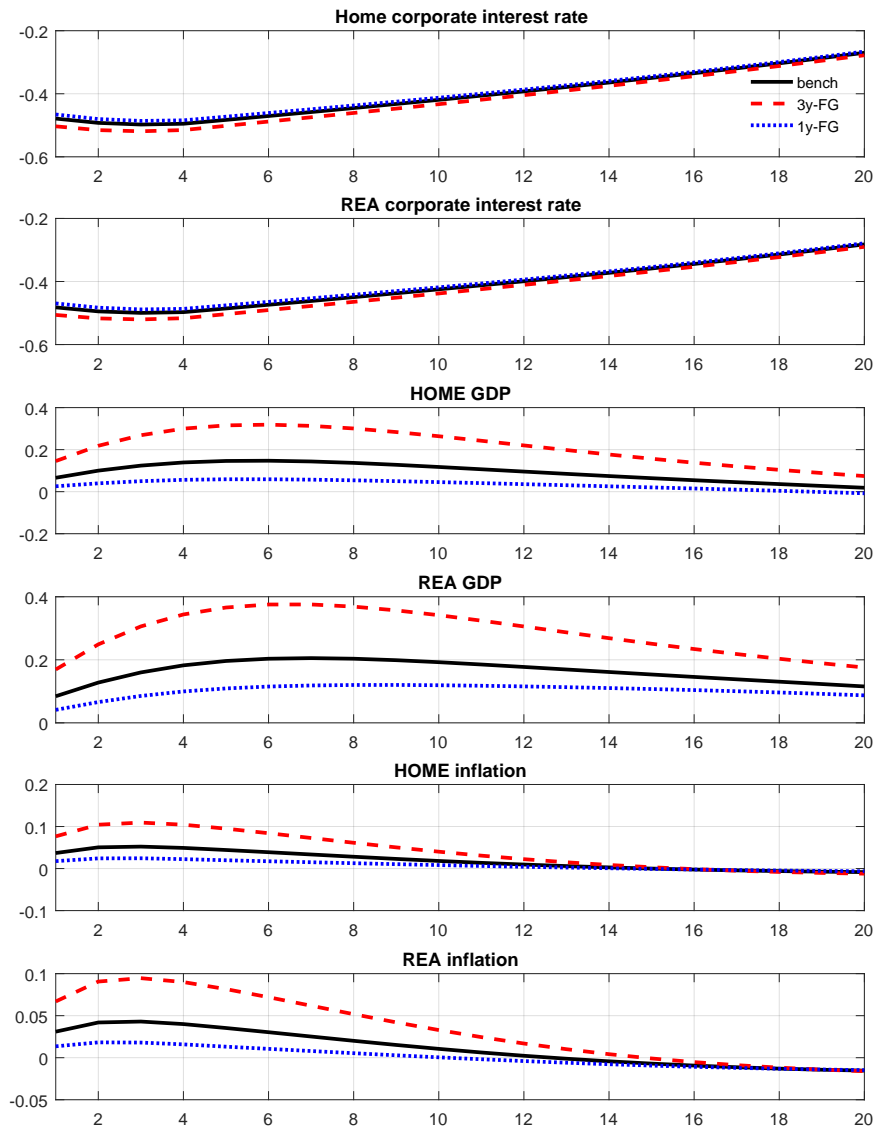
Notes: horizontal axis, quarters; vertical axis, annualized pp dev. from the steady state; for equity prices, % dev.

Figure 7: Alternative exit strategies from CSPP



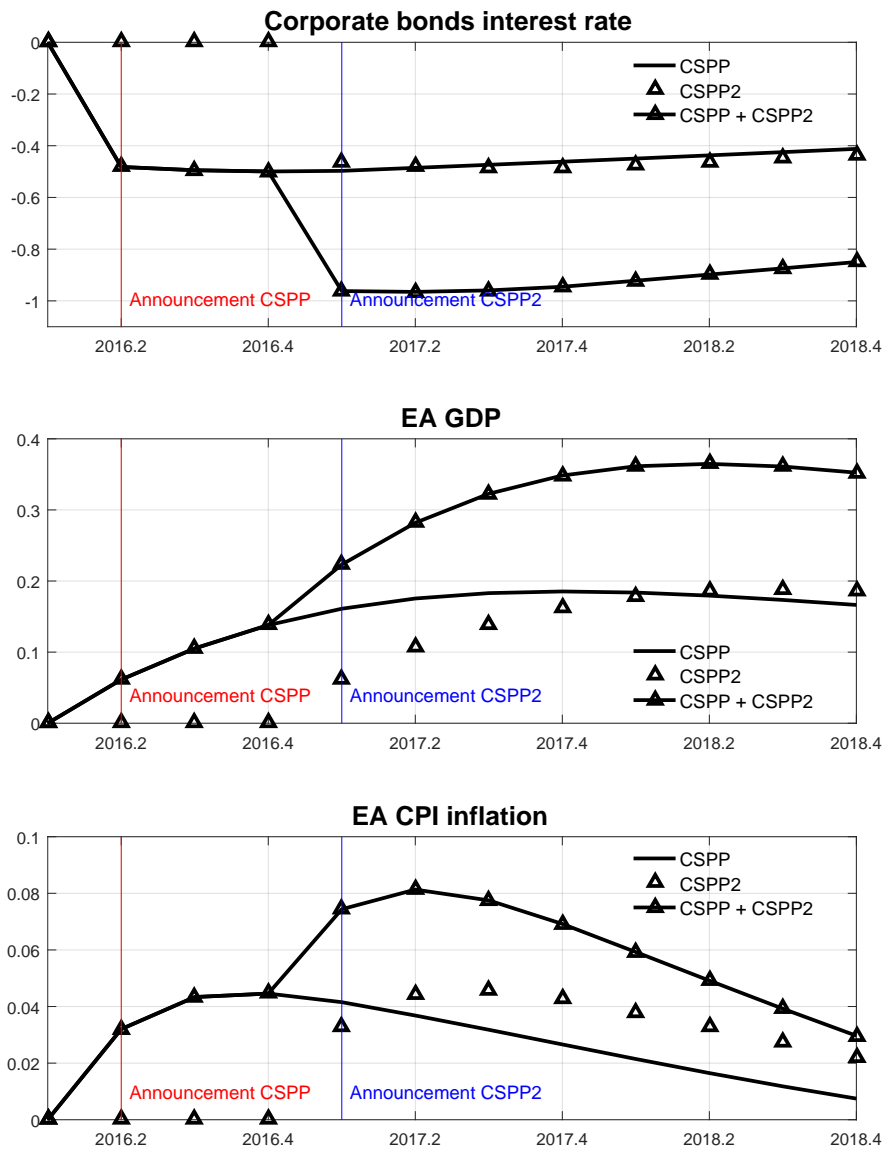
Notes: horizontal axis, quarters; GDP in real terms; vertical axis, % deviations from the steady state; for nominal interest rate and inflation, annualized pp.

Figure 8: Forward guidance



Notes: horizontal axis, quarters; GDP in real terms; vertical axis, % deviations from the steady state; for nominal interest rate and inflation, annualized pp.

Figure 9: Combined impact of CSPP and CSPP2 on EA economy



Notes: horizontal axis, quarters; GDP in real terms; vertical axis, % deviations from the steady state; for nominal interest rate and inflation, annualized pp.