BANCA D'ITALIA
EUROSISTEMA

Temi di Discussione

(Working Papers)

Macroeconomic effectiveness of non-standard monetary policy and early exit. A model-based evaluation

by Lorenzo Burlon, Andrea Gerali, Alessandro Notarpietro and Massimiliano Pisani

July 2016

Number 1074

BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working papers)

Macroeconomic effectiveness of non-standard monetary policy and early exit. A model-based evaluation

by Lorenzo Burlon, Andrea Gerali, Alessandro Notarpietro
and Massimiliano Pisani

Number 1074 - July 2016

The purpose of the Temi di discussione *series is to promote the circulation of working papers prepared within the Bank of Italy or presented in Bank seminars by outside economists with the aim of stimulating comments and suggestions.*

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

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

MACROECONOMIC EFFECTIVENESS OF NON-STANDARD MONETARY POLICY AND EARLY EXIT. A MODEL-BASED EVALUATION

by Lorenzo Burlon, Andrea Gerali, Alessandro Notarpietro and Massimiliano Pisani*

Abstract

This paper evaluates the macroeconomic effects of the Eurosystem's expanded Asset Purchase Programme (APP) under alternative strategies as regards (i) the unwinding of asset positions accumulated under the APP and (ii) communication of current and future paths of the policy rate (forward guidance). To this purpose, we simulate a New Keynesian model of the euro area. Our results are as follows. First, as the monetary authority brings forward the selling of long-term sovereign bonds, the stimulus from the APP on inflation and economic activity is correspondingly reduced. In particular, if the bonds are sold immediately after purchases end, the impact on inflation is negligible. Second, if the monetary authority communicates that it will hold the policy rate constant for one year instead of two, the APP is less effective, and the inflation increase is halved. Third, the subdued impact of the APP associated with an early exit from the programme delays the return to a standard monetary policy regime.

JEL Classification: E43, E52, E58.
Keywords: DSGE models, open-economy macroeconomics, non-standard monetary policy, zero lower bound.

Contents

* Bank of Italy, Directorate General for Economics, Statistics and Research.

It is extremely difficult to appraise the effectiveness of a program all of whose parameters have been announced at the beginning of the program. But I regard it as significant with respect to the effectiveness of QE that the taper tantrum in 2013, apparently caused by a belief that the Fed was going to wind down its purchases sooner than expected, had a major effect on interest rates.

Vice Chairman of the U.S. Federal Reserve Board Stanley Fischer[1]

1 Introduction[2]

The launch of the euro area Expanded Asset Purchase Programme (APP) has spurred a debate on the elements of its design (amounts of purchases, composition, and duration) that influence its effectiveness in stimulating the real economy and inflation.

On the one hand, some have emphasized the costs of an over-prolonged programme, which could fuel inflation and inflation expectations well above the definition of price stability, thus forcing the monetary authority to subsequently embrace a restrictive stance. On the other hand, others have stressed the macroeconomic costs of a programme that does not last for a sufficient amount of time (so called "early exit") and, thus, turns out to be insufficient to achieve the price stability objective. The risk is that this may result in reiterated implementation of (individually taken) too timid successive non-standard measures, which may end up being counterproductive, because the commitment to achieve price stability becomes less and less credible as time goes by.

In this paper we evaluate the APP effectiveness in relation with its announced duration and the possibility that the programme is exited too early, by simulating a three-region New Keynesian model of the euro area (EA) and the world economy. The EA is formalized as a monetary union of two regions, Home and rest of the EA (REA), where Home is of medium size (its GDP is around 20% of overall EA GDP). The model includes a third region outside the EA, which represents the

[1] See Fischer (2016).

[2] We thank for useful comments Martina Cecioni, Giuseppe Grande, Stefano Siviero and participants at the Bank of Italy Workshop "Unconventional monetary policy: effectiveness and risks" (March 2016). The 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.

rest of the world (RW). The presence of the latter region makes it possible to take into account the role of the nominal exchange rate and extra-EA trade for the transmission of the monetary stimulus to the real economy.

Crucially, we relax the so called "Wallace neutrality", and make short- and long-term sovereign bonds imperfect substitute. In this way, the central bank purchases of long-term sovereign bonds do affect the consumption-saving decisions of households and firms. Specifically, we follow Chen, Cúrdia, and Ferrero (2012), and introduce a preferred habitat assumption in the otherwise standard New Keynesian open economy framework. In each EA region some households (labeled as "restricted") have access only to long-term sovereign bonds and, indirectly, invest in physical capital accumulation, as they hold a constant (parametric) share of domestic "capital producers." The purchase of long-term government bonds by the monetary authority reduces long-term interest rates and induces restricted households to increase consumption and investment via the standard intertemporal substitution effect. The reduction in the long-term nominal interest rate leads to an increase in inflation expectations, which in turn reinforces the expansionary effect on aggregate demand and contributes to further reduce the real interest rate.

We simulate the following scenarios.[3]

First ("benchmark" case), we simulate the EA APP. The shock is calibrated so that it corresponds to overall quarterly purchases of euro 180 billion, that last for seven quarters. It is assumed that long-term sovereign bonds are held to maturity (on average 8 years) and, thereafter, the obtained principal payments are reinvested anew in long-term sovereign bonds as soon as they mature, for a period of 5 years. Subsequently, the central bank starts to gradually sell the bonds.

Second, we simulate the effects of three alternative scenarios of "early exit from sovereign bond holdings:" in one case, the principal payments are reinvested for one year only; in the alternative cases, there is no reinvestment, as the central bank starts to gradually sell the bonds before they mature, i.e. either immediately or four years after the last quarter in which the purchases are made. In all (benchmark and "early exit from sovereign bond holdings") scenarios we assume that the

[3]The scenarios are simulated assuming perfect foresight. Households and firms are surprised by the shock in the first period and fully anticipate shocks perturbing the economy in subsequent periods.

monetary authority commits to keeping the short-term policy rate at its baseline level (0.25%) during the first two years of the simulations (we call it "Forward Guidance", FG henceforth).

Third, we explore the consequences of assuming that the same purchases are carried out as in the benchmark scenario but the short-term rate is kept at the baseline for one year instead of two. This scenario can be considered as a case of "early exit from FG."

Fourth, we assume a negative demand shock that endogenously drives the EA monetary policy rate to the zero lower bound (ZLB). On top of this shock, we simulate the APP under alternative assumptions in terms of sovereign bond reinvestment. In this scenario, there is no FG, as the monetary policy rate is set according to a standard Taylor rule and is constrained by the ZLB (the monetary authority would further decrease the rate in the absence of the ZLB).

Our results are as follows.

First, if the monetary authority brings forward the unwinding of its long-term sovereign bond holdings, the stimulus from the APP on inflation and economic activity is correspondingly reduced. If the bonds are immediately sold after the end of the purchases, the impact on inflation is negligible. If the bonds are held to maturity (8 year on average) or reinvested, the annualized increase in inflation is 0.8 percentage points (pp) at the peak, in about five quarters.

Second, if the monetary authority communicates that the policy rate will be held constant for a shorter period of time, the APP is less effective in stimulating inflation. If the FG lasts 1 year instead of 2, inflation increases by 0.3pp instead of 0.8pp (in about five quarters).

Third, an early exit from bond holdings strongly hampers the effectiveness of the programme in creating macroeconomic conditions conducive to the short-term policy rate being raised above the ZLB. The normalization of monetary policy conditions is therefore delayed.

The paper builds upon several recent contributions. Burlon, Gerali, Notarpietro, and Pisani (2015) evaluate the impact of the APP on EA macroeconomic and financial conditions assuming that some households are subject to a borrowing constraint. Chen, Cúrdia, and Ferrero (2012) introduce financial market segmentation à la Andrés, López-Salido, and Nelson (2004) to evaluate the impact of US quantitative easing. We tailor their set-up to a monetary union framework. Previous studies, on the US, as Gertler and Karadi (2011), Gertler and Kiyotaki (2011), and Cúrdia and Woodford (2011) study the effects of security purchase programs in closed-economy settings. Our exercise is calibrated to the EA.

The paper is organized as follows. Section 2 describes the main features of the model and the details of the calibration. Section 3 reports the main results. Section 4 concludes.

2 The model

We first provide an overview of the model. Subsequently, we illustrate the crucial features for the simulations (borrowing constraint and long-term sovereign bond market). 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 $n + n^* < 1$. For each region, size refers to the overall population, to the number of firms operating in each sector and, in the case of each EA region, the number of capital producers. Home and REA share the currency and the monetary authority. The latter sets the policy rate according to EA-wide variables (a standard Taylor rule holds) when it does not deliberately enact FG or when it is not constrained by the ZLB. The presence of the RW outside the EA allows to assess the role of the nominal exchange rate and extra-EA trade for the transmission of the APP.

We introduce financial segmentation à la Chen, Cúrdia, and Ferrero (2012), which allows the APP to have real effects in our model. In each EA region there are two types of households, restricted and unrestricted.

The restricted households have access only to the domestic long-term sovereign bond market and, indirectly, invest in physical capital accumulation, as they hold a constant (parametric) share of domestic "capital producers."

The unrestricted households (1) have access to the domestic short-term private bond and long-term sovereign bond markets, (2) trade a riskless private bond with RW households, and (3) invest in physical capital, as, similarly to the restricted households, they hold a constant share of domestic capital producers.[4] The latter accumulate physical capital by demanding final investment goods subject to quadratic adjustment costs on investment change (so a Tobin's Q holds). They rent capital to domestic firms producing intermediate goods. They maximize profits with respect to capital and investment taking prices as given, and evaluate returns according to a weighted (according the corresponding shares) average of unrestricted and restricted households' stochastic discount factors. The (net) revenues are rebated in a lump-sum way to domestic unrestricted and restricted households, according to their corresponding shares.[5]

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 non-tradable and tradable goods. The latter are 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.

On the production side, there are perfectly competitive firms that produce two final goods (consumption and investment goods) and monopolistic firms that produce intermediate goods (firms are owned by domestic unrestricted households). 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 can have different composition. Intermediate tradable and non-tradable goods are produced combining domestic capital and labor, 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

[4]The assumed financial market structure allows us to have meaningful EA net foreign asset position and trade balance. An international market for at least one euro-denominated sovereign bond allows for a further channel of transmission of the APP to the EA/RW exchange rate.

[5]For details, see Chen, Cúrdia, and Ferrero (2012).

a different price for each of the three markets. In line with other dynamic general equilibrium models of the EA (see, among the others, Christoffel, Coenen, and Warne 2008 and Gomes, Jacquinot, and Pisani 2010), we include adjustment costs on real and nominal variables, ensuring that consumption, production, and prices react in a gradual way to a shock. On the real side, habits and quadratic costs prolong the adjustment of consumption and investment, respectively. On the nominal side, quadratic costs make (nominal) wages and prices sticky.[6]

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

2.2 Restricted households

There exists a continuum of mass $0 \leq \lambda_R \leq 1$ of restricted households, indexed by j', with $j' \epsilon\ (0, n\lambda_R]$. 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 $L_R(j')$. Following common practice in the New Keynesian literature, the assumption of cashless economy holds in the model. The expected lifetime utility of the generic restricted household $j\prime$ is

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

where E_0 denotes the expectation conditional on information set at date 0, 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.

They have access only to the market of long-term sovereign bonds. The budget

[6] See Rotemberg (1982).

constraint is

$$\begin{aligned} & P_t^L B_{R,t}^L (j') - P_t^L R_t^L B_{R,t-1}^L (j') \\ = \ & \omega \Pi_t^{prof} + W_{R,t} (j') L_{R,t} (j') \\ & -P_t C_{R,t} (j') - AC_{R,t}^W (j'), \end{aligned} \tag{2}$$

where $B_{R,t}^L$ is the amount of long-term sovereign bonds. The variable R_t^L is the gross yield to maturity at time t on the long-term bond

$$R_t^L = \frac{1}{P_t^L} + \kappa.$$

The variable Π_t^{prof} is the Home capital producers' aggregate profit. Each individual restricted household gets profits from ownership of domestic capital producers, according to the constant (parametric) share $0 < \omega < 1$. The long-term sovereign bonds 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. It sets its nominal wage taking into account labor demand and quadratic adjustment costs AC_R^W à la Rotemberg on the nominal wage $W_R (j')$:[7]

$$AC_{R,t}^W (j') \equiv \frac{\kappa_W}{2} \left(\frac{W_{R,t} (j') / W_{R,t-1} (j')}{\Pi_{WR,t-1}^{\alpha_W} \bar{\Pi}_{EA}^{1-\alpha_W}} - 1 \right)^2 W_{R,t} L_{R,t}, \tag{3}$$

where $\kappa_W > 0$ and $0 \leq \alpha_W \leq 1$ are parameters, the variable $\Pi_{WR,t} \equiv W_{R,t}/W_{R,t-1}$ is the wage inflation rate, and $\bar{\Pi}_{EA}$ is the long-run 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, $W_{R,t} L_{R,t}$.[8]

Restricted households are crucial for the APP to have real effects in our model. As they cannot make arbitrage between short-term and long-term bonds, the so-called Wallace neutrality is relaxed, and short- and long-term sovereign bonds are

[7] See Rotemberg (1982).

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

not perfect substitutes for households. Thus, long-term sovereign bond prices and yields do matter for households consumption and saving decisions. The monetary policy authority can affect them by directly intervening in the long-term sovereign bond market (to change the long-term interest rate).

2.3 Unrestricted households

There exists a continuum of unrestricted households, indexed by j, with $j \epsilon (n\lambda_R, n]$. These households have the same preferences as restricted households, thus they consume and supply labor. The only difference is the discount factor, β_U, which is different from that of restricted households ($\beta_U > \beta_R$).

Home unrestricted households have access to multiple financial assets (all denominated in euro terms): the short-term sovereign bond, B^G, exchanged with the domestic government and paying the interest rate R^G; the short-term private bond, B^P, exchanged with REA unrestricted and RW households and paying the EA monetary policy rate R; the long-term sovereign bond, B_U^L, exchanged with the domestic restricted households, domestic government and, because of the APP, the EA monetary authority. Thus, they have several opportunities to smooth consumption when facing a shock. The budget constraint of the generic unrestricted household j is

$$\begin{aligned} & P_t^L B_{U,t}^L(j) - P_t^L R_t^L B_{U,t-1}^L(j) \\ & + B_t^G(j) - B_{t-1}^G(j) R_{t-1}^G \\ & + B_t^P(j) - B_{t-1}^P(j) R_{t-1}(1-\phi_t) \\ = \; & W_{U,t}(j) L_{U,t}(j) + (1-\omega)\Pi_t^{prof} + \Pi_t^P(j) - P_t C_{U,t}(j) \\ & - TAX_t(j) - AC_{U,t}^W(j) - AC_{U,t}^B(j). \end{aligned}$$

The term ϕ_t represents an exponential adjustment costs, needed to stabilize the position in the short-term private bond.[9] The term $AC_{U,t}^B$ is an adjustment cost

[9] The adjustment cost is defined as

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

on long-term sovereign bond holdings.[10]

The term $(1-\omega)$ represents the constant (parametric) share, assumed to be the same across unrestricted households, of domestic capital producers' aggregate profits. Unrestricted households own all domestic firms. The variable $\Pi_t^P(j)$ stands for dividends from ownership of domestic monopolistic firms (claims to firms' profits are not internationally tradable). The term $TAX_t > 0$ represents lump-sum taxes. The unrestricted households supply labor services under monopolistic competition, and face quadratic adjustment costs $AC_{U,t}^W$ when setting nominal wages (the cost is similar to the one paid by restricted households, see eq. 3).

First order conditions imply no-arbitrage conditions for the unrestricted households.[11] Thus, in equilibrium the interest rates paid by the different bonds are equal to the monetary policy rate R_t, except for the spreads induced by the longer maturity and the adjustment costs.[12]

2.4 Capital producers

There exists a continuum of mass $0 \leq n \leq 1$ of firms e that produce physical capital. They optimally choose capital K_t and investment I_t to maximize profits subject to the law of capital accumulation, the adjustment costs on investment, and taking prices as given. The law of motion of capital accumulation is

$$K_t(e) = (1-\delta) K_{t-1}(e) + \left(1 - AC_t^I(e)\right) I_t(e), \tag{4}$$

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

[10] We assume a standard quadratic form for the adjustment cost, that is,

$$AC_{U,t}^B(j) \equiv \frac{\phi_{b^L}}{2}\left(P_t^L B_{U,t}^L(j) - \bar{P}^L \bar{B}_U^L\right)^2, \text{ with } \phi_{b^L} > 0,$$

where $\bar{P}^L \bar{B}_U^L$ 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.

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

[12] See Chen, Cúrdia, and Ferrero (2012) for the details. Our calibration implies that households can modify their financial positions without facing relevant adjustment costs.

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

$$AC_t^I(e) \equiv \frac{\phi_I}{2}\left(\frac{I_t(e)}{I_{t-1}(e)} - 1\right)^2, \text{ with } \phi_I > 0. \tag{5}$$

Capital produces rent existing physical capital stock $K_{t-1}(e)$ at the nominal rate R_t^K to domestic firms producing intermediate tradable and non-tradable goods. Investment is a final non-tradable good, composed of intermediate (domestic and imported) tradable and non-tradable goods. Capital producers buy it in the corresponding market at price P_I.[13] Because of the adjustment costs on investment, a "Tobin's Q" holds.

When maximizing profits with respect to capital and investment, capital producers discount profits using the stochastic discount rate of restricted and unrestricted households, aggregated according to the corresponding shares.

2.5 Monetary policy

In almost all scenarios we assume that the monetary authority enacts the FG, i.e., it commits to keeping the short-term policy rate at its baseline level (0.25%) during the first two years of the simulations. In some scenarios it is assumed, instead, that the ZLB is an endogenous constraint on the policy rate, as the EA central bank, in the aftermath of a recessionary shock, cannot further reduce the rate, beyond the zero level. When neither the FG nor the ZLB hold, a standard Taylor rule kicks in to set the policy rate,

$$\frac{R_t}{\bar{R}} = max\left(1, \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R}\left(\frac{\Pi_{EA,t}}{\bar{\Pi}_{EA}}\right)^{(1-\rho_R)\rho_\pi}\left(\frac{GDP_{EA,t}}{GDP_{EA,t-1}}\right)^{(1-\rho_R)\rho_{GDP}}\right), \tag{6}$$

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

[13] As for the consumption basket, the investment bundle is a composite of tradable and non-tradable goods. The composition of consumption and investment goods can be different.

deviation from its long-run constant target $\bar{\Pi}_{EA}$) and GDP ($GDP_{EA,t}$).[14] When the policy rate exits from the ZLB, it reverts to the Taylor rule.[15]

Finally, the EA monetary authority can adopt the APP, formalized as an exogenous increase in the purchases of Home and REA long-term sovereign bonds by the EA monetary authority, respectively $B^L_{APP,t}$ and $B^{L*}_{APP,t}$.

2.6 Fiscal authority

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

$$\begin{aligned} & B^S_{g,t} - B^S_{g,t-1}R_{t-1} + P^L_t B^L_{g,t} - P^L_t R^L_t B^L_{g,t-1} \\ = \; & P_{N,t}C^g_t - TAX_t, \end{aligned} \tag{7}$$

where $B^S_{g,t} \geq 0$ and $B^L_{g,t} \geq 0$ are respectively the short- and long-term nominal sovereign debt. The variable C^g_t represents government purchases of goods and services. Consistent with the empirical evidence, C^g_t is fully biased towards the intermediate non-tradable good. Hence it is multiplied by the corresponding price index $P_{N,t}$.[16]

The government follows a fiscal rule defined on lump-sum taxes. This rule aims at bringing the short-term public debt $b^S_g > 0$ (as a % of domestic GDP), in line with its target $\bar{b}^S_g$ and at limiting its increase ($b^S_{g,t}/b^S_{g,t-1}$):

$$\frac{TAX_t}{TAX_{t-1}} = \left(\frac{b^S_{g,t}}{\bar{b}^S_g}\right)^{\phi_1} \left(\frac{b^S_{g,t}}{b^S_{g,t-1}}\right)^{\phi_2}, \tag{8}$$

where parameters $\phi_1, \phi_2 > 0$ call for an increase in lump-sum taxes whenever the short-term debt level is above target and for a larger increase whenever its dynamics is not converging. A similar rule holds in the REA. We include only

[14] The 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.

[15] We implement the ZLB by simulating the fully non-linear model under perfect foresight and specify equation (6) using the "max" operator.

[16] See Corsetti and Mueller (2006).

the short-term debt in the fiscal rule for two reasons. First, we hold the supply of long-term government bonds, $B^L_{g,t}$, fixed so as to isolate the direct demand effects of the APP. Second, we need the fiscal rule to stabilize the short-term debt and, as we assume that the long-term component is exogenous, the overall public debt. In the RW, as there is no distinction between short- and long-term domestic sovereign bonds, the rule holds for the overall public debt.

Finally, lump-sum taxes are paid by unrestricted households only. In this way we are able to isolate the response of restricted and indebted households to the APP from the indirect fiscal adjustments implied by the program.[17]

2.7 Bonds market clearing conditions

The market clearing condition for the Home long-term government bond is

$$\int_0^{n\lambda_R} B^L_{R,t}(j')dj' + \int_{n\lambda_R}^{n} B^L_{U,t}(j)dj + B^L_{APP,t} = B^L_{g,t}, \tag{9}$$

where the variable $B^L_{APP,t}$ represents the demand for long-term sovereign bonds by the EA monetary authority.

The market clearing condition for the Home short-term sovereign bond is

$$\int_{n\lambda_R}^{n} B^G_t(j)dj = B^S_{g,t}, \tag{10}$$

as the short-term sovereign bond is held only by unrestricted households. Similar equations hold in the REA.[18]

[17]The Ricardian equivalence does not hold, since Restricted households hold long-term sovereign bonds but are not subject to lump-sum taxes.Our assumption on the distribution of lump-sum taxes or, equivalently, on the initial distribution of public debt, implies that sovereign bond holdings are net wealth.

[18]In particular, the market clearing condition for the REA long-term government bond is

$$\int_0^{n^*\lambda^*_R} B^L_{R,t}(j'^*)dj^* + \int_{n^*\lambda^*_R}^{n^*} B^L_{U,t}(j^*)dj^* + B^{L*}_{APP,t} = B^{L*}_{g,t}, \tag{11}$$

where the variables $B^L_{R,t}(j'^*)$, $B^L_{U,t}(j^*)$, and $B^{L*}_{APP,t}$ represent the demand for REA long-term sovereign bonds by the REA restricted households, REA unrestricted households, and EA monetary authority, respectively.

2.8 Equilibrium

In each country 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 across unrestricted households. Profits from ownership of domestic capital producers are distributed to restricted and unrestricted households according to the corresponding shares held by each type of households, and are equally shared within each type. Thus, there is the representative household for each household type (restricted, and unrestricted), the representative firm for each sector (final non-tradable, intermediate tradable, and intermediate non-tradable), and the representative capital producer. The implied symmetric equilibrium is a sequence of allocations and prices such that, given initial conditions and considered shocks, households and firms satisfy their corresponding first order conditions, the Taylor rules, the fiscal rules, and the government budget constraints hold, and all markets clear.

2.9 Calibration

The model is calibrated at quarterly frequency. We set some parameter values so that steady-state ratios are consistent with average EA 2014 national account data, which are the most recent and complete available data. For remaining parameters we resort to previous studies and estimates available in the literature.[19]

Table 1 contains parameters for preferences and technology. Parameters with "$*$" and "$**$" are related to the REA and the RW, respectively. We assume perfect symmetry between the REA and the RW unless differently specified. The discount factor of EA unrestricted households is set to 0.9994, so that the steady-state short-term interest rate is equal to 0.24% on an annual basis. The discount factor of RW households is also set to 0.9994. The discount factor of restricted households determines the steady-state value of the long-term interest rate and is set to 0.995, so that in steady state the spread between short- and long-term bond is equal to 1.8pp. In each EA region the share of restricted households is set to 0.25. Given

[19]See the New Area Wide Model (NAWM, Christoffel, Coenen and Warne 2008) and Euro Area and Global Economy Model (EAGLE, Gomes, Jacquinot and Pisani 2010)

the lack of micro-evidence on this share, we set it to get a response of investment to the (benchmark) APP around four times as large as the response of consumption, in line with standard business cycle facts on response of investment, which is larger than that of consumption.

The value for the intertemporal elasticity of substitution, $1/\sigma$, is 1. The Frisch labor elasticity is set to 0.5. Habit is set to 0.8. The depreciation rate of capital is set to 0.025.

In the production functions of tradables and non-tradables, the elasticity of substitution between labor and capital is set to 0.90. To match investment-to-GDP ratios, the bias towards capital in the production function of tradables is set to 0.56 in Home and, in the REA and in the RW, to 0.46. The corresponding value in the production function of non-tradables is set to 0.53 in Home and 0.43 in the REA and RW. In the final consumption and investment goods the elasticity of substitution between domestic and imported tradable is set to 1.5, while the elasticity of substitution between tradables and non-tradables is set to 0.5, as empirical evidence suggests that it is harder to substitute tradables for non-tradables than to substitute across tradables. The biases towards the domestically produced good and composite tradable good are chosen to match the Home and REA import-to-GDP ratios. In the consumption bundle the bias towards the domestic tradable is 0.68 in Home, 0.59 in the REA, and 0.90 in the RW. The bias towards the composite tradable is set to 0.68 in Home and to 0.50 in the REA and the RW. For the investment basket, the bias towards the domestic tradable is 0.50 in Home, 0.49 in the REA, and 0.90 in the RW. The bias towards the composite tradable is 0.78 in Home and 0.70 in the REA and in the RW.

Table 2 reports gross mark-up values. In the Home tradable and non-tradable sectors and in the Home labor market the mark-up is set to 1.08, 1.29, and 1.60, respectively (the corresponding elasticities of substitution across varieties are set to 13.32, 4.44, and 2.65). In the REA tradable and non-tradable sectors and in the REA labor market the gross mark-ups are respectively set to 1.11, 1.24, and 1.33 (the corresponding elasticities are set to 10.15, 5.19, and 4.00). Similar values are chosen for the corresponding parameters in the RW.

Table 3 contains parameters that regulate the dynamics. Adjustment costs on investment change are set to 7.5. Nominal wage quadratic adjustment costs are set to 400. In the tradable sector, we set the nominal adjustment cost parameter to 400 for Home tradable goods sold domestically and in the REA; for Home goods sold in the RW, the corresponding parameter is set to 50. The same parameterization is adopted for the REA, while for the RW we set the adjustment cost on goods exported to Home and the REA to 50. Nominal price adjustment costs are set to 600 in the non-tradable sector.

The parameter regulating the adjustment costs paid by the unrestricted household on deviations of long-term sovereign bond positions from steady-state levels, ϕ_{b^L}, is set to 0.000067 and to 0.00047 in Home and REA, respectively. The parameters regulating the adjustment cost on private bond position, paid by Home unrestricted households and RW households, are set to 0.0015 and 0.003. 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 long-term sovereign bonds to the benchmark APP should be in line with existing evidence for the EA.[20]

Table 4 reports the parametrization of the systematic feedback rules followed by the fiscal and monetary authorities. In the fiscal policy rule (8) we set $\phi_1 = 0.05$ and $\phi_2 = 10.01$ for Home, and $\phi_1 = \phi_2 = 1.01$ for the REA and the RW. It is always lump-sum transfers to adjust. The central bank of the EA targets the contemporaneous EA-wide consumer price inflation (the corresponding parameter 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 0.92. The values are identical for the corresponding parameters of the Taylor rule in the RW.

Table 5 reports the great ratios, which are matched by the model steady state under our baseline calibration. We assume a zero steady-state net foreign asset position of each region. The sizes of Home and REA GDPs as shares of world GDP are set to 4% and to 18%, respectively. So the Home GDP is around 20% of EA GDP.

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. We assume that in each country long-term sovereign bond holdings

[20]See Altavilla, Carboni and Motto (2015).

are equally shared between unrestricted and restricted households. The parameter κ is calibrated to match the average duration of the representative long-term EA sovereign bond, which is equal to 8 years.

Variables of the RW are set to values equal to those of corresponding REA variables.

The chosen calibration yields impulse response functions to a standard monetary policy shock (+0.25 basis points) for GDP and inflation in each EA region that are in line with the workhorse estimated models of the EA in the literature.[21]

3 Results

We initially describe the simulated scenarios, and, subsequently, we report the results.

3.1 Simulated scenarios

First ("benchmark" case), we simulate the EA APP. The shock is calibrated so that it corresponds to overall quarterly purchases of euro 180 billion, that last for seven quarters. It is assumed that long-term sovereign bonds are held to maturity (on average 8 years) and, thereafter, the obtained principal payments are reinvested anew in long-term sovereign bonds as soon as they mature, for a period of 5 years. Subsequently, the central bank starts to gradually sell the bonds.

Second, we simulate the effects of three alternative scenarios of "early exit from sovereign bond holdings:" in one case, the principal payments are reinvested for one year only; in the alternative cases, there is no reinvestment, as the central bank starts to gradually sell the bonds before they mature, i.e. either immediately or four years after the last quarter in which the purchases are made. In all (benchmark and "early exit from bond holdings") scenarios we assume that the monetary authority commits to keeping the short-term policy rate at its baseline level (0.25%) during the first two years of the simulations (we call it "Forward Guidance", FG henceforth).

[21] See, for example, the New Area Wide Model (NAWM, Christoffel, Coenen and Warne 2008) and the Euro Area and Global Economy Model (EAGLE, Gomes, Jacquinot and Pisani 2010).

Third, we explore the consequences of assuming that the same purchases are carried out as in the benchmark scenario but the short-term rate is kept at the baseline for one year instead of two. This scenario can be considered as a case of "early exit from FG."

Fourth, we assume a negative demand shock that endogenously drives the EA monetary policy rate to the zero lower bound (ZLB). On top of this shock, we simulate the APP under alternative assumptions in terms of sovereign bond reinvestment. In this scenario, there is no FG, as the monetary policy rate is set according to a standard Taylor rule and is constrained by the ZLB (the monetary authority would further decrease the rate in the absence of the ZLB).

In Section 3.2, we report results of the benchmark case, corresponding to the simulation of the APP. The shock is calibrated so that it corresponds to overall quarterly purchases of euro 180 billion, that last for seven quarters. Home and REA long-term sovereign bond purchases are proportional to the size of the corresponding region (measured as a share of EA GDP). It is assumed that long-term sovereign bonds are held to maturity (on average 8 years) and, thereafter, the obtained principal payments are reinvested anew in long-term sovereign bonds as soon as they mature, for a period of 5 years. Subsequently, the central bank starts to gradually sell the bonds.

The benchmark scenario is compared with three alternative scenarios of "early exit from sovereign bond holdings:" in one case, the principal payments are reinvested for one year only; in the alternative cases, there is no reinvestment, as the central bank starts to gradually sell the bonds before they mature, i.e. either immediately or four years after the last quarter in which the purchases are made. In all (benchmark and "early exit from bond holdings") scenarios we assume that the monetary authority commits to keeping the short-term policy rate at its baseline level (0.25%) during the first two years of the simulations (FG).

In Section 3.3, we explore the consequences of assuming that the same purchases are carried out as in the benchmark scenario but the short-term rate is kept at the baseline for one year instead of two. This scenario can be considered as a case of "early exit from FG."

Fourth, in Section 3.4, we assume a EA-wide negative demand shock that endogenously drives the EA monetary policy rate, set according to the Taylor rule (eq. 6), to the zero lower bound (ZLB). On top of this shock, we simulate the APP under alternative assumptions in terms of sovereign bond reinvestment. In this scenario, there is no FG, as the monetary policy rate is set according to a standard Taylor rule and is constrained by the ZLB (the monetary authority would further decrease the rate in the absence of the ZLB). In this way, we assess the impact of APP on the normalization of monetary policy conditions (endogenous exit of the policy rate from the ZLB).

All scenarios are simulated under perfect foresight. Households and firms are surprised by the shock in the first period and fully anticipate shocks perturbing the economy in subsequent periods.

3.2 Early exit from bond holdings

Figure 1 shows results for the benchmark case (5 year-reinvestment and 2 year-FG). Economic activity and the inflation rate increase in both EA regions. The effects are rather symmetric across the two regions. Inflation gradually increases, by about 0.8pp (annualized) after five quarters. Thereafter, it gradually decreases. GDP increases by around 1.0% (peak level) after five quarters.

Home and REA consumption and investment benefit from the reduction in the long-term interest rate. Consumption is also affected by the intertemporal substitution effect, associated with the lower short-term real interest rate that positively affects unrestricted households. The real interest rate decreases because inflation increases, while the (nominal) monetary policy rate is kept constant at the baseline level by the monetary authority.

Consistent with the rise in production, labor effort and (not reported) real wages increase. Exports increase because the euro depreciates in nominal terms, making goods produced in the EA more competitive. Moreover, as each EA region is the main trade partner of the other, the increase in aggregate demand favors the increase in intra-EA exports and imports.

Figure 2 compares the benchmark scenario with others characterized by alternative early exits from long-term sovereign bond holdings. We report variables for the aggregate EA, as Home and REA responses are rather similar.[22] The top

[22] Results for Home and REA are available upon request.

panel shows the sovereign bond purchases. The black solid line represents the case of 5-year reinvestment (benchmark), the red dashed line the 1-year reinvestment, the green crossed and the blue solid lines represent two cases of no reinvestment, as the gradual exit starts 4 years after the end of purchases (exit after 4 years) or immediately after the end of purchases (immediate exit).

As shown in the second panel from the top, the earlier the exit from reinvestment, the lower and less persistent the decrease in the long-term interest rate. In the case of early exit, the central bank sustains bond demand for a relatively short amount of time. Thus, the price of the bond, which reflects current and future demand (of the bond), increases to a small extent; correspondingly, the long-term interest rate decreases to a small extent. In particular, the interest rate reduction is rather small in the "immediate exit" case.

The responses of EA CPI inflation and GDP (two bottom panels) are consistent with those of the long-term interest rates. The earlier the exit, the less pronounced is the increase in inflation and economic activity. Specifically, we do not find noticeable differences in the short- and medium-run effects of the 5-year and 1-year reinvestment cases. More crucially, the exit after 4 years reduces the (peak) effect on inflation and GDP to roughly 0.3% and 0.8%, respectively. Finally, the immediate exit is the worst scenario in terms of favoring inflation and economic activity, as both increase in a rather modest, almost negligible, way.

3.3 Early exit from FG

In the simulations previously reported the 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. We now assess the role of this commitment by changing, relative to the benchmark scenario, the announced number of periods during which the policy rate is kept constant. Specifically, in the alternative scenario, we consider one year.

Figure 3 reports the results. In both scenarios, the policy rate increases after the end of the commitment period. The central bank returns to follow the Taylor rule and therefore increases the policy rate (see top panel) to stabilize the macroeconomic conditions.

The long-term interest rate (second panel from the top) does not greatly change across the two scenarios, because its dynamics largely reflects the purchases programme, which is identical across the two scenarios.

The earlier the exit from the FG, the lower the effects on inflation (third panel from the top). In particular, the increase in inflation in the case of 1-year FG is half the increase when the FG lasts for 2 years (benchmark case). The lower increase is due to the fact that unrestricted households anticipate the more rapid increase in the policy rate and, thus, increase their aggregate demand for consumption to a lower extent. This implies that firms increase demand for capital and the price of their goods relatively less. Overall, the lower increase in aggregate demand implies lower inflation and, as shown in the next-to-bottom panel, lower GDP growth in the first two years (at the peak, it is roughly half the growth obtained in the benchmark case).

Finally, the lower GDP growth when the FG lasts for fewer periods can be explained also in terms of lower (gross) exports (not reported to save on space) towards the RW. The more rapid increase in the EA policy rate reduces the differential with the RW interest rate and, through the uncovered interest parity condition, reduces the nominal exchange rate depreciation. The lower depreciation limits the price-competitiveness gain of the goods produced in the EA (and, thus, the increase in EA exports).

3.4 Bond holdings and restoring normal monetary policy conditions

We now assume that a EA negative aggregate demand (for consumption and investment) shock drives the EA short-term monetary policy rate from its baseline (0.25%) to the zero level, where it stays for one year.[23] Real GDP and, to a lower extent, inflation fall. In the attempt to stabilize the macroeconomic conditions, the EA central bank reduces the policy rate according to the Taylor rule (6) until the ZLB is achieved, making further policy rate reductions impossible. As soon as the shock fades out and inflation and economic activity return to increase, the

[23]We implement a combination of negative shocks to both regions' consumption preferences and investment-specific technology.

central bank gradually rises the policy rate in accordance to the Taylor rule.

On top of the negative aggregate demand shock, we implement again the sovereign bond purchases programme. However, in this case we do not assume FG, as we want to evaluate the relationship between early exit from bond holdings and impact of the programme on the (endogenous) duration of the ZLB constraint. We consider the benchmark version of the programme (5-year version) and the immediate-exit version (the central bank sells purchased bonds immediately after the end of the purchasing period).

Figure 4 reports the results. In the case of the benchmark programme, the short-term monetary policy rate increases out of the ZLB after two quarters (red dashed line, top panel). In the immediate-exit case, the length of the ZLB is not reduced relative to the ZLB scenario (blue circled line and black solid line, respectively). The benchmark programme reduces the long-term interest rate relatively more than the extent implied by the immediate-exit programme. Thus, it has a larger stimulating effect on aggregate demand for consumption and investment. The expansion more than counterbalances the recessionary effect of the negative aggregate demand shock. Overall, EA consumption and investment decrease to a lower extent (not reported). Thus, GDP and inflation widely increase relative to the ZLB scenario. The inflation rate increases relative to the baseline level, inducing the EA central bank to enact an early rise in the short-term policy rate according to the Taylor rule. The immediate-exit version of the programme does not produce sufficiently expansionary effects on aggregate demand because of its limited impact on the long-term interest rate. Thus, economic activity and inflation do not greatly improve relative to the ZLB scenario and the central bank does not anticipate the increase in the monetary policy rate. As a result, the monetary policy regime does not return earlier to normality.

4 Conclusions

This paper addresses the relationship between effectiveness of the APP and the announcement of some main parameters, and in particular those that regulate the unwinding of purchases; the impact of FG is also explored. According to our results, the earlier the announced exit, the lower the effectiveness of the APP in both stimulating inflation and economic activity and, thus, in restoring a standard monetary policy regime.

Our work can be extended along several dimensions. First, we do not have considered the risks associated with an announcement of “too prolonged” measures that, for example, could fuel “excessive” asset price increases and, thus, jeopardize financial stability in some countries of the EA. This is the focus of a companion paper (see Burlon, Gerali, Notarpietro and Pisani 2016). Second, all simulations are run under perfect foresight, an assumption which implies full credibility of the announcements. This assumption can be relaxed to allow for imperfect credibility. Under this alternative assumption it would become possible to assess the effectiveness of alternative APP set-ups not only in stimulating the economy but also in restoring full credibility. We leave this issue for future research.

References

[1] Altavilla, C., G. Carboni, and R. Motto (2015). Asset purchases programmes and financial markets: lessons from the euro area, ECB Working Paper 1864, European Central Bank.

[2] Andrés, J., J. López-Salido, and E. Nelson (2004). Tobin's imperfect asset substitution in optimizing general equilibrium, *Journal of Money, Credit and Banking*, vol. 36(4), pp. 665–90.

[3] Burlon, L., A. Gerali, A. Notarpietro, and M. Pisani (2016). Non-standard monetary policy, asset prices and macroprudential policy in a monetary union. Mimeo.

[4] Burlon, L., A. Gerali, A. Notarpietro, and M. Pisani (2015). Inflation, financial conditions and non-standard monetary policy in a monetary union. A model-based evaluation. Temi di discussione (Economic working papers) 1015, Bank of Italy, Directorate General for Economics, Statistics and Research.

[5] Chen, H., V. Cúrdia, and A. Ferrero (2012). The macroeconomic effects of large-scale asset purchase programmes. *The Economic Journal*, 122, pp. 289–315.

[6] Christoffel, K., G. Coenen, and A. Warne (2008). The New Area-Wide Model of the Euro Area: A Micro-Founded Open-Economy Model for Forecasting and Policy Analysis. ECB Working Paper 944, European Central Bank.

[7] Corsetti, G., and G. J. Mueller (2006). Twin Deficits: Squaring Theory, Evidence and Common Sense. *Economic Policy*, vol. 48, pp. 597–638, October.

[8] Cúrdia, V. and M. Woodford (2011). The central-bank balance sheet as an instrument of monetary policy, *Journal of Monetary Economics*, vol. 58, pp. 54–79.

[9] Fischer, S. (2016). Speech at the "Policy Challenges in an Interconnected World" 32nd Annual National Association for Business Economics Economic

Policy Conference, Washington, D.C., March 7, 2016 Reflections on Macroeconomics Then and Now.

[10] Gertler, M., and P. Karadi (2011). A Model of Unconventional Monetary Policy. *Journal of Monetary Economics*, vol. 58, pp. 17–34.

[11] Gertler, M. and N. Kiyotaki (2011). Chapter 11 - Financial Intermediation and Credit Policy in Business Cycle Analysis, In: B. M. Friedman and M. Woodford, Editor(s), *Handbook of Monetary Economics*, Elsevier, vol. 3, pp. 547–599.

[12] Gomes, S., P. Jacquinot, and M. Pisani (2010). The EAGLE. A Model for Policy Analysis of Macroeconomic Interdependence in the Euro Area. ECB Working Paper 1195, European Central Bank.

[13] Pesenti, P. (2008). The Global Economy Model (GEM): Theoretical Framework, *IMF Staff Papers*, Volume 55, Issue 2, pp.243–284.

[14] Rotemberg, Julio J. (1982). Monopolistic Price Adjustment and Aggregate Output. *Review of Economic Studies,* vol. 49, pp. 517–531.

[15] Woodford, M. (2001). Fiscal requirements for price stability. *Journal of Money, Credit and Banking*, vol. 33, pp. 669–728.

Table 1: Parameterization

Parameter	H	REA	RW
Discount factor $\beta_U, \beta_U^*, \beta^{**}$	0.9994	0.9994	0.9994
Discount factor β_R, β_R^*	0.995	0.995	–
Intertemporal elasticity of substitution $1/\sigma$	1.0	1.0	1.0
Share of restricted households λ_R	0.25	0.25	–
Inverse of Frisch Elasticity of Labor Supply τ	2.0	2.0	2.0
Habit h	0.8	0.8	0.8
Depreciation rate of capital δ	0.025	0.025	0.025
Tradable Intermediate Goods			
Substitution between factors of production $\xi_T, \xi_T^*, \xi_T^{**}$	0.90	0.90	0.90
Bias towards capital $\alpha_T, \alpha_T^*, \alpha_T^{**}$	0.56	0.46	0.46
Non tradable Intermediate Goods			
Substitution between factors of production $\xi_N, \xi_N^*, \xi_N^{**}$	0.90	0.90	0.90
Bias towards capital $\alpha_N, \alpha_N^*, \alpha_N^{**}$	0.53	0.43	0.43
Final consumption goods			
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 non tradables $\rho_A, \rho_A^*, \rho_A^{**}$	0.50	0.50	0.50
Bias towards tradable goods a_T, a_T^*, a_T^{**}	0.68	0.50	0.50
Final investment goods			
Subst. btw. dom. and imported goods $\phi_E, \phi_E^*, \phi_E^{**}$	1.50	1.50	1.50
Bias towards domestic tradable goods $\upsilon_H, \upsilon_F^*, \upsilon_G^{**}$	0.50	0.49	0.90
Subst. btw. tradables and non tradables $\rho_E, \rho_E^*, \rho_E^{**}$	0.50	0.50	0.50
Bias towards tradable goods $\upsilon_T, \upsilon_T^*, \upsilon_T^{**}$	0.78	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	non-tradables	Wages
H	1.08 ($\theta_T = 13.32$)	1.29 ($\theta_N = 4.44$)	1.60 ($\psi = 2.65$)
REA	1.11 ($\theta_T^* = 10.15$)	1.24 ($\theta_N^* = 5.19$)	1.33 ($\psi^* = 4$)
RW	1.11 ($\theta_T^{**} = 10.15$)	1.24 ($\theta_N^{**} = 5.19$)	1.33 ($\psi^{**} = 4$)

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
Real Adjustment Costs			
Investment ϕ_I, ϕ_I^*,ϕ_I^{**}	7.50	7.50	7.50
Adjustment Costs on bonds			
Households' long-term bond positions ϕ_{b^L}, $\phi_{b^L}^*$	0.000067	0.00047	–
Households' short-term private bond positions			
ϕ_{b1}, ϕ_{b1}^{**}	0.0015	–	0.0015
ϕ_{b2}, ϕ_{b2}^{**}	0.003	–	0.003
Nominal Adjustment Costs			
Wages κ_W, κ_W^*, κ_W^{**}	400	400	400
Home produced tradables κ_H, k_H^* k_H^{**}	400	400	50
REA produced tradables κ_H, k_H^* k_H^{**}	400	400	50
RW produced tradables κ_H, k_H^* k_H^{**}	50	50	400
Non-tradables κ_N, κ_N^*, κ_N^{**}	600	600	600

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

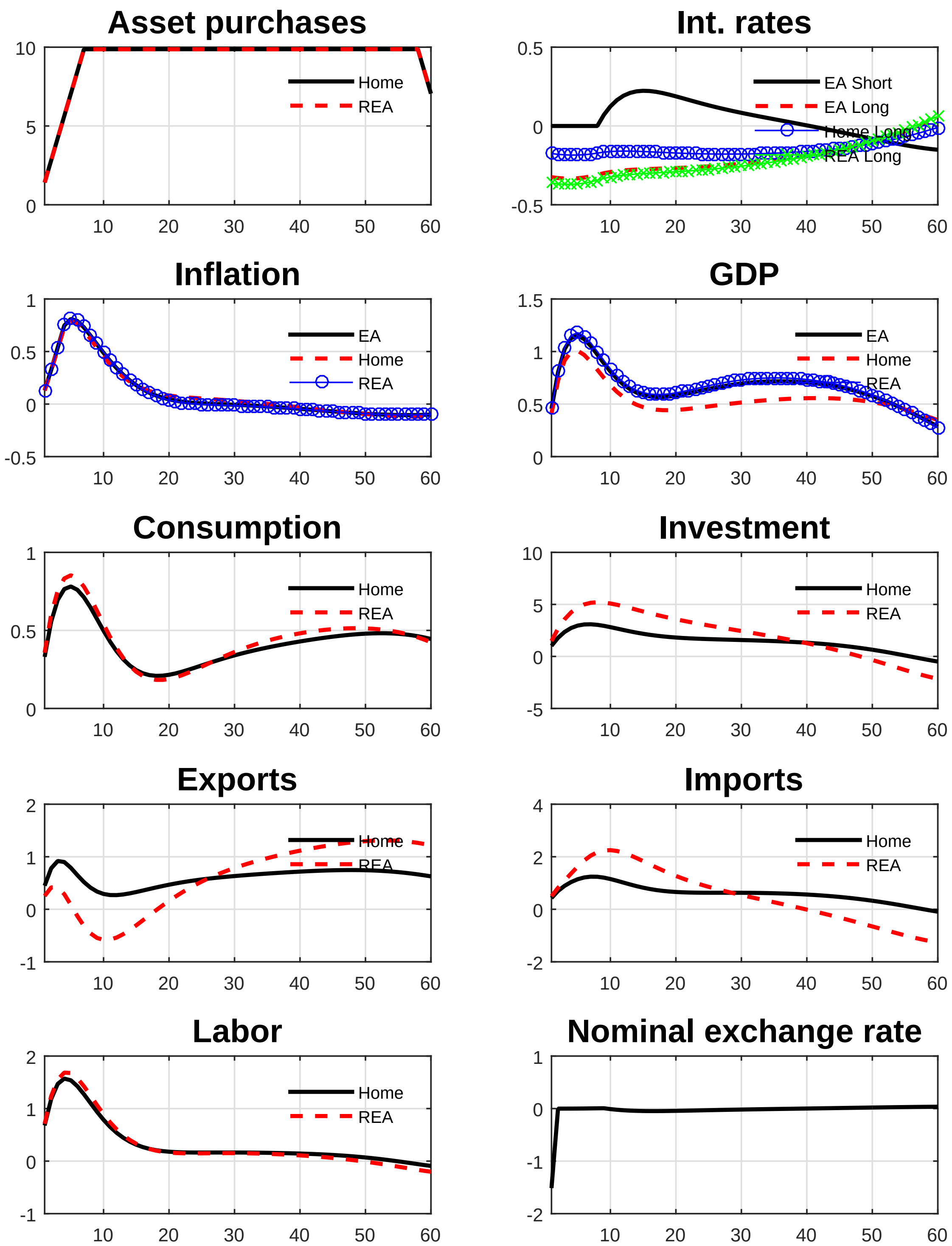
Parameter	H	REA	EA	RW
Fiscal policy rule				
$\phi_1, \phi_1^*, \phi_1^{**}$	0.05	1.01	-	1.01
$\phi_2, \phi_2^*, \phi_2^{**}$	10.01	1.01	-	1.01
Common monetary policy rule	-	-		
Lagged interest rate ρ_R, ρ_R^{**}	-	-	0.92	0.92
Inflation ρ_Π, ρ_Π^{**}	-	-	1.70	1.70
GDP growth $\rho_{GDP}, \rho_{GDP}^{**}$	-	-	0.10	0.10

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

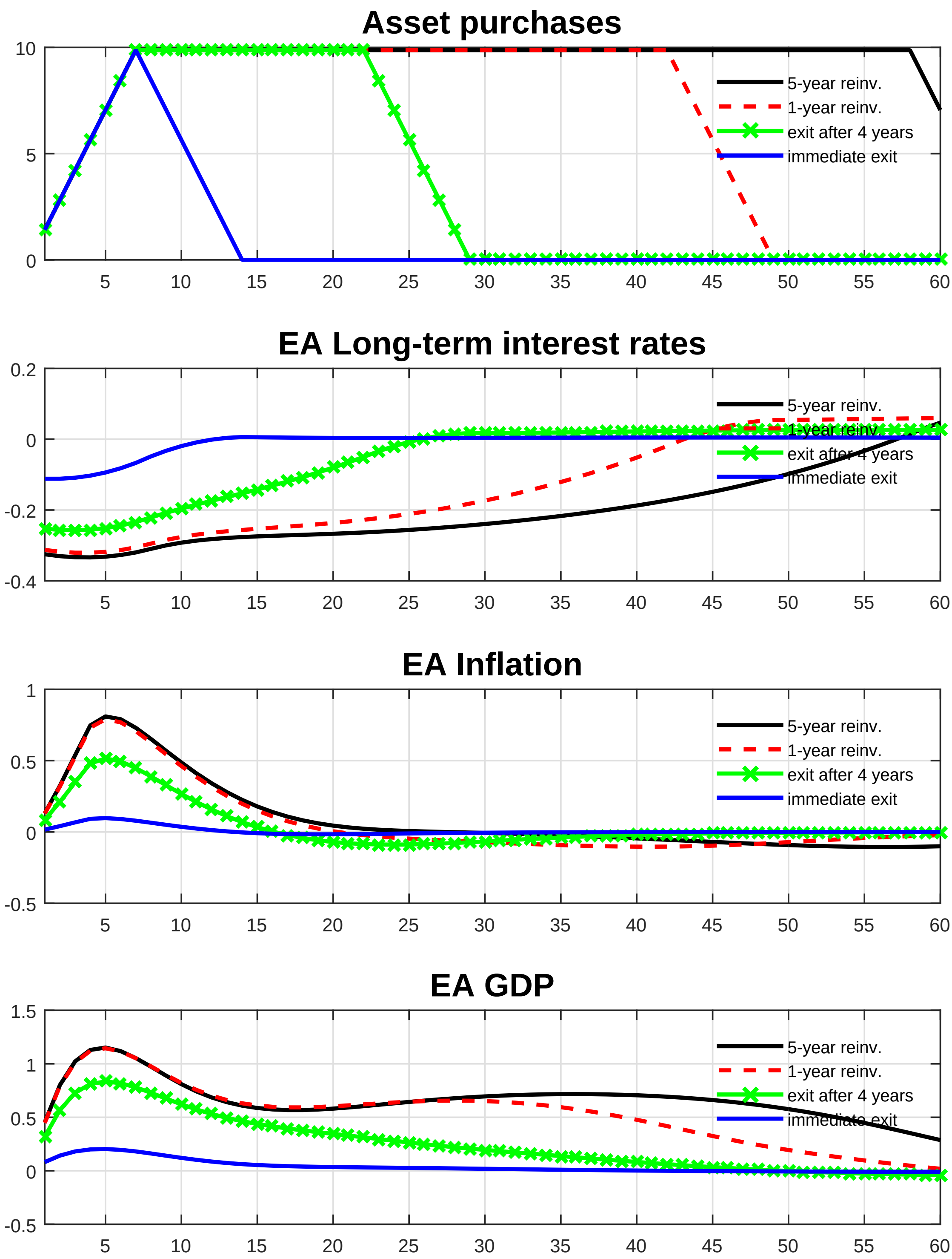
Table 5: Main macroeconomic variables (ratio to GDP)

	H	REA	RW
Macroeconomic variables			
Private consumption	61.0	57.1	64.0
Public consumption	20.0	20.0	20.0
Private investment	18.0	16.0	20.0
Imports	29.0	24.3	4.25
Net Foreign Asset Position	0.0	0.0	0.0
GDP (share of world GDP)	0.04	0.18	0.78
Private debt (ratio to annual GDP)	85.0	55.0	–
Short-term public debt (ratio to annual GDP)	13.0	8.0	–
Long-term public debt (ratio to annual GDP)	121.0	93.0	–

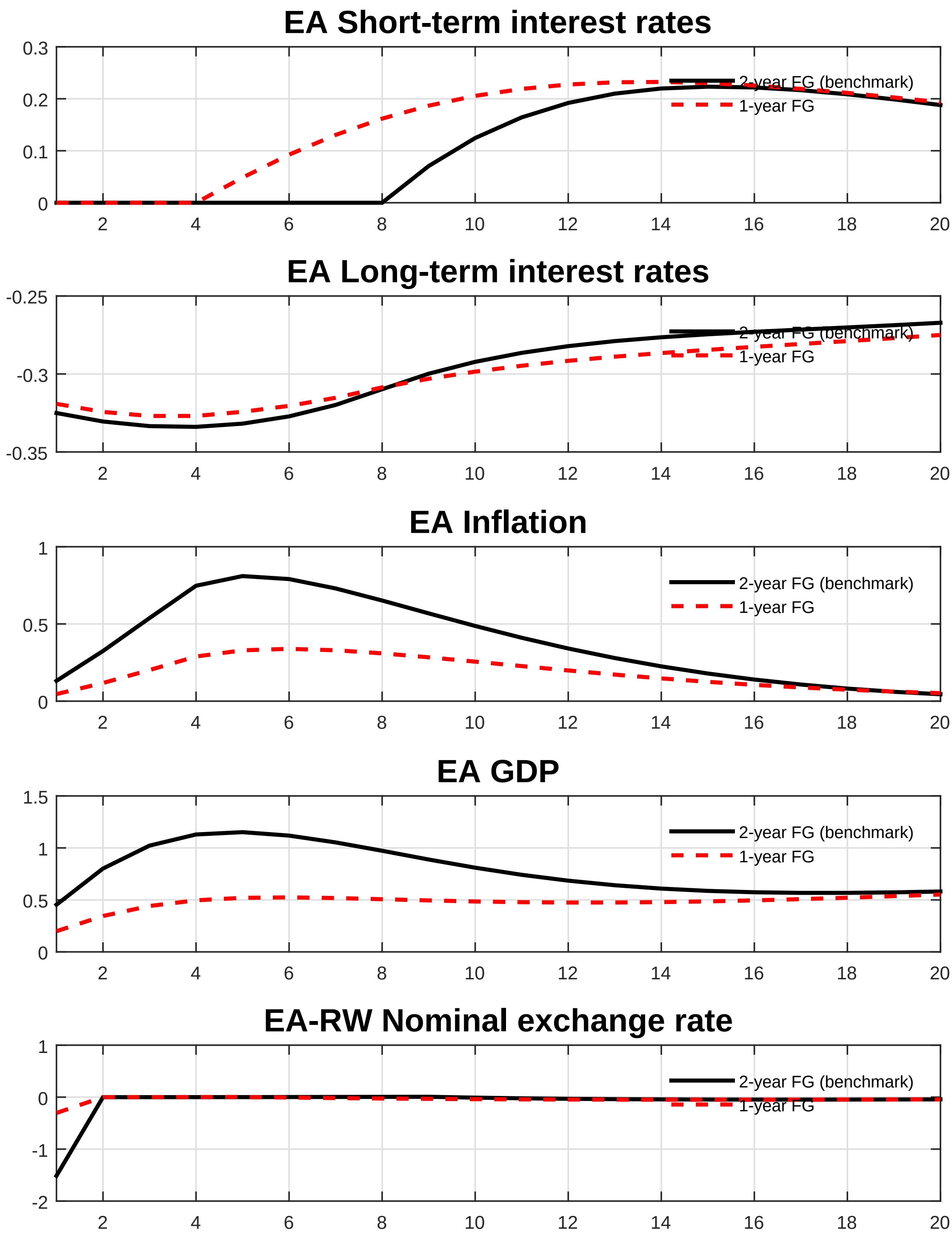
Note: H=Home; REA=rest of the euro area; RW= rest of the world.



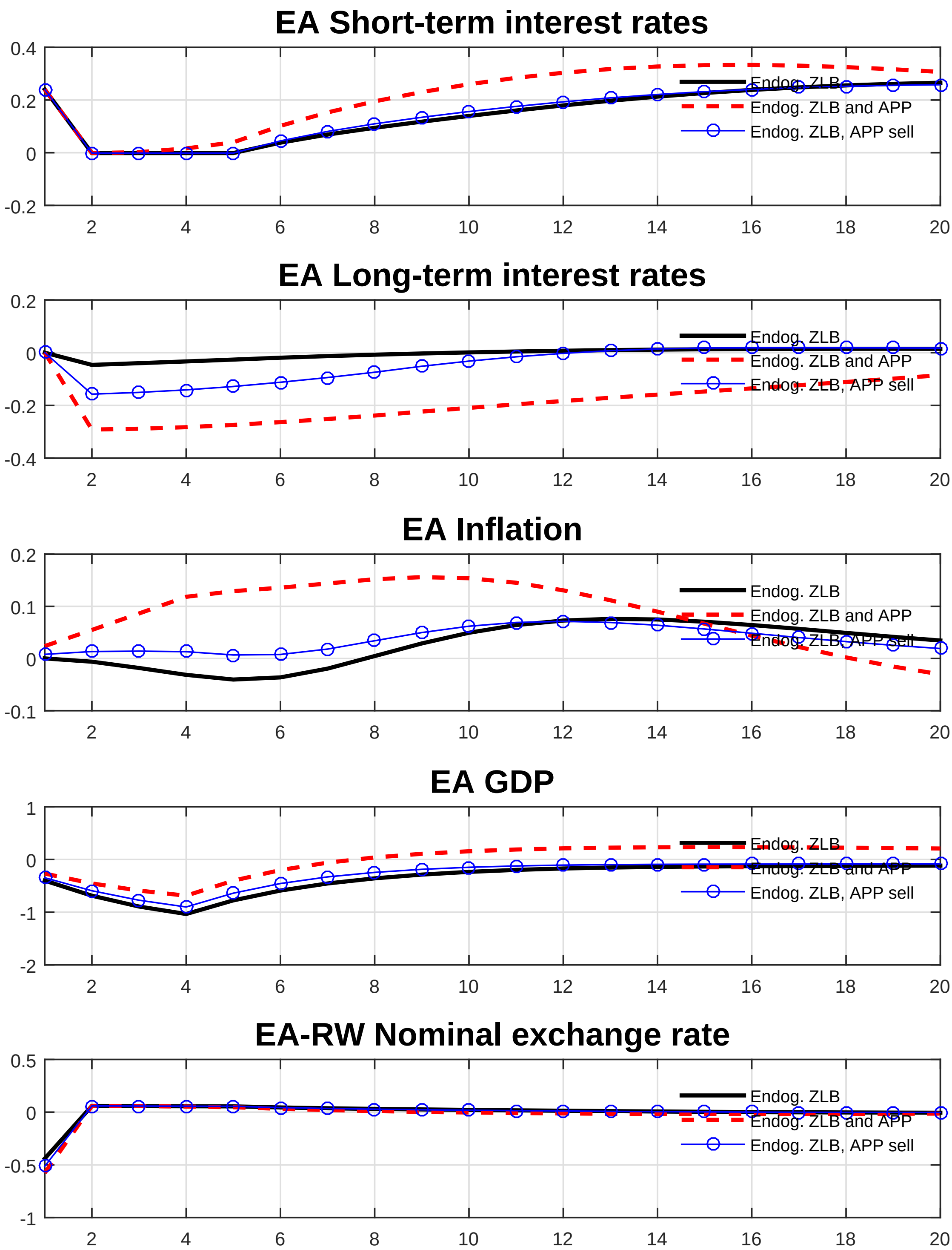
Notes: Horizontal axis, quarters; vertical axis, % deviations from the steady state. For inflation, annualized pp deviations.



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



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



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

Appendix

In this Appendix we report a detailed description of the model except for fiscal and monetary policies and households' optimization problems, which are reported in the main text.[24]

There are three blocs, Home, REA, and RW. In what follows we illustrate the Home economy. The structure of each of the other two regions (REA and the RW) is similar and to save on space we do not report it.

Final consumption and investment goods

There is a continuum of symmetric Home firms producing final non-tradable consumption under perfect competition. Each firm producing the consumption good is indexed by $x \in (0, n]$, where the parameter $0 < n < 1$ measures the size of Home. Firms in the REA and in the RW are indexed by $x^* \in (n, n + n^*]$ and $x^{**} \in (n + n^*, 1]$, respectively (the size of the world economy is normalized to 1). The CES production technology used by the generic firm x is

$$A_t(x) \equiv \left(\begin{array}{c} a_T^{\frac{1}{\phi_A}} \left(a_H^{\frac{1}{\rho_A}} Q_{HA,t}(x)^{\frac{\rho_A - 1}{\rho_A}} + a_G^{\frac{1}{\rho_A}} Q_{GA,t}(x)^{\frac{\rho_A - 1}{\rho_A}} + (1 - a_H - a_G)^{\frac{1}{\rho_A}} Q_{FA,t}(x)^{\frac{\rho_A - 1}{\rho_A}} \right)^{\frac{\rho_A}{\rho_A - 1} \frac{\phi_A - 1}{\phi_A}} \\ + (1 - a_T)^{\frac{1}{\phi_A}} Q_{NA,t}(x)^{\frac{\phi_A - 1}{\phi_A}} \end{array} \right)$$

where Q_{HA}, Q_{GA}, Q_{FA}, and Q_{NA} are bundles of respectively intermediate tradables produced in Home, intermediate tradables produced in the REA, intermediate tradables produced in the RW, and intermediate non-tradables produced in the Home country. The parameter $\rho_A > 0$ is the elasticity of substitution between tradables and $\phi_A > 0$ is the elasticity of substitution between tradable and non-tradable goods. The parameter a_H $(0 < a_H < 1)$ is the weight of the Home tradable, the parameter a_G $(0 < a_G < 1)$ the weight of tradables imported from the REA, and the parameter a_T $(0 < a_T < 1)$ the weight of tradable goods.

The production of investment good is similar. There are symmetric Home firms under perfect competition indexed by $y \in (0, n]$. Firms in the REA and in the RW are indexed by $y^* \in (n, n + n^*]$ and $y^{**} \in (n + n^*, 1]$. Output of the generic Home

[24]For a detailed description of the main features of the model see also Pesenti (2008).

firm y is

$$E_t(y) \equiv \left(v_T^{\frac{1}{\phi_E}} \left(v_H^{\frac{1}{\rho_E}} Q_{HE,t}(y)^{\frac{\rho_E-1}{\rho_E}} + v_G^{\frac{1}{\rho_E}} Q_{GE,t}(y)^{\frac{\rho_E-1}{\rho_E}} + (1-v_H-v_G)^{\frac{1}{\rho_E}} Q_{FE,t}(y)^{\frac{\rho_E-1}{\rho_E}} \right)^{\frac{\rho_E}{\rho_E-1}\frac{\phi_E-1}{\phi_E}} + (1-v_T)^{\frac{1}{\phi_E}} Q_{NE,t}(y)^{\frac{\phi_E-1}{\phi_E}} \right)$$

Finally, we assume that public expenditure C^g is composed by intermediate non-tradable goods only.

Intermediate goods

Demand

Bundles used to produce the final consumption goods are CES indexes of differentiated intermediate goods, each produced by a single firm under conditions of monopolistic competition:

$$Q_{HA}(x) \equiv \left[\left(\frac{1}{s}\right)^{\theta_T} \int_0^n Q(h,x)^{\frac{\theta_T-1}{\theta_T}} dh \right]^{\frac{\theta_T}{\theta_T-1}}, \tag{12}$$

$$Q_{GA}(x) \equiv \left[\left(\frac{1}{S-s}\right)^{\theta_T} \int_n^{n+n^*} Q(g,x)^{\frac{\theta_T-1}{\theta_T}} dg \right]^{\frac{\theta_T}{\theta_T-1}}, \tag{13}$$

$$Q_{FA}(x) \equiv \left[\left(\frac{1}{1-S}\right)^{\theta_T} \int_{n+n^*}^1 Q(f,x)^{\frac{\theta_T-1}{\theta_T}} df \right]^{\frac{\theta_T}{\theta_T-1}}, \tag{14}$$

$$Q_{NA}(x) \equiv \left[\left(\frac{1}{s}\right)^{\theta_N} \int_0^n Q(i,x)^{\frac{\theta_N-1}{\theta_N}} di \right]^{\frac{\theta_N}{\theta_N-1}}, \tag{15}$$

where firms in the Home intermediate tradable and non-tradable sectors are respectively indexed by $h \in (0,n]$ and $n \in (0,n]$, firms in the REA by $g \in (n, n+n^*]$, and firms in the RW by $f \in (n+n^*, 1]$. Parameters θ_T, $\theta_N > 1$ are respectively the elasticity of substitution across brands in the tradable and non-tradable sector. The prices of the intermediate non-tradable goods are denoted $p(i)$. Each firm x takes these prices as given when minimizing production costs of the final good.

The resulting demand for intermediate non-tradable input i is

$$Q_{A,t}(i,x) = \left(\frac{1}{s}\right)\left(\frac{P_t(i)}{P_{N,t}}\right)^{-\theta_N} Q_{NA,t}(x), \tag{16}$$

where $P_{N,t}$ is the cost-minimizing price of one basket of local intermediates:

$$P_{N,t} = \left[\int_0^n P_t(i)^{1-\theta_N}\, di\right]^{\frac{1}{1-\theta_N}}. \tag{17}$$

We can derive $Q_A(h,x)$, $Q_A(f,x)$, $C_A^g(h,x)$, $C_A^g(f,x)$, P_H, and P_F in a similar way. Firms y producing the final investment goods have similar demand curves. Aggregating over x and y, it can be shown that total demand for intermediate non-tradable good i is

$$\begin{aligned} & \int_0^n Q_{A,t}(i,x)\, dx + \int_0^n Q_{E,t}(i,y)\, dy + \int_0^n C_t^g(i,x)\, dx \\ = & \left(\frac{P_t(i)}{P_{N,t}}\right)^{-\theta_N} \left(Q_{NA,t} + Q_{NE,t} + C_{N,t}^g\right), \end{aligned}$$

where C_N^g is public sector consumption. Home demands for (intermediate) domestic and imported tradable goods can be derived in a similar way.

Supply

The supply of each Home intermediate non-tradable good i is denoted by $N^S(i)$:

$$N_t^S(i) = \left((1-\alpha_N)^{\frac{1}{\xi_N}} L_{N,t}(i)^{\frac{\xi_N-1}{\xi_N}} + \alpha^{\frac{1}{\xi_N}} K_{N,t}(i)^{\frac{\xi_N-1}{\xi_N}}\right)^{\frac{\xi_N}{\xi_N-1}}. \tag{18}$$

Firm i uses labor $L_{N,t}^p(i)$ and capital $K_{N,t}(i)$ with constant elasticity of input substitution $\xi_N > 0$ and capital weight $0 < \alpha_N < 1$. Firms producing intermediate goods take the prices of labor inputs and capital as given. Denoting W_t the nominal wage index and R_t^K the nominal rental price of capital, cost minimization implies that

$$L_{N,t}(i) = (1-\alpha_N)\left(\frac{W_t}{MC_{N,t}(i)}\right)^{-\xi_N} N_t^S(i) \tag{19}$$

and

$$K_{N,t}(i) = \alpha \left(\frac{R_t^K}{MC_{N,t}(i)} \right)^{-\xi_N} N_t^S(i)$$

where $MC_{N,t}(n)$ is the nominal marginal cost:

$$MC_{N,t}(i) = \left((1-\alpha) W_t^{1-\xi_N} + \alpha \left(R_t^K \right)^{1-\xi_N} \right)^{\frac{1}{1-\xi_N}}. \tag{20}$$

The productions of each Home tradable good, $T^S(h)$, is similarly characterized.

Price setting in the intermediate sector

Consider now profit maximization in the Home intermediate non-tradable sector. Each firm i sets the price $p_t(i)$ by maximizing the present discounted value of profits subject to the demand constraint and the quadratic adjustment costs,

$$AC_{N,t}^p(i) \equiv \frac{\kappa_N^p}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 Q_{N,t},$$

which is paid in unit of sectorial product $Q_{N,t}$ and where $\kappa_N^p \geq 0$ measures the degree of price stickiness. The resulting first-order condition, expressed in terms of domestic consumption, is

$$p_t(i) = \frac{\theta_N}{\theta_N - 1} mc_t(i) - \frac{A_t(i)}{\theta_N - 1}, \tag{21}$$

where $mc_t(i)$ is the real marginal cost and $A_t(i)$ contains terms related to the presence of price adjustment costs:

$$\begin{aligned} A_t(i) \approx \; & \kappa_N^p \frac{P_t(i)}{P_{t-1}(i)} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right) \\ & - \beta \kappa_N^p \frac{P_{t+1}(i)}{P_t(i)} \left(\frac{P_{t+1}(i)}{P_t(i)} - 1 \right) \frac{Q_{N,t+1}}{Q_{N,t}}. \end{aligned}$$

The above equations clarify the link between imperfect competition and nominal rigidities. When the elasticity of substitution θ_N is very large and hence the competition in the sector is high, prices closely follow marginal costs, even though adjustment costs are large. To the contrary, it may be optimal to maintain stable prices and accommodate changes in demand through supply adjustments when the average markup over marginal costs is relatively high. If prices were flexible, optimal pricing would collapse to the standard pricing rule of constant markup over marginal costs (expressed in units of domestic consumption):

$$p_t(i) = \frac{\theta_N}{\theta_N - 1} mc_{N,t}(i). \tag{22}$$

Firms operating in the intermediate tradable sector solve a similar problem. We assume that there is market segmentation. Hence the firm producing the brand h chooses $p_t(h)$ in the Home market, a price $p_t^*(h)$ in the REA, and a price $p_t^{**}(h)$ in the RW to maximize the expected flow of profits (in terms of domestic consumption units),

$$E_t \sum_{\tau=t}^{\infty} \Lambda_{t,\tau} \left[\begin{array}{c} p_\tau(h) y_\tau(h) + p_\tau^*(h) y_\tau^*(h) + p_\tau^{**}(h) y_\tau^{**}(h) \\ -mc_{H,\tau}(h) (y_\tau(h) + y_\tau^*(h) + y_\tau^{**}(h)) \end{array} \right],$$

subject to quadratic price adjustment costs similar to those considered for non-tradables and standard demand constraints. The term E_t denotes the expectation operator conditional on the information set at time t, $\Lambda_{t,\tau}$ is the appropriate discount rate, and $mc_{H,t}(h)$ is the real marginal cost. The first order conditions with respect to $p_t(h)$, $p_t^*(h)$, and $p_t^{**}(h)$ are

$$p_t(h) = \frac{\theta_T}{\theta_T - 1} mc_t(h) - \frac{A_t(h)}{\theta_T - 1}, \tag{23}$$

$$p_t^*(h) = \frac{\theta_T}{\theta_T - 1} mc_t(h) - \frac{A_t^*(h)}{\theta_T - 1}, \tag{24}$$

$$p_t^{**}(h) = \frac{\theta_T}{\theta_T - 1} mc_t(h) - \frac{A_t^{**}(h)}{\theta_T - 1}, \tag{25}$$

where θ_T is the elasticity of substitution of intermediate tradable goods, while $A(h)$ and $A^*(h)$ involve terms related to the presence of price adjustment costs:

$$
\begin{aligned}
A_t(h) &\approx \kappa_H^p \frac{P_t(h)}{P_{t-1}(h)} \left(\frac{P_t(h)}{P_{t-1}(h)} - 1 \right) \\
&\quad -\beta \kappa_H^p \frac{P_{t+1}(h)}{P_t(h)} \left(\frac{P_{t+1}(h)}{P_t(h)} - 1 \right) \frac{Q_{H,t+1}}{Q_{H,t}}, \\
A_t^*(h) &\approx \theta_T - 1 + \kappa_H^p \frac{P_t^*(h)}{P_{t-1}^*(h)} \left(\frac{P_t^*(h)}{P_{t-1}^*(h)} - 1 \right) \\
&\quad -\beta \kappa_H^p \frac{P_{t+1}^*(h)}{P_t^*(h)} \left(\frac{P_{t+1}^*(h)}{P_t^*(h)} - 1 \right) \frac{Q_{H,t+1}^*}{Q_{H,t}^*}, \\
A_t^{**}(h) &\approx \theta_T - 1 + \kappa_H^p \frac{P_t^{**}(h)}{P_{t-1}^{**}(h)} \left(\frac{P_t^{**}(h)}{P_{t-1}^{**}(h)} - 1 \right) \\
&\quad -\beta \kappa_H^p \frac{P_{t+1}^{**}(h)}{P_t^{**}(h)} \left(\frac{P_{t+1}^{**}(h)}{P_t^{**}(h)} - 1 \right) \frac{Q_{H,t+1}^{**}}{Q_{H,t}^{**}},
\end{aligned}
$$

where κ_H^p,${\kappa_H^p}^*$,${\kappa_H^p}^{**} > 0$ respectively measure the degree of nominal rigidity in the Home country, in the REA, and in the RW.

Labor market

In the case of firms in the intermediate non-tradable sector, the labor input $L_N(i)$ is a CES combination of differentiated labor inputs supplied by domestic agents and defined over a continuum of mass equal to the country size ($j \in [0, n]$):

$$
L_{N,t}(i) \equiv \left(\frac{1}{n} \right)^{\frac{1}{\psi}} \left[\int_0^n L_t(i,j)^{\frac{\psi-1}{\psi}} \, dj \right]^{\frac{\psi}{\psi-1}}, \tag{26}
$$

where $L(i,j)$ is the demand of the labor input of type j by the producer of good i and $\psi > 1$ is the elasticity of substitution among labor inputs. Cost minimization implies that

$$
L_t(i,j) = \left(\frac{1}{n} \right) \left(\frac{W_t(j)}{W_t} \right)^{-\psi} L_{N,t}(j), \tag{27}
$$

where $W(j)$ is the nominal wage of labor input j and the wage index W is

$$
W_t = \left[\left(\frac{1}{n} \right) \int_0^n W_t(h)^{1-\psi} \, dj \right]^{\frac{1}{1-\psi}}. \tag{28}
$$

Similar equations hold for firms producing intermediate tradable goods. Each household is the monopolistic supplier of a labor input j and sets the nominal wage facing a downward-sloping demand obtained by aggregating demand across Home firms. The wage adjustment is sluggish because of quadratic costs paid in terms of the total wage bill,

$$AC_t^W = \frac{\kappa_W}{2} \left(\frac{W_t}{W_{t-1}} - 1 \right)^2 W_t L_t, \tag{29}$$

where the parameter $\kappa_W > 0$ measures the degree of nominal wage rigidity and L_t is the total amount of labor in the Home economy.

RECENTLY PUBLISHED "TEMI" (*)

N. 1047 – *A new method for the correction of test scores manipulation* by Santiago Pereda Fernández (January 2016).

N. 1048 – *Heterogeneous peer effects in education* by by Eleonora Patacchini, Edoardo Rainone and Yves Zenou (January 2016).

N. 1049 – *Debt maturity and the liquidity of secondary debt markets*, by Max Bruche and Anatoli Segura (January 2016).

N. 1050 – *Contagion and fire sales in banking networks*, by Sara Cecchetti, Marco Rocco and Laura Sigalotti (January 2016).

N. 1051 – *How does bank capital affect the supply of mortgages? Evidence from a randomized experiment*, by Valentina Michelangeli and Enrico Sette (February 2016).

N. 1052 – *Adaptive models and heavy tails*, by Davide Delle Monache and Ivan Petrella (February 2016).

N. 1053 – *Estimation of counterfactual distributions with a continuous endogenous treatment*, by Santiago Pereda Fernández (February 2016).

N. 1054 – *Labor force participation, wage rigidities, and inflation*, by Francesco Nucci and Marianna Riggi (February 2016).

N. 1055 – *Bank internationalization and firm exports: evidence from matched firm-bank data*, by Raffaello Bronzini and Alessio D'Ignazio (February 2016).

N. 1056 – *Retirement, pension eligibility and home production*, by Emanuele Ciani (February 2016).

N. 1057 – *The real effects of credit crunch in the Great Recession: evidence from Italian provinces*, by Guglielmo Barone, Guido de Blasio and Sauro Mocetti (February 2016).

N. 1058 – *The quantity of corporate credit rationing with matched bank-firm data*, by Lorenzo Burlon, Davide Fantino, Andrea Nobili and Gabriele Sene (February 2016).

N. 1059 – *Estimating the money market microstructure with negative and zero interest rates*, by Edoardo Rainone and Francesco Vacirca (February 2016).

N. 1060 – *Intergenerational mobility in the very long run: Florence 1427-2011*, by Guglielmo Barone and Sauro Mocetti (April 2016).

N. 1061 – *An evaluation of the policies on repayment of government's trade debt in Italy*, by Leandro D'Aurizio and Domenico Depalo (April 2016).

N. 1062 – *Market timing and performance attribution in the ECB reserve management framework*, by Francesco Potente and Antonio Scalia (April 2016).

N. 1063 – *Information contagion in the laboratory*, by Marco Cipriani, Antonio Guarino, Giovanni Guazzarotti, Federico Tagliati and Sven Fischer (April 2016).

N. 1064 – *EAGLE-FLI. A macroeconomic model of banking and financial interdependence in the euro area*, by by Nikola Bokan, Andrea Gerali, Sandra Gomes,Pascal Jacquinot and Massimiliano Pisani (April 2016).

N. 1065 – *How excessive is banks' maturity transformation?*,by Anatoli Segura Velez and Javier Suarez (April 2016).

N. 1066 – *Common faith or parting ways? A time-varying factor analysis*, by Davide Delle Monache, Ivan Petrella and Fabrizio Venditti (June 2016).

N. 1067 – *Productivity effects of eco-innovations using data on eco-patents*, by Giovanni Marin and Francesca Lotti (June 2016).

N. 1068 – *The labor market channel of macroeconomic uncertainty*, by Elisa Guglielminetti (June 2016).

N. 1069 – *Individual trust: does quality of public services matter?*, by Silvia Camussi and Anna Laura Mancini (June 2016).

(*) Requests for copies should be sent to:
Banca d'Italia – Servizio Studi di struttura economica e finanziaria – Divisione Biblioteca e Archivio storico – Via Nazionale, 91 – 00184 Rome – (fax 0039 06 47922059). They are available on the Internet www.bancaditalia.it.

2014

G. M. TOMAT, *Revisiting poverty and welfare dominance*, Economia pubblica, v. 44, 2, 125-149, **TD No. 651 (December 2007).**

M. TABOGA, *The riskiness of corporate bonds*, Journal of Money, Credit and Banking, v.46, 4, pp. 693-713, **TD No. 730 (October 2009).**

G. MICUCCI and P. ROSSI, *Il ruolo delle tecnologie di prestito nella ristrutturazione dei debiti delle imprese in crisi*, in A. Zazzaro (a cura di), Le banche e il credito alle imprese durante la crisi, Bologna, Il Mulino, **TD No. 763 (June 2010).**

F. D'AMURI, *Gli effetti della legge 133/2008 sulle assenze per malattia nel settore pubblico,* Rivista di politica economica, v. 105, 1, pp. 301-321, **TD No. 787 (January 2011).**

R. BRONZINI and E. IACHINI, *Are incentives for R&D effective? Evidence from a regression discontinuity approach,* American Economic Journal : Economic Policy, v. 6, 4, pp. 100-134, **TD No. 791 (February 2011).**

P. ANGELINI, S. NERI and F. PANETTA, *The interaction between capital requirements and monetary policy*, Journal of Money, Credit and Banking, v. 46, 6, pp. 1073-1112, **TD No. 801 (March 2011).**

M. BRAGA, M. PACCAGNELLA and M. PELLIZZARI, *Evaluating students' evaluations of professors,* Economics of Education Review, v. 41, pp. 71-88, **TD No. 825 (October 2011).**

M. FRANCESE and R. MARZIA, *Is there Room for containing healthcare costs? An analysis of regional spending differentials in Italy,* The European Journal of Health Economics, v. 15, 2, pp. 117-132, **TD No. 828 (October 2011).**

L. GAMBACORTA and P. E. MISTRULLI, *Bank heterogeneity and interest rate setting: what lessons have we learned since Lehman Brothers?,* Journal of Money, Credit and Banking, v. 46, 4, pp. 753-778, **TD No. 829 (October 2011).**

M. PERICOLI, *Real term structure and inflation compensation in the euro area*, International Journal of Central Banking, v. 10, 1, pp. 1-42, **TD No. 841 (January 2012).**

E. GENNARI and G. MESSINA, *How sticky are local expenditures in Italy? Assessing the relevance of the flypaper effect through municipal data,* International Tax and Public Finance, v. 21, 2, pp. 324-344, **TD No. 844 (January 2012).**

V. DI GACINTO, M. GOMELLINI, G. MICUCCI and M. PAGNINI, *Mapping local productivity advantages in Italy: industrial districts, cities or both?*, Journal of Economic Geography, v. 14, pp. 365–394, **TD No. 850 (January 2012).**

A. ACCETTURO, F. MANARESI, S. MOCETTI and E. OLIVIERI, *Don't Stand so close to me: the urban impact of immigration,* Regional Science and Urban Economics, v. 45, pp. 45-56, **TD No. 866 (April 2012).**

M. PORQUEDDU and F. VENDITTI, *Do food commodity prices have asymmetric effects on euro area inflation,* Studies in Nonlinear Dynamics and Econometrics, v. 18, 4, pp. 419-443, **TD No. 878 (September 2012).**

S. FEDERICO, *Industry dynamics and competition from low-wage countries: evidence on Italy*, Oxford Bulletin of Economics and Statistics, v. 76, 3, pp. 389-410, **TD No. 879 (September 2012).**

F. D'AMURI and G. PERI, *Immigration, jobs and employment protection: evidence from Europe before and during the Great Recession,* Journal of the European Economic Association, v. 12, 2, pp. 432-464, **TD No. 886 (October 2012).**

M. TABOGA, *What is a prime bank? A euribor-OIS spread perspective,* International Finance, v. 17, 1, pp. 51-75, **TD No. 895 (January 2013).**

G. CANNONE and D. FANTINO, *Evaluating the efficacy of european regional funds for R&D,* Rassegna italiana di valutazione, v. 58, pp. 165-196, **TD No. 902 (February 2013).**

L. GAMBACORTA and F. M. SIGNORETTI, *Should monetary policy lean against the wind? An analysis based on a DSGE model with banking,* Journal of Economic Dynamics and Control, v. 43, pp. 146-74, **TD No. 921 (July 2013).**

M. BARIGOZZI, CONTI A.M. and M. LUCIANI, *Do euro area countries respond asymmetrically to the common monetary policy?,* Oxford Bulletin of Economics and Statistics, v. 76, 5, pp. 693-714, **TD No. 923 (July 2013).**

U. ALBERTAZZI and M. BOTTERO, *Foreign bank lending: evidence from the global financial crisis,* Journal of International Economics, v. 92, 1, pp. 22-35, **TD No. 926 (July 2013).**

R. De Bonis and A. Silvestrini, *The Italian financial cycle: 1861-2011,* Cliometrica, v.8, 3, pp. 301-334, **TD No. 936 (October 2013).**

G. Barone and S. Mocetti, *Natural disasters, growth and institutions: a tale of two earthquakes,* Journal of Urban Economics, v. 84, pp. 52-66, **TD No. 949 (January 2014).**

D. Pianeselli and A. Zaghini, *The cost of firms' debt financing and the global financial crisis,* Finance Research Letters, v. 11, 2, pp. 74-83, **TD No. 950 (February 2014).**

J. Li and G. Zinna, *On bank credit risk: sytemic or bank-specific? Evidence from the US and UK,* Journal of Financial and Quantitative Analysis, v. 49, 5/6, pp. 1403-1442, **TD No. 951 (February 2015).**

A. Zaghini, *Bank bonds: size, systemic relevance and the sovereign,* International Finance, v. 17, 2, pp. 161-183, **TD No. 966 (July 2014).**

G. Sbrana and A. Silvestrini, *Random switching exponential smoothing and inventory forecasting,* International Journal of Production Economics, v. 156, 1, pp. 283-294, **TD No. 971 (October 2014).**

M. Silvia, *Does issuing equity help R&D activity? Evidence from unlisted Italian high-tech manufacturing firms,* Economics of Innovation and New Technology, v. 23, 8, pp. 825-854, **TD No. 978 (October 2014).**

2015

G. de Blasio, D. Fantino and G. Pellegrini, *Evaluating the impact of innovation incentives: evidence from an unexpected shortage of funds,* Industrial and Corporate Change, , v. 24, 6, pp. 1285-1314, **TD No. 792 (February 2011).**

M. Bugamelli, S. Fabiani and E. Sette, *The age of the dragon: the effect of imports from China on firm-level prices*, Journal of Money, Credit and Banking, v. 47, 6, pp. 1091-1118, **TD No. 737 (January 2010).**

R. Bronzini, *The effects of extensive and intensive margins of FDI on domestic employment: microeconomic evidence from Italy*, B.E. Journal of Economic Analysis & Policy, v. 15, 4, pp. 2079-2109, **TD No. 769 (July 2010).**

A. Di Cesare, A. P. Stork and C. de Vries, *Risk measures for autocorrelated hedge fund returns,* Journal of Financial Econometrics, v. 13, 4, pp. 868-895, **TD No. 831 (October 2011).**

G. Bulligan, M. Marcellino and F. Venditti, *Forecasting economic activity with targeted predictors,* International Journal of Forecasting, v. 31, 1, pp. 188-206, **TD No. 847 (February 2012).**

A. Ciarlone, *House price cycles in emerging economies,* Studies in Economics and Finance, v. 32, 1, **TD No. 863 (May 2012).**

D. Fantino, A. Mori and D. Scalise, *Collaboration between firms and universities in Italy: the role of a firm's proximity to top-rated departments,* Rivista Italiana degli economisti, v. 1, 2, pp. 219-251, **TD No. 884 (October 2012).**

A. Bardozzetti and D. Dottori, *Collective Action Clauses: how do they Affect Sovereign Bond Yields?,* Journal of International Economics , v 92, 2, pp. 286-303, **TD No. 897 (January 2013).**

D. Depalo, R. Giordano and E. Papapetrou, *Public-private wage differentials in euro area countries: evidence from quantile decomposition analysis,* Empirical Economics, v. 49, 3, pp. 985-1115, **TD No. 907 (April 2013).**

G. Barone and G. Narciso, *Organized crime and business subsidies: Where does the money go?,* Journal of Urban Economics, v. 86, pp. 98-110, **TD No. 916 (June 2013).**

P. Alessandri and B. Nelson, *Simple banking: profitability and the yield curve,* Journal of Money, Credit and Banking, v. 47, 1, pp. 143-175, **TD No. 945 (January 2014).**

M. Taneli and B. Ohl, *Information acquisition and learning from prices over the business cycle,* Journal of Economic Theory, 158 B, pp. 585–633, **TD No. 946 (January 2014).**

R. Aaberge and A. Brandolini, *Multidimensional poverty and inequality,* in A. B. Atkinson and F. Bourguignon (eds.), Handbook of Income Distribution, Volume 2A, Amsterdam, Elsevier, **TD No. 976 (October 2014).**

V. Cuciniello and F. M. Signoretti, *Large banks,loan rate markup and monetary policy,* International Journal of Central Banking, v. 11, 3, pp. 141-177, **TD No. 987 (November 2014).**

M. Fratzscher, D. Rimec, L. Sarnob and G. Zinna, *The scapegoat theory of exchange rates: the first tests,* Journal of Monetary Economics, v. 70, 1, pp. 1-21, **TD No. 991 (November 2014).**

A. NOTARPIETRO and S. SIVIERO, *Optimal monetary policy rules and house prices: the role of financial frictions,* Journal of Money, Credit and Banking, v. 47, S1, pp. 383-410, **TD No. 993 (November 2014).**

R. ANTONIETTI, R. BRONZINI and G. CAINELLI, *Inward greenfield FDI and innovation,* Economia e Politica Industriale, v. 42, 1, pp. 93-116, **TD No. 1006 (March 2015).**

T. CESARONI, *Procyclicality of credit rating systems: how to manage it,* Journal of Economics and Business, v. 82. pp. 62-83, **TD No. 1034 (October 2015).**

M. RIGGI and F. VENDITTI, *The time varying effect of oil price shocks on euro-area exports,* Journal of Economic Dynamics and Control, v. 59, pp. 75-94, **TD No. 1035 (October 2015).**

2016

E. BONACCORSI DI PATTI and E. SETTE, *Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register,* Journal of Financial Intermediation , v. 25, 1, pp. 54-76, **TD No. 848 (February 2012).**

M. MARCELLINO, M. PORQUEDDU and F. VENDITTI, *Short-Term GDP Forecasting with a mixed frequency dynamic factor model with stochastic volatility,* Journal of Business & Economic Statistics , v. 34, 1, pp. 118-127, **TD No. 896 (January 2013).**

M. ANDINI and G. DE BLASIO, *Local development that money cannot buy: Italy's Contratti di Programma,* Journal of Economic Geography, v. 16, 2, pp. 365-393, **TD No. 915 (June 2013).**

L. ESPOSITO, A. NOBILI and T. ROPELE, *The Management of Interest Rate Risk During the Crisis: Evidence from Italian Banks,* Journal of Banking & Finance, v. 59, pp. 486-504, **TD No. 933 (September 2013).**

F. BUSETTI and M. CAIVANO, *The Trend–Cycle Decomposition of Output and the Phillips Curve: Bayesian Estimates for Italy and the Euro Area,* Empirical Economics, V. 50, 4, pp. 1565-1587, **TD No. 941 (November 2013).**

M. CAIVANO and A. HARVEY, *Time-series models with an EGB2 conditional distribution,* Journal of Time Series Analysis, v. 35, 6, pp. 558-571, **TD No. 947 (January 2014).**

G. ALBANESE, G. DE BLASIO and P. SESTITO, *My parents taught me. evidence on the family transmission of values,* Journal of Population Economics, v. 29, 2, pp. 571-592, **TD No. 955 (March 2014).**

R. BRONZINI and P. PISELLI, *The impact of R&D subsidies on firm innovation,* Research Policy, v. 45, 2, pp. 442-457, **TD No. 960 (April 2014).**

L. BURLON and M. VILALTA-BUFI, *A new look at technical progress and early retirement,* IZA Journal of Labor Policy, v. 5, **TD No. 963 (June 2014).**

A. BRANDOLINI and E. VIVIANO, *Behind and beyond the (headcount) employment rate,* Journal of the Royal Statistical Society: Series A, v. 179, 3, pp. 657-681, **TD No. 965 (July 2015).**

D. DOTTORI and M. MANNA, *Strategy and Tactics in Public Debt Management,* Journal of Policy Modeling, v. 38, 1, pp. 1-25, **TD No. 1005 (March 2015).**

A. CALZA and A. ZAGHINI, *Shoe-leather costs in the euro area and the foreign demand for euro banknotes,* International Journal of Central Banking, v. 12, 1, pp. 231-246, **TD No. 1039 (December 2015).**

E. CIANI, *Retirement, Pension Eligibility and Home Production,* Labour Economics, v. 38, pp. 106-120, **TD No. 1056 (March 2016).**

L. D'AURIZIO and D. DEPALO, *An Evaluation of the Policies on Repayment of Government's Trade Debt in Italy,* Italian Economic Journal, v. 2, 2, pp. 167-196, **TD No. 1061 (April 2016).**

FORTHCOMING

S. MOCETTI, M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Financial Services Research, **TD No. 752 (March 2010).**

F BRIPI, *The role of regulation on entry: evidence from the Italian provinces,* World Bank Economic Review, **TD No. 932 (September 2013).**

G. DE BLASIO and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Regional Science and Urban Economics, **TD No. 953 (March 2014).**

A. L. MANCINI, C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, **TD No. 958 (April 2014).**

L. BURLON, *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory, **TD No. 961 (April 2014).**

G. ZINNA, *Price pressures on UK real rates: an empirical investigation,* Review of Finance, **TD No. 968 (July 2014).**

A. BORIN and M. MANCINI, *Foreign direct investment and firm performance: an empirical analysis of Italian firms,* Review of World Economics, **TD No. 1011 (June 2015).**

F. CORNELI and E. TARANTINO, *Sovereign debt and reserves with liquidity and productivity crises,* Journal of International Money and Finance, **TD No. 1012 (June 2015).**