Financial Factors in Business Cycles*
(Preliminary)

Lawrence Christiano†, Roberto Motto‡, and Massimo Rostagno§

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Abstract

We augment a standard monetary DSGE model to include financial markets, and fit the model to EA and US data. The empirical results draw attention to a new shock and to an important new nominal rigidity. The new shock originates in the financial sector and accounts for a significant portion of business cycle fluctuations. We do a detailed study of the role of this shock in the boom-bust of the late 1990s and early 2000s. The new nominal friction corresponds to the fact that lending contracts are typically denominated in nominal terms. Consistent with Fisher (1933), we show that the distributional consequences of this nominal rigidity play an important role in the propagation of shocks. Finally, we exploit the existence of financial variables in our model to investigate the consequences of adopting a monetary policy which reacts to the stock market or to a broad monetary aggregate.

*This paper expresses the views of the authors and not necessarily those of the European Central Bank.

†Northwestern University and National Bureau of Economic Research

‡European Central Bank

§European Central Bank

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1 Introduction

In recent years, there has been considerable interest in understanding the interaction of financial markets and the macroeconomy. In part, this is a reaction to several dramatic stock market boom-bust episodes - the US in the late 1990s, and Japan in the 1980s. These episodes raise questions:

- Are there shocks that originate in financial markets (i.e., 'bubbles', 'irrational exuberance'), and do these contribute to business cycle fluctuations?
- Do financial markets play an important role in the propagation of non-financial market shocks?
- How, if at all, should policy react to financial market shocks?

We investigate these questions using the model of Christiano, Motto and Rostagno (2003,2007). The model builds on the basic structure of Christiano, Eichenbaum and Evans (2005) by incorporating sticky wages and prices, adjustment costs in investment, habit persistence in preferences and variable capital utilization. Regarding financial markets, the model integrates the neoclassical banking model of Chari, Christiano and Eichenbaum (1995). In addition, the model integrates the model of financing frictions built by Bernanke, Gertler and Gilchrist (1999) (BGG), modifed as in Christiano, Motto and Rostagno (2003,2007) to allow for Fisher (1933) debt-deflation effects. Finally, our analysis proceeds in the spirit of Smets and Wouters (2003,2007) by including a relatively large range of shocks and by using Bayesian methods for model estimation and for evaluation of model fit.

By incorporating these model features we are able to substantially expand the number of variables to be analyzed relative to standard DSGE models. In particular, we can consider various monetary aggregates, various interest rates, a measure of the external finance premium, and the value of the stock market, in addition to the standard macroeconomic aggregates. We now briefly summarize our four key results.

First, the posterior modes of the parameters of the Euro Area (EA) and the US models are plausible, and the fit of each model is reasonably good, using fit criteria based on out-of-sample forecasting performance. We use the root mean square error criteria suggested by Smets and Wouters (2003), as well optimal forecast combination methods. We develop and apply the classical sampling theory for these fit criteria, and we hope these are of independent interest.

Second, BGG financial frictions play an important role in amplifying ('accelerating') the transmission of shocks that move output and price in the same direction, such as monetary policy shocks. They mitigate the effects of other shocks. The banking sector plays a less substantial role, both as a source of shocks and in modifying the transmission of shocks originating outside the banking sector. An exception is that banks are important in amplifying and making more persistent the effects of monetary policy shocks.

An important feature of the financial frictions in our model is a particular nominal rigidity that was stressed by Irving Fisher (1933). Following BGG, we suppose that one class of people, entrepreneurs, possess a special ability to run and manage capital. For entrepreneurs to operate at an efficient scale, they acquire loans from the other class of people - households. We assume (as in Fisher, 1933) that the nominal interest on the loans is not contingent on the state of the economy at the time the loans are repaid. As a result, if a shock drives up the price level then real resources are transfered from households to entrepreneurs. By shifting purchasing power from people who do not know how to run and manage capital to people who do, the rise in the price level enables the latter to expand the amount of capital and economic activity in the economy. Similarly, a shock which drives the price level down works in the other direction.

We refer to the mechanism whereby changes in the price level reallocate income between households and entrepreneurs the 'Fisher debt-deflation channel'. Consistent with the intuition, we find that the Fisher debt-deflation channel amplifies the effects of shocks which drive output and the price level in the same direction, and buffers the effects of shocks which drive output and the price level in opposite directions.

It is interesting to contrast the nominal rigidity emerging from asset prices with the more conventional nominal rigidities associated with prices and wages. In the latter case, the rigidities have their effect because the setting of wages and/or prices and or prices in the past exerts an impact on wages and prices governing current economic relations. The financial nominal rigidity works in a different way. In our model interest rates on loans are not constrained by past agreements. Instead, the allocative effects of the financial nominal rigidity operates through its impact on the distribution of income between different types of agent.

Our third finding is that a shock which originates within the BGG financial frictions is an important driving factor in business fluctuations. The shock accounts for a substantial fraction of the variance of macroeconomic variables in our estimated EA and US models. In addition, we decompose the EA and US data in our sample into components due to the different shocks in the model. When we do this, we find that our financial shock plays an important role throughout the sample in determining the evolution of macroeconomic variables, including output, inflation, consumption and investment. We find that this shock is particularly important for understanding the boom-bust period of the late 1990s and early 2000s. We now briefly explain this latter analysis.

We find that inference about the shocks driving the boom in output, investment and the stock market in the late 1990s and the bust thereafter is sensitive to whether the stock market is included in the analysis. When the episode is studied in the conventional way, using a version of our model that leaves out financial frictions and using data that does not include the stock market, then we confirm the conventional conclusion: the key shock driving investment and output is a favorable supply shock in the technology for constructing capital ('marginal efficiency of investment').

But, the conventional model has an implication that has not been noticed in the literature. According to that model, the stock market corresponds to the price of capital. Consistent with standard undergraduate demand and supply analysis, the notion that the 1990s data were driven by a favorable capital supply shock implies that the price of capital should have fallen in the late 1990s. That is, the conventional analysis implies that the stock market should have collapsed in the late 1990s and then risen during the post 2000 'bust'. But, of course this is exactly the opposite of what actually happened. Intuition suggests that if capital increases at the same time that its price increases, then the fundamental shocks must be to the demand for capital, and not to its supply. Consistent with this intuition, when we include stock market data explicitly in the analysis, we attribute the dynamics of the boom-bust to a demand shock in the market for capital. The demand shock originates in our version of the BGG financial frictions. As in the case of all shocks, our model leaves the ultimate origin of our financial shock unexplained. Still, we believe that the introduction of financial factors into the analysis of the data sheds important new light on the sources of fluctuations.

Fourth, the presence of a non-trivial financial sector in our model makes it possible to investigate the consequences of introducing feedback from financial variables to monetary policy. Using our estimated EA and US models, we display the trade-offs between inflation and output variability ('Taylor frontiers') that the monetary authority can achieve by reacting to the stock market and to a broad measure of money. We find that reacting to broad money always stabilises output volatility in the US and the EA, while reacting to the stock market is stabilising in the US and (if very strong) destabilising in the EA.

The plan of the paper is as follows. The next two sections describe the model and the estimation results. After that, we describe our four results. Many technical details and some additional results are relegated to appendices.

2 The Model

This section provides a brief overview of the model. With one exception, it corresponds to the model in Christiano, Motto and Rostagno (2007). The exception is that here, we drop the specification that the central bank's inflation target varies over time. For completeness, we nevertheless give a description that is detailed enough to make it clear what the basics shocks and propagation mechanisms are.

The model is composed of households, firms, capital producers, entrepreneurs and banks.

At the beginning of the period, households supply labor and entrepreneurs supply capital to homogeneous factor markets. In addition, households divide their high-powered money into currency and bank deposits. Currency pays no interest, and is held for the transactions services it generates. All transactions services are modeled by placing the associated monetary asset in the utility function. Bank deposits pay interest and also generate transactions services. Banks use household deposits to loan firms the funds they need to pay their wage bills and capital rental costs. Firms and banks use labor and capital to produce output and transactions services, respectively.

The output produced by firms is converted into consumption goods, investment goods and goods used up in capital utilization. Capital producers combine investment goods with used capital purchased from entrepreneurs to produce new capital. This new capital is then purchased by entrepreneurs. Entrepreneurs make these purchases using their own resources, as well as bank loans. Banks obtain the funds to lend to entrepreneurs by issuing liabilities to households.

2.1 Goods Production

We adopt the standard Dixit-Stiglitz framework for final goods production. Final output, Y_t, is produced by a perfectly competitive, representative firm. It does so by combining a continuum of intermediate goods, indexed by $j \in [0,1]$, using the technology

$$Y_t = \left[\int_0^1 Y_{jt}^{\frac{1}{\lambda_{f,t}}} dj \right]^{\lambda_{f,t}}, \ 1 \leq \lambda_{f,t} < \infty, \tag{1}$$

where Y_{jt} denotes the time-t input of intermediate good j and $\lambda_{f,t}$ is a shock. The time series representations of this and all other stochastic processes in the model will be discussed below. Let P_t and P_{jt} denote the time-t price of the consumption good and intermediate good j, respectively. The firm chooses Y_{jt} and Y_t to maximize profits, taking prices as given.

We assume that final output can be converted into consumption goods one-for-one. One unit of final output can be converted into $\mu_{\Upsilon,t}\Upsilon^t$ investment goods, where $\Upsilon > 1$ is the trend rate of investment-specific technical change, and $\mu_{\Upsilon,t}$ is a stationary stochastic process. Because firms that produce consumption and investment goods using final output are assumed to be perfectly competitive, the date t equilibrium price of consumption and investment goods are P_t and $P_t / \left(\mu_{\Upsilon,t}\Upsilon^t\right)$, respectively.

The j^{th} intermediate good used in (1) is produced by a monopolist using the following production function:

$$Y_{jt} = \begin{cases} \epsilon_t K_{jt}^{\alpha} \left(z_t l_{jt}\right)^{1-\alpha} - \Phi z_t^* & \text{if } \epsilon_t K_{jt}^{\alpha} \left(z_t l_{jt}\right)^{1-\alpha} > \Phi z_t^* \\ 0, & \text{otherwise} \end{cases}, \ 0 < \alpha < 1, \tag{2}$$

where Φz_t^* is a fixed cost and K_{jt} and l_{jt} denote the services of capital and homogeneous labor. Fixed costs are modeled as growing with the exogenous variable, z_t^* :

$$z_t^* = z_t \Upsilon^{\left(\frac{\alpha}{1-\alpha}t\right)},\ \Upsilon > 1, \tag{3}$$

where the growth rate of z_t^* corresponds to the growth rate of output in steady state. We suppose that fixed costs grow at this rate to ensure that they remain relevant along the equilibrium growth path, and to be consistent with balanced growth.

In (2), the persistent shock to technology, z_t, has the following time series representation:

$$z_t = \mu_{z,t} z_{t-1},$$

where $\mu_{z,t}$ is a stochastic process. The variable, ϵ_t, is a stationary shock to technology.

The homogeneous labor employed by firms in (2) and the differentiated labor supplied by individual households are related as follows:

$$l_t = \left[\int_0^1 (h_{t,i})^{\frac{1}{\lambda_w}} di\right]^{\lambda_w},\ 1 \leq \lambda_w. \tag{4}$$

Below, we discuss how $h_{t,i}$ is determined.

Intermediate-goods firms are competitive in factor markets, where they confront a rental rate, $P_t \tilde{r}_t^k$, on capital services and a wage rate, W_t, on labor services. Each of these is expressed in units of money. Also, each firm must finance a fraction, ψ_k, of its capital services expenses in advance. Similarly, it must finance a fraction, ψ_l, of its labor services in advance. The gross rate of interest it faces for this type of working-capital loan is R_t.

We adopt a variant of Calvo sticky prices. In each period, t, a fraction of intermediate-goods firms, $1 - \xi_p$, can reoptimize their price. If the i^{th} firm in period t cannot reoptimize, then it sets price according to:

$$P_{it} = \tilde{\pi}_t P_{i,t-1},$$

where

$$\tilde{\pi}_t = \left(\pi_t^{target}\right)^{\iota} (\pi_{t-1})^{1-\iota}. \tag{5}$$

Here, $\pi_{t-1} = P_{t-1}/P_{t-2}$ and π_t^{target} is the target inflation rate in the monetary authority's monetary policy rule, which is discussed below. The i^{th} firm that can optimize its price at time t chooses $P_{i,t} = \tilde{P}_t$ to optimize discounted profits:

$$E_t \sum_{j=0}^{\infty} \left(\beta \xi_p\right)^j \lambda_{t+j} \left[P_{i,t+j} Y_{i,t+j} - P_{t+j} s_{t+j} \left(Y_{i,t+j} + \Phi z_{t+j}^*\right)\right]. \tag{6}$$

Here, λ_{t+j} is the multiplier on firm profits in the household's budget constraint. Also, $P_{i,t+j}$, $j > 0$ denotes the price of a firm that sets $P_{i,t} = \tilde{P}_t$ and does not reoptimize between $t+1, ..., t+j$. The equilibrium conditions associated with firms are derived in the appendix.

2.2 Capital Producers

At the end of period t, capital producers purchase investment goods, I_t, and installed physical capital, x, that has been used in period t. Capital producers use these inputs to produce new installed capital, x', that can be used starting period $t+1$. In producing capital goods, capital producers face adjustment costs. In our baseline specification, these costs are expressed in terms of I_t/I_{t-1} :

$$x' = x + \left(1 - S(\zeta_{i,t}\, I_t/I_{t-1})\right) I_t.$$

Here, S is a function with the property that in steady state, $S = S' = 0$, and $S'' > 0$. Also, $\zeta_{i,t}$ is a shock to the marginal efficiency of investment. Since the marginal rate of transformation from previously installed capital (after it has depreciated by $1-\delta$) to new capital is unity, the price of new and used capital are the same, and we denote this by $Q_{\bar{K}',t}$. The firm's time-t profits are:

$$\Pi_t^k = Q_{\bar{K}',t}\left[x + \left(1 - S(\zeta_{i,t} I_t/I_{t-1})\right) I_t\right] - Q_{\bar{K}',t}x - \frac{P_t}{\Upsilon^t \mu_{\Upsilon,t}} I_t.$$

The capital producer's problem is dynamic because of the adjustment costs. It solves:

$$\max_{\{I_{t+j}, x_{t+j}\}} E_t \left\{\sum_{j=0}^{\infty} \beta^j \lambda_{t+j} \Pi_{t+j}^k\right\},$$

where E_t is the expectation conditional on the time-t information set, which includes all time-t shocks. Also, λ_t is the multiplier on the household's budget constraint.[1]

Let $\bar{K}_{t+j}$ denote the beginning-of-time $t+j$ physical stock of capital in the economy, and let δ denote the depreciation parameter. From the capital producer's problem it is evident that any value of x_{t+j} whatsoever is profit maximizing. Thus, setting $x_{t+j} = (1-\delta)\bar{K}_{t+j}$ is consistent with profit maximization and market clearing. The aggregate stock of physical capital evolves as follows

$$\bar{K}_{t+1} = (1-\delta)\bar{K}_t + \left(1 - S(\zeta_{i,t}\, I_t/I_{t-1})\right) I_t.$$

2.3 Entrepreneurs

At the end of period t, the entrepreneur uses net worth, N_{t+1}, plus a bank loan to purchase the new, installed physical capital, $\bar{K}_{t+1}$, from capital producers. The entrepreneur then experiences an idiosyncratic productivity shock: the purchased capital, $\bar{K}_{t+1}$, transforms into $\bar{K}_{t+1}\omega$, where ω is a unit mean, lognormally distributed random variable across all

[1] See (17) below.

entrepreneurs. Here, $\log \omega$ has variance σ_t^2, where the t subscript indicates that σ_t is itself the realization of a random variable. The random variable, ω, is drawn independently across entrepreneurs and over time. In period $t+1$, after observing the period $t+1$ shocks, the entrepreneur determines the utilization rate of capital, and then rents capital services in competitive markets. In choosing the capital utilization rate, the entrepreneur takes into account the utilization cost function:

$$P_{t+1}\Upsilon^{-(t+1)}\tau_{t+1}^{oil}a(u_{t+1})\omega\bar{K}_{t+1},$$

where a is an increasing and convex function, and τ_{t+1}^{oil} is a shock which we identify with the real price of oil. After determining the utilization rate of capital and earning rent (net of utilization costs) on it, the entrepreneur sells the undepreciated part of its capital to the capital producers and pays off its debt to banks. Entrepreneurs with ω large enough pay interest, Z_{t+1}, on their bank loan. The entrepreneurs who declare that they cannot fully repay their bank loan are monitored, and they must turn over everything they have to the bank. The interest rate, Z_{t+1}, and loan amount to entrepreneurs are determined as in a standard debt contract. In particular, the loan amount and interest rate maximize the entrepreneur's expected state at the end of the loan contract, subject to a zero profit condition on the bank. The bank's zero profit condition reflects that the funds loaned to entrepreneurs must be obtained by the bank from households. The zero profit condition states that the amount the household must pay for those funds must equal the amount that the bank receives from entrepreneurs. In our benchmark model, the nominal amount owed to households in period $t+1$ is not contingent on the shocks realized in period $t+1$. This is the nominal rigidity mentioned in the introduction. To investigate the importance of this rigidity we also consider a version of the model in which the real amount owed to households in period $t+1$ is not contingent on the period t shocks.

After the entrepreneur has settled its debt to the bank in period $t+1$, and the entrepreneur's capital has been sold to capital producers, the entrepreneur's period $t+1$ net worth is determined. At this point, the entrepreneur exits the economy with probability $1-\gamma_{t+1}$, and survives to continue another period with probability γ_{t+1}. The probability, γ_{t+1}, is the realization of a stochastic process. Each period new entrepreneurs are born in sufficient numbers so that the population of entrepreneurs remains constant. New entrepreneurs born in period $t+1$ receive a transfer of net worth, W_{t+1}^e. Because W_{t+1}^e is relatively small, this death and birth process helps to ensure that entrepreneurs do not accumulate enough net worth, so that eventually they become independent of banks. Entrepreneurs selected to exit consume a fraction of their net worth in the period that they are selected to exit the economy, and the remaining fraction of their net worth is transferred as a lump-sum payment to households.

We interpret the random variable, γ_t, as a reduced form way to capture an 'asset price bubble' or 'irrational exuberance'. In informal discussions these phrases are often used to refer to increases in stock market wealth that are not clearly linked to shifts in preferences or technology. This is literally the case in our model when γ_t jumps. The random variable, σ_t, is a way to capture the notion that the riskiness of entrepreneurial varies over time.

2.4 Banking

There is a representative, competitive bank. The bank intermediates loans between households and firms, and it produces transactions services using capital, labor and reserves.

In period t, banks make working capital loans, S_t^w, to intermediate goods producers and other banks. Working capital loans are for the purpose of financing wage payments and capital rental costs:

$$S_t^w = \psi_l W_t l_t + \psi_k P_t \tilde{r}_t^k K_t.$$

Here, ψ_l and ψ_k are the fraction of the wage and capital rental bills, respectively, that must be financed in advance. Note that these apply to all homogeneous labor, l_t, and capital services, K_t, reflecting our assumption that both intermediate goods producing firms and banks must finance their period t variable input costs at the beginning of period t. The funds for working capital loans are obtained by issuing demand deposit liabilities to households.

In period t, banks make loans to entrepreneurs, B_{t+1}, to purchase capital. Banks obtain funds for these types of loans by issuing two types of liabilities to households - savings deposits, D_{t+1}^m, and time deposits, T_t - subject to:

$$D_{t+1}^m + T_t \geq B_{t+1}. \tag{7}$$

Household savings deposits pay interest, R_{t+1}^m, in period $t+1$ and also generate some transactions services. Time deposits generate interest, R_{t+1}^T, in period $t+1$ but they provide no transactions services.

Our model has implications for various monetary aggregates: currency, M_1 (currency plus demand deposits), M_3 (M_1 plus savings deposits), high powered money (currency plus bank reserves) and bank reserves. The reason we assume banks finance loans to entrepreneurs by issuing two types of liabilities rather than one, is that this allows us to match the M_3 velocity growth.[2] If banks issued only one type of liability and this were included in M_3, then the velocity of M_3 would be low compared to its empirical counterpart. This is because the quantity of debt to entrepreneurs is high in our calibrated model.

In period $t+1$ the bank earns a return, R_{t+1}^e, on B_{t+1}. It passes this on to households in the form of interest, R_{t+1}^T, on T_t and interest, R_{t+1}^m, on D_{t+1}^m. In our benchmark model, we suppose that R_{t+1}^e is a function of information available at time t. We suppose the same is true of R_{t+1}^T and R_{t+1}^m. We also consider a version of the model in which the real return,

[2] In Christiano, Motto and Rostagno (2003), banks finance entrepreneurial loans with only one type of liability.

$\left(1+R_{t+1}^{e}\right)/\pi_{t+1}$, is not contingent on the realization of period t shocks. In any case, the following condition must be satisfied:

$$\left(1+R_{t+1}^{e}\right)B_{t+1} \geq \left(1+R_{t+1}^{T}\right)T_{t}+\left(1+R_{t+1}^{m}\right)D_{t+1}^{m}. \tag{8}$$

The maturity period of loans to entrepreneurs coincides with the maturity period of household savings and time deposits. The loans are issued at the time new, installed capital is sold after the goods market closes and they are repaid at the same time next period.

To finance working capital loans, S_t^w, the bank issues demand deposit liabilities, D_t^h, to households. These liabilities are issued in exchange for receiving A_t units of high-powered money from the households, so that

$$D_t^h = A_t. \tag{9}$$

Working capital loans are made in the form of demand deposits, D_t^f, to firms, so that

$$D_t^f = S_t^w. \tag{10}$$

Total demand deposits, D_t, are:

$$D_t = D_t^h + D_t^f. \tag{11}$$

Demand deposits pay interest, R_t^a. We suppose that the interest on demand deposits that are created when firms and banks receive working capital loans are paid to the recipient of the loans. Firms and banks hold these demand deposits until the wage bill is paid in a settlement period that occurs after the goods market.

Interest paid by firms on working capital loans is $R_t + R_t^a$. Since firms receive interest payments on deposits, net interest on working capital loans is R_t. The maturity period of time t working capital loans to firms and banks and the maturity period of demand deposits coincide. A period t working capital loan is extended just prior to production in period t, and then paid off after production. The household deposits funds into the bank just prior to production in period t and then liquidates the deposit after production.

Demand and savings deposits are associated with transactions services. The bank has a technology for converting homogeneous labor, l_t^b, capital services, K_t^b, and excess reserves, E_t^r, into transactions services:

$$\frac{D_t+\varsigma D_t^m}{P_t} = x_t^b\left(\left(K_t^b\right)^{\alpha}\left(z_t l_t^b\right)^{1-\alpha}\right)^{\xi_t}\left(\frac{E_t^r}{P_t}\right)^{1-\xi_t} \tag{12}$$

Here ς is a positive scalar and $0<\alpha<1$. Also, x_t^b is a technology shock that is specific to the banking sector. In addition, $\xi_t \in (0,1)$ is a shock to the relative value of excess reserves, E_t^r. We include excess reserves as an input to the production of demand deposit services as a reduced form way to capture the precautionary motive of a bank concerned about the possibility of unexpected withdrawals. Excess reserves are defined as follows:

$$E_t^r = A_t - \tau D_t, \tag{13}$$

where τ denotes required reserves.

At the end of the goods market, the bank settles claims for transactions that occurred in the goods market and that arose from its activities in the previous period's entrepreneurial loan and time deposit market. The bank's sources of funds at this time are: interest and principal on working capital loans, $(1 + R_t + R_t^a)S_t^w$, plus interest and principal on entrepreneurial loans extended in the previous period, $(1 + R_t^e)B_t$, plus the reserves it received from households at the start of the period, A_t, plus newly created time and savings deposits, $T_t + D_{t+1}^m$. The bank's uses of funds include new loans, B_{t+1}, extended to entrepreneurs, plus principal and interest payments on demand deposits, $(1 + R_t^a)D_t$, plus interest and principal on saving deposits, $(1 + R_t^m)D_t^m$, plus principal and interest on time deposits, $\left(1 + R_t^T\right) T_{t-1}$, plus gross expenses on labor and capital services. Thus, the bank's net source of funds at the end of the period, Π_t^b, is:

$$\begin{aligned}\Pi_t^b = {} & (1 + R_t + R_t^a)S_t^w + (1 + R_t^e)\, B_t + A_t + T_t + D_{t+1}^m - B_{t+1} - (1 + R_t^a)D_t \\ & - (1 + R_t^m)D_t^m - \left(1 + R_t^T\right) T_{t-1} - \left[(1 + \psi_k R_t)\, P_t \tilde{r}_t^k K_t^b\right] - \left[(1 + \psi_l R_t)\, W_t l_t^b\right].\end{aligned}$$

Taking into account (9), (10) and (11), and rearranging, this reduces to:

$$\begin{aligned}\Pi_t^b = {} & R_t S_t^w + \left[(1 + R_t^e)\, B_t - (1 + R_t^m)D_t^m - \left(1 + R_t^T\right) T_{t-1}\right] - \left[B_{t+1} - T_t - D_{t+1}^m\right] \\ & - R_t^a A_t - (1 + \psi_k R_t)\, P_t \tilde{r}_t^k K_t^b - (1 + \psi_l R_t)\, W_t l_t^b.\end{aligned} \tag{14}$$

In solving its problem, the bank takes rates of return and factor prices as given. In addition, B_{t+1} is determined by the considerations spelled out in the previous subsection, and so here $\{B_{t+1}\}$ is also taken as given. At date t, the bank takes D_t^m, T_{t-1} as given, and chooses S_t^w, D_{t+1}^m, T_t, A_t, K_t^b, l_t^b, E_t^r. The constraints are (7), (8), (9), (10), (11), (12) and (13). The equilibrium conditions associated with the bank problem are derived in the Appendix.

2.5 Households

There is a continuum of households, indexed by $j \in (0, 1)$. Households consume, save and supply a differentiated labor input. They set their wages using the variant of the Calvo (1983) frictions described by Erceg, Henderson and Levin (2000). We first describe the household utility function and budget constraint. We then discuss the household's wage setting problem. Detailed derivations of equilibrium conditions appear in the Appendix, as does a derivation of the appropriate utilitarian welfare function for our model.

The sequence of decisions by the j^{th} household during a period are as follows. First, the current period aggregate shocks are realized. Second, the household purchases state-contingent securities whose payoff is contingent upon whether it can reoptimize its wage decision. Third, the household sets its wage rate after finding out whether it can reoptimize or not. Fourth, the household supplies the labor that is demanded at its posted wage rate. In addition, the household makes its consumption and portfolio decisions. In the analysis below, we do not index the consumption and portfolio decisions by j, because the state contingent securities guarantee that, in equilibrium these decisions are the same for all households (see Erceg, Henderson and Levin (2000).)

The preferences of the j^{th} household are given by:

$$E_t^j \sum_{l=0}^{\infty} \beta^l \zeta_{c,t+l} \{ u(C_{t+l} - bC_{t+l-1}) - \zeta_{t+l} z(h_{j,t+l}) \tag{15}$$
$$- \upsilon \frac{\left[\left(\frac{(1+\tau^c)P_{t+l}C_{t+l}}{M_{t+l}} \right)^{(1-\chi_{t+l})\theta} \left(\frac{(1+\tau^c)P_{t+l}C_{t+l}}{D^h_{t+l}} \right)^{(1-\chi_{t+l})(1-\theta)} \left(\frac{(1+\tau^c)P_{t+l}C_{t+l}}{D^m_{t+l}} \right)^{\chi_{t+l}} \right]^{1-\sigma_q}}{1-\sigma_q} \},$$

where E_t^j is the expectation operator, conditional on aggregate and household j idiosyncratic information up to, and including, time t; C_t denotes time t consumption; h_{jt} denotes time t hours worked; τ^c is a tax on consumption; $\zeta_{c,t}$ is an exogenous shock to time t preferences; and χ_t is a shock to the demand for savings deposits relative to other forms of money. In order to help assure that our model has a balanced growth path, we specify that u is the natural logarithm. When $b > 0$, (15) allows for habit formation in consumption preferences. The term in square brackets captures the notion that currency, M_t, savings deposits, D_t^m, and household demand deposits, D_t^h, contribute to utility by providing transactions services. The value of those services are an increasing function of the level of consumption expenditures (inclusive of consumption tax, τ^c). Finally, we employ the following functional form for $z(h_t)$:

$$z(h_t) = \psi_L \frac{h_t^{1+\sigma_L}}{1+\sigma_L}$$

We now discuss the household's period t uses and sources of funds. The household begins the period holding the monetary base, M_t^b. It divides this between currency, M_t, and deposits at the bank, A_t subject to:

$$M_t^b - (M_t + A_t) \geq 0. \tag{16}$$

In exchange for A_t, the household receives a demand deposit, D_t^h, from the bank. Thus, $D_t^h = A_t$. Demand deposits pay R_t^a and also offer transactions services.

The period t money injection is X_t. This is transferred to the household, so that by the end of the period the household is in possession of $M_t + X_t$ units of currency. We assume that the household's period t currency transactions services are a function of M_t only, and not X_t, because X_t arrives 'too late' to be useful in current period transactions. We make a similar assumption about demand deposits. At some point later in the period, the household is in possession of not just D_t^h, but also the deposits that it receives from wage payments. We assume that the household only enjoys transactions services on D_t^h, and that the other deposits come in 'too late' to generate transactions services for the household.

The household also can acquire savings and time deposits, D_{t+1}^m and T_t, respectively. These can be acquired at the end of the period t goods market and pay rates of return, $1 + R_{t+1}^m$ and $1 + R_{t+1}^T$ at the end of the period $t+1$ goods market. The household can use its funds to pay for consumption goods, $(1 + \tau^c) P_t C_t$ and to acquire high powered money, M_{t+1}^b, for use in the following period.

Sources of funds include after-tax wage payments, $\left(1 - \tau^l\right) W_{j,t} h_{j,t}$, where $W_{j,t}$ is the household's wage rate; profits, Π, from producers of capital, banks and intermediate good firms; and $A_{j,t}$. The latter is the net payoff on the state contingent securities that the household purchases to insulate itself from uncertainty associated with being able to reoptimize its wage rate. In addition, households receive lump-sum transfers, $1 - \Theta$, corresponding to the net worth of the $1 - \gamma_t$ entrepreneurs who exit the economy the current period. Also, the household pays a lump-sum tax, W_t^e, to finance the transfer payments made to the γ_t entrepreneurs that survive and to the $1 - \gamma_t$ newly born entrepreneurs. Finally, the household pays other lump-sum taxes, $Lump_t$. These observations are summarized in the following asset accumulation equation:

$$\begin{aligned}
&(1 + R_t^a)\left(M_t^b - M_t\right) + X_t - T_t - D_{t+1}^m \\
&- (1 + \tau^c) P_t C_t + (1 - \Theta)(1 - \gamma_t) V_t - W_t^e + Lump_t \\
-\aleph_{t+40} + \sigma_t^{\aleph}(1 + &\left[1 - \tau_t^D\right] R_t^{\aleph})\aleph_t + \left(1 + R_t^T\right) T_{t-1} + (1 + R_t^m) D_t^m \\
&+ \left(1 - \tau^l\right) W_{j,t} h_{j,t} + M_t + \Pi_t + A_{j,t} - M_{t+1}^b \geq 0.
\end{aligned} \tag{17}$$

Equation (17) also allows the household to purchase a 10-year bond, $\aleph_{t+40}$, which pays $R_t^{\aleph}$ at maturity. Because households are identical in terms of their portfolios, equilibrium requires that $\aleph_t$ are in zero net supply. We nevertheless introduce $\aleph_t$ in order to evaluate the model's implications for the term spread. To quantify the model's ability to match the empirical term spread, we introduce the random variable, $\sigma_t^{\aleph}$. The mean value of $\sigma_t^{\aleph}$ is fixed at unity. If the variance of $\sigma_t^{\aleph}$ were zero, the model would have no difficulty in accounting for the term spread. Formally, we treat $\sigma_t^{\aleph}$ as a tax on the return to $\aleph_t$, whose proceeds are returned to the household in $Lump_t$. The household knows the value of $R_t^{\aleph}$ at date, $t-40$, when $\aleph_t$ is purchased. The household becomes aware of $\sigma_t^{\aleph}$ at the date when the bond matures.

The j^{th} household faces the following demand for its labor:

$$h_{j,t} = \left(\frac{W_{j,t}}{W_t}\right)^{\frac{\lambda_w}{1-\lambda_w}} l_t,\ 1 \leq \lambda_w, \tag{18}$$

where l_t is the quantity of homogeneous labor employed by goods-producing intermediate good firms and banks, W_t is the wage rate of homogeneous labor, and $W_{j,t}$ is the j^{th} household's wage. Homogeneous labor is thought of as being provided by competitive labor contractors who use the production function, (4). The j^{th} household is the monopoly supplier of differentiated labor of type $h_{j,t}$. In a given period the j^{th} household can optimize its wage rate, $W_{j,t}$, with probability, $1-\xi_w$. With probability ξ_w it cannot reoptimize, in which case it sets its wage rate as follows:

$$W_{j,t} = \tilde{\pi}_{w,t} \left(\mu_{z^*}\right)^{1-\vartheta} \left(\mu_{z^*,t}\right)^{\vartheta} W_{j,t-1},$$

where $0 \leq \vartheta \leq 1$ and

$$\tilde{\pi}_{w,t} \equiv \left(\pi_t^{target}\right)^{\iota_w} \left(\pi_{t-1}\right)^{1-\iota_w},\ 0 < \iota_w < 1. \tag{19}$$

Here, π_t^{target} is the target inflation rate of the monetary authority.

The household's problem is to maximize (15) subject to the various non-negativity, the demand for labor, the Calvo wage-setting frictions, and (17). The equilibrium conditions associated with the household problem are derived in the appendix.

2.6 Resource Constraint

We now develop the aggregate resource constraint for this economy. Clearing in the market for final goods implies:

$$\mu \int_0^{\bar{\omega}_t} \omega dF(\omega) \left(1+R_t^k\right) \frac{Q_{\bar{K}',t-1}\bar{K}_t}{P_t} + \frac{\tau_t^{oil} a(u_t)}{\Upsilon^t} \bar{K}_t + \frac{\Theta(1-\gamma_t)V_t}{P_t} + G_t + C_t + \left(\frac{1}{\Upsilon^t \mu_{\Upsilon,t}}\right) I_t \leq Y_t. \tag{20}$$

The first object in (20) represents final output used up in bank monitoring. The second term captures capital utilization costs.[3] The third term corresponds to the consumption of the

[3]Here, we use the fact that an entrepreneur's rate of utilization, u_t, is independent of the draw of ω. In addition, we use the fact that the integral of ω across entrepreneurs is unity.

$1-\gamma_t$ entrepreneurs who exit the economy in period t. We model government consumption, G_t, as in Christiano and Eichenbaum (1992):

$$G_t = z_t^* g_t,$$

where g_t is a stationary stochastic process. This way of modeling G_t helps to ensure that the model has a balanced growth path. The last term on the left of the equality in the goods clearing condition is the amount of final goods used up in producing I_t investment goods. In the appendix, we develop a scaled version of the resource constraint. In addition, we follow the strategy of Yun (1996), in deriving the relationship between Y_t and aggregate capital and aggregate labor supply by households.

2.7 Monetary Policy

For monetary policy, we adopt a flexible representation of the Taylor rule. We adopt the following standard notion. If we have a variable, x_t, whose steady state is x, then

$$\hat{x}_t \equiv \frac{x_t - x}{x}, \tag{21}$$

denotes the percent deviation of x_t from its steady state value. It follows that $x\hat{x}_t$ is the actual deviation from steady state. When x_t is a variable such as the rate of interest, then $400x\hat{x}_t$ expresses x_t as a deviation from steady state, in annualized, percent terms.

Suppose the $target$ target interest rate of the monetary authority is R^{target}. We suppose that this variable is set as follows:

$$\begin{aligned}\left(400R^{target}\hat{R}_t^{target}\right) &= \rho_i\left(400R^{target}\hat{R}_{t-1}^{target}\right) + (1-\rho_i)\alpha_\pi 400\pi\left[E_t\left(\hat{\pi}_{t+1}\right) - \bar{\pi}\right] \\ &+ (1-\rho_i)\alpha_y 100\left(\hat{y}_t - \hat{y}_{t-1}\right) + (1-\rho_i)\alpha_{d\pi}400\pi\left(\hat{\pi}_t - \hat{\pi}_{t-1}\right) + \varepsilon_t.\end{aligned} \tag{22}$$

We suppose that $\bar{\pi}$, the monetary authority's target inflation, coincides with the steady state inflation rate of the model. The inclusion of the first difference of $\hat{y}_t$ and $\hat{\pi}_t$ in (22) is motivated by the findings of Levin, Onatski, Williams and Williams (2006) (LOWW) and Smets and Wouters (2007) (SW).

In (22), $100\left(\hat{y}_t - \hat{y}_{t-1}\right)$ denotes the log deviation from steady state of GDP growth, in percent terms. We define GDP as the sum of investment, consumption and government consumption. Also, $400\pi\left(\hat{\pi}_t - \hat{\pi}_{t-1}\right)$ denotes the change in inflation, expressed at an annual percent rate. Finally, ε_t in (22) denotes a monetary policy shock, which we assume is uncorrelated over time.

Our way of writing the Taylor rule, although notationally cumbersome, puts it in a form that its parameters, ρ_i, α_π, $\alpha_{d\pi}$, α_c, and α_y, may easily be compared with Taylor rule parameters estimated in the literature. These use interest rates and inflation measured in annual percent terms and output growth expressed in percent terms.

2.8 Fundamental Shocks

We have the following 15 shocks in our model:

$$\left(\hat{x}_t^b \quad \hat{\mu}_{\Upsilon,t} \quad \hat{\chi}_t \quad \hat{g}_t \quad \hat{\mu}_{z^*,t} \quad \hat{\gamma}_t \quad \hat{\epsilon}_t \quad \varepsilon_t \quad \hat{\sigma}_t \quad \hat{\zeta}_{c,t} \quad \hat{\zeta}_{i,t} \quad \hat{\tau}_t^{oil} \quad \hat{\lambda}_{f,t} \quad \hat{\xi}_t \quad \hat{\sigma}_{\aleph,t} \right), \tag{23}$$

where a hat over a variable means (21). Also,

$$\mu_{z^*,t} \equiv \mu_{z,t} + \frac{\alpha}{1-\alpha},$$

and σ_t denotes With one exception, each of the variables in (23) has a univariate first order autoregressive representation with two free parameters. The exception is the monetary policy shock, ε_t, which we assume is *iid* so that it has only a variance parameter.

3 Estimation

We apply a Bayesian version of the maximum likelihood strategy used in Christiano, Motto and Rostagno (2003). The strategy is designed to accommodate the fact that the computation of the model's steady state is very time intensive. We divide the model parameters into two sets. The first set contains the parameters that control the steady state. The values of some of these parameters, such as α and δ, are simply taken from the literature. The values of the other parameters that control the steady state are set so that the model reproduces key sample averages in the data. We discuss the steady state parameters in the first subsection below. The second set of parameters is estimated using the Bayesian procedures in An and Schorfheide (2005), Schorfheide (2000) and Smets and Wouters (2003,2007). The parameters estimated here include the ones that characterize monetary policy, wage and price frictions, shock processes, capital utilization and investment adjustment costs. We discuss these parameters in the second subsection below. After that, we briefly discuss the estimated shocks and apply RMSE tests for model fit.

3.1 Parameters Governing Steady State

Values of parameters that control the nonstochastic part of our model economies are displayed in Table 1. The left and right columns report results for the EA and US, respectively.

The values of the parameters that control the financial frictions (e.g., γ, μ, $F(\bar{\omega})$ and $Var(\log \omega)$) were primarily determined by our desire to match the external financial premium, the equity to debt ratio and the rate of return on capital.[4] The value of the quarterly

[4] Following Carlstrom and Fuerst (1997), we define the external finance premium in our model to be the spread between Z and R^e.

survival rate of entrepreneurs, γ, that we use for both the EA and US models is fairly similar to the 97.28 percent value used in BGG. The value of μ used for the EA model is similar to the value of 0.12 used in BGG. The value of μ in our US model is a little larger, though still well within the range of $0.20 - 0.36$ that Carlstrom and Fuerst (1997) defend as empirically relevant. The value of $F(\bar{\omega})$ that we use for our US model is slightly higher than the 0.75 quarterly percent value used in BGG, or the 0.974 percent value used in Fisher (1999). The value of $F(\bar{\omega})$ used in our EA model exceeds the corresponding empirical estimates by a more substantial margin. Smaller values of $F(\bar{\omega})$ caused the model to understate the equity to debt ratio, the external finance premium and credit velocity. The interval defined by the values of $Var(\log \omega)$ in our EA and US models contains in its interior, the value of 0.28 used by BGG and the value of 0.4 estimated by Levin, Natalucci and Zakrajsek (2004) on US data.

Several additional features of the parameter values in Table 1 are worth emphasizing. During the calibration, we imposed $\psi_k = \psi_l$, i.e., that the fraction of capital rental and labor costs that must be financed in advance are equal. Note, however, that these fractions are much higher in the EA than in the US. This result reflects our finding (see below) that velocity measures in the EA are smaller than their counterparts in the US.

Consider the tax rates in Panel E of Table 1. We obtained the labor tax rate for the EA by first finding the labor tax rate data for each of the 12 EA countries from the OECD in 2002.[5] We then computed a weighted average of the tax rates, based on each country's share in GDP. The result, 45 percent, is reported in Table 1. The tax rate on capital is taken from Eurostat and refers to the EA implicit tax rate on capital over the period 1995-2001.

We now turn to the US tax rates. We compute effective tax rates by extending the data compiled by Mendoza, Razin and Tesar (1994) to 2001. The differences in tax rates between the EA and the US are notable. The relatively high tax on consumption in the EA reflects the value-added tax in the EA. The relatively high tax on capital income in the US has been noted elsewhere. For example, Mendoza et al. find that in 1988 the tax rate on capital income was 40 percent in the US, 24 percent in Germany, 25 percent in France and 27 percent in Italy. The value for the US tax rate on capital income that we use is similar to Mulligan (2002)'s estimate, who finds that the US capital income tax rate was about 35 percent over the period 1987-1997. McGrattan and Prescott (2004) also report a value for the US capital tax rate similar to ours. According to them, the corporate income tax rate was 35 percent over the period 1990-2001.[6] Regarding the labor tax rate, our estimates imply a lower value for the US than the EA. This pattern is consistent with the findings of Prescott (2003), whose estimates of the labor tax rate in Germany, France and Italy are

[5]See 'Taxing Wages', OECD Statistics, Organisation for Economic Co-operation and Development, 2004.

[6]McGrattan and Prescott (2004) report that the tax rate on capital has been coming down. For the period, 1960-1969 they report an average value of 45%.

higher than for the US.

Consistent with the analysis of Prescott (2002), our model parameters imply that the wedge formed from the ratio of the marginal product of labor to the marginal household cost of labor is greater in the EA than in the US. This wedge is, approximately,

$$\frac{1+\tau_c}{1-\tau_w}\lambda_w\lambda_f.$$

Our model parameters imply that this wedge is 2.75 in the EA and 1.74 in the US.

Steady state properties of the EA and US versions of our model are provided in Tables 2 and 3. Details of our data sources are provided in the footnotes to the tables. Consider Table 2 first. The model understates somewhat the capital output ratio in both regions. This reflects a combination of the capital tax rate, as well as the financial frictions. Following BGG, we take the empirical analog of $N/(K-N)$ to be the equity to debt ratio of firms. Our EA model implies this ratio is around unity, which coincides with the estimate reported by . Our US model implies a much higher value for this ratio. This is consistent with the analysis of McGrattan and Prescott (2004), who find that the equity to debt ratio in the US averaged 4.7 over the period 1960-1995 and then rose sharply thereafter. The difference in the equity to debt ratios of our two models is consistent with the finding that banking finance in the EA is substantially larger than what it is in the US (see, for example, De Fiore and Uhlig, 2005). Finally, note that around one percent of labor and capital resources are in the banking sector in our EA and US models. The table reports that the empirical counterpart of this number is 5.9 percent. Although this suggests the model greatly understates amount of resources going into banking, this is probably not true. Our empirical estimate is the average share of employment in the finance, insurance and real estate sectors. These sectors are presumably substantially greater than the banking sector in our model.

Now consider the results in Table 3. The numbers in the left panel of that table pertain to monetary velocity measures. Note how the various velocity measures tend to be lower in the EA than in the US. The steady state of the model is reasonably consistent with these properties of the data. Note that we omit a measure of the velocity of credit for the EA. This is because the available data on credit for the EA are incomplete. We have bank loans to nonfinancial corporations, which have an average GDP velocity of 2.60 over the period 1998Q4-2003Q4. We suppose that this greatly overstates the correctly measured velocity of credit, because our EA measure of credit does not include corporate bonds. Note that according to the model, the velocity of credit in the EA is substantially smaller than it is in the US. This is consistent with the finding in Table 2, which indicates that the equity to debt ratio in the EA is much smaller than the corresponding value in the US.

The right panel of Table 3 reports various rates of return. The model's steady state matches the data reasonably well, in the cases where we have the data. In the case of the EA, the rate on demand deposits, R^a, corresponds to the overnight rate (the rate paid on demand deposits in the EA) and the rate of return on capital, R^k, is taken from estimates of the European Commission. As regards the US, the rate of return on capital is taken from Mulligan (2002), who shows that the real return was about 8 percent over the period 1987-1999.

We identify the external finance premium with the spread between the 'cost of external finance', Z and the return on household time deposits, R^e. Given that there is substantial uncertainty about the correct measure of the premium, we report a range based on findings in the literature and our own calculations. In the case of the US, Table 3 suggests a spread in the range of 200-298 basis points. This encompasses the values suggested by BGG, Levin, Natalucci and Zakrajsek (2004) and De Fiore and Uhlig (2005).[7] In the case of the EA the table suggests a range of 67-267 basis points. Although the results for the US and the EA might not be perfectly comparable, the evidence reported in the table suggests that the spread is probably higher in the US than in the EA. This is consistent with the findings of Carey and Nini (2004) and Cecchetti (1999), who report that the spread is higher in the US than in the EA by about 30-60 basis points. In order to match this evidence, we have chosen a calibration of the model that delivers a spread in the US that is 40 basis points higher than in the EA.

[7] Bernanke, Gertler and Gilchrist (1999) measure the external finance premium as approximately the historical average spread between the prime lending rate and the six-month Treasury bill rate, which amounts to 200 basis points. Levin, Natalucci and Zakrajsek (2004) report a spread of 227 basis points for the median firm included in their sample. De Fiore and Uhlig (2005) report that the spread between the prime rate on bank loans to business and the commercial paper is 298 basis points over the period 1997-2003. Carlstrom and Fuerst (1997) report a somewhat lower spread of 187 basis points.

3.2 Parameters Governing Dynamics

In the case of the US, we use the following 15 variables to estimate the model parameters that do no influence steady state:

$$X_t = \begin{pmatrix} \Delta \log \left(\frac{N_{t+1}}{P_t} \right) \\ \pi_t \\ \log \left(\text{per capita hours}_t \right) \\ \Delta \log \left(\text{per capita GDP}_t \right) \\ \Delta \log \left(\frac{W_t}{P_t} \right) \\ \Delta \log \left(\text{per capita } I_t \right) \\ \Delta \log \left(\frac{\text{per capita } M1_t}{P_t} \right) \\ \Delta \log \left(\frac{\text{per capita } M3_t}{P_t} \right) \\ \Delta \log \left(\text{per capita consumption}_t \right) \\ \text{External Finance Premium}_t \\ R_t^{long} - R_t^e \\ R_t^e \\ \Delta \log P_{I,t} \\ \Delta \log \text{real oil price}_t \\ \Delta \log \left(\frac{\text{per capita bank reserves}_t}{P_t} \right) \end{pmatrix}. \tag{24}$$

In the case of the EA, we use these variables, minus bank reserves. We have not been able to compile an EA-wide data series on bank reserves. The variables we use include the ones used in Primiceri, Schaumburg and Tambalotti (2006) (PST), LOWW and SW. Of course, the structure of our model allows us to include a variety of financial variables that are absent from PST, LOWW and SW, including the stock market, the external finance premium, and three monetary aggregates. Our data sample begins in 1981Q1. We use the first 16 quarters as a 'training sample', so that the likelihood is evaluated using data drawn from the period 1985Q1-2006Q4. Details of how we compute the likelihood are provided in Appendix C.

We adopt the following functional form for the costs of capital utilization:

$$a(u) = 0.5b\sigma_a u^2 + b(1 - \sigma_a)u + b((\sigma_a/2) - 1).$$

Here, b is selected to ensure $u = 1$ in steady state and $\sigma_a \geq 0$ is a parameter that controls the degree of convexity of costs. We adopt the following specification of investment adjustment costs:

$$S(x) = \exp\left[A\left(x - \frac{I}{I_{-1}}\right)\right] + \exp\left[-A\left(x - \frac{I}{I_{-1}}\right)\right] - 2,$$

where

$$A = \left(\frac{1}{2}S''\right)^2.$$

Here, I/I_{-1} denotes the steady state growth rate of investment and S'' is a parameter whose value is the second derivative of S with respect to x, in steady state. Note that S and its first derivative are both zero in steady state.

Prior and posterior distributions of the parameters that do not control steady state are displayed in Table 4.[8] We allow for the presence of iid measurement error on each of the variables used in our analysis (see R in (**??**) in the appendix). The priors on the measurement errors have a Weibull distribution with standard deviation equal to 10 percent of the standard deviation of the underlying variable, based on the past 10 years' observations. The Weibull distribution has a second parameter, whose value is indicated Table 5.

The total number of parameters that controls the dynamics of the model which we estimated is 55 and 53 for the US and EA versions of the model, respectively. There are three fewer parameters in the EA version of the model because we drop the shock to the demand for bank reserves, ξ_t, and the measurement error on bank reserves.[9]

Of the parameters that we estimate, 7 relate to the price and wage setting behavior of firms and households and to elasticities regulating the cost of adjusting portfolios and investment flows:

$$\overbrace{\xi_p,\ \xi_w}^{\text{Calvo wage and price setting}}, \quad \overbrace{S''}^{\text{investment adjustment costs}}, \quad \overbrace{\iota,\ \iota_w}^{\text{weight on steady state inflation, in price and wage-updating equations}},$$
$$\overbrace{\vartheta}^{\text{weight on realized permanent technology shock in wage equation}}, \quad \overbrace{\sigma_a}^{\text{capital utilization parameter}}.$$

Four parameters pertain to the monetary policy rule, (22):

$$\overbrace{\rho_i}^{\text{monetary policy persistence}}, \quad \overbrace{\alpha_\pi}^{\text{reaction to inflation}}, \quad \overbrace{\alpha_y}^{\text{response to output change}}, \quad \overbrace{\alpha_{d\pi}}^{\text{response to inflation change}}.$$

The priors and posteriors of the above parameters are displayed in Figure 1. In the US version of the model, there are 15 parameters that control the variance of the observation

[8]Posterior probability intervals are computed using the Laplace approximation (for completeness, the Laplace approximation is discussed in the appendix.) Smets and Wouters (2007) report that results based on the Laplace approximation are very similar to those based on the MCMC algorithm. We plan to incorporate the results based on the MCMC algorithm in a later draft.

[9]The 55 free parameters that control the dynamics of the US model break down as follows: there are 15 measurement error parameters (one for each variable), 29 shock parameters (2 for 15 of the shocks and 1 for the monetary policy shock) and 11 parameters that control the monetary policy rule and two adjustment cost functions.

errors. In addition, there are 29 parameters that control the time series representations of the shocks: 2 parameters for each of 14 shocks and one for the monetary policy shock.

In the case of the Calvo parameters, ξ_p, ξ_w, our priors imply that prices and wages are reoptimized on average once a year in the Euro Area, and every 1.6 quarters in the US. Our priors are fairly tight, reflecting the extensive empirical analysis of the behavior of prices in recent years. With one exception, the posteriors on ξ_p, ξ_w are shifted substantially to the right, relative to our priors. The exception is that for the EA, the priors and posteriors on ξ_w are close. The posterior modes imply that prices and wages in the EA are reoptimized every 4 and 3 quarters, respectively. In the case of the US, our posteriors imply that prices and wages are reoptimized every 2 and 4.8 quarters, respectively. For the US the results are roughly in line with those reported by Smets and Wouters (2007).[10] An important difference is that they are able to estimate a reasonable degree of wage and price rigidity only by replacing the Dixit-Stiglitz aggregator with the specification suggested by Kimball (1995) which allows for a time-varying demand elasticity. Interestingly, our estimate of the degree of price stickiness for the US is considerably less than those reported by LOWW and PST, who find that price contracts have a duration of about 5 quarters.

Our findings for prices are in accord with recent microeconomic studies which suggest prices are more flexible in the US than in the EA. Moreover, the implication of our model for the frequency with which prices are reoptimized in the US are reasonably close to the empirical findings of Bils and Klenow (2004), Golosov and Lucas (2007) and Klenow and Kryvtsov (2004). These authors conclude that firms re-optimize prices a little more frequently than once every 2 quarters.[11] Prices in our US model are only a little less flexible than these studies suggest.

As in LOWW, our results indicate that there is a high degree of indexation of wages to the persistent technology shock. These findings differ from PST. They impose the restriction that the degree of wage indexation to inflation and the permanent technology shock are the same. Although our results support this restriction, we find that the degree of indexation is large while PST find that the degree of wage indexation is small. Smets and Wouters (2007) also report a high degree of wage indexation, though somewhat smaller than ours. Our results for the degree of indexation of prices to inflation differ sharply between the US

[10] Smets and Wouters (2004)'s estimates also report that wages in the US are more sticky than they are for the EA. The 90 percent probability intervals around the posterior modes for ξ_w in the EA and US do not overlap. However, this result is based on on their full sample estimates, which corresponds to the period, 1974-2002. When Smets and Wouters (2004) work with a shorter sample, 1993-2002, then the modes of their posterior distributions imply that wages in the EA are more sticky than they are in the US.

[11] For example, in calibrating their model to the micro data, Golosov and Lucas (2003, Table 1, page 20) select parameters to ensure that firms re-optimize prices on average once every 1.5 quarters.

and EA. For the US we find a relatively high degree of indexation, while for the EA it is low. Our US results on this dimension differ from those reported in PST, LOWW and SW, we find that there is relatively little indexation of prices to inflation.

Regarding investment adjustment costs, our priors on S'' are in line with CEE. However, the posterior distribution is shifted sharply to the right, and is much larger than the posterior modes reported in PST and SW.

Our estimates imply a high cost of varying capital utilization. This is consistent with the findings in Altig, Christiano, Eichenbaum and Linde (2004) (ACEL), who report a similar result for US data only, using a very different estimation strategy. LOWW report that there is very little information in the data about the costs of varying capital utilization. This contrasts with our results, since our posterior distribution easily rules out values of σ_a that are small enough to imply substantial variation in capacity utilization.

We now turn to the parameters of the monetary policy rule, (22). Our estimates suggest that the EA and US policy rules exhibit a high degree of inertia (the parameter, ρ_i), and a relatively strong long-run response to anticipated inflation (α_π). In addition, the estimated reaction function exhibits modest sensitivity to the growth rate of output (α_y) and to the recent change in inflation ($\alpha_{d\pi}$). The response to inflation appears to be stronger than what Taylor (1993) recommends, although the form of the interest rate rule used here differs somewhat from the one he proposes.[12] The estimated policy rules in PST, LOWW and SW are consistent with our results in that they also imply strong response of monetary policy to inflation and a high degree of intertia. Finally, the standard deviation of the monetary policy shock in the Taylor rule is 46 and 48 basis points, respectively, in the EA and US models.

In terms of the other standard deviations, it is worth noting that $\sigma_t^\aleph$ is estimated to have a positive variance. The 90% probability interval about the mode of the posterior distribution for the EA is fairly tight, 0.011-0.019, and well above zero. The 90 % probability interval for the US is somewhat larger, having the same lower bound and having upper bound 0.017-0.044. This finding is consistent with the evidence reported in the literature that term structure data do not conform well to a simple expectations hypothesis (see, for example, Rudebusch and Swanson, 2007). Other variance estimates that are of interest are those that control variables which must lie inside a particular interval or which have a particular lower bound. These include ξ_t, χ_t, γ_t and $\lambda_{f,t}$. Of these, all the shocks on γ_t are of reasonable magnitude. In the case of γ_t, its steady state value of 0.98, according to Table 1. According to Table 4, the standard deviation of the innovation to $\log \gamma_t$ has mode 0.017 in the EA and 0.0063 in the US. The EA results imply that a two-standard deviation positive shock to $\log \gamma_t$ drives it above unity. In fact this understates the likelihood of exceeding unity because

[12] According to the 'Taylor rule', the nominal rate of interest responds to the current realized rate of inflation and the current realized level of output. The coefficient on realized inflation is 1.5 and the coefficient on realized output is 0.5.

$\log \gamma_t$ is also estimated to be highly serially correlated.

We estimated two special versions of our model. The 'simple model' is the version of our model without the banking system, without the financial frictions and without money (i.e., υ set to zero in (15)). This corresponds closely to the model in CEE or SW. The 'Financial accelerator model' introduces the BGG financial frictions into the simple model. Alternatively, it is the version of our model without a banking system and without money. The posterior modes of the parameters of these two models are reported in Tables B.1 and B.2, Appendix B.

3.3 Estimated Shocks

We briefly examine a subset of the shocks emerging from model estimation. Figures 2a and 2b display the (demeaned) EA and US data used in the analysis, together with the associated two-sided smoothed estimates from the model, computed at the mode of the posterior distribution of the parameters. The vertical distances between the actual and smoothed data is our estimate of the measurement error in the data. These distances are extremely small because of the small magnitude of the measurement error standard deviations that we assume (see Table 5). The smoothed estimate of the data, in Figures 2a and 2b can equivalently be thought of as being the simulation of the model in response to the estimated (by two-sided Kalman smoothing) economic shocks. The similarity between raw data and model predicted data shows that we have a nearly exact decomposition of the historical data into economic shocks.

These shocks are graphed in Figures 3a and 3b. Consider the shock, $\zeta_{c,t}$. Because we model $\zeta_{c,t}$ as a first order autoregression, when that variable is perturbed it creates an expectation of returning to the mean. As a result, when $\zeta_{c,t}$ is below its mean of unity this creates an effect similar to a rise in the discount rate, and so it stimulates saving. It is interesting that in the EA, this variable has trended down since 1990 (see Figure 3a), helping to account for the trend increase in EA desired saving in the past decade. In results not shown, we found that a key shock driving the three-month interest rate down between the mid-1980s and the early 2000s is the continuous fall in $\zeta_{c,t}$. The shock, $\zeta_{c,t}$ displays a similar downtrend in the US too, and helps account for the fall in the US short term rate.

Note that in the EA the banking technology shock, x_t^b, exhibits a significant upward trend. In results not shown here, we found that this shock was important for explaining the trend up in the growth rate of $M1$ in the EA. There is a strong rise in x_t^b in the US after 2000, and we are still investigating the reason for this.

Note that the banking reserve demand parameter, ξ, displays sharp spikes in the US in 1984 and in late 2001 (the latter corresponds to a huge jump in reserves on September 11). These spikes represent our model's explanation of the spikes in the non-borrowed reserves data in Figure 2b.

We isolate several shocks for special attention in the next section, $\sigma_{\aleph,t}$, γ_t and $\zeta_{i,t}$.So, although these display interesting movements in Figures 2a and 2b, we do not discuss them further here.

3.4 RMSE Tests of Model Fit

Identification of dimensions on which a model does not fit well is a crucial task of empirical analysis. In this section, we evaluate our model's fit by comparing its out of sample forecasting performance with that of other models. In practice, out of sample root mean square forecast errors (RMSE) represent an important criterion for model fit. Recently, Del Negro, Schorfheide, Smets and Wouters (2007) implement more sophisticated measures of model fit. They show that these measures work very much like RMSE tests, and so we restrict ourselves to the latter here.

An advantage of the RMSE calculations that we report is that we can use standard sampling theory to infer the statistical significance of differences in RMSE results for different models.[13] We do this in two ways. We apply the procedure suggested in Christiano (1989) for evaluating the difference between two RMSEs. In addition, we apply a regression-based procedure that selects optimal combinations of forecasts from different models. For the most part, the two procedures provide similar results, and so we display results for the RMSE procedure in the text. Results based on the regression-based procedure are presented in Appendix E.

RMSE results for all the variables in our analysis are reported in Figures 4a and 4b for the EA and US, respectively. Our first forecast is computed in 2001Q3, when we compute 1, 2, ..., 12 quarter ahead forecasts. We compute forecasts using our baseline model (labelled CMR in the figures), reestimating its parameters every other quarter. We also compute RMSE's using our simple model (i.e., our version of CEE and SW) and our financial accelerator model (i.e., CEE with BGG financial frictions). In addition, we use a Bayesian Vector Autoregression (BVAR) re-estimated each quarter with standard Minnesota priors.

The grey area in Figures 4a and 4b represent classical 95 percent confidence intervals. To understand these, let $RMSE^{BVAR}$ and $RMSE^{CMR}$ denote the RMSEs from the BVAR and our models, respectively, for some forecast horizon. Appendix E shows that, in a large sample,

$$RMSE^{BVAR} - RMSE^{CMR} \sim N(0, \frac{V}{T}),$$

where T is the number of observations used in computing the RMSE. An asymptotically valid estimator of V, denoted $\hat{V}$, is derived in Appendix E. The grey area in Figures 4a and

[13] For further discussion, see Christiano (2007).

4b represent:

$$RMSE^{BVAR} \pm 1.96\sqrt{\frac{\hat{V}}{T}}.$$

So, if $RMSE^{CMR}$ lies outside the grey area, then the null hypothesis that the two models produce the same RMSE is rejected at the 5 % level, in favor of the alternative that one or the other model produces a lower RMSE.

Consider the top left panel of Figures 4a and 4b, which pertains to the real value of the stock market. Note that the random walk model is dominated in each case by all our other models. Our baseline model significantly dominates the BVAR, and there is virtually no difference between the RMSE's of our baseline model and of our simple accelerator model.

Now consider the other panels for the EA, in Figure 4a. In the case of inflation, all the models dominate the BVAR, and there is little difference among the structural models. In the case of hours worked, the simple financial accelerator model does worse than the other models, and our baseline model does worse at the shortest horizons. However, at horizons over 2 years, the baseline model does about as well as the BVAR, the random walk model and the simple model. In the case of GDP forecasts, all the models perform roughly the same. In the case of the real wage, the BVAR is worse than the other models which exhibit roughly the same performance. On the risk premium and the spread between the long and short term rates, there is little significant difference among the models. Interestingly, our baseline model outperforms the simple model on the short term rate, while our baseline model and the other models are all roughly the same. Finally, our model's RMSE performance is comparable or better than the others on the price of investment goods and oil prices, though there is some deterioration at the longer horizon on the price of investment goods.

In a later draft we will report an overall statistic characterizing model RMSE performance. However, although our model turns in a noticeably poor RMSE performance on the monetary aggregates, we expect that our overall statistic of fit will look reasonably good.

Now consider the results for the US. For most of the variables, our model's forecasting performance is as good as the other models' or better. However, there are more exceptions to this pattern than in the case of the EA. For example, our model does significantly worse than the BVAR in forecasting inflation, a property it shares with the financial accelerator model. The same is true for the risk premium and the spread between long and short term rates. We are still studying these shortcomings of our model, in order to understand what they telling us about how we should modify the model.

SW also report out of sample RMSE's. Although their results are based on a different US sample (1990Q1-2004Q4), we can with caution compare their results with those for our simple model. In terms of inflation and the short term interest rate, SW show that their model is dominated by the BVAR at horizons up to 2 years, while their model does better at longer horizons. This is consistent with our findings for the simple model. In addition, consistent with our simple model results, SW report that their model dominates a BVAR in forecasting GDP, hours worked, consumption, investment and the real wage at all horizons.

All things considered our model does reasonably well in terms of RMSEs.

4 Properties of the Estimated Models

This section describes the dynamic properties of our EA model. We first discuss a selection of impulse response functions. This discussion shows the dynamic effects of a selection of shocks on the variables of our model. We show how the propagation of the shocks is influenced by the banking sector, the BGG financial frictions, and the nominal rigidity in entrepreneurial lending contracts. We then turn to variance decompositions.

4.1 Impulse Response Functions

4.1.1 Monetary Policy Shock

Figure 5 displays the dynamic response of the model variables to a monetary policy shock, ε_t, in (22). In addition to displaying the responses implied by our benchmark model, we also display the responses implied by our estimated simple and financial accelerator models, and by a version of the benchmark model referred to as 'benchmark, no Fisher effect' in the figure. To understand the latter, recall the nominal rigidity in the debt contracts in the benchmark model. In particular, the nominal payments owed by banks in period $t+1$ because of loans they make to entrepreneurs in period t are not contingent on the realization of period $t+1$ shocks. Because the payments made by banks are financed by receipts obtained from entrepreneurs, the nominal rigidity in debt contracts gives rise to a Fisher debt-deflation effect in the benchmark model. A surprise rise in the price level increases the real value of the transfer made from entrepreneurs to households. Other other things the same, this cuts into entrepreneurs' net worth and inhibits their ability to borrow for the purpose of buying capital. This acts as a drag on economic activity because the capital entrepreneurs buy is supplied by capital producers who, when they experience a drop in demand, cut back on purcases of investment goods. We evaluate the importance of this Fisher debt-deflation channel by considering an alternative specification in which the total amount that entrepreneurs transfer is fixed in real terms (see the discussion before (8).) This version of the benchmark model is indicated by the 'benchmark, no Fisher effect' label in the diagrams. Unlike the other two versions of the model, which are estimated, the parameters of the benchmark, no Fisher effect model take on the same values as they do in the benchmark model. The size of the monetary policy shock is the same in each model.

In the benchmark model, the monetary policy shock drives up the short term interest rate by 40 basis points, and the interest rate returns monotonically to its mean afterward. The internal propagation of the model is strong in that the effects on output, employment and other variables continue well after the roughly 2 years it takes for the effects on the interest rate to die out. Output, investment, consumption and hours worked display an inverted 'U' shape. The maximal response of investment is roughly three times as big, in percent terms, as the response of output, and peaks two years after the shock. The fall in investment drives down the price of capital (not shown), and the implied capital losses contribute to a fall in entrepreneurial net worth. The drop in net worth is roughly twice as big as the drop in the price of capital, presumably because net worth is also reduced by the fall in income earned by entrepreneurs. These effects contribute to a rise in the external finance premium paid by entrepreneurs and reinforce the drop in investment.

The role of the banks and BGG financial frictions in the propagation of the monetary policy shock is substantial. The peak drop in output is 2.5 times greater in the benchmark model than it is in the simple model. The persistence of the output response is also substantially greater with the added features of our benchmark model. In the simple model, the impact on output is nearly over after 12 quarters, while it takes over 60 quarters for this to happen in the benchmark model. In terms of the response of inflation, consumption and hours worked, a little over half the difference between the simple and benchmark models reflects the BGG financial frictions. In the case of investment, the price of capital and net worth, the BGG financial frictions have a far greater impact than the banking sector. The peak drop in investment in the simple model is about 0.1 percent in the simple model and it is about 0.6 percent in the benchmark model. Without banks, but with BGG financial frictions, the peak drop is a little over 0.4 percent. Similarly, the BGG financial frictions are the primary reason that the response of investment is so long-lasting in the benchmark model. The presence of BGG financial frictions adds substantially to the drop in the real wage after a monetary policy shock. Presumably this reflects the substantial acceleration effects, which reduce the demand for investment and lead to a fall in the demand for labor.

Now consider the role of the Fisher debt-deflation channel. The monetary policy shock generates a fall in the price level, which results in a transfer of resources from entrepreneurs to households. The consequence is that the debt-deflation channel reinforces the fall in output that occurs in the wake of a contractionary monetary policy shock. This effect is quantitatively large, with the benchmark responses in output, investment, consumption and employment all lying well below what they are in the version of the model without the debt-deflation channel. We conclude that the Fisher debt-deflation channel is a substantial part of the mechanism whereby financial frictions alter the propagation of monetary policy shocks in our model.

4.1.2 Financial Friction Shock

The empirical analysis reported below attributes a substantial role to γ_t, the survival probability of entrepreneurs, in the dynamics of the data. Figure 6 reports the response of the model variables to an innovation in this shock. To understand the effect of the shock in the benchmark model, recall that the number of entrepreneurs who exit is always balanced in the model by the number that enter. The effect of exit and entry is to reduce the wealth in the hands of entrepreneurs as a group because those who exit typically have more net worth than those who enter. When a shock drives γ_t up, this process is slowed down and the class of entrepreneurs is left with more wealth under its control. With the additional wealth, the entrepreneurs purchase more capital, which drives up its price and adds even more to entrepreneurial net worth. We interpret γ_t as the model's way of capturing the fact that asset values sometimes move for reasons that are not obviously linked to movements in fundamentals. According to Figure 6, the shock leads to a surge in output, investment and hours worked. After a delay, consumption rises too. The shock leads to a fall in bankruptcies, a rise in the value of assets and a rise in the net worth of entrepreneurs. As in the case of the money shock, the rise in net worth is greater, in percent terms, than the rise in the price of capital (not shown). Again, this is because the jump in γ_t triggers an economic expansion, which raises the rental income of entrepreneurs and further raises entrepreneurial net worth. Note that the banking system does not contribute much to the propagation of γ_t. The responses with and without the banking sector are virtually the same.

It is interesting that, overall, consumption and investment are procyclical with respect to a γ shock.[14] A γ shock can be interpreted as a disturbance to the intertemporal Euler equation. In models with fewer frictions than ours, such a shock drives consumption and investment in opposite directions, and so has only a small impact on output. The fact consumption and investment might comove in response to a shock like γ is discussed extensively by PST (see also Christiano and Davis (2007).)

Note that the Fisher debt-deflation channel plays essentially no role in the propagation of the γ shock.

4.1.3 Marginal Efficiency of Investment

Figure 7 displays the response of model variables to a shock in the marginal efficiency of investment, ζ_{it}. A rise in this variable makes investment more expensive. It leads to a fall in

[14]Note that the initial response of consumption to a positive γ shock is negative. This is not a generic implication of our model. If wage indexation to inflation is slightly less and if wages are slightly stickier, then consumption never falls below zero. For example, in the simulation reported in Figure 6, $\xi_w = 0.67$ and the degree of indexation of wages to lagged inflation is $1 - \iota_w = 0.62$ (see Table 4). If instead $1 - \iota_w = 0.33$ and $\xi_w = 0.74$, then consumption never falls below zero in the first few quarters after a γ shock.

output, employment and investment, as well as consumption. The greater cost of producing capital generates a rise in the price of capital and, because of capital gains, a rise in the net worth of entrepreneurs. Because these have the effect of stimulating output in the model, the BGG financial frictions tend to moderate the response of investment, consumption and employment to the ζ_{it} shock. This is evident in Figure 7, which shows that the fall in these variables is smaller in the benchmark model than in the simple model. In some ways the marginal efficiency of investment shock resembles the financial wealth shock. However, realizations of these shocks that drive up output and employment have an opposite impact on net worth and the price of capital.

For intuition about the different effects of γ_t and ζ_{it}, consider Figure 8. That figure presents a stylized representation of the supply and demand for capital in the model. Demand is affected by the shocks that hit entrepreneurs because they are the buyers of capital. The shocks that affect entrepreneurs include the shock to their riskiness, σ_t, which affects entrepreneurs' ability to obtain loans. In addition, entrepreneurs are affected by the shock to γ_t, and the shock to the price of oil, τ_t^{oil}. The supply of capital is affected by the shocks that hit the producers of capital. These include ζ_{it} and the price of investment goods, $\mu_{\Upsilon,t}$. A shock which raises γ_t shifts the demand for capital right and raises the price of capital. This shock is expansionary on consumption, output and employment as explained above. A shock which reduces ζ_{it} shifts the supply of capital right, and entrepreneurs are led to buy more capital as its price falls. This shock is also expansionary on consumption output and employment.

Consider now the role of the Fisher debt-deflation channel with the ζ_{it} shock. According to the result in Figure 7, the fall in output is moderated when the Fisher debt-deflation channel is removed. This is because the shock produces a fall in the price level, which results in a decrease in the real value of the resources transfered from entrepreneurs to households. In this way, the Fisher debt-deflation channel amplifies the fall in output in response to a ζ_{it} shock.

4.1.4 Technology Shock in the Banking Sector

Figure 9 displays the dynamic response of the benchmark model to a technology shock in the banking sector, x_t^b. The shock has effects much like those of a technology shock. Output, investment, consumption are increased and inflation drops. Note that the Fisher debt-deflation channel operates in the way expected. The fall in the price level produced by the shock raises the real value of the transfer from entrepreneurs to households, so that the response of output and investment is smaller in the benchmark model than it is in the version of the benchmark without the Fisher debt-deflation effect. The response of net worth is far greater when the Fisher debt-deflation channel is removed.

4.1.5 Temporary, Neutral Technology Shock

Figure 10 displays the response of the economy to the temporary, neutral technology shock, ϵ_t, in (2). Interestingly, the benchmark model produces roughly the same response in output as the simple model. However, the reason is that the financial frictions moderate the rise in output, while the banking sector accelerates it, and the two effects roughly cancel on output. Note that the response of investment in the benchmark model is substantially smaller than it is in the simple model. This appears to be because the banking sector has a relatively small impact the response of investment to ϵ_t, while the BGG financial frictions subtantially moderate that response.

The Fisher debt-deflation channel is the reason the financial frictions in the benchmark model have such a moderating effect on the response of output and employment to ϵ_t. To see why, note that the technology shock produces a fall in the price level, and so ϵ_t triggers a transfer of resources from entrepreneurs to households. To see the effects of the Fisher debt-deflation channel, note from Figure 10 that when the channel is removed, then the response of output is substantially greater. Also, the response of investment nearly doubles and the response of net worth nearly triples. Clearly, the Fisher debt-deflation channel is very important in determining the propagation of technology shocks.

4.1.6 Shock to Preferences

Figure 11 displays the response of the economy to a shock to preferences, $\varsigma_{c,t}$ (see (15).) This shock leaves the intratemporal margin between consumption and leisure unaffected, and raises the preference for current over future utility. Not surprisingly, consumption rises and investment falls. The increased demand for output, in conjunction with the sticky wage mechanism, results in a rise in output and employment. Inflation rises as the rise in output drives up marginal cost.

The response of output, consumption and investment in the benchmark and financial accelerator models to $\varsigma_{c,t}$ are virtually indistinguishable. So, the banking sector plays very little role in propagating this shock. The Fisher debt-deflation channel works as expected. The rise in inflation results in a transfer of wealth to entrepreneurs in the benchmark model and this is why investment and output are both higher in the benchmark model than they are in the version of that model without the nominal rigidity in lending contracts.

4.1.7 Shock to Markup

Figure 12 displays the response of the economy to a shock in the firm markup, $\lambda_{f,t}$. The shock in effect makes the economy less competitive and so output, consumption and investment fall, while inflation rises. The Fisher debt-deflation channel has a substantial impact with this shock. with the rise in inflation, the shock transfers income from households to entrepreneurs and so it stimulates output and investment. The magnitude of this effect may be seen in noting how much higher (less negative) the benchmark responses are than the ones generated by the version of the model with no debt-deflation channel. Because the shock drives output and the price level in opposite directions, the debt-deflation channel has the effect of reducing the size of the response to a shock.

4.2 Variance Decompositions

Figure 13 displays the variance decompositions of the variables, in frequency domain, for our baseline EA model and for each variable used in the estimation. On the horizontal axis is displayed frequency, $\omega \in (0, \pi)$. The vertical bars bracket the business cycle frequencies (3-8 years). Note that in the case of real net worth growth, essentially all of the variance at all frequencies is due to the financial wealth shock, γ_t. The financial shock also accounts for much of the variance of the short term interest rate, the risk premium and output, investment, and real wage growth in the frequencies below the business cycle frequencies. In addition, it accounts for a substantial portion of consumption growth in the low frequencies. With the exception of its effect on net worth, the importance of γ_t tapers off as we consider higher frequencies. However, γ_t is an important shock for output and investment growth and the risk premium in the business cycle frequencies.

The marginal efficiency of investment shock, ζ_{it}, is important for output and investment growth, inflation, and hours worked. It is relatively unimportant for the other variables, including consumption. This importance extends over all frequencies though it tapers off in the very lowest frequencies. It is interesting that $\zeta_{c,t}$ is not important for output and employment (though, not surprisingly, it is important for consumption). This contrasts with the results reported in PST, who find that $\zeta_{c,t}$ is very important for output and employment. Relative to the analysis in PST, the variable, γ_t, appears to have taken over the role of $\zeta_{c,t}$ as an intertemporal disturbance. In this sense, the financial frictions and γ_t may provide an interpretation of the PST finding that in their model $\zeta_{c,t}$ is important for output and employment.

Another shock that deserves emphasis is $\lambda_{f,t}$. This shock is important in the business cycle frequencies for inflation, hours, output growth, real wage growth, and consumption growth. The entrepreneurial riskiness shock, σ_t, is with two exceptions, unimportant. It explains a little of the variance of hours, and accounts for the lion's share of the variance in the risk premium. Note how the variance of investment price and oil price growth is explained at all frequencies by their respective shocks. This is because these shocks are recursive relative to the rest of the model.

Finally, recall that we included the term premium shock, $\sigma_t^{\aleph}$, in the household's budget constraint, (17), as an indicator of the performance of the expectations hypothesis in accounting for the term structure of interest rates. Figure 13 indicates that a large fraction of the variance of the spread between the long term interest rate and the short term interest rate is accounted for by fluctuations in $\sigma_t^{\aleph}$. This evidence, together with the evidence in Table 4 and in the literature (e.g., Rudebusch and Swanson, 2007) indicates that substantial deviations from expectations hypothesis of the term structure are required to understand the term structure of interest rates. Note that $\sigma_t^{\aleph}$ has no impact on any variables in the model, apart from the term structure. This reflects that $\sigma_t^{\aleph}$ only affects the long term interest rate, and not any other variable in the system.

5 Shocks and Stories

In effect, our estimated models and shocks provide 'stories' about why the data evolved as they did in our sample. We find that in many instances, the stories that the models tell about the EA and the US are consistent with analyses provided in the literature. Since these are typically not based on explicit models, in effect our analysis provides them with an analytic foundation. In addition, since the analyses in the literature are based on a much broader set of observations than we have used in the estimation of our model, consistency represents a check of sorts on the model.

The outcome of this check raises our confidence in the model. We first study the impact of six broad categories of shocks on output growth and inflation in the EA and US. We then investigate the impact of individual shocks.

Our findings are that in both the EA and the US, shocks affecting the demand and supply of capital are key to understanding the data. Among these shocks, the two most important are shocks to the wealth of entrepreneurs, γ_t, and to the marginal efficiency of investment, $\zeta_{i,t}$. The former type of shock exists because of the presence of financial frictions. This is part of the basis for our conclusion that financial frictions are important for understanding the dynamics of the EA and US economies. We also identify some differences between the EA and US economies. Monetary policy shocks appear to play an important role in the EA, but less so in the US.

We find that technology shocks affecting the production of goods play a very different role in the EA and the US. They are procyclical and relatively unimportant for output growth in the EA. In the US, these shocks are sometimes quite important, and often they are countercyclical. Our findings differ from those of Smets and Wouters (2005), who also use a DSGE model for a comparative study of the EA and the US at business cycle frequencies and fail to detect significant differences in the sources of cyclical variation across the two countries.

5.1 Six Broad Categories of Shocks

We organize our shocks into six broad categories. The 'Goods Technology' category is composed of the technology shocks affecting the production of the final output good, Y_t. The 'Capital producers and Entrepreneurs' category is composed of shocks that affect the demand and supply of capital. On the demand side, we include all the shocks that affect the entrepreneurs: the oil shock, τ_t^{oil}, the riskiness shock, σ_t, and asset valuation shock, γ_t. On the supply side, we include the shocks that affect the producers of capital: the marginal efficiency of investment shock, ζ_{it}, and the shock to the price of investment goods, $\mu_{\Upsilon,t}$. The 'Demand' category includes the shock to government consumption, as well as to the preference for current utility. The 'Banking and Money Demand' category includes the two shocks perturbing households' demand for and banks' provision of inside money. Finally, the monetary policy shock is assigned to its own category: 'Monetary policy'. The six groups of shocks are summarized as follows:

$$
\begin{array}{rl}
\text{Goods Technology:} & \lambda_{ft},\ \epsilon_t,\ \mu_{z,t}^{*} \\
\text{Capital producers and entrepreneurs:} & \mu_{\Upsilon,t},\ \zeta_{i,t}\ ,\ \tau_t^{oil},\ \gamma_t,\ \sigma_t \\
\text{Demand:} & \zeta_{c,t},\ g_t \\
\text{Banking and Money demand}\ : & \chi_t,\ x_t^b,\ \xi_t \\
\text{Monetary policy:} & \varepsilon_t.
\end{array}
$$

In this subsection, we study the role of these shocks in the dynamics of output and inflation. We consider output growth first. Figures 14a and 14b decompose GDP growth in the EA and the US into shocks associated with our six categories. Figures 15a and 15b report the corresponding results for inflation. In each case, the dark line indicates the actual data, and the bars associated with each observation indicate the contribution of shocks in our six groups. In each period, the sum of the length of the bars (with the length of bars below the mean line being negative) equals the actual data in the dark line. We first consider output growth. After that we consider inflation.

5.1.1 Output Growth in the EA

Consider the results for the EA first. There are five observations that deserve emphasis. First, banking and money demand shocks play very little role in the overall dynamics of output growth. An exception is late 1993 and early 1994, when these shocks exerted some drag on output growth.

Second, capital producers and entrepreneurs are an important source of shocks. In the two recessions in our EA data set, they are an important source of drag on the economy. Also, in the very first part of the data set, they exert an important positive effect. We shall see later that a key shock from this sector is γ_t (the other key shock is ζ_{it}). This is one of the reasons for our finding that including financial frictions is key to understanding business cycle dynamics.

Third, monetary policy shocks, ε_t, exert a substantial impact on output growth in the EA. Moreover, in a result discussed extensively in Christiano, Motto and Rostagno (2007), monetary policy shocks exerted a strong, positive pull on EA output in the past eight quarters.

Fourth, consider the model's analysis of the causes of the recession in the early 1990s. Note how in the early 1990s, monetary policy exerted a negative influence on EA growth. This is consistent with a conventional interpretation of this episode. Under this interpretation, the initial economic weakness was caused by the high interest rates associated with the 1990 reunification of Germany. Under the conventional interpretation, the further collapse in output in 1992 was due to the breakdown of the exchange rate mechanism and the associated financial crises in several European countries. Our demand shocks, as well as the capital producer and entrepreneur shocks may be our model's reduced form way of capturing this financial instability.

Fifth, consider the boom-bust period from 1995 to 2004. Note that in the mid-1990s, monetary policy shocks were expansionary. Our model is consistent with a popular analysis of the period. According to this analysis, interest rates in many traditionally high-interest rate countries fell in 1997 as a consequence of market anticipations that they would join Monetary Union. The idea is that these interest rate reductions acted as a potent monetary stimulus to the respective economies and more broadly to the EA as a whole. This analysis of the role of expansionary monetary policy in the 1990s boom is one that is shared by our model. Towards the end of the 1990s boom, demand shocks and those shocks associated with the building and financing of capital take over as the forces driving the expansion.

Turning to the economic bust, according to the model analysis the downturn was due to sharply contractionary shocks emerging from the sector with capital producers and entrepreneurs. In addition, poor goods technology shocks and low demand contributed to the weak economic performance after 2000. As noted above, expansionary monetary policy exerted an important positive impact on the economy and was key in alleviating the downturn.

5.1.2 Output Growth in the US

Consider now the results for the US, in Figure 15b. Several results are worth emphasizing here. First, shocks originating in the banking and money demand are very small, and only slightly more important than in the EA. Second, and like in the EA, monetary policy shocks play a noticeable role in output.

Third, as in the EA, capital producers and entrepreneurs (dominated by γ_t and ζ_{it}) are an important source of shocks. They play a key role in the two recessions, as well as in the strong growth of the late 1990s. Our model's interpretation of the role of financial factors in the 1990 recession is consistent with the consensus view of Federal Reserve staff economists, as characterized in Reifschneider, Stockton and Wilcox (1997). According to these three authors, balance sheet problems in firms held back aggregate demand.[15] The main shock among the entrepreneurs and capital producers, driving the economy down in the 1990 recession is γ_t. A fall in this variable produces balance sheet problems in the model because it reduces the amount that entrepreneurs can borrow for the purpose of financing investment.

Entrepreneurs and capital producer shocks also play a substantial role in the strong growth of the late 1990s, and to some extent also in the collapse with the 2001 recession. Again, γ_t plays an important role here. The estimated rise in γ_t is the model's reduced form way of capturing the 'irrational exuberance' that was said to characterize investors' frame of mind at the time. The subsequent fall in γ_t returns this shock back to more normal values and helped to initiate the 2000 recession, according to the model (see Figure 3b). Below, we go more deeply into the way γ_t and ζ_{it} act our model economy.

Fourth, although monetary policy shocks appear to play a smaller role in the dynamics of output in the US compared to the EA, it is still interesting to consider the episodes when monetary policy exerted a noticeable impact. For example, contractionary monetary policy shocks appear to have contributed a small amount to help push down output growth in 1988-1989, during the early phases of what became the 1990 recession. This is consistent with Blinder and Reis' (2005) assertion that 1988-1989 was a time when the Fed's attempt to fine-tune the economy was counterproductive and inadvertently helped to tip the economy into recession. The results also suggest that monetary policy was contractionary in 1994, because of a combination of a reduced inflation objective and low monetary policy shocks (see Goodfriend (1998) for additional discussion). Finally, as in the EA, US monetary policy shocks appear to have been generally expansionary in response to the 2000 recession and then stayed that way until mid 2004, whereupon it became tighter. Our analysis contrasts in an interesting way with the analysis in Taylor (2007). Taylor argues that although monetary policy in the immediate wake of the recession was consistent with previous patterns given the state of the economy, the extent of time that the interest rate was kept low was a monetary policy shock. We find that the entire episode from the start of the recession to the tightening in 2004 was a deviation from previous patterns.

[15] Quoting from the paper, '...the [Board] staff gave weight to the possibility that credit constraints and balance sheet problems were holding back aggregate demand [in the 1990 recession]. The micro-level research on the role of bank credit, the anecdotal reports of credit availability difficulties, and survey evidence gathered from the banks themselves suggested that these influences could not be dismissed. Certainly, judging from public pronouncements, many Fed policymakers also were of the view that these influences were exerting a significant drag on activity.'

Fifth, goods technology shocks exhibit what at first appears to be a counterintuitive effects. During the 1990s recession they are positive and during the early phases of the 1990s expansion they are negative. They turn positive in the late phases of the 1990s expansion, but then continue positive and strong during the 2000 recession. The behavior of goods technology shocks in the 1990s is interesting, because labor productivity growth was high throughout the period, averaging 1.61 percent per year in the period 1980-1995, and then 2.96 percent per year during 1996-2005.[16] Evidently, the initial phase of the jump in productivity growth was not due to a rise in multifactor productivity, while the rise in labor productivity after 2000 was due to multifactor productivity. This implication of our model is consistent with the analysis of Kohn (2003), who argued that the high labor productivity in the 1990s reflected increased capital per worker resulting from strong investment, while the high labor productivity after 2000 reflected an increase in multifactor productivity (TFP) at the time. Quoting from Kohn (2003):

> "Productivity was boosted importantly by high investment [in the 1990s] but not more recently. From a growth accounting perspective, capital deepening–the amount of capital for each worker–has become much less important as a contributor to productivity growth since 2000, with most of the increases attributed to rising multifactor productivity. [...]. The rapid growth of output, the high profits, and the elevated share prices of the second half of the 1990s seemed to lead businesses to concentrate on expanding and on acquiring the latest technology rather than on wringing all they could out of the capital they were buying. The drop in profits, the heightened caution in financial markets, and the slower growth of demand in the past few years have reduced incentives to expand and have put considerable pressure on businesses to damp spending and cut costs."

The results for goods technology shocks are interesting in part because they are so different from what we find for the EA, where TFP appears to be consistently procyclical (see Figure 10a). It may well reflect - consistent with Kohn's conjecture - a relatively greater ability in the US economy to find ways to obtain more output from factors of production in difficult times. The pattern is consistent with one identified in Field (2003). He observed that between 1929 and 1936, a period that includes the worst years of the US Great Depression, US business investment in research and development surged. Mills (1934) makes a

[16] These productivity growth numbers are annual, percent. They correspond to output per hour of all persons in the business sector, and were obtained from the Federal Reserve Bank of St. Louis' website, FRED.

similar observation about the US Great Depression. After reporting that output per hour in industrial activity rose 11 percent in 1930 over 1929 and another 4 percent in 1931 over 1930, he concludes (p. 8): 'These figures are in accordance with our expectations. Depression brings a tightening up of efficiency and a systematic attempt to eliminate resources and waste. Industrial productivity almost invariably increases during such a period of economic strain.'

To further evaluate the model's implications for TFP, we obtained TFP growth estimates constructed by Timmer, Ypma and van Ark (2005). These data are of interest because they are obtained by a very different methodology than ours. According to Timmer, et al, TFP grew 0.80 percent per year in the period 1995-1999 and 0.60 percent in the period 2000-2004 in the European Union. In the US, TFP grew 0.89 percent in the first period and 1.60 percent in the second period. So, in terms of relative TFP growth performance during the boom-bust cycle, the Timmer, et al data are consistent with the implications of our model estimates.

Sixth, consider the recession of the early 1990s. We have already discussed the role of capital producer and entrepreneur shocks in this recession. Note that negative demand shocks also play an important role in the beginning of this recession. Interestingly, this is consistent with the analysis of Blanchard (1998), who placed demand shocks at the center of his analysis of that recession.

Seventh, consider the boom-bust period, 1995 to 2004. As noted before, the really important shocks here, according to the model, are those associated with capital producers and entrepreneurs. As noted before, the early part of the boom occurred in spite of the drag created by negative goods producing technology shocks. The beginning of the bust, in 2000, is associated with the disappearance of positive capital producer and entrepreneur shocks, and with substantial negative demand shocks. Positive forces during the bust period include (as noted before) goods producing technology shocks and monetary policy shocks.

At an informal level it is not hard to see why capital producers and entrepreneurs lie at the core of our model's explanation of the US boom-bust experience in the 1990s. Note from Figure 2b how the external finance premium in the US is low in the 1990s, and then rises sharply during the bust. Recall that the model reproduces these observations virtually exactly. In addition, the model reproduces the surge in the stock market. The factors that the model has to explain these movements help it to explain the strong investment boom and subsequent collapse.

In several ways, the dynamics of the 2000 boom and bust are quite different between the EA and the US. In the US, the capital producers and entrepreneurs play a more central role. In the EA, monetary policy play a relatively more important role over the 1990s and later.

5.1.3 Inflation in the EA and the US

Figures 15a and 15b display the impact of the various shocks in our model, on inflation. From Figure 15a we see that the group of shocks having the biggest impact on inflation in the first half of the sample in the EA is demand. The capital producers and entrepreneurs also play an noticeable role.

5.2 The Greenspan Conundrum

Note from the last panel in Figure 3b how our term structure shock, $\sigma_{\aleph,t}$, rises beginning in late 2004, in the US. This is the time of the Greenspan 'conundrum', when the Fed began to raise short rates and long rates responded by falling. In decomposition figures analogous to Figures 11 and 13, which decomposes the term premium (long rate minus short rate) into shocks. We find that the rise in $\sigma_{\aleph,t}$ is an important reason for the fall in the term premium in 2004, according to the model analysis. We interpret this finding as being consistent with the 'conundrum' view, as it says that the fall in the term premium is not due to fundamentals but instead is due to some other unspecified factor, $\sigma_{\aleph,t}$. We continue to study our model's analysis of this episode. We are exploring the possibility that the movement in long rates may at least partly have reflected the market's response to news about a future deterioration in productivity growth (our model for news shocks is displayed in Appendix H.) Consistent with this possibility is the fact that actual reductions in the neutral technology shock in late 2004 also help account for the fall in the term premium then, in results that we do not report here.

5.3 The Impact of Individual Shocks

In this section, we consider the dynamic impact on aggregate variables of individual shocks. In particular, we compare the actual evolution of key variables with what their evolution had been if only one particular shock had been active.

Consider Figure 16 first. The solid line in each of the left column of graphs displays the annual average growth rate of EA GDP, while the right column corresponds to US annual GDP growth. The dotted lines indicate what GDP growth would have been if all shocks, apart from the indicated shock, had been zero in our sample. In particular, we indicate the contribution to annual GDP growth of the financial wealth shock, the monetary policy shock (ε_t), the utility shock ($\zeta_{c,t}$), the shock to the marginal efficiency of investment, and the shock to the price of oil (τ_t^{oil}). Apart from the price of oil, these are the major shocks that affect GDP. Note the countercyclical impact of $\zeta_{i,t}$ on GDP. We discuss this further, below.

Figure 17 displays the role of the four most important shocks in the dynamics of inflation in the EA and the US.

Figure 18 displays the impact of the most important shocks in the dynamics of the value of equity in the model. Note that the most important shock in the EA and the US is γ_t. In the US, $\zeta_{i,t}$ also plays a role in the evolution of the stock market.

The impact of γ_t and $\zeta_{i,t}$ on output and the stock market and can be understood in terms of the simple diagram in Figure 8. Movements in γ_t, which affect the demand for capital, push net worth and output in the same direction. Movements in $\zeta_{i,t}$, which affect the supply of capital, drive these variables in opposite directions. We discuss this further in the following subsection.

5.4 US Boom-Bust

Our model analysis provides an interpretation of the boom-bust in the late 1990s and early 2000s. To see this, consider the results displayed in Figure 19. The left two columns pertain to the benchmark model, and the right column pertains to the simple model.

Consider the analysis based on the benchmark model first. The first column indicates the movements in the γ_t shock, as well as its impact on net worth ('capital price', the DOW in the data), investment, and output. These figures are reproduced here, for convenience, from Figure 3b and Figures 16-18.

Note from the first column that the movement in γ_t induces a movement in the DOW that matches the data qualitatively, but not quite quantitatively. If the amplitude of fluctuation in γ_t had been greater, the model would have been able to come much closer to matching the DOW with only the γ_t shock. Why did the model estimation not produce this larger fluctuation in γ_t? The answer lies in the chart in the third row. That displays the actual rate of investment, as well as what investment would have been, had there only been the γ_t shock. Note that the model overpredicts the fluctuation in investment. Similarly, the chart in the fourth row indicates that the model overpredicts the boom-bust fluctuation in output. So, the model does not rely fully on γ_t to explain the DOW, because to do so would have produced counterfactually large fluctuations in output and investment.

The model analysis indicates that we cannot explain the movement in the DOW by appealing only to fluctuations in demand arising from γ_t. To attempt to do so creates a conflict: given our econometric estimate of the slope of capital supply, explaining the boom-bust in the DOW with only a shift to demand (via γ_t) produces a counterfactually large expansion and contraction in investment and output. A similar puzzle is often encountered in discussions of sharp rise in prices during the period of the 'housing bubble'. Under the assumption that the huge rise in price was driven by demand, then why was there not a much larger rise in the quantity of houses produced? The question is often answered with the supposition that there is a sharp rise in costs due to local housing ordinances, the activities of vested interests, etc.. Similarly, our model 'resolves' the boom-bust puzzle in the stock market by positing a sharp rise and fall in marginal cost, $\zeta_{i,t}$, before and after

2000. As suggested by the intuition in Figure 8, the rise and fall in $\zeta_{i,t}$ over the boom-bust cycle corrects the excesses in the demand-driven theory of the boom-bust puzzle provided by γ_t. This can be seen by looking at the second column of graphs in Figure 19. Note how the model with only $\zeta_{i,t}$ predicts a rise and fall in the DOW. At the same time, the rise in $\zeta_{i,t}$ exerts a downward force on investment and output. In effect, the model says that in the time of the boom, other costs - in addition to the usual adjustment costs - kicked in to prevent the expansion of investment that would ordinarily have been associated with such a large rise in equity values.

The third column in Figure 19 shows the US boom-bust from the perspective of out simple model, the one without banks and financial frictions. This model was estimated in the usual way, by ignoring data on the stock market. Note that the estimated movements in $\zeta_{i,t}$ are exactly opposite to those implied by the benchmark model. According to the first row, last column, the estimated $\zeta_{i,t}$ exhibits a sharp fall in the late 1990s and a rise after 2000. According to the results in the third row, most of the movement in investment is attributed to $\zeta_{i,t}$. This too, is exactly opposite of what we found in the benchmark analysis, where the impact of $\zeta_{i,t}$ on investment is to undo the impact on investment of the fundamental forces driving the stock market.

In the second row, we see a major shortcoming of the simple model's boom-bust analysis. In that model, we compute the price of installed capital, and that is the object that we match with the stock market.[17] By attributing all the movement in investment to $\zeta_{i,t}$ and ignoring the stock market, that model generates the strongly counterfactual implication that stock market should have *fallen* in the late 1990s and then jumped with the 2001 recession. In effect, the stock market is a powerful signal about the source of shocks. The fact that the stock market rose while investment was expanding suggests that the dominant forces driving both variables were operating on the demand for capital, not the supply as the simple model supposes.

6 Policy Implications

The nature of our model allows us to investigate alternative monetary policy rules in which the authorities respond to financial variables such as credit growth, the stock market and/or

[17] It is possible to decentralize our simple model, so that production is operated by entrepreneurs who issue equity in order to finance the purchase of capital (see, e.g., Boldrin, Christiano and Fisher (2001)). In this decentralization, the price of equity corresponds to the price of capital. A minor difference between the price of capital in the model and the DOW is that the latter is 'price times quantity' while the former is just a price. We conjecture that this difference is not very important because movements in physical quantities of capital are small relative to movements in price over periods as long as a decade.

monetary aggregates. We conduct a preliminary investigation along these lines here.

Figure 20 shows what the standard deviation of output and inflation would have been in our sample over the period 1987-2006, if the monetary authorities had added real stock market growth (top graph) or broad money growth (bottom graph) to the Taylor rule. We consider the EA (solid line) and the US (starred line). In the case of the stock market and broad money growth, we considered a range of weights ranging from 0.01 to 0.20, in increments of 0.025. The smallest weight corresponds to the points $\sigma(y)$, $\sigma(\pi)$ equal to unity in the graphs.

The results indicate that in the EA, very little is to be gained by a central bank interested in output and inflation stabilization, by responding to the stock market. Starting with a relatively small response, output and inflation volatility both rise. In the EA, responding to broad money is relatively more effective at stabilizing output. In the case of the US, responding to broad money or the stock market produces similar results.

Figure 21a exhibits the data underlying some of the results in Figure 20. It shows how the data in the EA would have looked under the counterfactual policies (dotted line). The axial data (solid) are displayed too. The top figure considers the case of a small response (weight, 0.05) to the stock market, one which raises the volatility of inflation and reduces the volatility of output (the dotted line is the counterfactual data, the solid line is the actual data). The bottom figure displays what happens under a counterfactual policy in which policy responds with a weight of 0.05 to M3 growth instead. The effects in the top and bottom graphs are similar in magnitude. Similar results are reported in Figure 21 for the US.

7 Conclusion

One way to understand the nature of our results builds on the perspective offered in PST. An interpretation of the rejection of standard intertemporal Euler equations in the literature is that economic shocks enter these equations. Consistent with this interpretation, when PST use a version of our simple model to interpret the data, they find that an intertemporal consumption preference shock (like our $\zeta_{c,t}$) is important. In effect, our analysis pursues a more structural interpretation of PST's result by incorporating the BGG financial frictions. Shocks emanating from these frictions work like intertemporal preference disturbances.[18] Consistent with PST's results, we find that one shock emanating from the BGG financial frictions is particularly important for understanding the dynamics of the data.

[18] See Christiano and Davis (2007) for further discussion.

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Table 1: Model Parameters, EA and US (Time unit of Model: quarterly)			
		Euro Area	US
Panel A: Household Sector			
β	Discount rate	0.999	0.9966
σ_L	Curvature on Disutility of Labor	1.00	1.00
υ	Weight on Utility of Money	0.001	0.001
σ_q	Curvature on Utility of Money	-6.00	-7.00
θ	Power on Currency in Utility	0.74	0.77
χ	Power on Saving Deposits in Utility	0.49	0.55
b	Habit persistence parameter	0.56	0.63
λ_w	Steady state markup, suppliers of labor	1.05	1.05
Panel B: Goods Producing Sector			
μ_z	Growth Rate of the economy (APR)	1.50	1.36
ψ_k	Fraction of capital rental costs that must be financed	0.92	0.45
ψ_l	Fraction of wage bill that must be financed	0.92	0.45
δ	Depreciation rate on capital.	0.02	0.03
α	Power on capital in production function	0.36	0.40
λ_f	Steady state markup, intermediate good firms	1.20	1.20
Φ	Fixed cost, intermediate goods	0.262	0.042
Panel C: Entrepreneurs			
γ	Percent of Entrepreneurs Who Survive From One Quarter to the Next	97.80	97.62
μ	Fraction of Realized Profits Lost in Bankruptcy	0.1	0.33
$F(\bar{\omega})$	Percent of Businesses that go into Bankruptcy in a Quarter	2.60	1.30
$\sigma \equiv Var(log(\omega))$	Variance of (Normally distributed) log of idiosyncratic productivity parameter	0.12	0.67
Panel D: Banking Sector			
ξ	Power on Excess Reserves in Deposit Services Technology	0.94	0.94
x^b	Constant In Front of Deposit Services Technology	101.91	52.15
Panel E: Policy			
τ	Bank Reserve Requirement	0.02	0.01
τ^c	Tax Rate on Consumption	0.20	0.05
τ^k	Tax Rate on Capital Income	0.28	0.32
τ^l	Tax Rate on Labor Income	0.45	0.24
x	Growth Rate of Monetary Base (APR)	3.37	3.71

Table 2: Steady State Properties, Model versus Data, EA and US				
Variable	Model, EA	Data, EA 1998:1-2003:4	Model, US	Data, US 1998:1-2003:4
$\frac{k}{y}$	8.74	12.5[1]	6.99	10.7[2]
$\frac{i}{y}$	0.21	0.20[3]	0.22	0.25[4]
$\frac{c}{y}$	0.56	0.57	0.58	0.56
$\frac{g}{y}$	0.23	0.23	0.20	0.20
r^k	0.042	n.a.	0.059	n.a.
$\frac{N}{K-N}$ ('Equity to Debt')	1.09	1.08-2.19[5]	7.67	>4.7[6]
Transfers to Entrepreneurs (as % of Goods Output)	1.54	n.a.	4.31	n.a.
Banks Monitoring Costs (as % of Output Goods)	0.96	n.a.	0.27	n.a.
Output Goods (in %) Lost in Entrepreneurs Turnover	0.20	n.a.	1.50	n.a.
Percent of Aggregate Labor and Capital in Banking	0.93	n.a.	0.95	5.9[7]
Inflation (APR)	1.84	1.84[8]	2.32	2.32[9]

Note: n.a. - Not available. [1] Capital stock includes also government capital, as disaggregated data are not available. Source: Euro Area Wide Model (EAWM), G.Fagan, J.Henry and R.Mestre (2001) [2] Capital stock includes private non-residential fixed assets, private residential, stock of consumer durables and stock of private inventories. Source: BEA. [3] Investment includes also government investment and does not include durable consumption, as disaggregated data are not available. Source: EAWM. [4] Investment includes residential, non-residential, equipment, plants, business durables, change in inventories and durable consumption. Source: BEA. [5] The equity to debt ratio for corporations in the euro area is 1.08 in 1995, 2.19 in 1999 and afterwards moves down reaching 1.22 in 2002. Taking into account the unusual movements in asset prices in the second half of the 1990s, the steady-state equity to debt ratio is probably closer to the lower end of the range reported in the Table. Debt includes loans, debt securities issued and pension fund reserves of non-financial corporations. Equity includes quoted and non-quoted shares. Source: Euro area Flow of Funds. [6] E.McGrattan and E.Prescott (2004) estimates the equity to debt ratio for the corporate sector over the period 1960-2001. Over the period 1960-1995 the ratio is quite stable and averaged at 4.7. In 1995 it started exhibiting an extraordinary rise. In 2001, the last year included in their sample, the ratio is 60. The unprecedented sharp rise that occurred in the second half of the 1990s makes the calibration of such ratio for the purpose of our analysis very difficult. For comparison, Masulis (1988) reports an equity to debt ratio for US corporations in the range of 1.3-2 for the period 1937-1984. [7] Based on analysis of data on the finance, insurance and real estate sectors over the period 1987-2002. [8] Average inflation (annualised), measured using GDP deflator. [9] Average inflation (annualised), measured using GDP Price Index over the period 1987-2003.

Table 3: Money and Interest Rates. Model versus Data, EA and US									
Money	Model, EA	Data, EA	Model, US	Data, US	Interest Rates (APR)	Model, EA	Data, EA	Model, US	Data, US
M1 Velocity	3.31	3.31	6.42	6.92	Demand Deposits, R^a	0.82	0.76	0.52	n.a.
Broad Money Velocity	1.31	1.32	1.68	1.51	Saving Deposits, R^m	3.29	2.66	4.54	n.a.
Base Velocity	14.58	14.83	24.34	23.14	Long-term Assets	3.78	4.86	5.12	5.99
Currency/Base	0.69	0.69	0.75	0.75	Rate of Return on Capital, R^k	8.21	8.32	10.52	10.0
Currency/Total Deposits	0.07	0.06	0.05	0.05	Cost of External Finance, Z	6.04	4.3-6.3	7.79	7.1-8.1
(Broad Money-M1)/Base	6.75	6.76	10.69	12.16	Gross Rate on Work. Capit. Loans	4.09	n.a.	7.14	7.07
Credit Velocity	0.78	n.a.	3.16	3.25	Time Deposits, R^e	3.78	3.60	5.12	5.12

Notes to Table 3:

Data for the Euro area: the sample is 1998:4-2003:4

(1) ‘Broad Money’ is M3. (2) The interest rate on ‘Demand Deposits’ is the overnight rate. (3) The interest rate on ‘Saving Deposits’ is the own rate on (M3-M1). (4) The interest rate on ‘Longer-term Assets’ is the rate on 10-year Government Bonds. (5) The ‘Rate of Return on Capital’ is the Net Return on Net Capital Stock (source: European Commission). (6) The ‘Cost of External Finance’ is obtained by adding a measure of the external finance premium to R^e. We consider three different measures of the external finance premium: (i) we follow De Fiore and Uhlig (2005), who estimate that the spread is 267 basis points, based on studying the spread between short term bank lending rates to enterprises and a short-term risk free rate. (ii) we consider the spread between BAA and AAA bonds, which amounts at 135 basis.points. (iii) we computed a weighted average of three items (a) the spread between short-term bank lending rates to enterprises and the risk-free rate of corresponding maturity, (b) the spread between long-term bank lending rates and the risk-free rate of corresponding maturity, and (c) the spread between yields on corporate bonds and the risk-free rate of corresponding maturity. We use outstanding stocks to compute the weights. The resulting spread estimate is 67 basis points. Adding these spreads to our measure of the risk-free rate gives the range displayed in the table. (6) We were not able to find EA data corresponding to ‘Gross Rate on Working Capital Loans’. (7) The Rate on ‘Time Deposits’ is the 3-month Euribor.

Data for the US: the left column refers to 1959-2003; the right column to 1987:1-2003:4.

(1) ‘Broad Money’ is M2. (2) The interest rate on ‘Longer-term Assets’ is the rate on 10-year Government Bonds. (3) Rate of Return on Capital: based on Mulligan’s (2002) estimate of the real return over the period 1987-1999 to which we added average inflation. (4) ‘Cost of External Finance’: Bernanke, Gertler and Gilchrist (1999) suggest a spread of 200 basis points over the risk-free rate. Levin, Natalucci and Zakrajsek (2004) find a spread of 227 basis points for the median firm in their sample over 1997-2003. De Fiore and Uhlig (2005) find a spread of 298 basis points. Adding these spreads to our measure of the risk-free rate gives the range displayed in the table. (5) The rate on ‘Working Capital Loans’ is the rate on commercial and industrial loans (source: Survey of terms of business lending, Federal Reserve Board of Governors). (6) The interest rate on ‘Time Deposits’ is the Federal Funds Rate. (7) ‘Credit velocity’ is nominal GDP divided credit, where credit is the sum of bank loans to businesses plus securities other than equity issued by businesses. (8) We have not yet obtained US data on R^a, R^m and R^k.

Table 4: Parameter estimates: EA and US

		Prior			Posterior Euro area			Posterior US		
		Type	Mean	Std. dev.	Mode	Std. dev. (Hess.)	90% Prob. Interval**	Mode	Std. dev. (Hess.)	90% Prob. Interval**
ξ_p	Calvo prices	Beta	0.75* 0.375	0.05	0.7410	0.0345	0.684-0.798	0.5149	0.0384	0.452-0.578
ξ_w	Calvo wages	Beta	0.75* 0.375	0.1	0.6709	0.0372	0.610-0.732	0.7909	0.0219	0.755-0.827
ι	Weight on steady state inflation	Beta	0.5	0.15	0.8850	0.0557	0.793-0.977	0.2877	0.1111	0.105-0.470
ι_w	Weight on steady state inflation	Beta	0.5	0.15	0.3752	0.0943	0.220-0.530	0.3263	0.0987	0.164-0.489
ϑ	Weight on technology growth	Beta	0.5	0.15	0.8788	0.0511	0.795-0.963	0.9166	0.0370	0.856-0.977
S''	Investment adjust. cost	Normal	7.7	3.5	22.047	2.8924	17.29-26.80	15.537	2.2588	11.82-19.25
σ_a	Capacity utilization	Gamma	6	5	24.523	7.1772	12.72-36.33	24.858	6.2860	14.52-35.20
α_π	Weight on inflation in Taylor rule	Normal	1.75	0.1	1.8706	0.0872	1.727-2.014	1.8851	0.0874	1.741-2.029
α_y	Weight on output growth in Taylor rule	Normal	0.1	0.05	0.1128	0.0497	0.031-0.194	0.1146	0.0492	0.034-0.196
$\alpha_{d\pi}$	Weight on change in infl. in Taylor rule	Normal	0.3	0.1	0.2348	0.0969	0.075-0.394	0.2116	0.0985	0.050-0.375
ρ_i	Coeff. on lagged interest rate	Beta	0.8	0.05	0.8640	0.0138	0.841-0.887	0.8844	0.0123	0.864-0.905
ρ	Banking technol. shock (x_t^b)	Beta	0.5	0.2	0.9837	0.0078	0.971-0.997	0.9871	0.0077	0.975-0.999
ρ	Bank reserve demand shock (ξ_t)**	Beta	0.5	0.2	/**	/**		0.5913	0.0990	0.428-0.754
ρ	Term premium shock ($\sigma_t^{\aleph}$)	Beta	0.5	0.2	0.8106	0.0234	0.772-0.849	0.6526	0.0583	0.557-0.748
ρ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Beta	0.5	0.2	0.9667	0.0181	0.937-0.996	0.9832	0.0058	0.974-0.993
ρ	Money demand shock (χ_t)	Beta	0.5	0.2	0.9944	0.0040	0.988-0.999	0.9772	0.0125	0.957-0.998
ρ	Government consumption shock (g_t)	Beta	0.5	0.2	0.9009	0.0574	0.807-0.995	0.9194	0.0232	0.881-0.957
ρ	Persistent product. shock ($\mu_{z,t}^*$)	Beta	0.5	0.2	0.0613	0.0446	0.001-0.135	0.1603	0.0760	0.035-0.285
ρ	Transitory product. shock (ϵ_t)	Beta	0.5	0.2	0.9700	0.0158	0.944-0.996	0.9828	0.0082	0.969-0.996
ρ	Financial wealth shock (γ_t)	Beta	0.5	0.2	0.7003	0.0530	0.613-0.787	0.9373	0.0105	0.920-0.955
ρ	Riskiness shock (σ_t)	Beta	0.5	0.2	0.8080	0.0313	0.757-0.860	0.9298	0.0210	0.895-0.964
ρ	Consump. prefer. shock ($\zeta_{c,t}$)	Beta	0.5	0.2	0.9570	0.0138	0.934-0.980	0.9692	0.0060	0.959-0.979
ρ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Beta	0.5	0.2	0.5517	0.1083	0.374-0.730	0.9698	0.0059	0.960-0.980
ρ	Oil price shock (τ_t^{oil})	Beta	0.5	0.2	0.9240	0.0265	0.881-0.967	0.9439	0.0238	0.905-0.983
ρ	Price mark-up shock ($\lambda_{f,t}$)	Beta	0.5	0.2	0.9389	0.0250	0.898-0.980	0.9777	0.0112	0.959-0.996

Table 4, continued

		Prior			Posterior Euro area			Posterior US		
		Type	Mode	Df.	Mode	Std. dev. (Hess.)	90% Prob. Interval	Mode	Std. dev. (Hess.)	90% Prob. Interval
σ	Banking technol. shock (x_t^b)	Inv. Gamma	0.01	5 d	0.0901	0.0071	0.078-0.102	0.0736	0.0058	0.064-0.083
σ	Bank reserve demand shock (ξ_t)**	Inv. Gamma	0.01	5 d	/**	/**	/**	0.0071	0.0006	0.006-0.008
σ	Term premium shock ($\sigma_t^{\aleph}$)	Inv. Gamma	0.1	5 d	0.0150	0.0027	0.011-0.019	0.0305	0.0084	0.017-0.044
σ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Inv. Gamma	0.003	5 d	0.0033	0.0003	0.003-0.004	0.0032	0.0002	0.003-0.004
σ	Money demand shock (χ_t)	Inv. Gamma	0.01	5 d	0.0254	0.0020	0.022-0.029	0.0187	0.0015	0.016-0.021
σ	Government consumption shock (g_t)	Inv. Gamma	0.01	5 d	0.0155	0.0012	0.014-0.017	0.0209	0.0016	0.018-0.024
σ	Persistent product. shock ($\mu_{z,t}^*$)	Inv. Gamma	0.01	5 d	0.0054	0.0005	0.005-0.006	0.0076	0.0006	0.007-0.009
σ	Transitory product. shock (ϵ_t)	Inv. Gamma	0.01	5 d	0.0043	0.0004	0.004-0.005	0.0043	0.0004	0.004-0.005
σ	Financial wealth shock (γ_t)	Inv. Gamma	0.01	5 d	0.0169	0.0024	0.013-0.021	0.0063	0.0006	0.004-0.007
σ	Riskiness shock (σ_t)	Inv. Gamma	0.01	5 d	0.0794	0.0064	0.069-0.090	0.0356	0.0031	0.031-0.041
σ	Consump. prefer. shock ($\zeta_{c,t}$)	Inv. Gamma	0.01	5 d	0.0267	0.0056	0.018-0.036	0.0364	0.0061	0.026-0.046
σ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Inv. Gamma	0.01	5 d	0.0290	0.0030	0.024-0.034	0.1572	0.0372	0.096-0.218
σ	Oil price shock (τ_t^{oil})	Inv. Gamma	0.1	5 d	0.1550	0.0119	0.135-0.175	0.1317	0.0099	0.115-0.148
σ	Monetary policy shock (ε_t)	Inv. Gamma	0.25	5 d	0.4644	0.0370	0.404-0.525	0.4782	0.0374	0.417-0.540
σ	Price markup shock ($\lambda_{f,t}$)	Inv. Gamma	0.01	5 d	0.0110	0.0021	0.007-0.014	0.0075	0.0008	0.006-0.009

* Upper numbers refer to EA, lower numbers to US. The US priors was taken from LOWW. The EA prior for prices is consistent with the results produced by the Inflation Persistent Network (see Altissimo et al., 2006). Probability intervals based on Laplace approximation.

** The bank reserve demand shock is not used for the estimation of the euro area model.

Table 5. Measurement Errors: Standard Deviations

	Prior			Euro area Posterior		US	
	Type	a	b	Mode	St.error (Hessian)	Mode	St.error (Hessian)
Inflation	Weibull	0.00009 0.00010	5	0.00009	0.00002	0.00010	0.00002
GDP Growth	Weibull	0.00019 0.00028	5	0.00018	0.00004	0.00027	0.00006
Consumption Growth	Weibull	0.00020 0.00019	5	0.00019	0.00004	0.00018	0.00004
Investment Growth	Weibull	0.00081 0.00077	5	0.00080	0.00017	0.00076	0.00016
Hours	Weibull	0.00145 0.00209	5	0.00110	0.00032	0.00231	0.00034
Real Wage Growth	Weibull	0.00029 0.00040	5	0.00028	0.00006	0.00040	0.00009
Relative Price of Investment Growth	Weibull	0.00018 0.00002	5	0.00035	0.00008	0.00003	0.00001
Real Price of Oil Growth	Weibull	0.01391 0.01207	5	0.01343	0.00296	0.01161	0.00257
Real M1 Growth	Weibull	0.00098 0.00155	5	0.00095	0.00021	0.00157	0.00032
Real M3 Growth	Weibull	0.00049 0.00075	5	0.00047	0.00010	0.00072	0.00016
Real Net Worth Growth	Weibull	0.00899 0.00919	5	0.01055	0.00164	0.01227	0.00143
External Finance Premium	Weibull	0.00010 0.00010	5	0.00010	0.00002	0.00009	0.00002
Short-term Nominal Interest Rate	Weibull	0.00011 0.00023	5	0.00012	0.00002	0.00020	0.00005
Spread (Long-Short Rate)	Weibull	0.00015 0.00034	5	0.00014	0.00003	0.00030	0.00007
Bank reserves	Weibull	/* 0.00073	5	/*	/*	0.00035	0.00008

Table : **Euro Area.** Model Implied Variances Expressed in Terms of Sample Variances of the Corresponding Empirical Variables

	$\Delta(N/P)$	π	Log, H	ΔY	$\Delta(W/P)$	ΔI	$\Delta M1$	$\Delta M3$	ΔC	$Premium$	$Spread$	R	Rel. π^I	π^{oil}
Benchmark Model	1.2	2.4	4.5	3.5	2.2	2.5	5.5	50	2.9	6.6	4.5	0.79	1	1
Financial Accelerator	1.2	2.5	3.9	3.2	2.2	2.6	–	–	2.7	6.8	–	0.96	1	1
Simple Model	–	1.6	2.7	3.5	1.9	1.2	–	–	2.1	–	–	0.4	0.99	1

Table : US. Model-Implied Variances Expressed in Terms of Sample Variances of the Corresponding Empirical Variables

	$\Delta(N/P)$	π	Log, H	ΔY	$\Delta(W/P)$	ΔI	$\Delta M1$	$\Delta M3$	ΔC	$Premium$	$Spread$	R	$\Delta(P^I/P)$	$\Delta(P^{oil}/P)$	$\Delta(Reserve)$
Benchmark Model	0.7	43	8.6	6.2	2	9.3	4.9	44	12	92	23	12	0.99	1	3.3
Financial Accelerator	0.7	55	9.2	6.3	2.2	9.8	–	–	14	120	–	19	0.99	1	–
Simple Model	–	5.5	1.8	3.3	1.3	1.9	–	–	3.4	–	–	0.97	0.97	1	–

Table : Euro Area. Properties of the Economic Shocks' Innovations															
		$\lambda_{f,t}$	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$
Mean		0.0006	0.02	0.0003	0.0056	0.002	-0.0007	-0.001	-0.0005	-0.02	-0.007	0.001	0.006	-0.02	-0.0005
Auto-Correlation		-0.3	0.53	0.21	0.37	-0.02	-0.29	0.32	-0.06	0.49	0.46	-0.07	-0.18	0.23	0.49
Cross-Correlation															
	$\lambda_{f,t}$	0.25	0.25	0.46	0.26	0.23	0.35	-0.18	-0.17	-0.42	-0.07	-0.14	0.17	-0.39	0.01
	xb_t		0.09	0.22	0.3	0.23	0.01	-0.18	-0.07	-0.75	-0.02	-0.7	0.08	-0.21	-0.06
	$\mu_{\Upsilon,t}$			0.01	0.16	0.26	0.14	0.03	-0.22	-0.25	0.13	-0.24	0.02	-0.51	0.05
	χ_t				0.03	0.03	0.29	-0.22	0.14	-0.07	0.02	-0.07	-0.09	-0.27	-0.38
	g_t					0.02	-0.12	-0.05	0.1	-0.26	-0.01	-0.08	0.47	-0.17	0.12
	$\mu_{z,t}$						0.01	-0.29	-0.48	0.02	-0.24	0.07	0.07	0.05	-0.11
	γ_t							0.02	0.01	0.04	0.53	0.07	0.13	-0.22	0.36
	ϵ_t								0.01	0.09	0.08	0.16	-0.23	0.06	-0.02
	$M.Pol.$									0.48	-0.04	0.48	-0.16	0.22	-0.24
	σ_t										0.08	-0.02	0.12	-0.25	0.27
	$\zeta_{c,t}$											0.03	0.23	0.27	0.29
	$\zeta_{i,t}$												0.03	0.04	0.39
	τ_t^{oil}													0.16	-0.06
	$Spread$														0.02

Note: Figures refer to the smoothed innovations.

Table : US. Properties of the Economic Shocks' Innovations

		$\lambda_{f,t}$	ξ_t	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$Mon.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$
Mean		0.00025	0.00016	0.015	0.00024	4e-5	0.0032	-0.00043	5e-5	-0.00016	-0.065	-0.0011	-0.0026	0.0064	-0.012	0.0044
Auto-Correlation		-0.06	-0.23	0.68	0.51	0.45	-0.3	-0.03	-0.03	-0.14	0.52	0.28	-0.09	-0.25	0.17	0.05
Cross-Correlation																
	$\lambda_{f,t}$	0.01	0.12	0.19	0	-0.01	0.23	-0.02	-0.32	0.17	-0.46	-0.34	0.03	0.08	-0.2	-0.23
	ξ_t		0.01	-0.16	-0.04	0.54	0	0.1	0.18	-0.03	0.06	-0.11	0	0.11	0.09	-0.11
	xb_t			0.08	0.27	0.03	-0.05	0.24	0.03	-0.18	-0.67	0.12	-0.54	0.01	-0.31	-0.11
	$\mu_{\Upsilon,t}$				0.01	0.22	0.15	0.03	0.12	0.06	-0.2	0.16	-0.06	0.04	-0.13	-0.01
	χ_t					0.02	0.13	0.07	-0.01	0.01	0.29	0.21	0.2	0.09	0.18	0
	g_t						0.03	-0.44	-0.04	0.55	0.18	0	0.12	0.23	-0.11	-0.25
	$\mu_{z,t}$							0.01	-0.11	-0.49	-0.23	0.03	-0.29	-0.01	-0.11	-0.07
	γ_t								0.01	-0.4	-0.05	0.16	-0.19	0.54	-0.22	0.13
	ϵ_t									0.01	0.16	-0.1	0.31	-0.38	0.16	-0.04
	$Mon.Pol.$										0.47	0.16	0.4	0.04	0.25	0.13
	σ_t											0.04	-0.06	-0.04	0.04	0.24
	$\zeta_{c,t}$												0.04	0.05	0.28	0.32
	$\zeta_{i,t}$													0.16	-0.16	-0.31
	τ_t^{oil}														0.14	-0.03
	$Spread$															0.03

Note: Figures refer to the smoothed innovations.

Table : Euro Area. Variance Decomposition at Business Cycle Frequencies (in percent)															
	$\lambda_{f,t}$	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$	$Meas.Err.$
$D(N/P)$	2	0	0	0	0	0	84	0	3	8	0	2	0	0	1
	(2)	(–)	(0)	(–)	(0)	(0)	(83)	(0)	(3)	(8)	(0)	(3)	(0)	(–)	(1)
π	37	0	0	0	1	1	8	13	4	1	13	20	2	0	0
	(37)	(–)	(0)	(–)	(1)	(0)	(7)	(15)	(3)	(1)	(13)	(20)	(2)	(–)	(0)
	[42]	[–]	[0]	[–]	[3]	[0]	[–]	[18]	[3]	[–]	[8]	[23]	[3]	[–]	[0]
Log, H	19	0	0	0	5	1	7	4	3	6	10	45	0	0	0
	(20)	(–)	(0)	(–)	(5)	(1)	(8)	(5)	(2)	(6)	(9)	(43)	(0)	(–)	(0)
	[14]	[–]	[1]	[–]	[11]	[1]	[–]	[6]	[2]	[–]	[7]	[57]	[0]	[–]	[0]
DY	15	0	0	0	6	4	12	10	4	2	10	37	0	0	0
	(15)	(–)	(0)	(–)	(7)	(4)	(13)	(9)	(3)	(2)	(10)	(37)	(0)	(–)	(0)
	[9]	[–]	[1]	[–]	[13]	[4]	[–]	[9]	[2]	[–]	[7]	[55]	[0]	[–]	[0]
$D(W/P)$	33	0	0	0	0	48	1	11	0	0	1	4	2	0	0
	(32)	(–)	(0)	(–)	(0)	(50)	(1)	(10)	(0)	(0)	(1)	(4)	(2)	(–)	(0)
	[28]	[–]	[0]	[–]	[1]	[54]	[–]	[11]	[0]	[–]	[1]	[4]	[1]	[–]	[0]
DI	2	0	0	0	0	0	26	0	1	1	1	68	0	0	0
	(2)	(–)	(0)	(–)	(0)	(0)	(29)	(0)	(1)	(1)	(1)	(65)	(0)	(–)	(0)
	[3]	[–]	[0]	[–]	[0]	[0]	[–]	[2]	[0]	[–]	[2]	[91]	[0]	[–]	[0]
$DM1$	42	5	0	10	1	0	5	9	20	0	4	2	2	0	0
$DM3$	10	30	0	2	1	1	6	3	13	0	18	15	1	0	0
DC	24	1	0	0	1	2	2	23	9	0	34	2	2	0	0
	(25)	(–)	(0)	(–)	(1)	(2)	(4)	(20)	(6)	(1)	(36)	(4)	(2)	(–)	(0)
	[15]	[–]	[0]	[–]	[6]	[2]	[–]	[20]	[5]	[–]	[45]	[5]	[1]	[–]	[0]
$Premium$	0	0	0	0	0	0	46	0	1	52	0	0	0	0	0
	(0)	(–)	(0)	(–)	(0)	(0)	(46)	(0)	(1)	(52)	(0)	(1)	(0)	(–)	(0)
$Spread$	13	0	0	0	0	0	9	3	13	0	4	15	1	40	0
R	22	0	0	0	1	1	14	8	17	0	15	20	2	0	0
	(23)	(–)	(0)	(–)	(1)	(1)	(14)	(10)	(14)	(0)	(15)	(21)	(2)	(–)	(0)
	[30]	[–]	[0]	[–]	[3]	[0]	[–]	[13]	[19]	[–]	[9]	[24]	[2]	[–]	[0]
$D(P^I/P)$	0	0	99	0	0	0	0	0	0	0	0	0	0	0	1
	(0)	(–)	(99)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(–)	(1)
	[0]	[–]	[99]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[0]	[–]	[1]
$D(P^{oil}/P)$	0	0	0	0	0	0	0	0	0	0	0	0	99	0	1
	(0)	(–)	(0)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(99)	(–)	(1)
	[0]	[–]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[99]	[–]	[1]

Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if such a variable is present, are in the following rows. Financial Accelerator model is denoted by (). Simple model is denoted []. Note: Variance decomposition corresponds to periodic components with cycles of 8-32 quarters, obtained using the model spectrum.

Table : US. Variance Decomposition at Business Cycle Frequencies (in percent)

	$\lambda_{f,t}$	ξ_t	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$	$Meas.Err.$
$D(N/P)$	1	0	0	0	0	0	0	58	0	1	5	0	31	0	0	3
	(1)	(–)	(–)	(0)	(–)	(0)	(0)	(52)	(0)	(1)	(5)	(0)	(38)	(0)	(–)	(3)
π	11	0	0	0	0	2	2	32	10	2	0	5	35	2	0	0
	(12)	(–)	(–)	(0)	(–)	(2)	(2)	(32)	(11)	(2)	(0)	(5)	(33)	(2)	(–)	(0)
	[15]	[–]	[–]	[0]	[–]	[4]	[2]	[–]	[15]	[14]	[–]	[2]	[43]	[4]	[–]	[0]
Log, H	25	0	0	0	0	5	3	24	5	3	1	8	24	1	0	0
	(31)	(–)	(–)	(0)	(–)	(7)	(5)	(17)	(6)	(3)	(1)	(9)	(19)	(1)	(–)	(0)
	[44]	[–]	[–]	[0]	[–]	[5]	[6]	[–]	[12]	[8]	[–]	[2]	[20]	[3]	[–]	[0]
DY	16	0	0	0	0	6	3	28	17	3	1	7	18	1	0	0
	(19)	(–)	(–)	(0)	(–)	(7)	(4)	(22)	(18)	(3)	(1)	(8)	(16)	(1)	(–)	(0)
	[30]	[–]	[–]	[0]	[–]	[7]	[2]	[–]	[32]	[7]	[–]	[3]	[17]	[3]	[–]	[0]
$D(W/P)$	14	0	0	0	0	1	48	8	12	1	0	2	11	2	0	0
	(15)	(–)	(–)	(0)	(–)	(2)	(53)	(5)	(12)	(1)	(0)	(2)	(8)	(2)	(–)	(0)
	[6]	[–]	[–]	[0]	[–]	[1]	[75]	[–]	[6]	[2]	[–]	[0]	[7]	[1]	[–]	[0]
DI	1	0	0	0	0	0	0	49	0	0	1	0	48	0	0	0
	(1)	(–)	(–)	(0)	(–)	(0)	(0)	(50)	(0)	(0)	(1)	(0)	(48)	(0)	(–)	(0)
	[28]	[–]	[–]	[1]	[–]	[2]	[0]	[–]	[17]	[6]	[–]	[7]	[38]	[2]	[–]	[0]
$DM1$	19	0	2	0	5	1	0	24	11	6	0	3	27	2	0	0
$DM3$	4	0	10	0	2	1	2	32	3	3	0	10	31	1	0	0
DC	16	0	1	0	0	2	0	14	24	4	0	14	24	2	0	0
	(14)	(–)	(–)	(0)	(–)	(2)	(0)	(22)	(18)	(3)	(0)	(11)	(28)	(2)	(–)	(0)
	[6]	[–]	[–]	[0]	[–]	[4]	[1]	[–]	[29]	[2]	[–]	[46]	[10]	[2]	[–]	[0]
$Premium$	0	0	0	0	0	0	0	57	0	0	39	0	3	0	0	0
	(0)	(–)	(–)	(0)	(–)	(0)	(0)	(48)	(0)	(0)	(46)	(0)	(6)	(0)	(–)	(0)
$Spread$	4	0	0	0	0	1	1	43	3	3	1	2	35	1	7	0
R	4	0	0	0	0	1	1	41	4	2	0	5	40	1	0	0
	(5)	(–)	(–)	(0)	(–)	(1)	(1)	(40)	(5)	(2)	(0)	(5)	(39)	(1)	(–)	(0)
	[8]	[–]	[–]	[1]	[–]	[2]	[2]	[–]	[7]	[7]	[–]	[2]	[68]	[2]	[–]	[0]
$D(P^I/P)$	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
	(0)	(–)	(–)	(100)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(–)	(0)
	[0]	[–]	[–]	[100]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[0]	[–]	[0]
$D(P^{oil}/P)$	0	0	0	0	0	0	0	0	0	0	0	0	0	99	0	1
	(0)	(–)	(–)	(0)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(99)	(–)	(1)
	[0]	[–]	[–]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[99]	[–]	[1]
$Reserve$	8	24	1	0	5	1	1	22	7	4	0	2	25	1	0	0

Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if present, are in the following rows. Financial Accelerator model is denoted by (). Simple model is denoted by []. Note: Variance decomposition corresponds to periodic components with cycles of 8-32 quarters, obtained using the model spectrum.

Table : Euro Area. Variance Decomposition at Low Frequencies (in percent)

	$\lambda_{f,t}$	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$	$Meas.Err.$
$D(N/P)$	1	0	0	0	0	0	91	0	2	2	0	3	0	0	2
	(1)	(–)	(0)	(–)	(0)	(0)	(91)	(0)	(1)	(2)	(0)	(3)	(0)	(–)	(1)
π	13	0	0	0	1	1	30	7	5	0	31	11	2	0	0
	(13)	(–)	(0)	(–)	(1)	(1)	(32)	(8)	(3)	(0)	(29)	(11)	(1)	(–)	(0)
	[29]	[–]	[1]	[–]	[4]	[2]	[–]	[16]	[4]	[–]	[14]	[29]	[2]	[–]	[0]
Log, H	33	0	0	0	3	1	26	2	2	1	3	29	0	0	0
	(32)	(–)	(0)	(–)	(2)	(1)	(30)	(1)	(1)	(1)	(3)	(28)	(0)	(–)	(0)
	[31]	[–]	[1]	[–]	[13]	[3]	[–]	[3]	[1]	[–]	[4]	[43]	[0]	[–]	[0]
DY	13	0	0	0	1	7	44	10	2	1	4	17	0	0	0
	(12)	(–)	(0)	(–)	(1)	(7)	(50)	(7)	(1)	(1)	(4)	(16)	(0)	(–)	(0)
	[16]	[–]	[1]	[–]	[6]	[14]	[–]	[22]	[1]	[–]	[7]	[32]	[1]	[–]	[0]
$D(W/P)$	31	0	0	0	0	17	27	14	0	0	1	7	1	0	0
	(29)	(–)	(0)	(–)	(0)	(19)	(33)	(9)	(0)	(0)	(2)	(7)	(1)	(–)	(0)
	[34]	[–]	[1]	[–]	[1]	[32]	[–]	[21]	[0]	[–]	[2]	[7]	[2]	[–]	[0]
DI	5	0	0	0	0	1	62	1	1	1	3	27	0	0	0
	(4)	(–)	(0)	(–)	(0)	(1)	(66)	(1)	(1)	(1)	(3)	(23)	(0)	(–)	(0)
	[11]	[–]	[4]	[–]	[2]	[2]	[–]	[11]	[0]	[–]	[12]	[58]	[0]	[–]	[0]
$DM1$	33	4	0	11	0	1	23	8	3	0	11	3	2	0	0
$DM3$	4	27	0	2	0	2	27	1	2	0	22	12	0	0	0
DC	13	1	0	0	1	4	32	19	1	0	18	8	1	0	0
	(12)	(–)	(0)	(–)	(1)	(5)	(40)	(13)	(1)	(0)	(19)	(8)	(1)	(–)	(0)
	[9]	[–]	[1]	[–]	[7]	[8]	[–]	[21]	[1]	[–]	[42]	[10]	[1]	[–]	[0]
$Premium$	0	0	0	0	0	0	80	0	1	16	1	1	0	0	0
	(0)	(–)	(0)	(–)	(0)	(0)	(81)	(0)	(1)	(16)	(1)	(1)	(0)	(–)	(0)
$Spread$	7	0	0	0	1	0	45	2	2	0	11	14	1	17	0
R	6	0	0	0	1	2	36	5	1	0	39	8	1	0	0
	(6)	(–)	(0)	(–)	(0)	(1)	(40)	(5)	(1)	(0)	(35)	(9)	(1)	(–)	(0)
	[20]	[–]	[2]	[–]	[5]	[3]	[–]	[13]	[5]	[–]	[18]	[32]	[2]	[–]	[0]
$D(P^I/P)$	0	0	99	0	0	0	0	0	0	0	0	0	0	0	1
	(0)	(–)	(99)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(–)	(1)
	[0]	[–]	[99]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[0]	[–]	[1]
$D(P^{oil}/P)$	0	0	0	0	0	0	0	0	0	0	0	0	99	0	1
	(0)	(–)	(0)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(99)	(–)	(1)
	[0]	[–]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[99]	[–]	[1]

Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if such a variable is present, are in the following rows. Financial Accelerator model is denoted by (). Simple model is denoted []. Note: Variance decomposition corresponds to periodic components with cycles of 33-1000 quarters, obtained using the model spectrum.

Table : US. Variance Decomposition at Low Frequencies (in percent)

	$\lambda_{f,t}$	ξ_t	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$	$Meas.Err.$
$D(N/P)$	0	0	0	0	0	0	0	47	0	0	1	0	49	0	0	2
	(0)	(–)	(–)	(0)	(–)	(0)	(0)	(48)	(0)	(0)	(1)	(0)	(49)	(0)	(–)	(2)
π	1	0	0	0	0	0	1	41	2	1	0	9	44	0	0	0
	(1)	(–)	(–)	(0)	(–)	(0)	(1)	(50)	(2)	(0)	(0)	(4)	(41)	(0)	(–)	(0)
	[4]	[–]	[–]	[2]	[–]	[3]	[9]	[–]	[4]	[11]	[–]	[4]	[61]	[2]	[–]	[0]
Log, H	8	0	0	0	0	1	0	41	1	0	0	1	48	0	0	0
	(7)	(–)	(–)	(0)	(–)	(1)	(0)	(47)	(0)	(0)	(0)	(1)	(44)	(0)	(–)	(0)
	[50]	[–]	[–]	[1]	[–]	[2]	[5]	[–]	[16]	[3]	[–]	[3]	[19]	[1]	[–]	[0]
DY	3	0	0	0	0	0	2	48	3	0	0	0	43	0	0	0
	(2)	(–)	(–)	(0)	(–)	(0)	(2)	(54)	(2)	(0)	(0)	(0)	(40)	(0)	(–)	(0)
	[29]	[–]	[–]	[1]	[–]	[1]	[12]	[–]	[32]	[2]	[–]	[6]	[15]	[2]	[–]	[0]
$D(W/P)$	5	0	0	0	0	0	7	39	3	0	0	0	45	0	0	0
	(3)	(–)	(–)	(0)	(–)	(0)	(5)	(49)	(2)	(0)	(0)	(0)	(39)	(0)	(–)	(0)
	[21]	[–]	[–]	[1]	[–]	[1]	[39]	[–]	[25]	[1]	[–]	[3]	[9]	[1]	[–]	[0]
DI	1	0	0	0	0	0	0	51	0	0	0	0	47	0	0	0
	(1)	(–)	(–)	(0)	(–)	(0)	(0)	(55)	(0)	(0)	(0)	(0)	(44)	(0)	(–)	(0)
	[29]	[–]	[–]	[2]	[–]	[2]	[3]	[–]	[16]	[2]	[–]	[15]	[30]	[1]	[–]	[0]
$DM1$	4	0	1	0	2	0	1	45	3	0	0	3	41	1	0	0
$DM3$	0	0	5	0	1	0	1	45	0	0	0	7	39	0	0	0
DC	3	0	0	0	0	0	1	43	5	0	0	2	45	0	0	0
	(2)	(–)	(–)	(0)	(–)	(0)	(1)	(51)	(3)	(0)	(0)	(1)	(41)	(0)	(–)	(0)
	[10]	[–]	[–]	[1]	[–]	[3]	[8]	[–]	[33]	[1]	[–]	[30]	[13]	[1]	[–]	[0]
$Premium$	0	0	0	0	0	0	0	85	0	0	6	2	6	0	0	0
	(0)	(–)	(–)	(0)	(–)	(0)	(0)	(89)	(0)	(0)	(5)	(1)	(5)	(0)	(–)	(0)
$Spread$	0	0	0	0	0	0	0	51	0	0	0	2	44	0	0	0
R	1	0	0	0	0	0	1	41	1	0	0	10	45	0	0	0
	(0)	(–)	(–)	(0)	(–)	(0)	(1)	(52)	(1)	(0)	(0)	(4)	(42)	(0)	(–)	(0)
	[5]	[–]	[–]	[3]	[–]	[2]	[13]	[–]	[4]	[1]	[–]	[6]	[65]	[1]	[–]	[0]
$D(P^I/P)$	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
	(0)	(–)	(–)	(100)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(–)	(0)
	[0]	[–]	[–]	[100]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[0]	[–]	[0]
$D(P^{oil}/P)$	0	0	0	0	0	0	0	0	0	0	0	0	0	99	0	1
	(0)	(–)	(–)	(0)	(–)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(99)	(–)	(1)
	[0]	[–]	[–]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[–]	[0]	[0]	[99]	[–]	[1]
$Reserve$	2	2	1	0	2	0	1	45	2	0	0	3	43	0	0	0

Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if present, are in the following rows. Financial Accelerator model is denoted by (). Simple model is denoted by []. Note: Variance decomposition corresponds to periodic components with cycles of 33-1000 quarters, obtained using the model spectrum.

Table : Euro area. Variance Decomposition Computed in Sample

	$\lambda_{f,t}$	xb_t	$\mu_{\Upsilon,t}$	χ_t	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$M.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}	$Spread$	$Total$
$D(N/P)$	0|0.4	0|-0.4	0|0.2	0|-0.2	0|-0.1	0|-0.4	1.3|1	0|0.5	0.1|0	0.1|-0.7	0|-0.2	0|0.7	0|0	0|0	1.5
	(0|0.4)	(–)	(0|0.2)	(–)	(0|-0.1)	(0|-0.3)	(1.3|1)	(0|0.4)	(0|0)	(0.1|-0.7)	(0|-0.4)	(0|0.7)	(0|0)	(–)	1.5
π	0.3|0.4	0|0.2	0|-0.7	0|0.6	0|-0.2	0|0.5	0.5|0.1	0.1|-0.1	0.3|-0.2	0|0.2	0.6|0.7	0.4|0.3	0.1|-0.3	0|0	2.3
	(0.4|0.4)	(–)	(0|-0.8)	(–)	(0|0)	(0|0.5)	(0.6|0.1)	(0.2|0.2)	(0.3|-0.2)	(0|0.1)	(0.4|0.7)	(0.5|0.4)	(0.1|-0.2)	(–)	2.4
	[0.3|0.5]	[–]	[0|-0.8]	[–]	[0|-0.3]	[0|0.7]	[–]	[0.2|0.3]	[0.2|-0.3]	[–]	[0.1|0.5]	[0.7|0.8]	[0|-0.3]	[–]	1.5
Log, H	0.9|0.6	0|0	0|0.3	0|-0.4	0.1|-0.1	0|-0.4	0.6|0.2	0.1|0.1	0.4|0.1	0.2|-0.3	0.3|0.5	2.1|0.1	0|-0.3	0|0	4.7
	(0.8|0.7)	(–)	(0|0.3)	(–)	(0.1|-0.1)	(0|-0.4)	(0.6|0.2)	(0.1|0.1)	(0.3|0.2)	(0.2|-0.3)	(0.2|0.4)	(1.9|0.1)	(0|-0.3)	(–)	4.2
	[1|0.4]	[–]	[0|0.2]	[–]	[0.3|-0.3]	[0|-0.5]	[–]	[0.1|0.2]	[0.2|0]	[–]	[0.1|0.3]	[2.9|0.4]	[0|-0.4]	[–]	4.6
DY	0.4|0.4	0|-0.5	0|0.4	0|0.2	0.2|-0.1	0.2|-0.4	1.3|0.5	0.3|0.6	0.3|-0.3	0.2|-0.1	0.3|0.6	1.1|-0.1	0|-0.4	0|0	4.4
	(0.4|0.4)	(–)	(0|0.4)	(–)	(0.2|-0.2)	(0.2|-0.4)	(1.4|0.5)	(0.3|0.5)	(0.2|-0.2)	(0.2|-0.1)	(0.3|0.6)	(1|0)	(0|-0.4)	(–)	4.1
	[0.1|0]	[–]	[0|0.3]	[–]	[0.4|-0.4]	[0.1|-0.2]	[–]	[0.3|0.8]	[0.1|-0.3]	[–]	[0.1|0.6]	[0.9|0.8]	[0|-0.3]	[–]	2.1
$D(W/P)$	0.6|0.4	0|-0.5	0|-0.1	0|-0.2	0|0.3	0.8|0.6	0.2|0.4	0.2|0.1	0|0.1	0|0	0.1|-0.1	0.2|-0.1	0.1|-0.2	0|0	2.2
	(0.6|0.4)	(–)	(0|-0.1)	(–)	(0|0.3)	(0.8|0.6)	(0.2|0.4)	(0.2|-0.1)	(0|0.1)	(0|-0.1)	(0.1|0)	(0.2|0)	(0.1|-0.2)	(–)	2.2
	[0.4|0.4]	[–]	[0|0]	[–]	[0|0.3]	[0.7|0.8]	[–]	[0.3|-0.2]	[0|0.1]	[–]	[0|0.1]	[0.2|0.4]	[0|-0.2]	[–]	1.6
DI	0.1|0.2	0|0	0|-0.2	0|-0.1	0|0.1	0|-0.4	3.2|0.3	0|0.4	0.1|0	0.2|0	0.1|0.2	2.4|0.2	0|-0.1	0|0	6.1
	(0.1|0.2)	(–)	(0|-0.2)	(–)	(0|0.4)	(0|-0.3)	(3.5|0.3)	(0|0.4)	(0.1|0)	(0.2|0)	(0.1|0)	(2.3|0.2)	(0|-0.2)	(–)	6.4
	[0|-0.2]	[–]	[0|-0.2]	[–]	[0|0.5]	[0|-0.2]	[–]	[0.1|0.7]	[0|-0.2]	[–]	[0|0.2]	[0.8|0.9]	[0|0]	[–]	0.99
$DM1$	0.8|0.4	0.7|0	0|0.4	1.4|0.8	0|0	0|-0.4	0.8|-0.3	0.2|-0.1	1.9|0.2	0|0	0.2|-0.2	0.2|-0.2	0.1|0.1	0|0	6.3
$DM3$	2.9|-0.1	20|-0.2	0|-0.5	1.7|0.1	0.3|-0.1	0.5|0.2	10|-0.2	1.3|0.2	8.3|0	0.3|0.1	9.7|0.4	7.1|0.4	0.5|0	0|0	63
DC	0.6|0.6	0.1|-0.6	0|0	0|0.1	0.1|0.5	0.1|-0.3	0.5|-0.3	0.8|0.5	0.5|-0.5	0|-0.2	1.5|0.8	0.3|0	0.1|-0.4	0|0	4.6
	(0.6|0.6)	(–)	(0|0)	(–)	(0|0.5)	(0.1|-0.2)	(0.7|-0.2)	(0.6|0.3)	(0.3|-0.5)	(0|-0.2)	(1.2|0.8)	(0.3|0)	(0.1|-0.4)	(–)	4
	[0.2|0.3]	[–]	[0|0.4]	[–]	[0.2|0.7]	[0.1|-0.1]	[–]	[0.6|0.6]	[0.2|-0.5]	[–]	[0.7|0.8]	[0.3|-0.4]	[0.1|-0.4]	[–]	2.4
$Premium$	0|0.6	0|-0.1	0|0.6	0|-0.3	0|-0.2	0|-0.4	4.6|0.2	0|0	0.2|-0.1	4.7|0.2	0.1|0	0.1|0.1	0|0.2	0|0	9.7
	(0|0.6)	(–)	(0|0.6)	(–)	(0|-0.2)	(0|-0.3)	(4.6|0.2)	(0|-0.1)	(0.2|-0.1)	(4.8|0.2)	(0|-0.1)	(0.1|0.1)	(0|0.2)	(–)	9.7
$Spread$	0.2|-0.2	0|0.6	0|-0.4	0|0.3	0|-0.5	0|0.2	1.1|0.2	0.1|0.1	0.6|0.6	0|0.2	0.4|0.6	0.9|0.3	0.1|-0.1	2.2|-0.2	5.6
R	0|0.2	0|0.7	0|-0.6	0|0.5	0|-0.8	0|0.6	0.2|0.3	0|-0.1	0.1|0.5	0|0.3	0.3|1	0.1|0.3	0|-0.4	0|0	0.7
	(0.1|0.2)	(–)	(0|-0.6)	(–)	(0|-0.5)	(0|0.7)	(0.3|0.3)	(0|0.4)	(0.1|0.6)	(0|0.1)	(0.2|1)	(0.2|0.4)	(0|-0.4)	(–)	0.83
	[0.1|0.5]	[–]	[0|-0.7]	[–]	[0|-0.7]	[0|0.8]	[–]	[0|0.2]	[0.1|0.7]	[–]	[0|0.7]	[0.3|0.9]	[0|-0.4]	[–]	0.57
$D(P^I/P)$	0|0	0|0	1|1	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	1
	(0|0)	(–)	(1|1)	(–)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(–)	1
	[0|0]	[–]	[1|1]	[–]	[0|0]	[0|0]	[–]	[0|0]	[0|0]	[–]	[0|0]	[0|0]	[0|0]	[–]	1
$D(P^{oil}/P)$	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	0|0	1|1	0|0	1
	(0|0)	(–)	(0|0)	(–)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(0|0)	(1|1)	(–)	1
	[0|0]	[–]	[0|0]	[–]	[0|0]	[0|0]	[–]	[0|0]	[0|0]	[–]	[0|0]	[0|0]	[1|1]	[–]	1

Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if present, are in the following rows. Financial accelerator model is denoted by (). Simple Model is denoted by []. Note: The first element of each column refers to the in-sample relative variance computed as var(y(i))/var(y), where var(y(i)) is the variance of variable y under the counterfactual simulation that all estimated shocks, with the exception of shock i, are set to zero, and var(y) is the variance of the two-sided fitted variable y. The second element of each column refers to the correlation, corr(y,y(i)). The last column displays the sum of the relative variances.

<table>
<tr><th colspan="17">Table : US. Variance Decomposition Computed in Sample</th></tr>
<tr><th></th><th>$\lambda_{f,t}$</th><th>ξ_t</th><th>xb_t</th><th>$\mu_{\Upsilon,t}$</th><th>χ_t</th><th>g_t</th><th>$\mu_{z,t}$</th><th>γ_t</th><th>ϵ_t</th><th>$M.Pol.$</th><th>σ_t</th><th>$\zeta_{c,t}$</th><th>$\zeta_{i,t}$</th><th>τ_t^{oil}</th><th>$Spread$</th><th>$Tot.$</th></tr>
<tr><td>$D(N/P)$</td><td>0|0.1
(0|0.1)</td><td>0|0
(–)</td><td>0|0.1
(–)</td><td>0|-0.1
(0|-0.2)</td><td>0|0
(–)</td><td>0|0.3
(0|0.3)</td><td>0|-0.2
(0|-0.2)</td><td>0.7|0.9
(0.5|0.9)</td><td>0|0
(0|0)</td><td>0|-0.1
(0|-0.1)</td><td>0|-0.7
(0|-0.7)</td><td>0|0.2
(0|0.2)</td><td>0.2|0.9
(0.3|0.9)</td><td>0|-0.1
(0|-0.1)</td><td>0|0
(–)</td><td>0.9
0.91</td></tr>
<tr><td>π</td><td>2.3|0.3
(3|0.3)
[0.5|0.1]</td><td>0|0
(–)
[–]</td><td>0.1|0.4
(–)
[–]</td><td>0.1|-0.6
(0.1|-0.7)
[0.2|-0.7]</td><td>0|-0.1
(–)
[–]</td><td>0.4|-0.1
(0.4|-0.1)
[0.1|-0.1]</td><td>0.8|0.2
(0.8|0.4)
[0.2|0.5]</td><td>21|-0.3
(24|-0.4)
[–]</td><td>1.3|-0.2
(1.3|0)
[0.4|0.1]</td><td>1.6|-0.2
(1.3|-0.2)
[2.2|-0.1]</td><td>0.6|0.3
(0.5|0.4)
[–]</td><td>4.2|0.5
(3.8|0.3)
[0.1|0.2]</td><td>11|0.2
(14|0.3)
[2.7|0.4]</td><td>0.5|0.4
(0.7|0.4)
[0.2|0.5]</td><td>0|0
(–)
[–]</td><td>44
51
6.7</td></tr>
<tr><td>Log, H</td><td>0.8|0.8
(0.8|0.8)
[1.4|0.7]</td><td>0|-0.1
(–)
[–]</td><td>0|-0.2
(–)
[–]</td><td>0|0.4
(0|0.3)
[0|0.5]</td><td>0|0.4
(–)
[–]</td><td>0.1|0.6
(0.1|0.6)
[0|0.2]</td><td>0.1|0.1
(0.1|0.3)
[0.1|0.2]</td><td>1.7|0.9
(1.3|0.8)
[–]</td><td>0|-0.2
(0|-0.2)
[0.1|0]</td><td>0.1|-0.7
(0.1|-0.6)
[0.2|-0.6]</td><td>0.1|-0.8
(0.1|-0.8)
[–]</td><td>0.1|0.3
(0.1|0.4)
[0|0]</td><td>0.9|-0.8
(0.9|-0.8)
[0.3|0.2]</td><td>0|0.2
(0|0.1)
[0|0.4]</td><td>0|0
(–)
[–]</td><td>3.9
3.4
2.2</td></tr>
<tr><td>DY</td><td>0.9|0.6
(0.9|0.6)
[1.5|0.5]</td><td>0|0
(–)
[–]</td><td>0|-0.3
(–)
[–]</td><td>0|0
(0|0)
[0|0.1]</td><td>0|0.4
(–)
[–]</td><td>0.2|0.2
(0.2|0.2)
[0.2|0]</td><td>0.3|-0.3
(0.3|-0.3)
[0.2|-0.3]</td><td>3.8|0.5
(3.4|0.4)
[–]</td><td>0.4|0.1
(0.3|0)
[0.8|0.3]</td><td>0.2|-0.4
(0.1|-0.4)
[0.4|-0.4]</td><td>0.3|-0.4
(0.2|-0.4)
[–]</td><td>0.3|0.4
(0.2|0.5)
[0.1|0.3]</td><td>1.5|-0.2
(1.7|-0.2)
[0.5|0.4]</td><td>0|0.1
(0|0.1)
[0.1|0.2]</td><td>0|0
(–)
[–]</td><td>7.9
7.3
3.9</td></tr>
<tr><td>$D(W/P)$</td><td>0.3|0.5
(0.3|0.5)
[0.2|0.6]</td><td>0|0.1
(–)
[–]</td><td>0|0.5
(–)
[–]</td><td>0|0.2
(0|0.2)
[0|0.2]</td><td>0|-0.1
(–)
[–]</td><td>0|0.5
(0|0.5)
[0|0.4]</td><td>0.6|0.8
(0.6|0.8)
[0.7|0.8]</td><td>0.6|0.4
(0.6|0.4)
[–]</td><td>0.1|-0.5
(0.1|-0.3)
[0.1|-0.2]</td><td>0|-0.3
(0|-0.3)
[0|-0.3]</td><td>0|-0.3
(0|-0.4)
[–]</td><td>0|0.4
(0|0.4)
[0|0]</td><td>0.4|-0.2
(0.4|-0.2)
[0.1|0.4]</td><td>0|0.1
(0|0.1)
[0|0.1]</td><td>0|0
(–)
[–]</td><td>2
2.1
1.2</td></tr>
<tr><td>DI</td><td>0.3|0.6
(0.3|0.5)
[0.9|0.6]</td><td>0|0.2
(–)
[–]</td><td>0|-0.1
(–)
[–]</td><td>0.1|0.3
(0|0.3)
[0.1|0.2]</td><td>0|0
(–)
[–]</td><td>0|0.1
(0|0.1)
[0.1|0.4]</td><td>0.1|-0.4
(0|-0.4)
[0|-0.2]</td><td>8.7|0.6
(8.9|0.6)
[–]</td><td>0|-0.1
(0|0)
[0.3|0.2]</td><td>0|-0.3
(0|-0.2)
[0.2|-0.3]</td><td>0.3|-0.5
(0.2|-0.5)
[–]</td><td>0|0.2
(0|0)
[0.2|0.1]</td><td>4.3|-0.4
(5.1|-0.4)
[0.8|0.3]</td><td>0|-0.2
(0|-0.1)
[0|0.2]</td><td>0|0
(–)
[–]</td><td>14
15
2.7</td></tr>
<tr><td>$DM1$</td><td>0.3|-0.2</td><td>0|0</td><td>0.2|-0.1</td><td>0|-0.4</td><td>0.5|0.9</td><td>0|-0.2</td><td>0|0.4</td><td>1.5|-0.2</td><td>0.1|-0.1</td><td>0.4|0.4</td><td>0.1|0.2</td><td>0.1|0.6</td><td>0.8|0.2</td><td>0|0.5</td><td>0|0</td><td>4</td></tr>
<tr><td>$DM3$</td><td>1.6|0.3</td><td>0|-0.3</td><td>11|0.6</td><td>0.2|0.1</td><td>2.1|0.1</td><td>0.4|-0.3</td><td>1.4|0.3</td><td>33|-0.2</td><td>1.1|0.4</td><td>2.2|-0.6</td><td>0.9|0.2</td><td>7.3|-0.2</td><td>17|0</td><td>0.5|-0.3</td><td>0|0</td><td>78</td></tr>
<tr><td>DC</td><td>1.9|0.6
(2.1|0.6)
[0.6|0.4]</td><td>0|0
(–)
[–]</td><td>0.2|-0.2
(–)
[–]</td><td>0|-0.2
(0|-0.2)
[0.1|-0.3]</td><td>0|0.3
(–)
[–]</td><td>0.2|-0.2
(0.2|-0.2)
[0.2|0.2]</td><td>0.2|-0.1
(0.2|-0.1)
[0.2|0]</td><td>7.7|-0.2
(11|-0.3)
[–]</td><td>1.8|0
(1.4|0)
[1.1|0]</td><td>0.8|-0.3
(0.5|-0.3)
[0.2|-0.4]</td><td>0.3|-0.2
(0.2|-0.2)
[–]</td><td>1.8|0.3
(1.4|0.4)
[2.1|0.4]</td><td>5.1|0.3
(7.2|0.4)
[0.8|0.1]</td><td>0.2|0
(0.3|0)
[0.1|0]</td><td>0|0
(–)
[–]</td><td>20
24
5.2</td></tr>
<tr><td>$Premium$</td><td>0.1|0.2
(0.1|0.2)</td><td>0|0.1
(–)</td><td>0|0.2
(–)</td><td>0|-0.4
(0|-0.3)</td><td>0|0
(–)</td><td>0.1|0.7
(0.1|0.7)</td><td>0.1|-0.4
(0.1|-0.5)</td><td>39|0.4
(29|0.4)</td><td>0.1|-0.8
(0|-0.7)</td><td>0.1|-0.3
(0|-0.2)</td><td>33|-0.2
(24|-0.1)</td><td>1.2|-0.3
(0.8|-0.2)</td><td>1|0.3
(1.1|0.2)</td><td>0|-0.4
(0.1|-0.5)</td><td>0|0
(–)</td><td>75
56</td></tr>
<tr><td>$Spread$</td><td>0.2|-0.6</td><td>0|-0.1</td><td>0|0.4</td><td>0|-0.1</td><td>0|0.5</td><td>0.1|0.2</td><td>0.1|-0.4</td><td>7.8|0.5</td><td>0.1|0.2</td><td>0.2|0.7</td><td>0.4|-0.5</td><td>0.4|0</td><td>3.1|-0.3</td><td>0.1|0</td><td>0.4|0.6</td><td>13</td></tr>
<tr><td>R</td><td>0.1|-0.4
(0.2|-0.5)
[0.1|-0.2]</td><td>0|-0.4
(–)
[–]</td><td>0|0.5
(–)
[–]</td><td>0|-0.4
(0|-0.5)
[0.1|-0.5]</td><td>0|-0.1
(–)
[–]</td><td>0|0.1
(0.1|0.2)
[0|-0.4]</td><td>0.1|-0.3
(0.1|-0.2)
[0.1|0.2]</td><td>3.8|0.4
(5.2|0.4)
[–]</td><td>0.1|0
(0.1|0.3)
[0|0.4]</td><td>0.1|0.7
(0.1|0.8)
[0|0.6]</td><td>0.1|-0.5
(0.1|-0.4)
[–]</td><td>1|0.9
(0.8|0.9)
[0|0.7]</td><td>1.8|-0.4
(2.9|-0.3)
[0.5|0.9]</td><td>0|-0.2
(0.1|-0.1)
[0|0.2]</td><td>0|0
(–)
[–]</td><td>7.1
9.7
0.78</td></tr>
<tr><td>$D(P^I/P)$</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(–)
[–]</td><td>0|0
(–)
[–]</td><td>1|1
(1|1)
[1|1]</td><td>0|0
(–)
[–]</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(0|0)
[–]</td><td>0|0
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[–]</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(0|0)
[0|0]</td><td>0|0
(–)
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1
1</td></tr>
<tr><td>$D(P^{oil}/P)$</td><td>0|0
(0|0)
[0|0]</td><td>0|0
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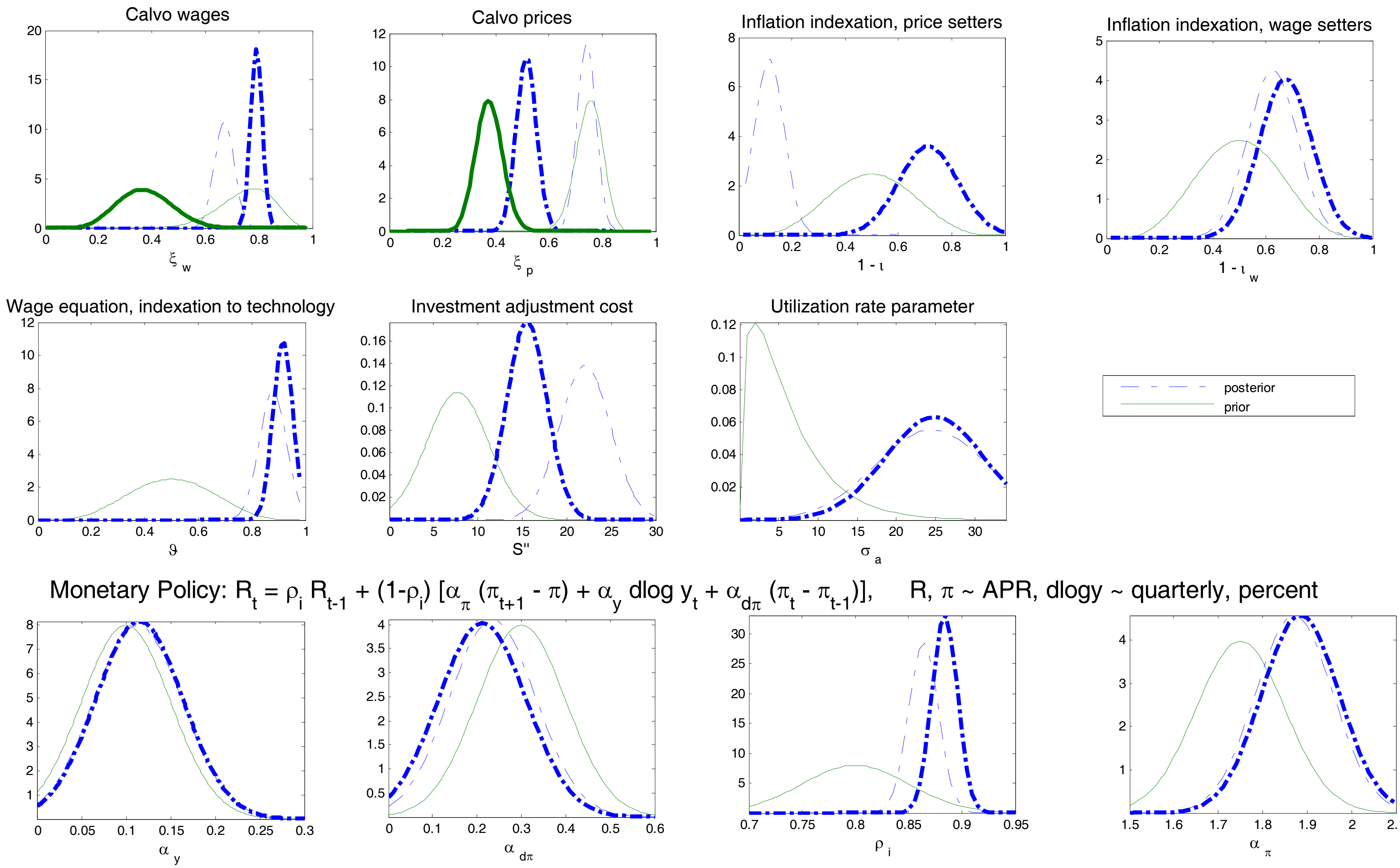
(0|0)
[0|0]</td><td>0|0
(0|0)
[0|0]</td><td>1|1
(1|1)
[1|1]</td><td>0|0
(–)
[–]</td><td>1
1
1</td></tr>
<tr><td>$Reserve$</td><td>0.1|-0.1</td><td>0.7|0.5</td><td>0.1|-0.2</td><td>0|-0.6</td><td>0.4|0.5</td><td>0|0</td><td>0|0.1</td><td>1.1|-0.1</td><td>0.1|-0.2</td><td>0.2|0.4</td><td>0|0.1</td><td>0.1|0.4</td><td>0.6|0.2</td><td>0|0.4</td><td>0|0</td><td>3.4</td></tr>
</table>

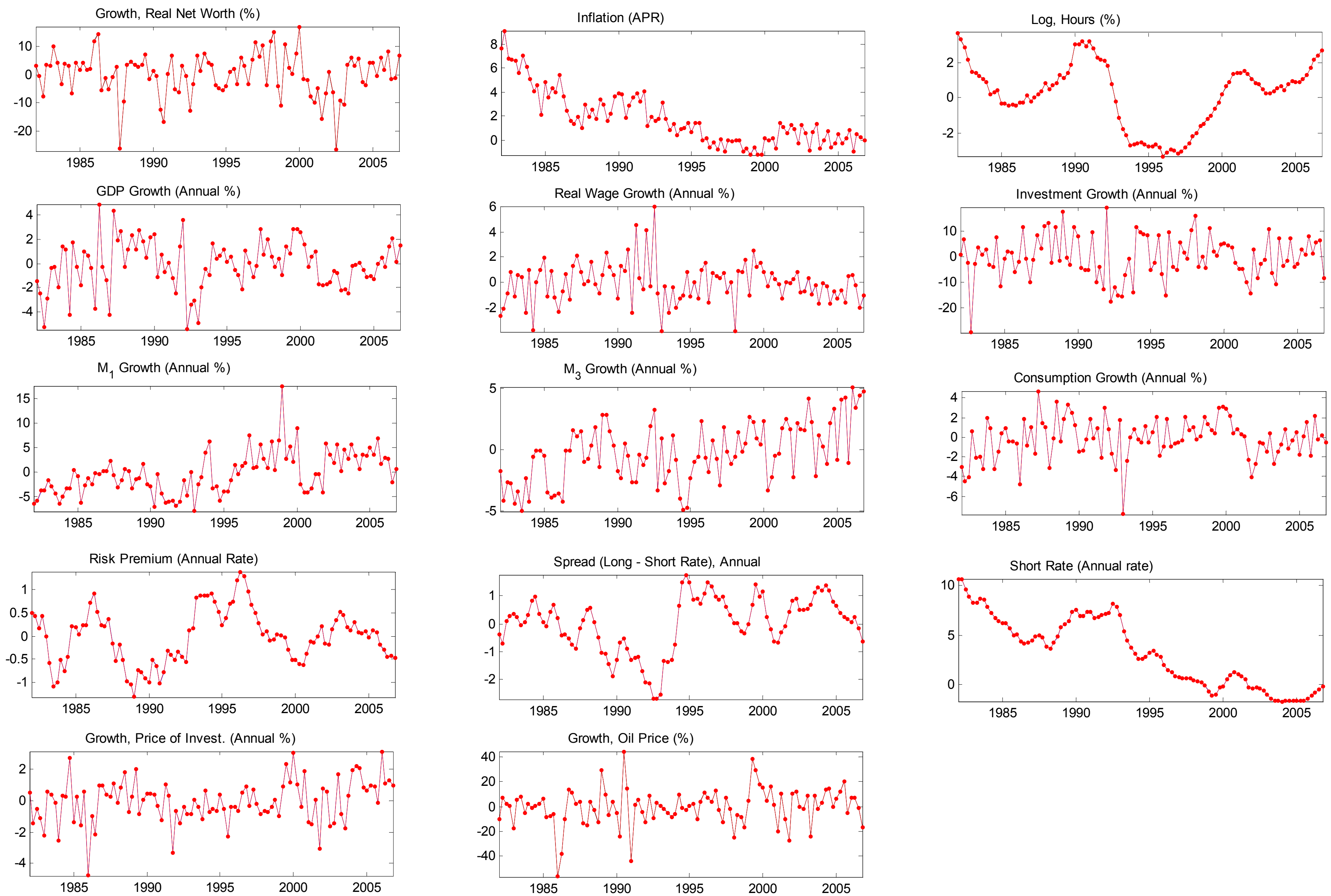
Legend: For each variable, figures for the benchmark model are in the first row. The alternative models, if present, are in the following rows. Financial accelerator model is denoted by (). Simple Model is denoted by []. Note: The first element of each column refers to the in-sample relative variance computed as var(y(i))/var(y), where var(y(i)) is the variance of variable y under the counterfactual simulation that all estimated shocks, with the exception of shock i, are set to zero, and var(y) is the variance of the two-sided fitted variable y. The second element of each column refers to the correlation, corr(y,y(i)). The last column displays the sum of the relative variances.

Figure 1: Priors and Posteriors (US - thick line, EA - thin line)



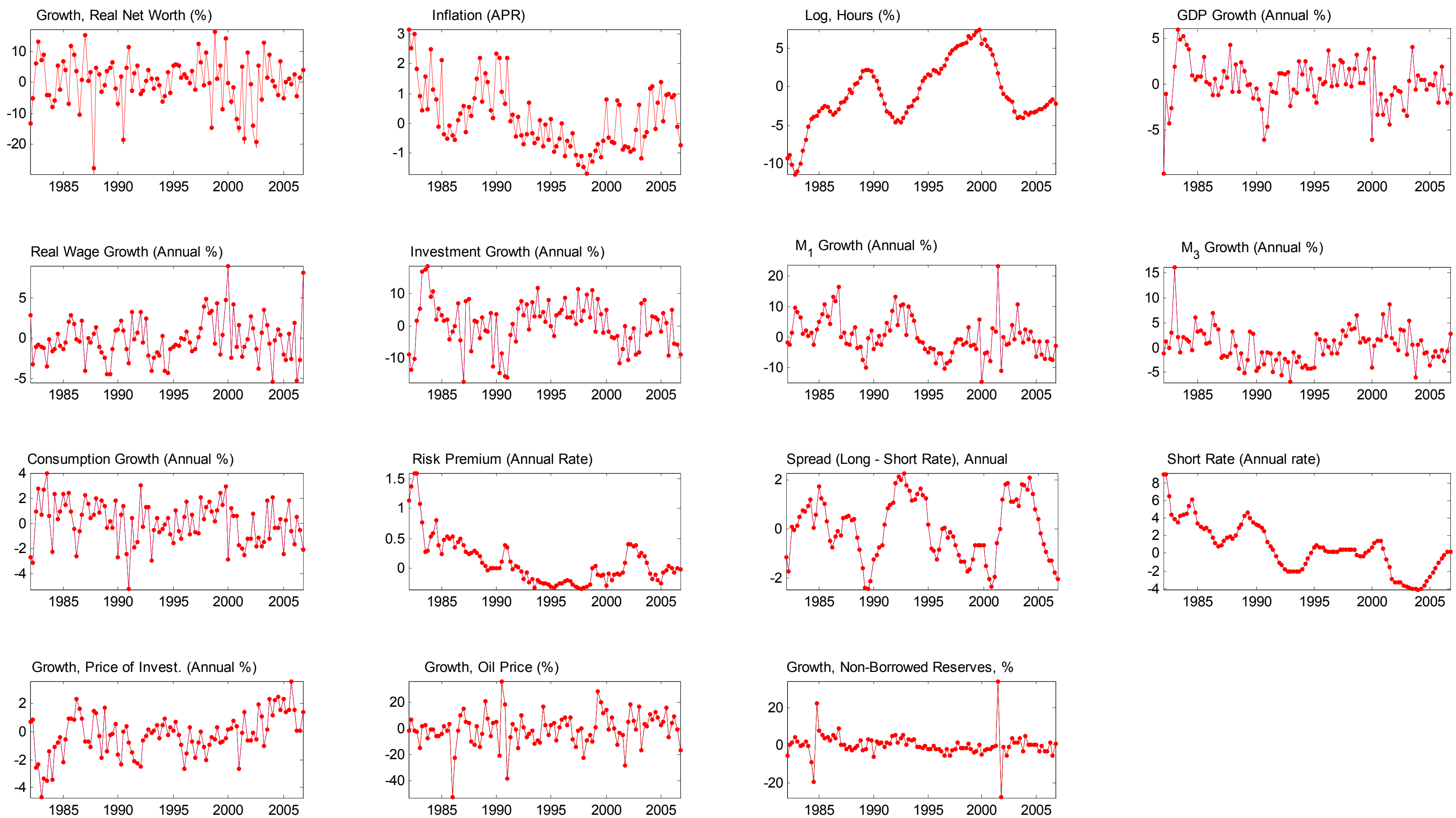
Note: posterior distributions computed using Laplace approximation

Figure 2a: Euro Area - Actual (solid line) and Fitted (dotted line) Data



Notes: (1) Vertical distance between lines in each corresponds to measurement error (which is approx zero).
(2) Model fitted values are computed using the two-sided Kalman smoother.

Figure 2b: US - Actual (solid line) and Fitted (dotted line) Data



See notes to figure 2a.

Figure 3a: EA, Estimated Economic Shocks

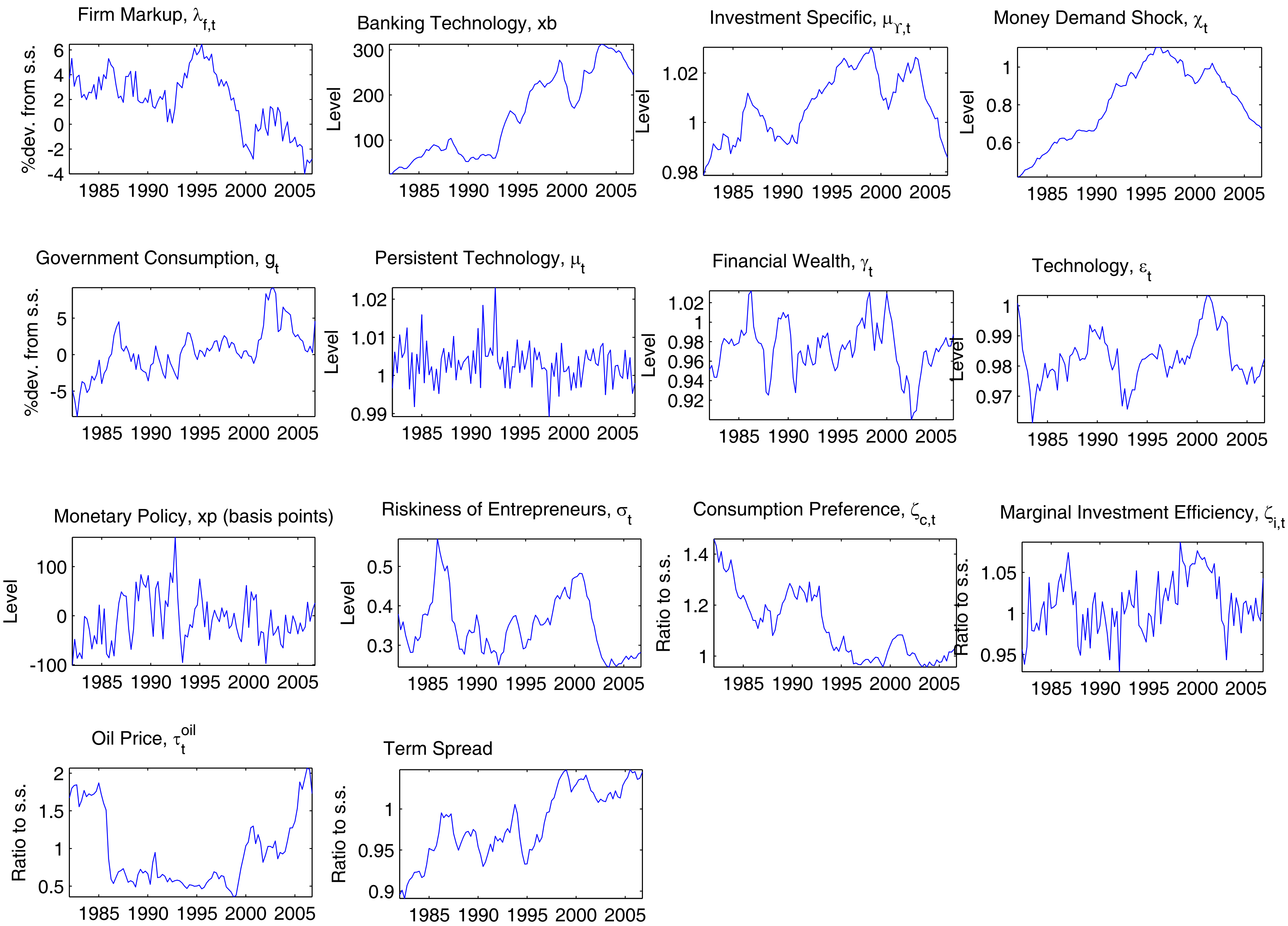


Figure 3b: US, Estimated Economic Shocks

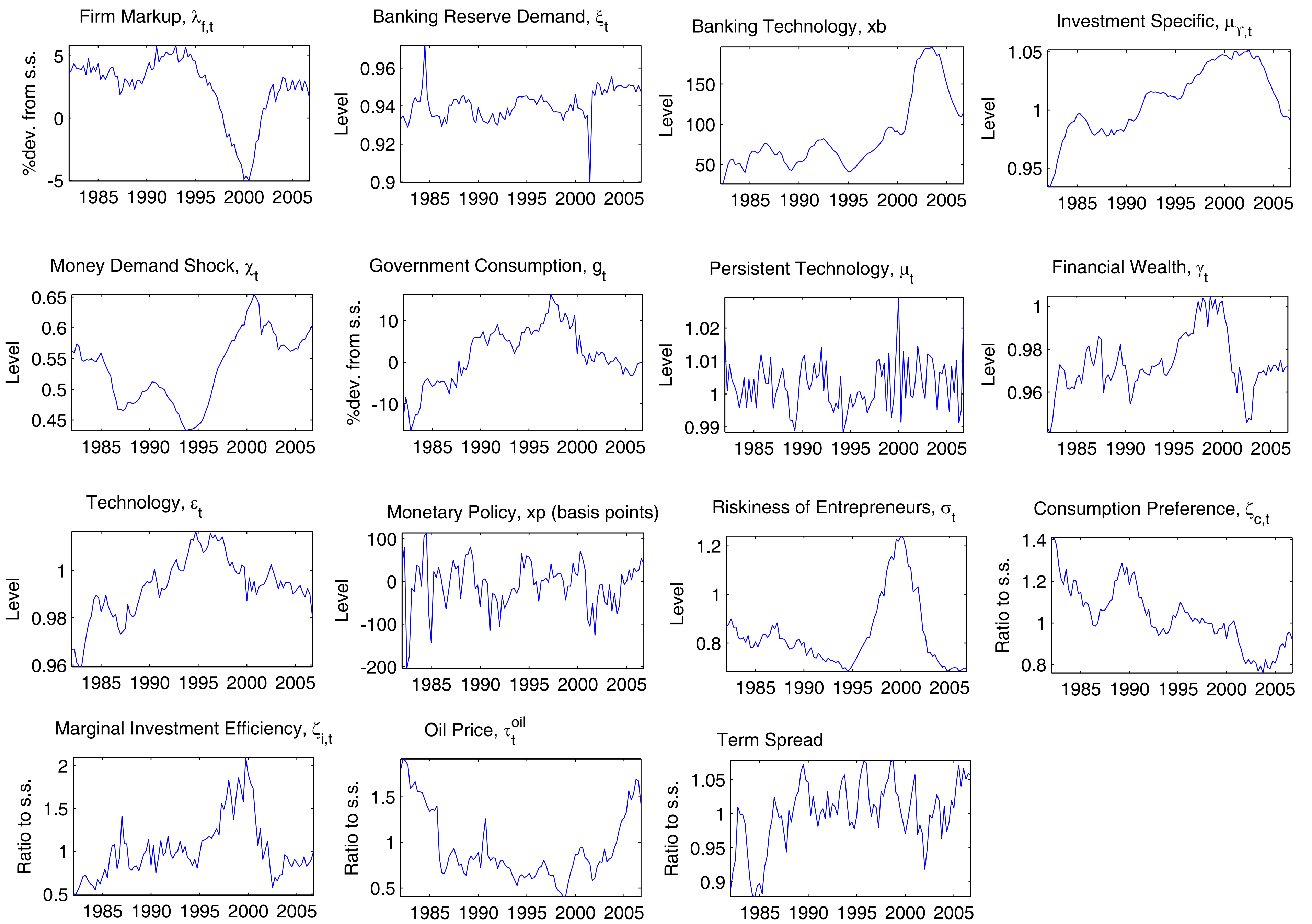


Figure 4a: Out of Sample RMSE, EA, 5 models Confidence Band Represents 95% Confidence Bound Centred Around BVAR

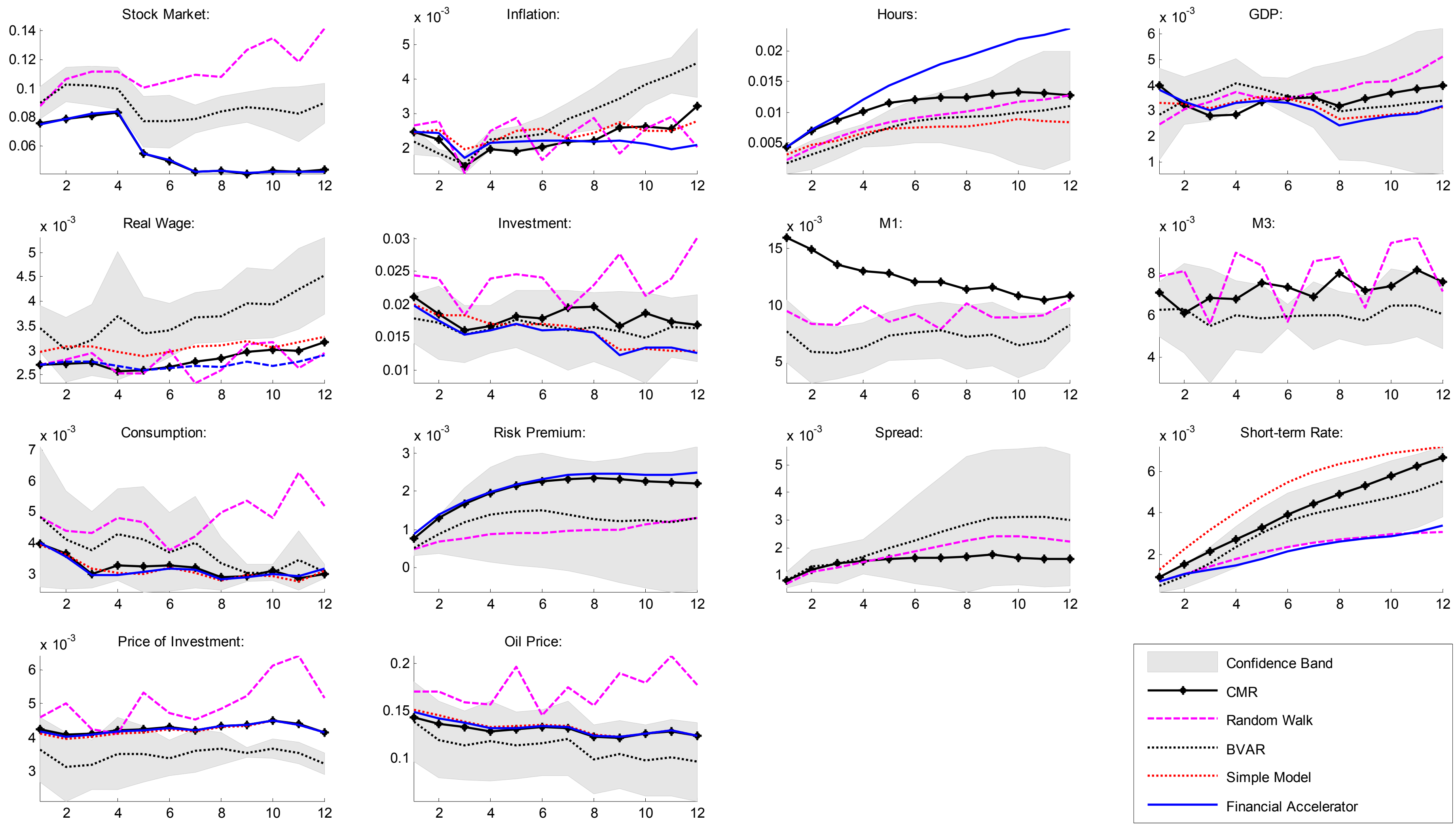


Figure 4b:Out of Sample RMSE, US, Out-of-Sample Confidence Band Represents 95 % Confidence Interval Centered on BVAR

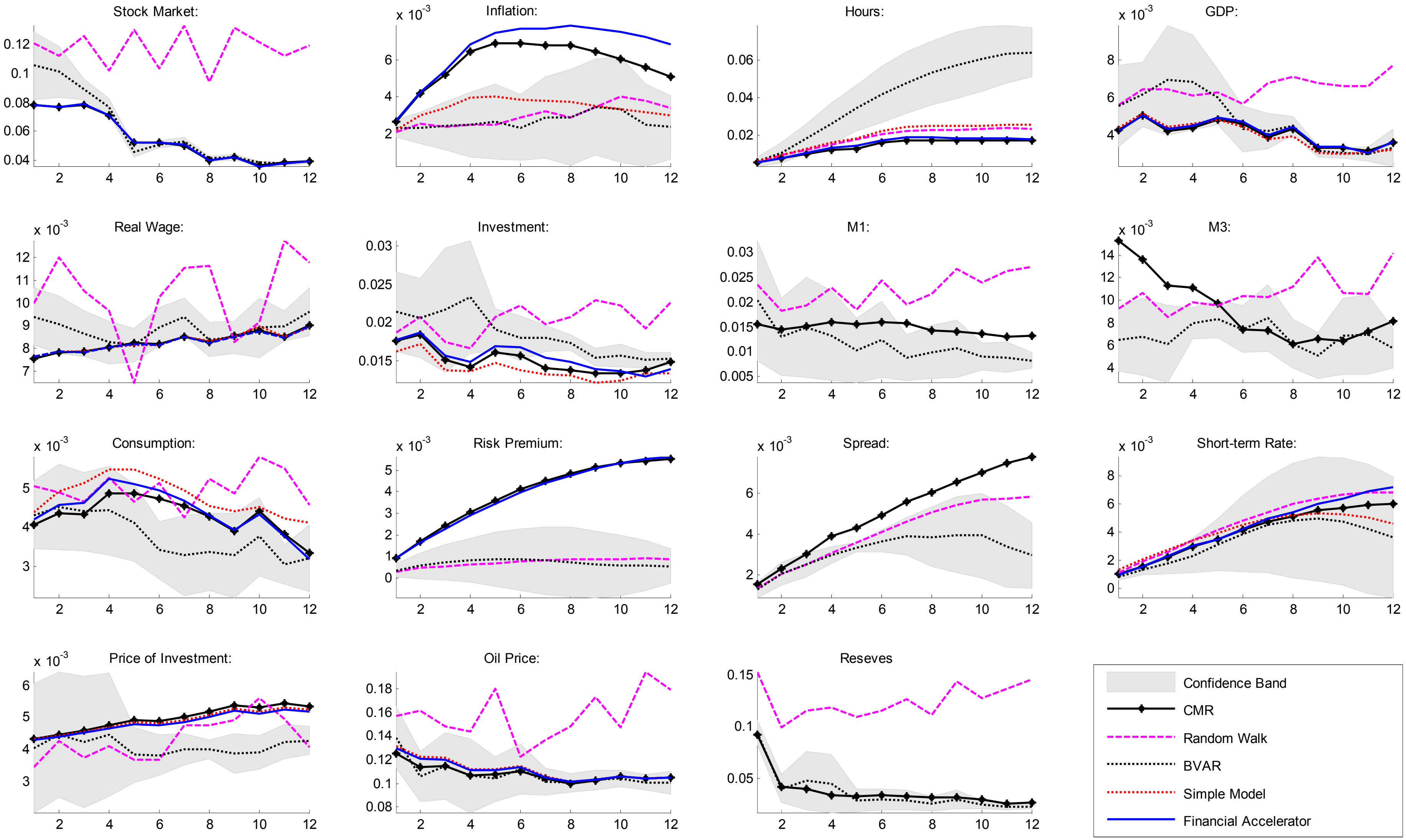


Figure 5: Response to a shock in monetary policy, ε_t, EA model

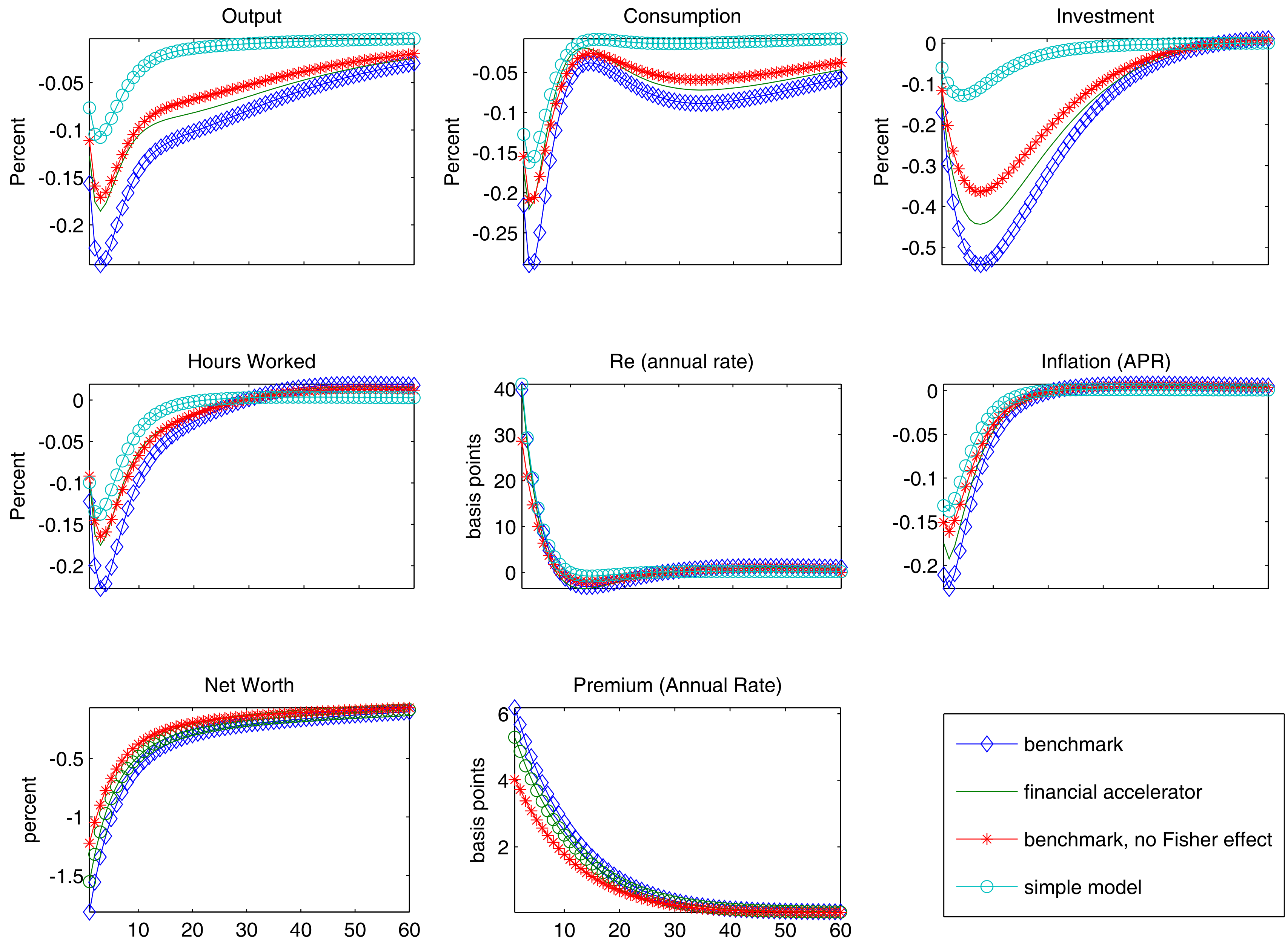


Figure 6: Response to a financial wealth shock, γ_t, EA model

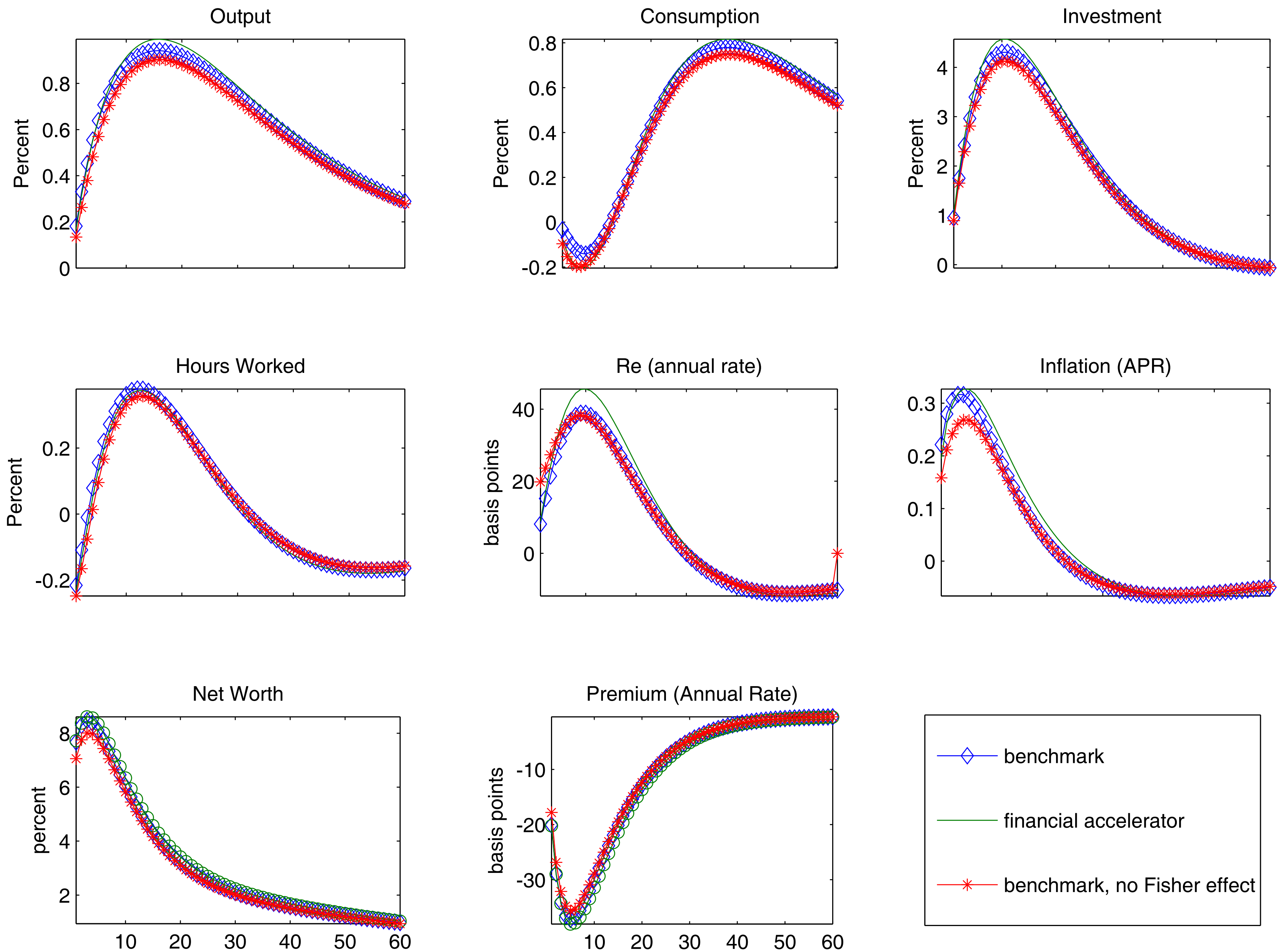


Figure 7: Response to a shock to the marginal efficiency of efficiency, $\zeta_{i,t}$, EA model

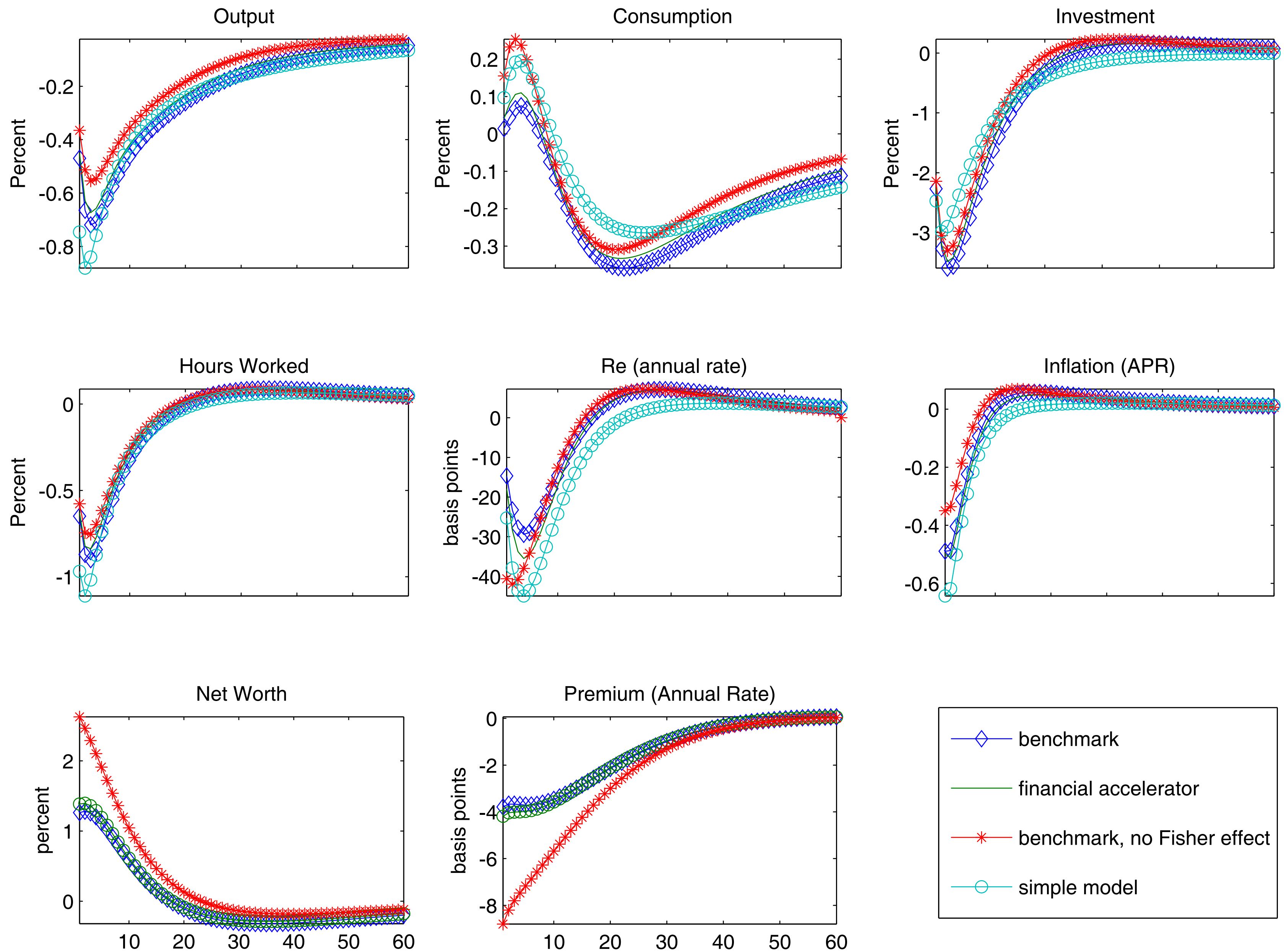


Figure 8: Supply (Capital Producers) and Demand (Entrepreneurs) for Capital

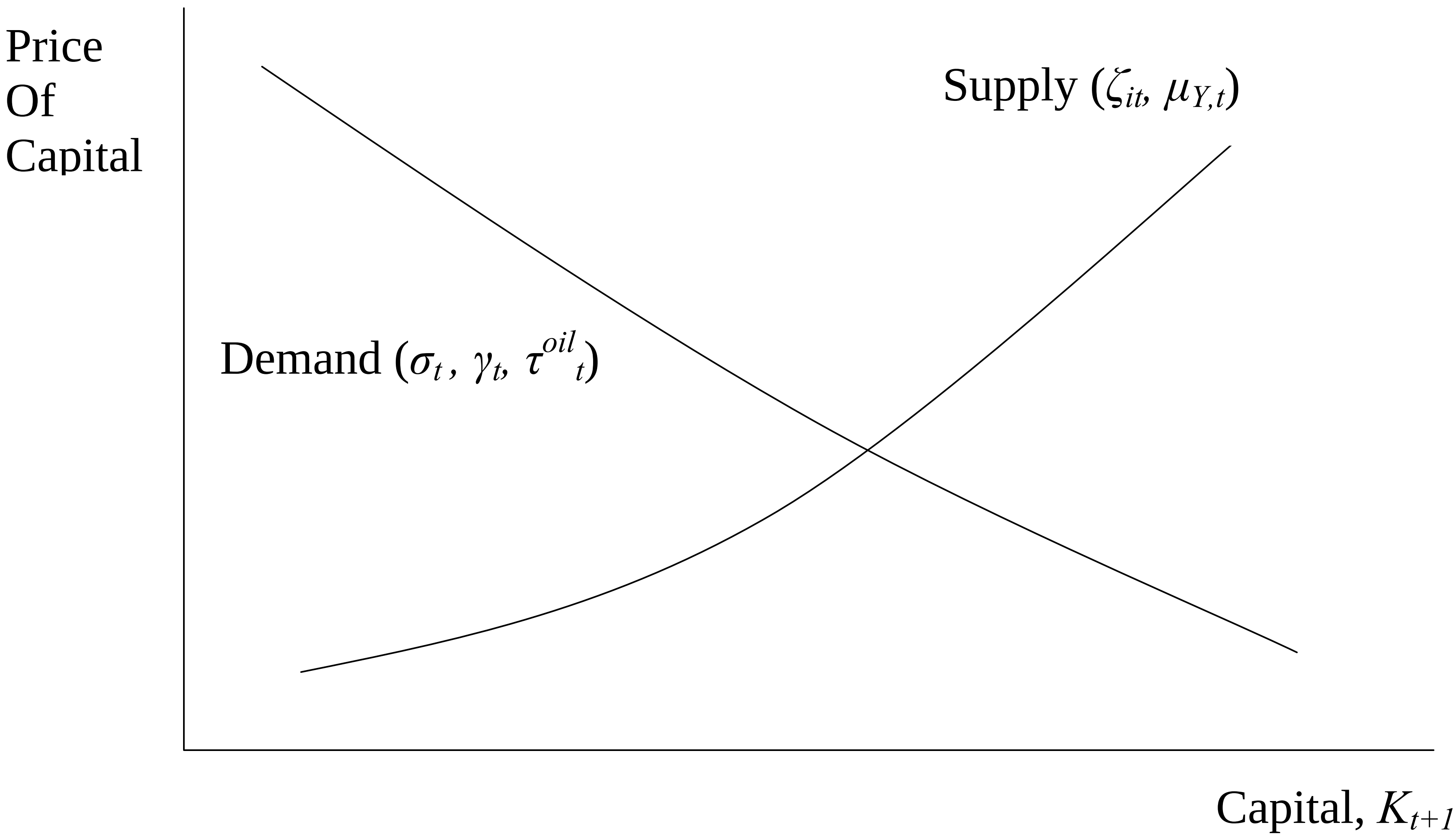


Figure 9: Response to a shock in the banking technology, x_t^b

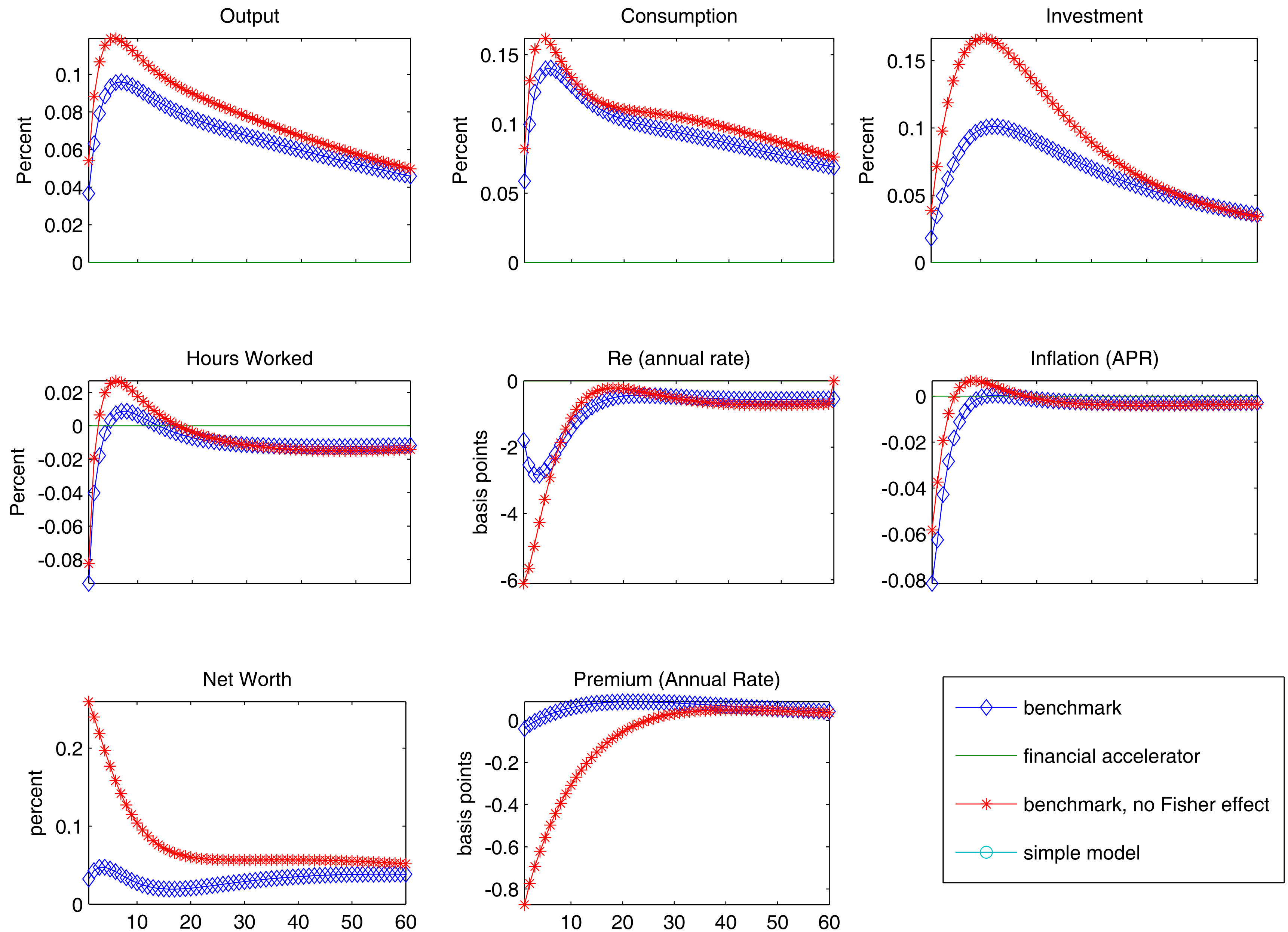


Figure 10: Response to a shock in the temporary neutral technology shock

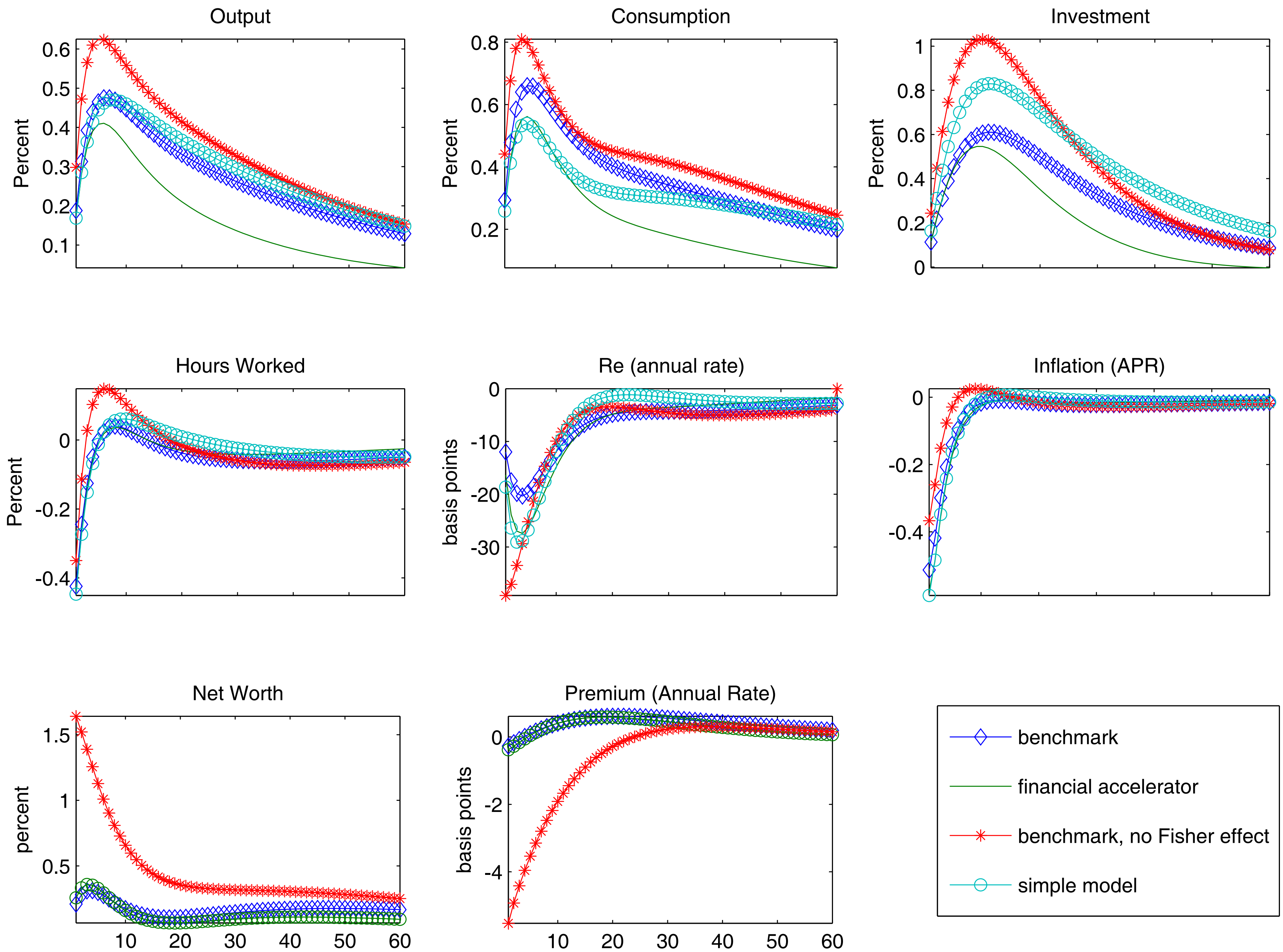


Figure 11: Response to a shock to preferences, $\zeta_{c,t}$

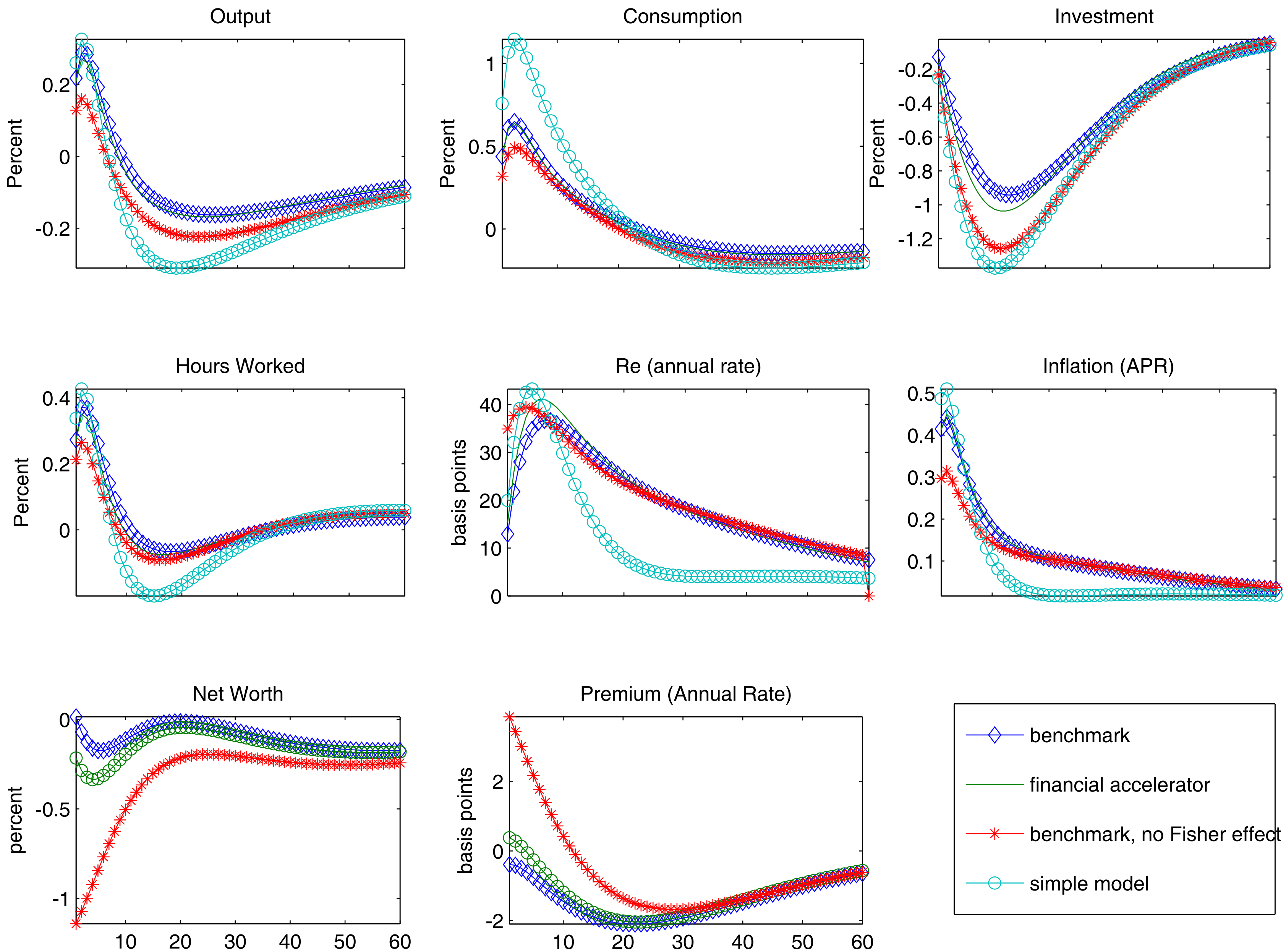


Figure 12: Response to a shock in $\lambda_{f,t}$

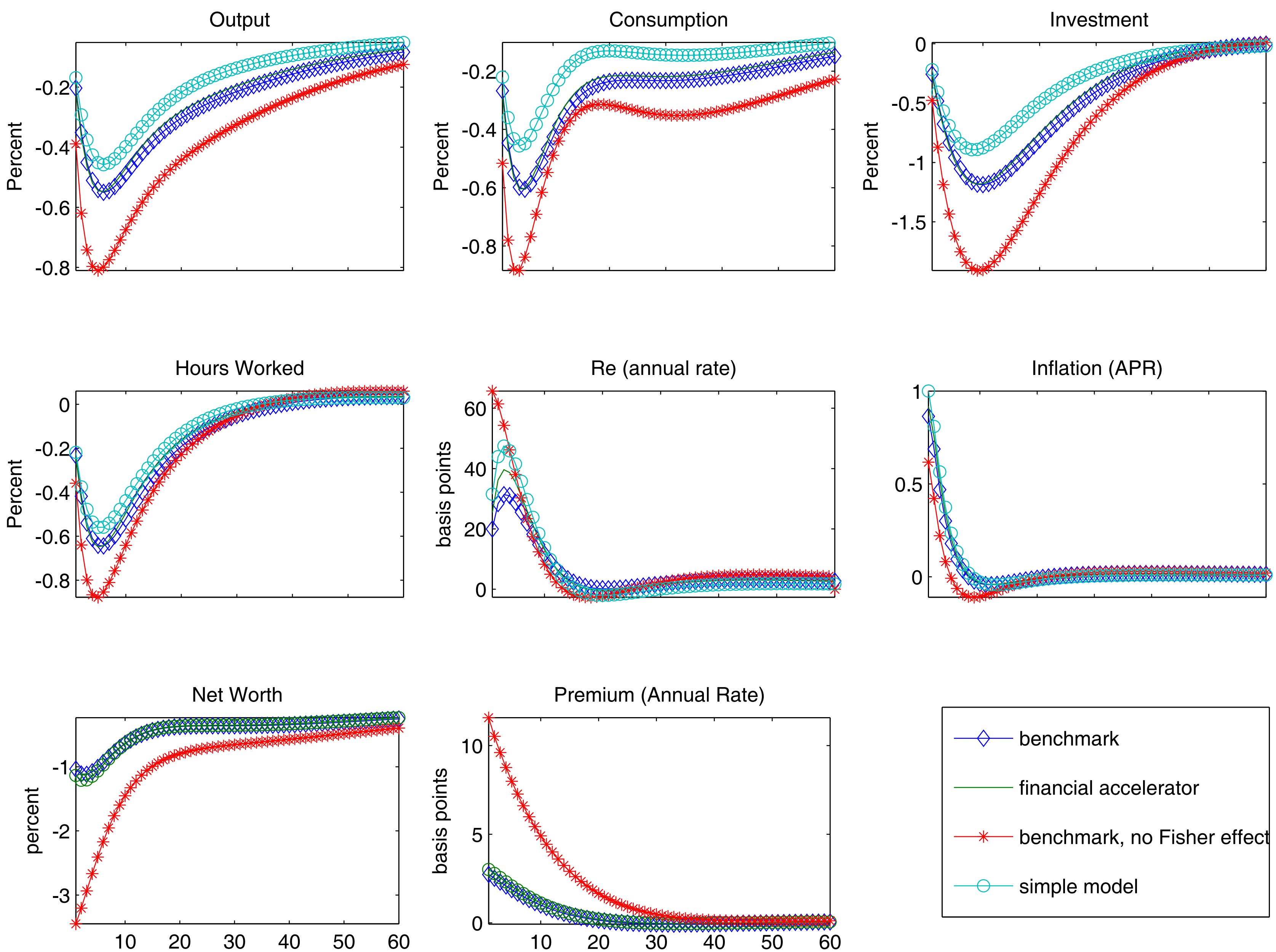


Figure 13: Variance Decomposition at Different Frequency

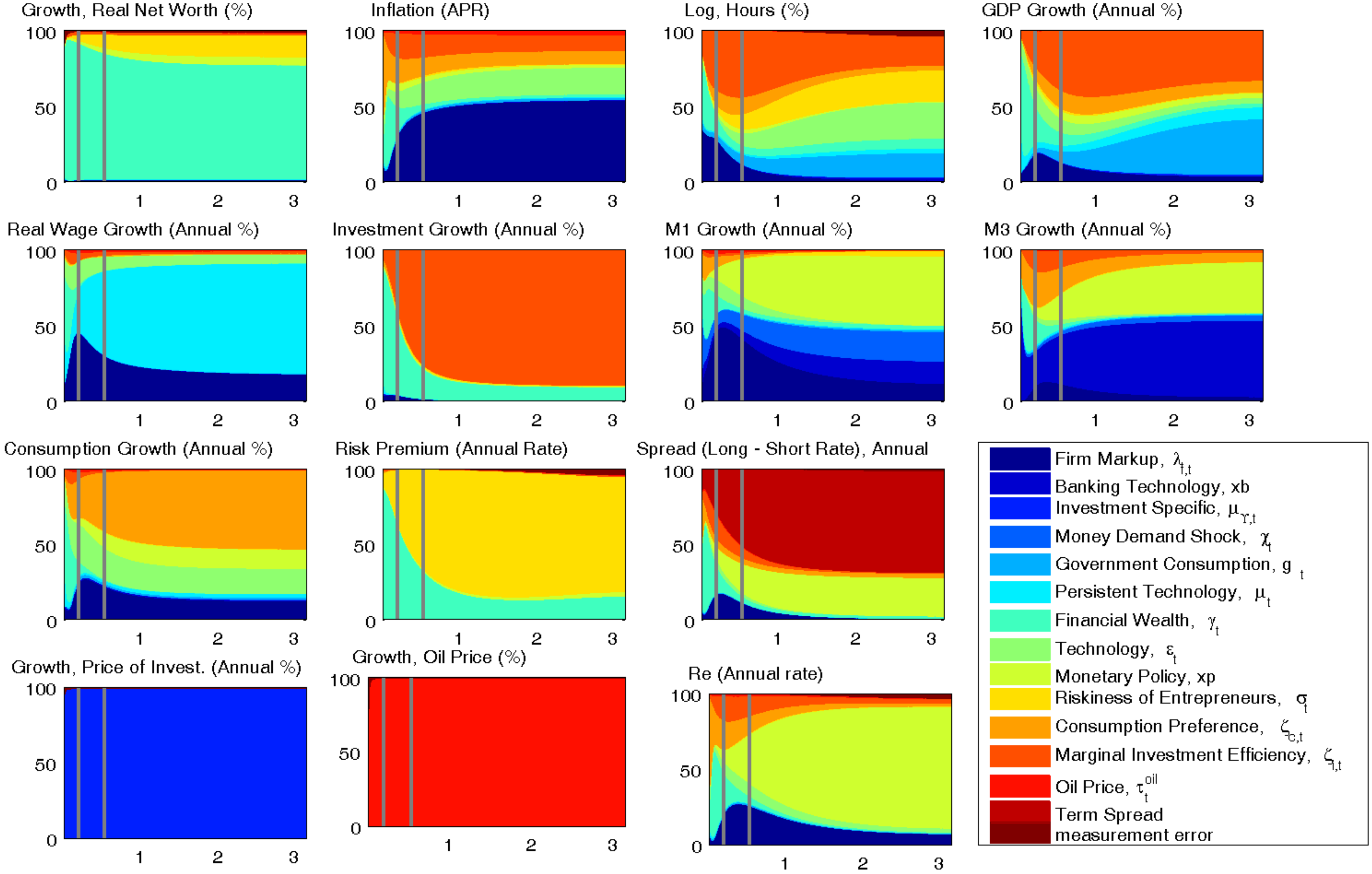


Figure 14a. Euro Area, Decomposition of historical GDP
(year-on-year % change)

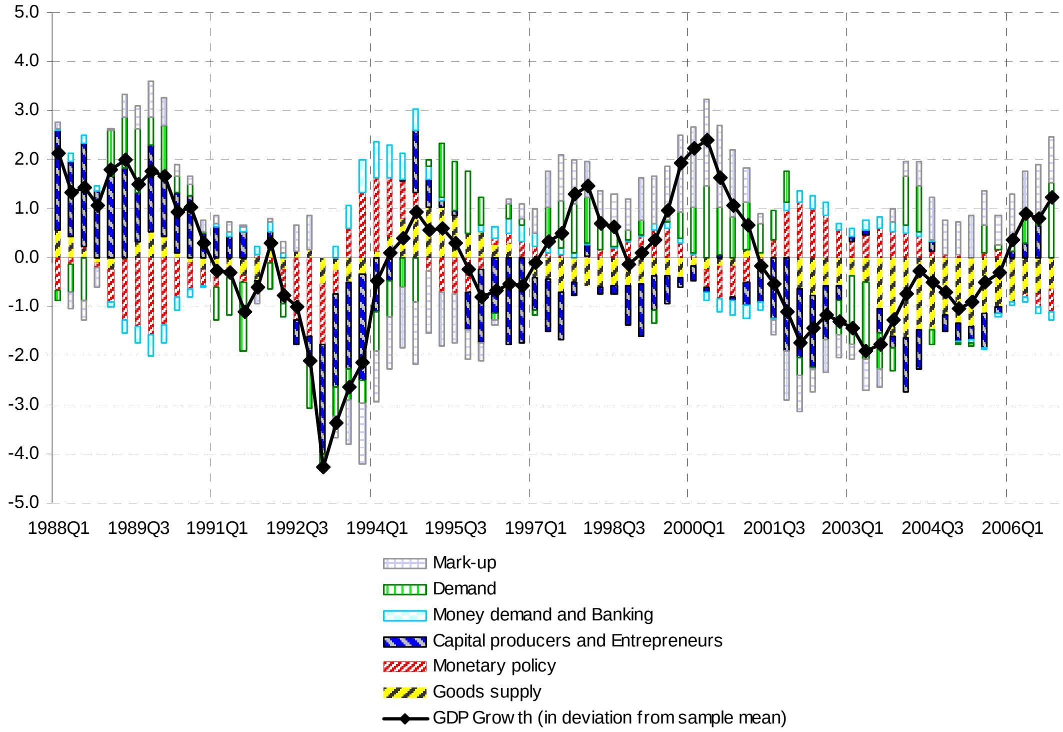


Figure 14b. US, Decomposition of historical GDP
(year-on-year % change)

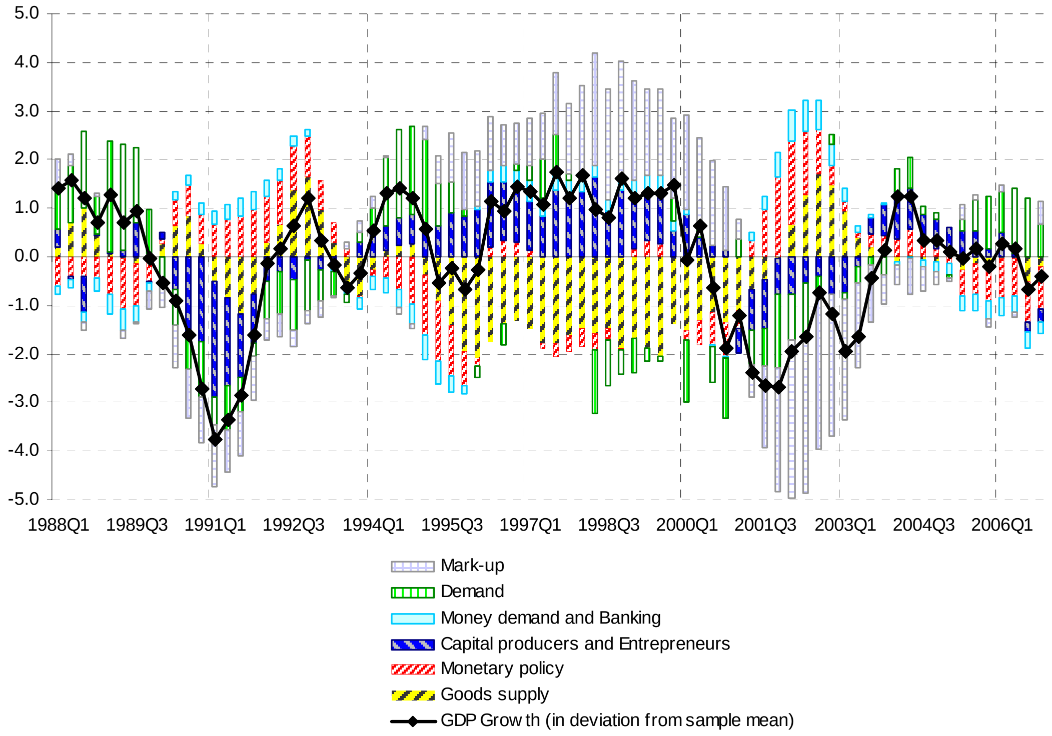


Figure 15a. Euro Area, Decomposition of historical inflation

(year-on-year % change)

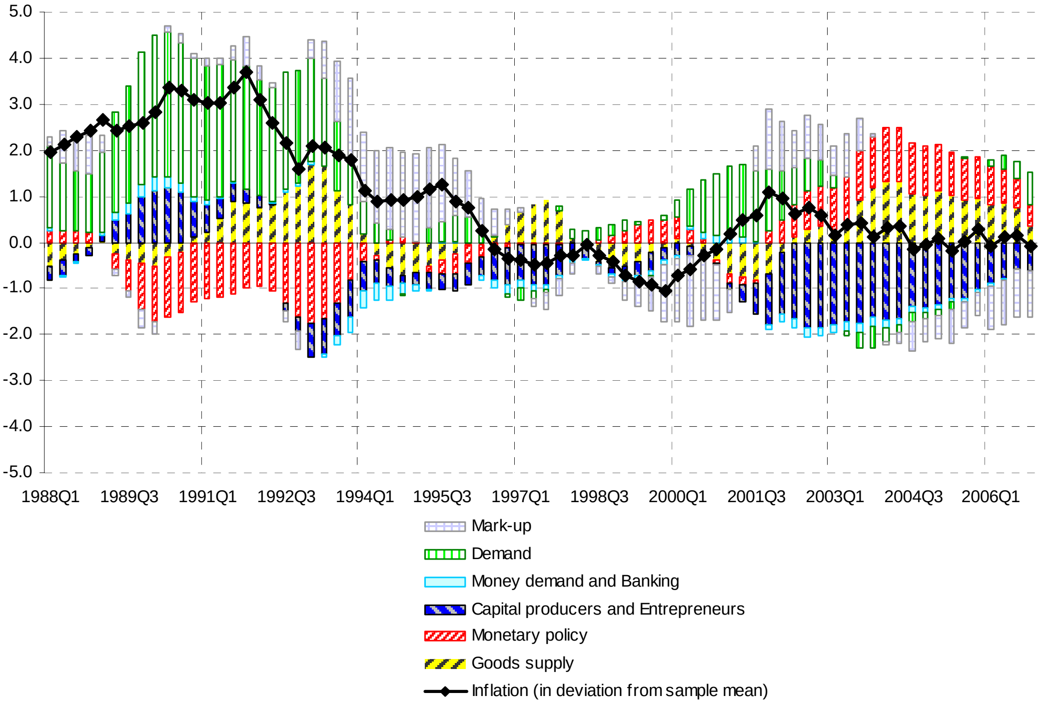


Figure 15b. US, Decomposition of historical inflation

(year-on-year % change)

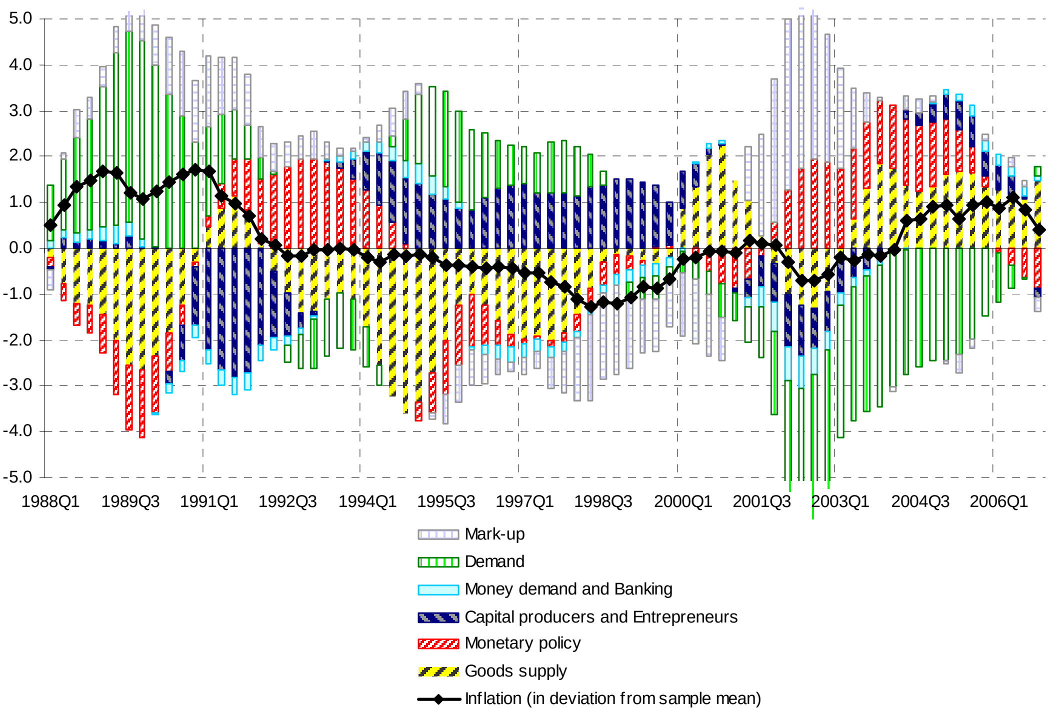


Figure 16: Smoothed GDP (-) and Data driven by just the indicated shock (*). EA (left) and US (right)

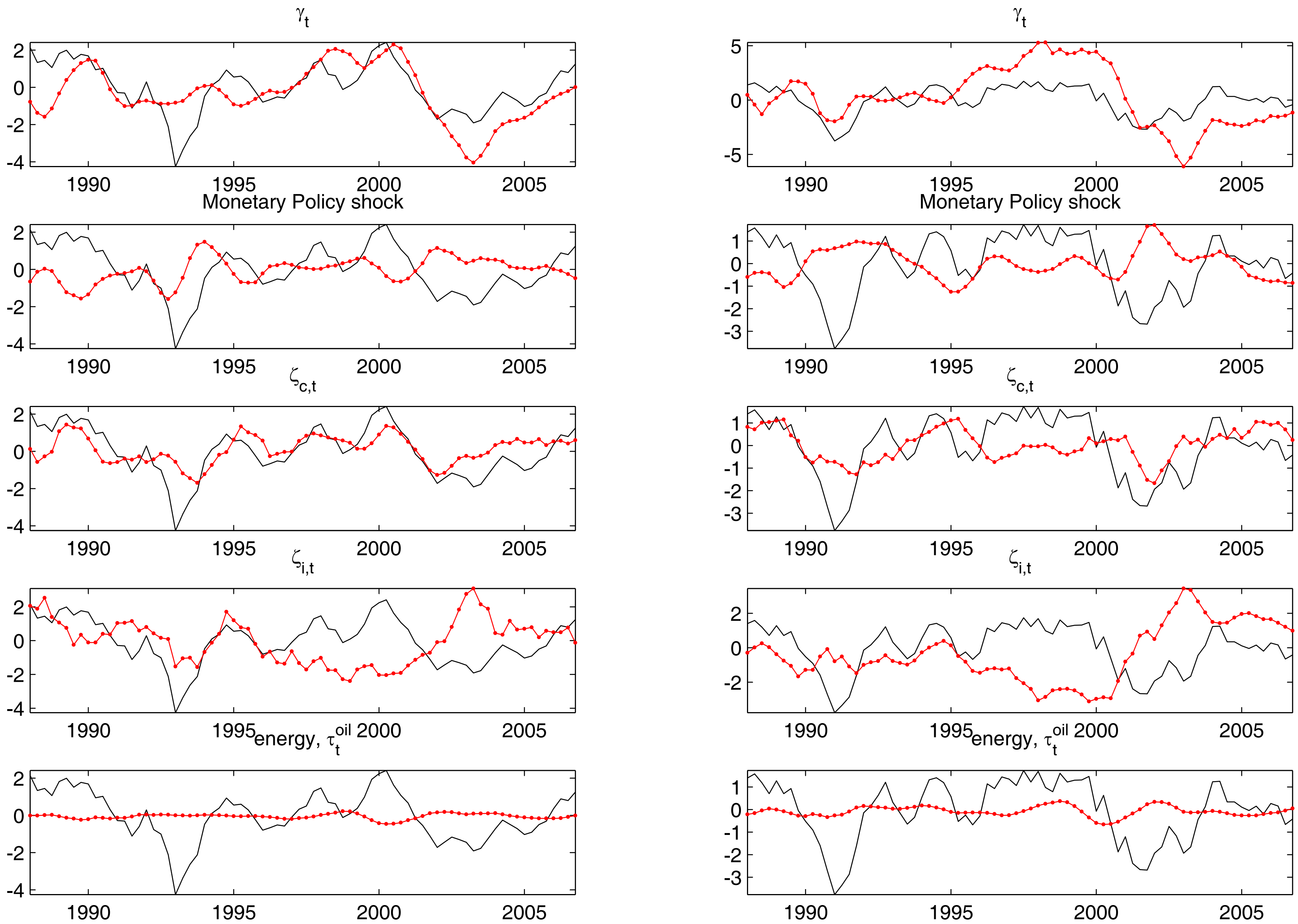


Figure 17: Smoothed Inflation (-) and Data driven by just the indicated shock (*). EA (left) and US (right)

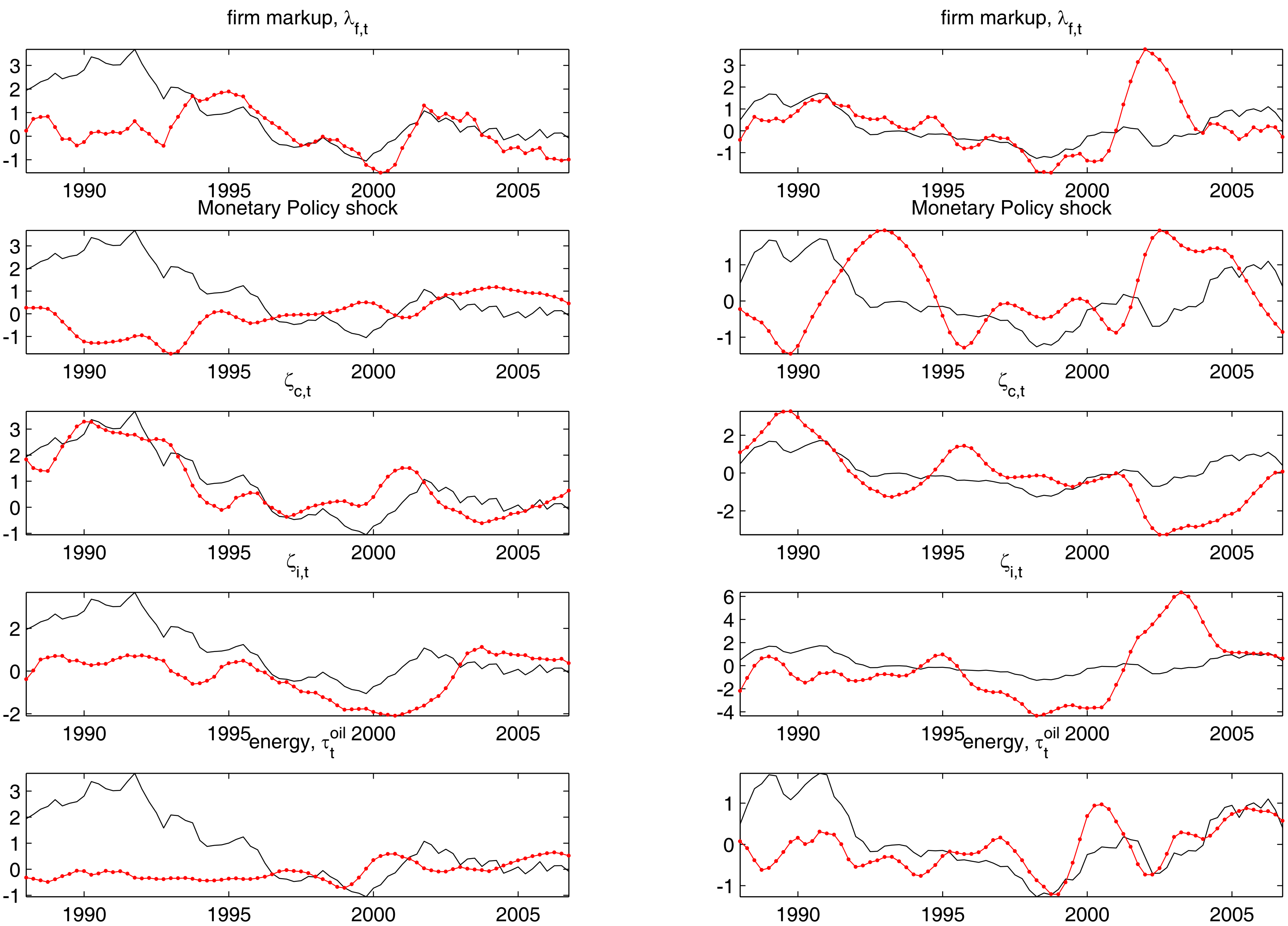


Figure 18: Smoothed Stock market (-) and Data driven by just the indicated shock (*). EA (left) and US (right)

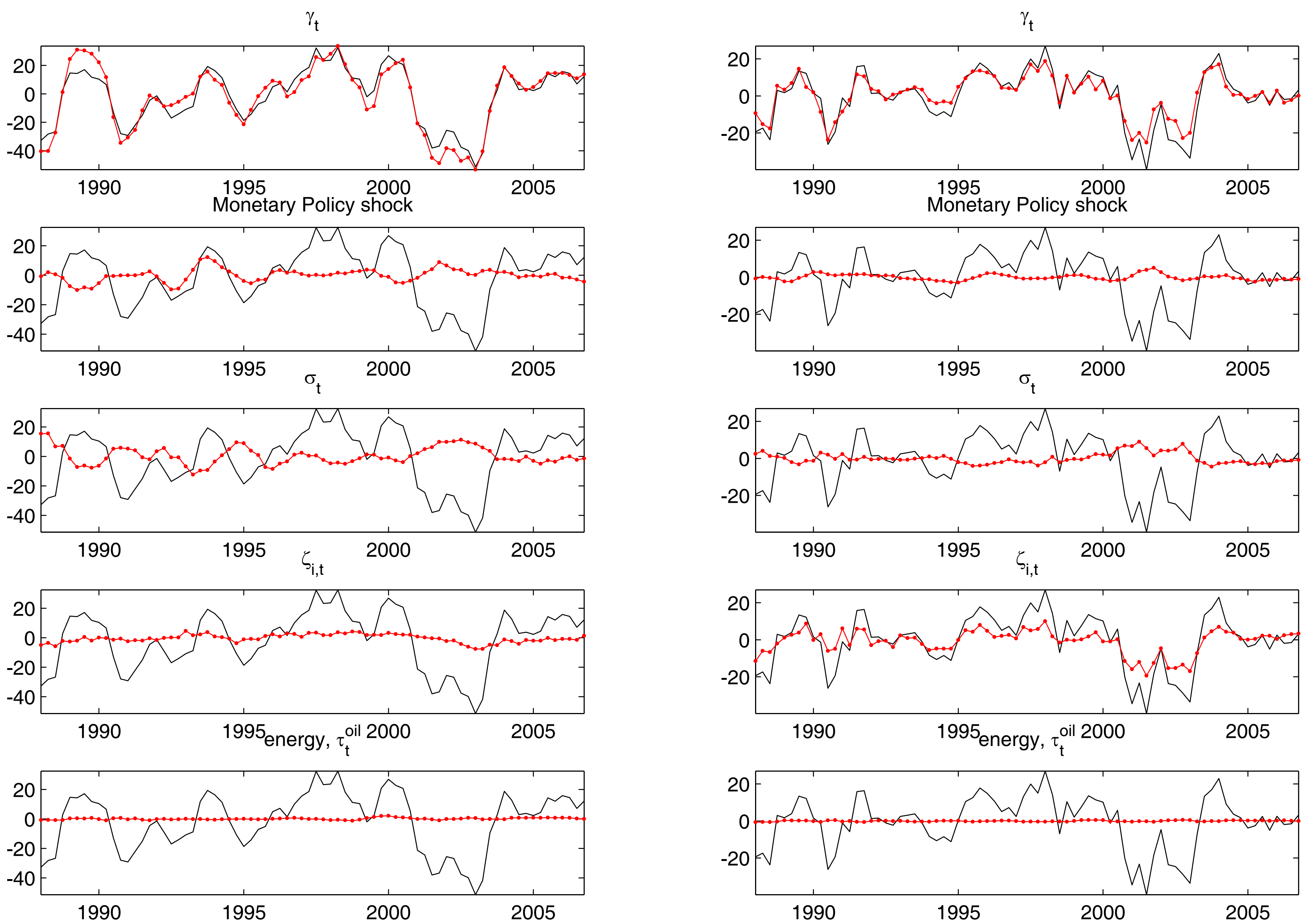


Figure 19: Anatomy of the US Boom-Bust

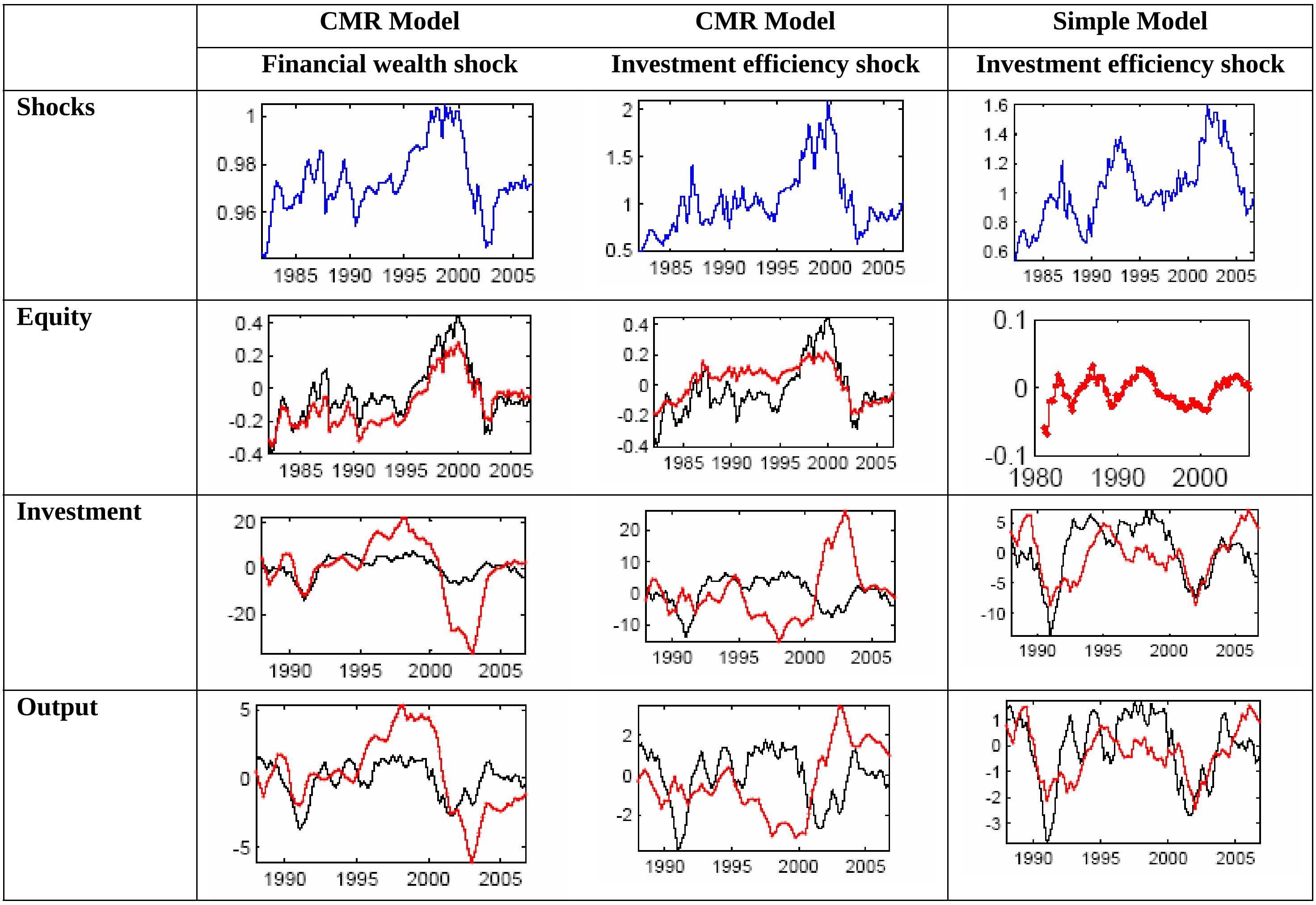


Figure 20a: various weights on stock market

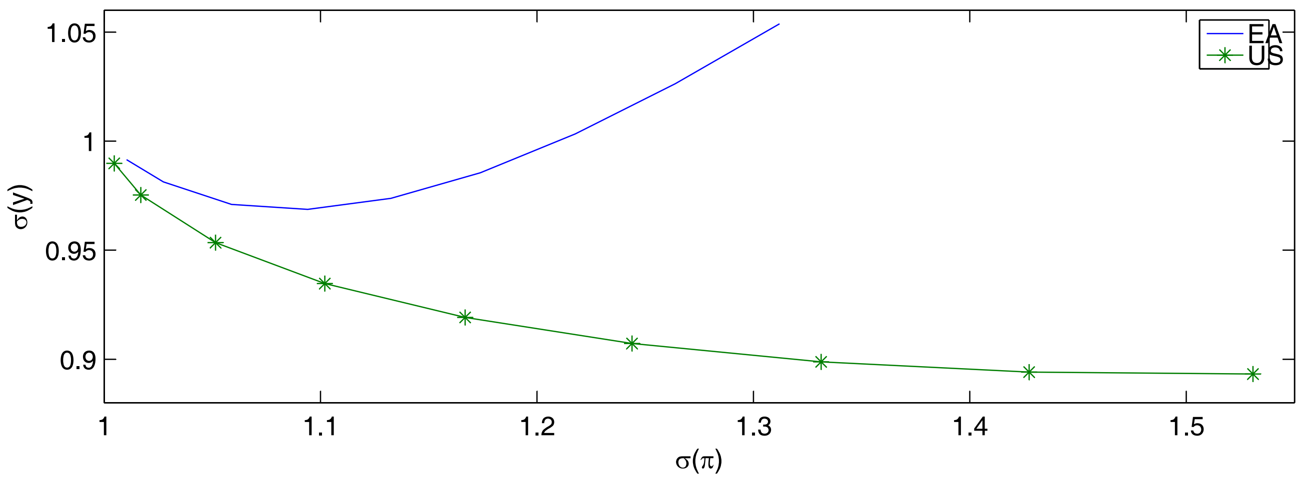


Figure 20b: various weights on broad money

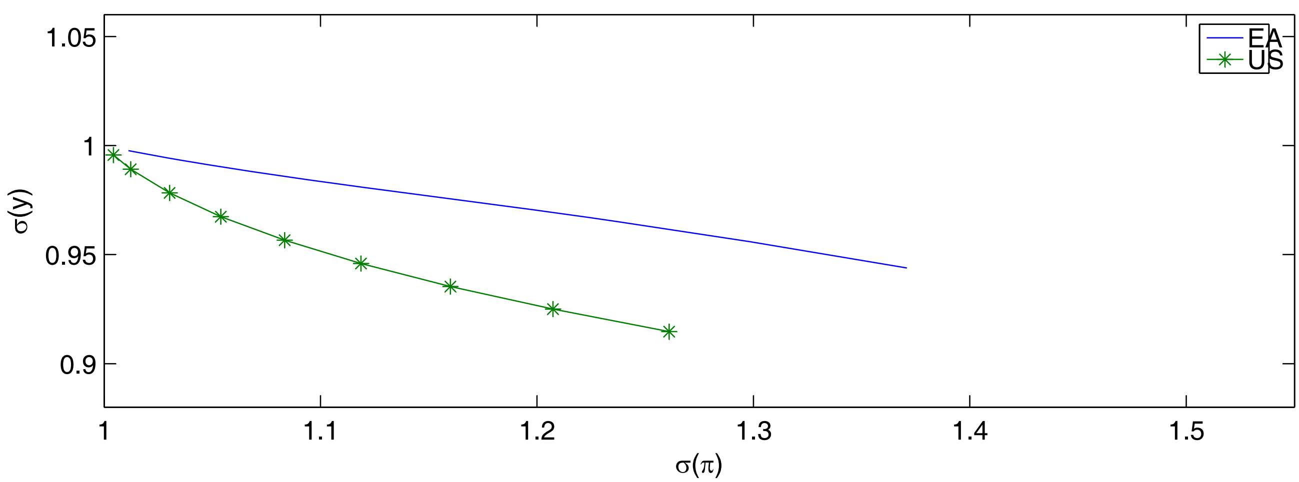
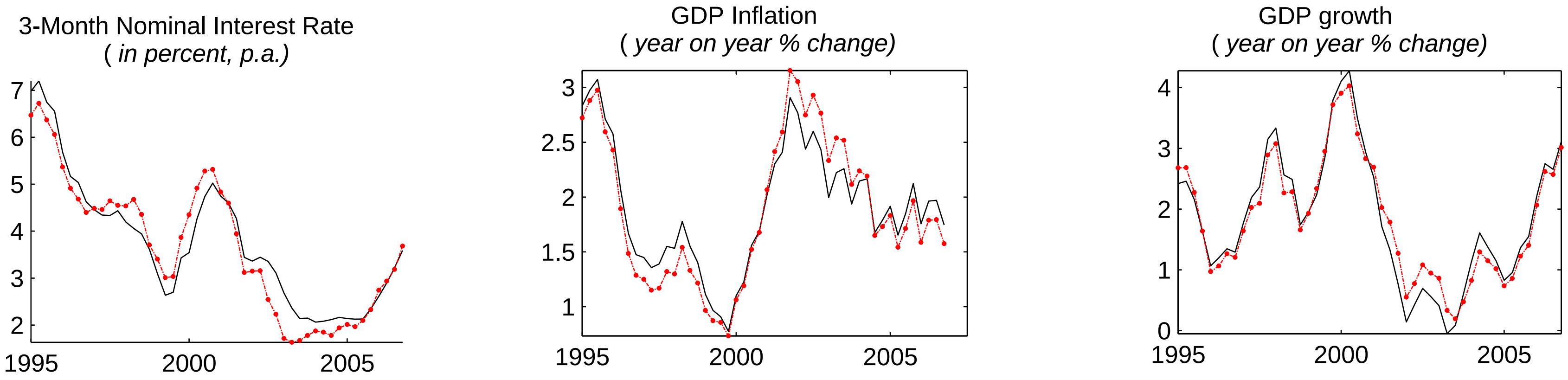


Figure 21a. EA, Actual (Black Line) and Counterfactual (Dotted Line)

Reaction to quarterly change in stock market with coefficient equal to 0.05



Reaction to quarterly change in M3 with coefficient equal to 0.05

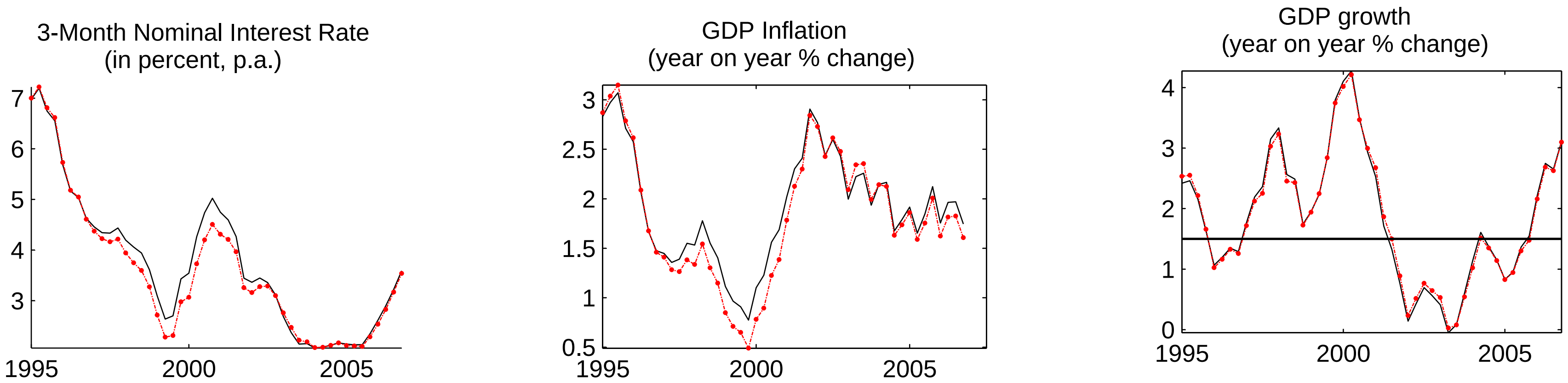
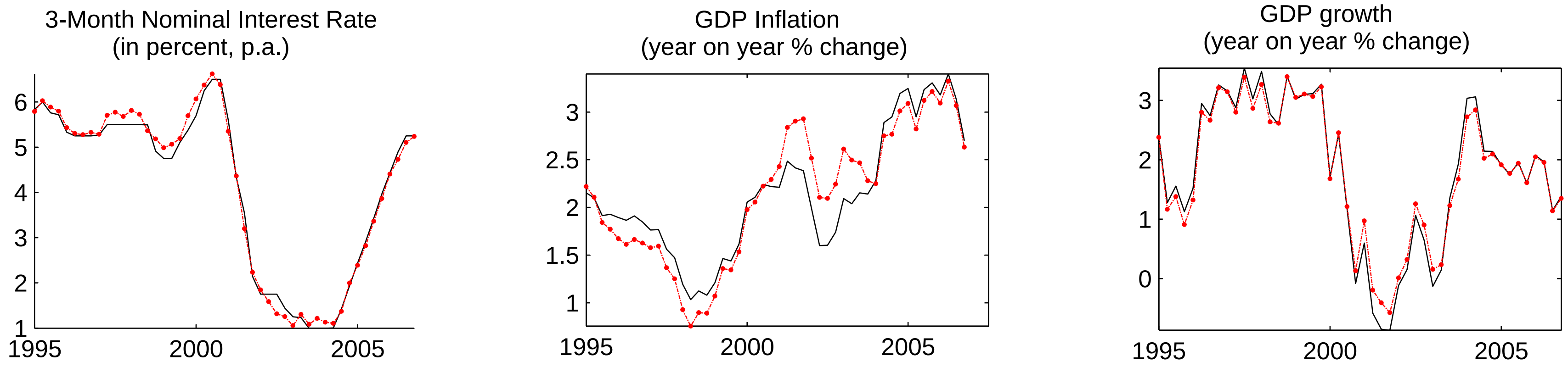


Figure 21b. US: Actual (Black Line) and Counterfactual (Dotted Line)

Reaction to quarterly change in stock market with coefficient equal to 0.05



Reaction to quarterly change in M2 with coefficient equal to 0.05

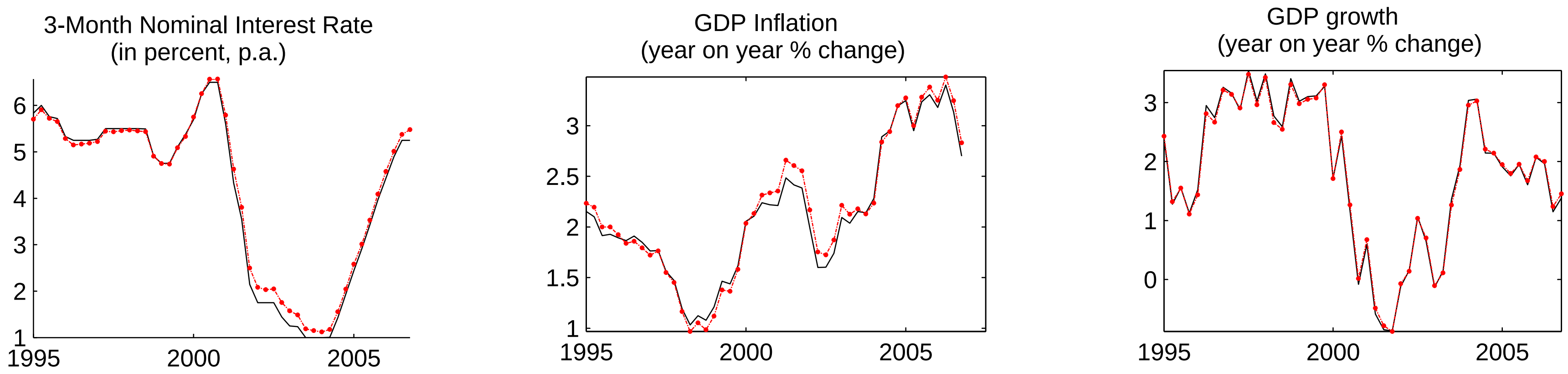


Figure Ea: Euro Area - Weight (λ) on Model versus (1-λ) on BVAR. +/- 1 std Confidence Interval.

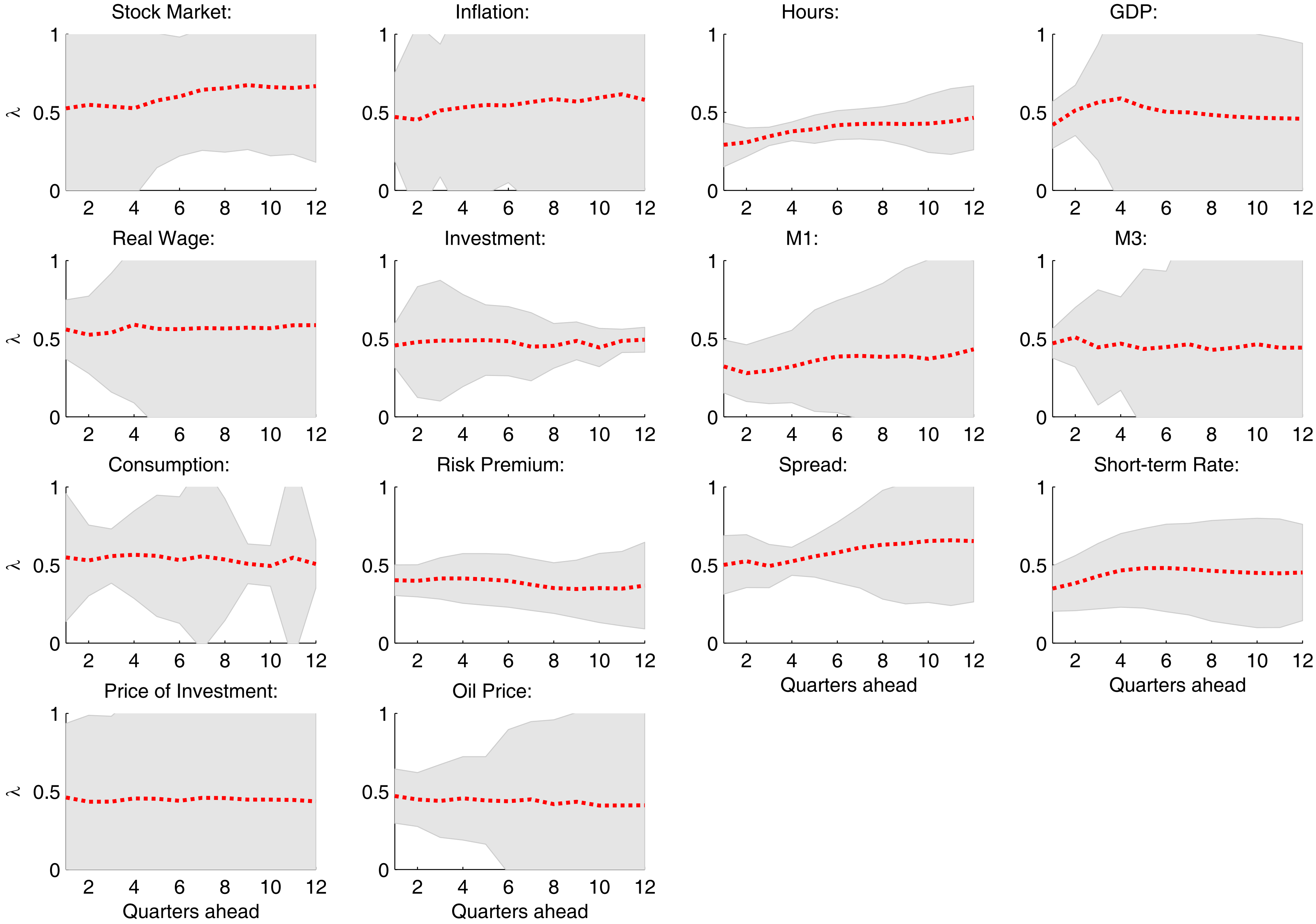


Figure Eb: US - Weight (λ) on Model versus (1-λ) on BVAR. +/- 1 std Confidence Interval.

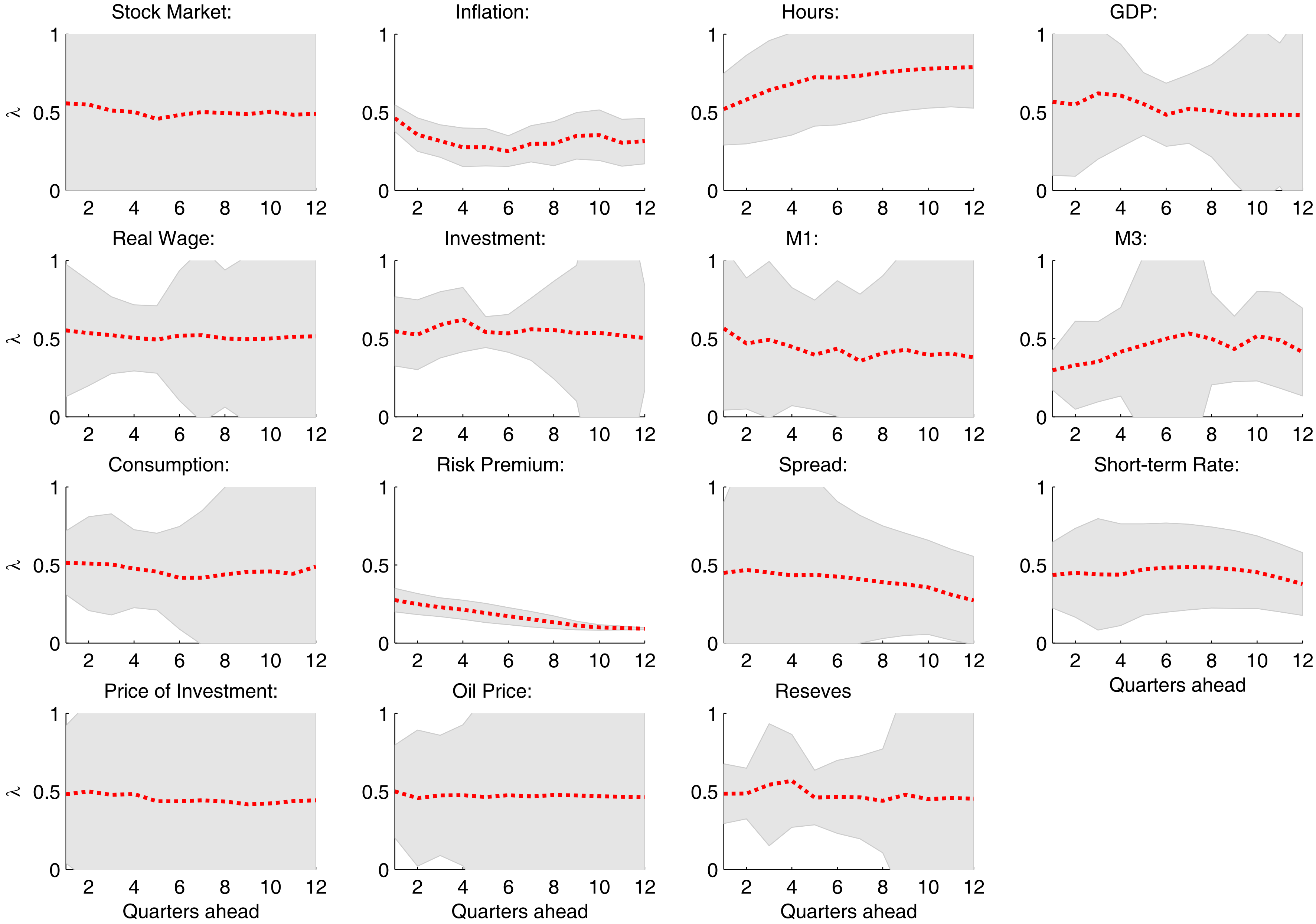


Table B.1. Simple Model Parameter Estimates: EA and US

		Prior			Posterior Euro area		Posterior US	
		Type	Mean	Std. dev.	Mode	Std. dev. (Hess.)	Mode	Std. dev. (Hess.)
ξ_p	Calvo prices	Beta	0.75^* 0.375	0.05	0.7263	0.0361	0.5388	0.0425
ξ_w	Calvo wages	Beta	0.75^* 0.375	0.1	0.6498	0.0444	0.7398	0.0310
ι	Weight on inflation objective	Beta	0.5	0.15	0.8846	0.0544	0.5165	0.1520
ι_w	Weight on inflation objective	Beta	0.5	0.15	0.3195	0.0874	0.2735	0.1138
ϑ	Weight on technology growth	Beta	0.5	0.15	0.8696	0.0554	0.9281	0.0327
S''	Investment adjust. cost	Normal	7.7	3.5	15.886	2.7404	1.1031	0.4303
σ_a	Capacity utilization	Gamma	6	5	27.827	7.9778	22.274	5.5214
α_π	Weight on inflation in Taylor rule	Normal	1.75	0.1	1.8778	0.0901	1.8992	0.0907
α_y	Weight on output growth in Taylor rule	Normal	0.1	0.05	0.1087	0.0499	0.1072	0.0499
$\alpha_{d\pi}$	Weight on change in infl. in Taylor rule	Normal	0.3	0.1	0.2422	0.0964	0.1756	0.0976
ρ_i	Coeff. on lagged interest rate	Beta	0.8	0.05	0.8193	0.0180	0.8177	0.0237
ρ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Beta	0.5	0.2	0.9753	0.0112	0.9885	0.0054
ρ	Government consumption shock (g_t)	Beta	0.5	0.2	0.9467	0.0242	0.9345	0.0225
ρ	Persistent product. shock ($\mu^*_{z,t}$)	Beta	0.5	0.2	0.0562	0.0414	0.1639	0.0763
ρ	Transitory product. shock (ϵ_t)	Beta	0.5	0.2	0.9623	0.0166	0.9929	0.0027
ρ	Consump. prefer. shock ($\zeta_{c,t}$)	Beta	0.5	0.2	0.9110	0.0312	0.9157	0.0245
ρ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Beta	0.5	0.2	0.3155	0.0869	0.8900	0.0318
ρ	Oil price shock (τ_t^{oil})	Beta	0.5	0.2	0.9167	0.0280	0.9137	0.0247
ρ	Price mark-up shock ($\lambda_{f,t}$)	Beta	0.5	0.2	0.9221	0.0264	0.9667	0.0161

Table B.1, continued.

		Prior			Posterior Euro area		Posterior US	
		Type	Mode	Df.	Mode	Std. dev. (Hess.)	Mode	Std. dev. (Hess.)
σ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Inv. Gamma	0.003	5 d	0.0033	0.0002	0.0032	0.0002
σ	Government consumption shock (g_t)	Inv. Gamma	0.01	5 d	0.0216	0.0016	0.0239	0.0018
σ	Persistent product. shock ($\mu_{z,t}^{*}$)	Inv. Gamma	0.01	5 d	0.0053	0.0005	0.0078	0.0007
σ	Transitory product. shock (ϵ_t)	Inv. Gamma	0.01	5 d	0.0040	0.0003	0.0041	0.0004
σ	Consump. prefer. shock ($\zeta_{c,t}$)	Inv. Gamma	0.01	5 d	0.0153	0.0021	0.0162	0.0020
σ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Inv. Gamma	0.01	5 d	0.0245	0.0020	0.0978	0.0045
σ	Oil price shock (τ_t^{oil})	Inv. Gamma	0.1	5 d	0.1555	0.0120	0.1327	0.0101
σ	Monetary policy shock (ε_t)	Inv. Gamma	0.25	5 d	0.5578	0.0477	0.5501	0.0468
σ	Price markup shock ($\lambda_{f,t}$)	Inv. Gamma	0.01	5 d	0.0093	0.0019	0.0066	0.0008

Notes: *Upper numbers refer to EA, lower numbers to US. The US priors was taken from LOWW. The EA prior for prices is consistent with the results produced by the Inflation Persistent Network (see Altissimo et al., 2006).
Simple model: version of main model without banking sector or financial frictions. This version basically corresponds to CEE or SW.

Table B.2. Financial Accelerator Parameter Estimates: Euro area and US

			Prior		Posterior Euro area		Posterior US	
		Type	Mean	Std. dev.	Mode	Std. dev. (Hess.)	Mode	Std. dev. (Hess.)
ξ_p	Calvo prices	Beta	0.75^* 0.375	0.05	0.7302	0.0363	0.4992	0.0368
ξ_w	Calvo wages	Beta	0.75^* 0.375	0.1	0.655	0.0416	0.7823	0.0288
ι	Weight on inflation objective	Beta	0.5	0.15	0.8587	0.0669	0.2498	0.1019
ι_w	Weight on inflation objective	Beta	0.5	0.15	0.2857	0.0845	0.2706	0.1090
ϑ	Weight on technology growth	Beta	0.5	0.15	0.8901	0.0471	0.9263	0.0333
S''	Investment adjust. cost	Normal	7.7	3.5	21.154	2.8468	18.075	2.5415
σ_a	Capacity utilization	Gamma	6	5	25.711	7.5877	23.001	6.0091
α_π	Weight on inflation in Taylor rule	Normal	1.75	0.1	1.8877	0.0824	1.7932	0.0913
α_y	Weight on output growth in Taylor rule	Normal	0.1	0.05	0.1126	0.0498	0.1083	0.0613
$\alpha_{d\pi}$	Weight on change in infl. in Taylor rule	Normal	0.3	0.1	0.2204	0.0970	0.2044	0.1086
ρ_i	Coeff. on lagged interest rate	Beta	0.8	0.05	0.8408	0.0154	0.8625	0.0139
ρ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Beta	0.5	0.2	0.9693	0.0166	0.9856	0.0060
ρ	Government consumption shock (g_t)	Beta	0.5	0.2	0.8546	0.0977	0.9159	0.0334
ρ	Persistent product. shock ($\mu^*_{z,t}$)	Beta	0.5	0.2	0.0573	0.0423	0.1488	0.0834
ρ	Transitory product. shock (ϵ_t)	Beta	0.5	0.2	0.9432	0.0281	0.9750	0.0172
ρ	Financial wealth shock (γ_t)	Beta	0.5	0.2	0.7212	0.0535	0.9727	0.0098
ρ	Riskiness shock (σ_t)	Beta	0.5	0.2	0.8150	0.0316	0.9312	0.0228
ρ	Consump. prefer. shock ($\zeta_{c,t}$)	Beta	0.5	0.2	0.9525	0.0152	0.9476	0.0165
ρ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Beta	0.5	0.2	0.5398	0.0998	0.9768	0.0076
ρ	Oil price shock (τ_t^{oil})	Beta	0.5	0.2	0.9157	0.0282	0.9234	0.0251
ρ	Price mark-up shock ($\lambda_{f,t}$)	Beta	0.5	0.2	0.9334	0.0276	0.9808	0.0122

Table B.2, continued

		Prior			Posterior Euro area		Posterior US	
		Type	Mode	Df.	Mode	Std. dev. (Hess.)	Mode	Std. dev. (Hess.)
σ	Investm. specific shock ($\mu_{\Upsilon,t}$)	Inv. Gamma	0.003	5 d	0.0033	0.0003	0.0032	0.0002
σ	Government consumption shock (g_t)	Inv. Gamma	0.01	5 d	0.0150	0.0013	0.0205	0.0016
σ	Persistent product. shock ($\mu^*_{z,t}$)	Inv. Gamma	0.01	5 d	0.0054	0.0005	0.0076	0.0006
σ	Transitory product. shock (ϵ_t)	Inv. Gamma	0.01	5 d	0.0041	0.0004	0.0040	0.0004
σ	Financial wealth shock (γ_t)	Inv. Gamma	0.01	5 d	0.0167	0.0024	0.0056	0.0005
σ	Riskiness shock (σ_t)	Inv. Gamma	0.01	5 d	0.0780	0.0063	0.0344	0.0029
σ	Consump. prefer. shock ($\zeta_{c,t}$)	Inv. Gamma	0.01	5 d	0.0265	0.0055	0.0243	0.0051
σ	Margin. effic. of invest. shock ($\zeta_{i,t}$)	Inv. Gamma	0.01	5 d	0.0289	0.0028	0.1774	0.0556
σ	Oil price shock (τ_t^{oil})	Inv. Gamma	0.1	5 d	0.1557	0.0120	0.1328	0.0101
σ	Monetary policy shock (ε_t)	Inv. Gamma	0.25	5 d	0.4985	0.0408	0.5019	0.0402
σ	Price markup shock ($\lambda_{f,t}$)	Inv. Gamma	0.01	5 d	0.0104	0.0019	0.0071	0.0008

- *Upper numbers refer to EA, lower numbers to US. The US priors were taken from LOWW. The EA prior for prices is consistent with the results produced by the Inflation Persistent Network (see Altissimo et al., 2006).
- Financial Accelerator refers to the version of our model without banks, but with financial frictions.

Table : Euro Area. Properties of the Economic Shocks' Innovations in Simple Model

		$\lambda_{f,t}$	$\mu_{\Upsilon,t}$	g_t	$\mu_{z,t}$	ϵ_t	$Mon.Pol.$	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}
Mean		0.0019	0.00035	0.0028	-0.00093	-0.00049	0.069	0.00093	0.0016	-0.011
Auto-Correlation		-0.24	0.2	-0.04	-0.35	0.01	0.51	-0.34	-0.08	0.24
Cross-Correlation										
	$\lambda_{f,t}$	0.44	0.44	0.23	0.29	-0.23	-0.28	-0.04	0.1	-0.4
	$\mu_{\Upsilon,t}$		0.01	0.3	0.13	-0.29	-0.21	-0.17	0.08	-0.52
	g_t			0.03	0.05	-0.1	-0.22	0.14	0.74	-0.1
	$\mu_{z,t}$				0.01	-0.58	0.05	0.11	0.19	0.04
	ϵ_t					0.01	0.08	0.21	-0.4	0.12
	$Mon.Pol.$						0.56	0.29	-0.26	0.15
	$\zeta_{c,t}$							0.02	0.13	0.24
	$\zeta_{i,t}$								0.03	0.13
	τ_t^{oil}									0.16

Note: Figures refer to the smoothed innovations.

Table : US. Properties of the Economic Shocks' Innovations in Simple Model										
		$\lambda_{f,t}$	$\mu_{\Upsilon,t}$	g_t	$\mu_{z,t}$	ϵ_t	$Mon.Pol.$	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}
Mean		0.00026	9.7e-5	0.0033	-0.0011	-6.6e-5	-0.081	-0.0018	0.0078	-0.015
Auto-Correlation		-0.03	0.5	-0.29	-0.05	-0.11	0.5	-0.17	-0.24	0.19
Cross-Correlation										
	$\lambda_{f,t}$	0.03	0.03	0.33	-0.09	0.09	-0.5	-0.01	0.24	-0.28
	$\mu_{\Upsilon,t}$		0.01	0.14	0.03	0.13	-0.1	0.16	0.02	-0.15
	g_t			0.03	-0.38	0.45	0.18	0.21	0.42	-0.07
	$\mu_{z,t}$				0.01	-0.56	-0.24	-0.26	0.14	-0.1
	ϵ_t					0.01	0.04	0.17	-0.15	0.04
	$Mon.Pol.$						0.54	0.31	-0.12	0.17
	$\zeta_{c,t}$							0.02	-0.04	0.17
	$\zeta_{i,t}$								0.1	-0.02
	τ_t^{oil}									0.13

Note: Figures refer to the smoothed innovations.

Table : **Euro Area.** Properties of the Economic Shocks' Innovations in Financial Accelerator Model												
		$\lambda_{f,t}$	$\mu_{\Upsilon,t}$	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$Mon.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}
Mean		0.00041	0.00029	0.0017	-0.00029	-0.00031	-0.00039	0.013	-0.00019	0.0022	0.0012	-0.018
Auto-Correlation		-0.28	0.21	0.01	-0.3	0.32	-0.07	0.46	0.45	-0.14	-0.15	0.24
Cross-Correlation												
	$\lambda_{f,t}$	0.48	0.48	0.25	0.36	-0.18	-0.15	-0.43	-0.08	-0.17	0.18	-0.39
	$\mu_{\Upsilon,t}$		0.01	0.27	0.15	0.03	-0.17	-0.24	0.12	-0.25	0.02	-0.52
	g_t			0.02	-0.12	-0.06	0.15	-0.26	-0.02	-0.11	0.45	-0.18
	$\mu_{z,t}$				0.01	-0.28	-0.5	0.01	-0.23	0.03	0.07	0.04
	γ_t					0.02	-0.03	0.01	0.52	0.14	0.14	-0.21
	ϵ_t						0.01	-0.06	0.07	0.11	-0.22	0.02
	$Mon.Pol.$							0.51	-0.05	0.37	-0.17	0.2
	σ_t								0.08	0.03	0.13	-0.24
	$\zeta_{c,t}$									0.03	0.19	0.25
	$\zeta_{i,t}$										0.03	0.04
	τ_t^{oil}											0.16

Note: Figures refer to the smoothed innovations.

Table : US. Properties of the Economic Shocks' Innovations in Financial Accelerator Model

		$\lambda_{f,t}$	$\mu_{\Upsilon,t}$	g_t	$\mu_{z,t}$	γ_t	ϵ_t	$Mon.Pol.$	σ_t	$\zeta_{c,t}$	$\zeta_{i,t}$	τ_t^{oil}
Mean		0.00019	0.00015	0.0024	-0.00023	4.1e-5	-0.0002	-0.063	-0.0026	-0.002	0.0063	-0.015
Auto-Correlation		0	0.5	-0.31	-0.03	-0.03	-0.14	0.45	0.13	-0.15	-0.22	0.18
Cross-Correlation												
	$\lambda_{f,t}$	-0.01	-0.01	0.22	0.01	-0.3	0.13	-0.45	-0.32	-0.09	0.09	-0.22
	$\mu_{\Upsilon,t}$		0.01	0.15	0.02	0.12	0.11	-0.17	0.13	0.06	0.04	-0.14
	g_t			0.03	-0.43	-0.05	0.56	0.21		0.07	0.23	-0.11
	$\mu_{z,t}$				0.01	-0.13	-0.48	-0.24	0.02	-0.33	-0.02	-0.11
	γ_t					0.01	-0.31	-0.09	0.11	0.05	0.5	-0.21
	ϵ_t						0.01	0.07	-0.05	0.23	-0.35	0.11
	$Mon.Pol.$							0.5	0.13	0.28	0.07	0.23
	σ_t								0.04	0.01	-0.07	0.04
	$\zeta_{c,t}$									0.03	-0.03	0.19
	$\zeta_{i,t}$										0.18	-0.15
	τ_t^{oil}											0.13

Note: Figures refer to the smoothed innovations.