

## Optimistic Expectations and Financial Crises

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Job market paper

This version: 7 November 2017

### *Abstract:*

I evaluate whether recessions accompanied by financial crises are different in a framework where pre crisis dynamics – especially debt burden – and expectations play a role in determining the magnitude of the recession. This is consistent with some empirical evidence. I model financial optimism as unrealised news on capital quality in a DSGE framework with financial intermediaries. I found that cycles associated with financial optimism differ from those caused by technological news: the former generate asset prices boom-bust cycles, stronger debt cycles and deterioration in banks' net worth. Real variables respond in a similar qualitative way to unjustified optimism, whether it produces a financial crisis or not.

*Keywords:* Financial crises, deep recessions, slow recoveries, debt overhang, news shocks, boom – bust cycles.

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## 1. Introduction:

The US subprime crisis was followed by a long and deep recession, much deeper and longer than any previous post-war US recession. At the same time, European Union countries suffered a combination of banking and government debt crises that caused large drops in employment and GDP.<sup>1</sup> These episodes proved false the idea that big financial and economic crises are exclusive to developing and emerging economies in which capital and financial markets are less efficient. It also underscored the fact that economic downturns that are accompanied by financial crises seem to be bigger and more persistent than other economic crises, and they are usually accompanied by persistent falls in asset prices and an explosive trend in government debt. (e.g. Reinhart and Rogoff, 2009; Cerra and Saxena, 2008)

Additionally, it seems that pre-crisis debt growth plays a role not only in feeding the risk of financial crisis, but also as a determinant of the magnitude of the recession (e.g. Hong and Tornell, 2005; Jorda et al, 2013). Dell'Ariccia et al (2008) and Kannan (2012) found evidence in this direction using firm level data, while Berkmen et al (2012) found that developing countries with a highly leveraged financial system, a rapid growth in credit and a preference for short term debt tend to experience stronger impacts of financial crises on growth. In the same spirit, there is evidence suggesting that when asset bubbles are fuelled by credit booms, the recessions that follow tend to be longer and deeper (Jorda et al., 2015).

On the other hand, empirical evidence suggests that output expectations prior to the crisis play an important role in determining the dynamics of the economy and explaining the financial crisis (Chauvet and Guo, 2003, and Cerra and Saxena, 2008). These findings are all consistent with the idea that the pre-crisis dynamics are important in determining the severity and persistence of recessions.

In this paper, I use unrealised news to model optimism in an otherwise standard DSGE model. This allows the pre-crisis dynamics to be related to the downturn dynamics. At the same time, comparisons of the effect of news about different shocks are done to evaluate the idea that financial crises are associated with deeper recessions and slower recoveries (Reinhart and Rogoff, 2009) due to some differential characteristics of these episodes.

The financial frictions literature has taught us that these frictions are an important amplification and propagation mechanism (e.g. Bernanke and Gertler ,1989). Within this framework, crisis experiments have been modelled as negative shocks on technology (e.g. Kiyotaki and Moore, 1997), net worth (e.g. Bernanke et al, 1999), and deleveraging shocks (e.g. Eggertsson and Krugman, 2012) among others. This literature has brought a better

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<sup>1</sup> Real GDP growth rates in 2009 for the Euro Area and the USA were -3.77% and -2.78%, according to the IMF data. Unemployment rates were above 8% in the USA during the period 2009-2012. Euro zone unemployment rallied from 7.58% in 2008 to 12.2% in 2013.

understanding of the link between macroeconomic and financial variables. Notwithstanding, important features of the economy and of the mechanisms behind the crisis might be missing. This is because negative exogenous and/or idiosyncratic shocks are usually blamed for the occurrence of economic downturns. In this way, pre-crisis economic dynamics have been neglected in standard economic DSGE models.

Conversely, the approach used in this paper accounts for the importance of the correlation between optimistic expectations, debt run-ups and the occurrence of deep and persistent downturns. I show here a model where the pre-crisis behaviour and the bust that follows are generated by optimistic expectations about future investment returns. To do so, I introduce news to an otherwise standard DSGE framework with financial frictions as presented by Gertler and Kiyotaki (2010). Financial optimism is modelled as unconfirmed news about capital returns, that if unjustified (ex-post) leads to a deleveraging process, an asset price bust and a financial crisis. An advantage of this framework is the fact that shocks to capital returns affect financial intermediaries more directly than typical TFP shocks. This allows me to distinguish between a “financial” and a traditional technology shock.

The modelled behaviour is similar to Keynes’ (1936) “animal spirits”, Pigou’s (1927) waves of optimism and Minsky’s (1977) financial instability hypothesis. . If people believe that an investment project is going to be profitable (and that the risk is acceptable), then they are willing to invest in that project. Entrepreneurs take on debt and a boom of debt and investment takes place. This also leads to a rise in asset prices.

A crisis occurs when the expectations about future high returns on investment (capital value) turn out to be false. In this case, returns on investment are not enough to service the debt. At the same time, asset prices go down, reflecting the actual productivity of capital and as a consequence, fire sales of assets need to take place to pay the debt. This leads to a drop in investment and a decline in output and net worth. This is a debt – deflation process a la Fisher (1933). Debt burden jointly with financial frictions implies that investment is delayed further, making recessions more persistent.

In this way, agents can affect the returns of their own investments and their balance sheets by accumulating capital and debt beyond what is optimal, due to optimism. This idea has been incorporated to some extent in models that use expectations as endogenous drivers of stock price collapses (e.g. Branch and Evans, 2011; Williams, 2012). The model presented here is related to news-driven business cycles literature, where news about technology or other shocks has been used to generate boom bust cycles (e.g. Beaudry and Portier, 2007 and 2013).

In section 2 I presented a simplified model as in Gertler and Kiyotaki (2010) which includes a private banking sector where financial frictions arise endogenously, as a consequence of the incentive to deviate resources for their own use. Unlike Gunn and Johri’s (2013) work, news about capital value, rather than the efficiency of the banking sector, drive the business cycles. It is also closely related to Gertler and Karali (2010) but unlike them, I do not restrict the way the economy adjusts to unrealised news.

In section 3 the calibration of the model is presented and a crisis experiment is defined. The results of this experiment are analysed in section 4. I found that optimistic news about future returns on capital lead to an excessive accumulation of debt and capital and, subsequently, to a boom in output. Once agents realise they were wrong, they need to liquidate capital to pay back the debt, but now the price of capital is much lower and they need to fire sale assets. This is a distinguishing feature of the model compared with Gunn and Johris's (2013).

In section 5, I compare cycles driven by financial and technology optimism. I found that the latter are not accompanied by asset price booms nor by an improvement in banks net worth during the expansion. This also implies bigger adjustments in these variables once people learn the truth about capital returns. I also found that financial crises are accompanied by stronger debt cycles. Some robustness checks are presented in section 6. Finally, some conclusions are presented in the last section.

## **2. Optimism and Financial Crisis**

In order to represent an economy where expectations play an important role – not only causing a financial crisis, but also amplifying and magnifying shocks – it is necessary to modify the rationality assumption. This is done here by introducing news on the returns on investment (assets value). Agents cannot tell whether the information is accurate, and their behaviour following the news generates booms in asset prices and build-ups of debt. When the news turn out to be wrong, they are followed by asset prices busts, deleveraging processes and long lasting recessions.

I modify the simplest version of the financial intermediation model by Gertler and Kiyotaki (2010). This is the case of a frictionless interbank market such that the only financial friction is related to the inability of the depositors to enforce the repayment of their “loans” to the banks. A banker has incentives to divert funds raised through deposits to personal uses. If she does that, then the bank defaults on its debt and it shuts down. The model is described in the following sub section.

### **2.1 The model**

The economy is populated by a continuum of households whose members can either be bankers or workers. Banks raise deposits from households and make loans to the goods producers. There are two types of producers: capital goods producers that operate under perfect competition, and goods producers of size 1. The behaviour of these economic units is described next.

#### **Goods producers:**

Firms operate under perfect competition in a national market and face a Coob-Douglas technology as follows:

$$(1) \quad Y_t = A_t F(K_t, L_t) = A_t K_t^\alpha L_t^{1-\alpha}$$

They get funding for their investment projects from the banks in the form of state dependent securities that pay returns  $Z_t$ . Firms buy capital goods (K) from capital goods producers at the price  $Q$  and hire labour (L) from families at an hourly wage  $W$ .

Optimization conditions are standard. Therefore, wages and returns per unit of capital are respectively given by:

$$(2) \quad W_t = (1 - \alpha)A_t \left(\frac{L_t}{K_t}\right)^{-\alpha} = (1 - \alpha)A_t \left(\frac{Y_t}{L_t}\right)$$

$$(3) \quad Z_t = \alpha A_t \left(\frac{L_t}{K_t}\right)^{1-\alpha} = \alpha \left(\frac{Y_t}{K_t}\right)$$

The capital accumulation equation is given by:

$$(4) \quad K_{t+1} = \Psi_{t+1}[I_t + (1 - \delta)K_t]$$

A shock to the capital quality ( $\Psi_{t+1}$ ) is interpreted here as a capital productivity shock or, more precisely, as a capital value shock. This would have indirect effects on the marginal productivities through a channel similar to a scale effect. This will become clearer later.

Capital goods producers:

Meanwhile, capital goods producers sell capital goods at the price  $Q$  to goods producers and they face convex adjustment costs of investment so that their maximization problem is:

$$\max_{I_t} E_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}}{\lambda_t} \left\{ Q_{t+i} I_{t+i} - \left[ 1 + f\left(\frac{I_{t+i}}{I_{t+i-1}}\right) \right] I_{t+i} \right\}$$

Where the adjustment cost function has the following properties:  $f(1) = f'(1) = 0$  and  $f''(\cdot) > 0$ ; and  $\lambda$  is the households' Lagrange multiplier associated with its budget constraint. The optimality condition for capital goods producers is given by equation 5 and it implies that in steady state the price of capital goods needs to be 1.

$$(5) \quad Q_t = 1 + f\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} f'\left(\frac{I_t}{I_{t-1}}\right) - E_t \beta \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{I_{t+1}}{I_t}\right)^2 f'\left(\frac{I_{t+1}}{I_t}\right)$$

Households:

The representative household is composed of a continuum of members of size 1. It is formed by  $f$  bankers and  $(1-f)$  workers. There is perfect consumption insurance within the household, which implies that the consumption is the same irrespective of being a banker or a worker. The utility function follows (Christiano, et al., 2008):

$$\max_{\{C_t\}, \{L_t\}} E_t \sum_{i=0}^{\infty} \beta^i \left[ \ln(C_{t+i} - \zeta C_{t+i-1}) - \chi \frac{H_{t+i}^{1+\varepsilon}}{1+\varepsilon} \right]$$

With:

$$H = 1 - L$$

Households choose their demand for consumption goods and their supply of hours worked subject to a budget constraint that includes transfers to and from financial and non-financial firms. Bankers transfer non-negative dividends to the families given their flow of funds constraint, and workers supply labour and transfer wage income to the families. The only asset Households can hold are bank deposits. They will receive the riskless gross interest rate  $R$  in exchange for their deposits. Therefore, the representative household budget constraint is given by:

$$(6) \quad D_{t+1} + C_t = W_t L_t + \Pi_t + R_t D_t$$

Where  $D$  is the quantity of bank deposits held by the households and  $\Pi$  are the net transfers from firms and banks. Deposits might be interpreted as one period maturity bonds. Given this, the optimization condition for households are given by:

$$(7) \quad W_t \lambda_t = \chi L_t^\varepsilon$$

$$(8) \quad E_t \beta \frac{\lambda_{t+1}}{\lambda_t} R_{t+1} = 1$$

$$(9) \quad \lambda_t = \frac{1}{(C_t - \zeta C_{t-1})} - \beta \zeta \frac{1}{(C_{t+1} - \zeta C_t)}$$

Notice that  $\lambda$  here represents the derivative of the Lagrangian with respect to current consumption. If the habit formation parameter ( $\zeta$ ) is set to zero we go back to the case without habit formation.

Banks:

Financial intermediaries are modelled as in Gertler and Kiyotaki (2010). Following them, a proportion  $(1 - \sigma)$  of banks randomly exits the market every period. This prevents bankers from overcoming financial constraints by retaining earnings. Exiting banks need to transfer any retained earnings to households and become workers. For simplicity, the number of banks is constant, therefore each period randomly  $(1 - \sigma)f$  workers become bankers.

Banks raise deposits ( $d_t$ ) from households at the beginning of each period and agree to pay an interest rate  $R_{t+1}$ . Later they learn the level of investment and make loans to goods

producers in the form of state contingent securities. These securities pay a dividend of  $Z_{t+1}$  and gross returns given by:

$$(12) \quad R_{kt+1} = \psi_{t+1} \frac{Z_{t+1} + (1 - \delta)Q_{t+1}}{Q_t}$$

A representative bank maximises the discounted sum of future net worth subject to the flow of funds constraint as follows:

$$\text{Max } V_t = E_t \sum_{i=1}^{\infty} (1 - \sigma) \sigma^{i-1} \beta^i \left( \frac{\lambda_{t+i}}{\lambda_t} \right) n_{t+i}$$

s.t.

$$(13) \quad Q_t s_t = n_t + d_t$$

Where the net worth of an individual bank ( $n$ ) is defined as:

$$n_t = [Z_t + (1 - \delta)Q_t] \psi_t s_{t-1} - R_t d_{t-1}$$

Financial friction: Bankers have incentives to transfer funds to their families. Divertible funds for an individual bank will be equal to  $\theta Q_t s_t$ . Diversion of funds will result in default and bankruptcy will occur. In this event, creditors would be able to reclaim the remaining  $(1 - \theta)Q_t s_t$  funds.

To prevent banks from transferring funds to their families the following incentive constraint must always hold:

$$V_t(s_t, d_t) \geq \theta Q_t s_t$$

Where  $V_t(s_t, d_t)$  is the maximized value of the value function.

Banks choose  $s_t$  and  $d_t$  at the beginning of period  $t$ , before aggregate uncertainty is realized (because they choose to divert funds between periods). Therefore, their maximization problem can be summarized by the following Bellman equation:

$$V_{t-1}(s_{t-1}, d_{t-1}) = E_{t-1} \Lambda_{t-1,t} \left\{ (1 - \sigma) n_t + \sigma \max_{d_t, s_t} V_t(s_t, d_t) \right\}$$

To solve this problem we need to guess the linear form for the value function, where  $Y_{st}$  and  $Y_t$  are time varying parameters, representing the banks' marginal valuation of securities and deposits (debt).

$$V_t(s_t, d_t) = Y_{st} s_t - Y_t d_t$$

The maximization of the value function subject to the incentive constraint implies a restriction on the amount of credit a bank can supply. In other words, it limits their ability to buy securities such that:

$$(14) \quad Q_t s_t = \phi_t N_t$$

Where  $\phi_t$  is the leverage ratio and it is defined by:

$$\phi_t = \frac{Y_t}{\theta - \mu_t}$$

With

$$\mu_t \equiv \frac{Y_{st}}{Q_t} - Y_t > 0$$

$\mu_t$  represents the marginal excess valuation of securities over deposits, such that when it rises, the securities valuation is higher.

Conditions on  $Y_t$  and  $\mu_t$  for the value function to be linear<sup>2</sup> complete the optimization conditions of the banks as follows:

$$(15) \quad Y_t = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1}$$

$$(16) \quad \mu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{kt+1} - R_{t+1})$$

With:

$$\Omega_{t+1} = 1 - \sigma + \sigma(Y_{t+1} + \phi_{t+1}\mu_{t+1})$$

Where  $\Omega_{t+1}$  is the stochastic marginal value of net worth.

Notice that when financial frictions are absent, the banks' optimization conditions are reduced to the equality of the expected returns on securities and the current deposit interest rate. Therefore, when  $\theta = 0$  the model is equivalent to a RBC model with investment adjustment cost and a capital production sector.

### Equilibrium:

In the aggregate, banks' net worth is the sum of existing surviving and entering banks' net worth. The latter receive transfers from the families equal to a proportion  $\xi$  of the total value of aggregated banks' assets. Which imply the following aggregate net worth equation for any particular period.

$$(17) \quad N_t = [Z_t + (1 - \delta)Q_t](\sigma + \xi)\Psi_t S_{t-1} - \sigma R_t D_{t-1}$$

Where S and D stand for aggregated securities holdings and aggregate deposits, respectively.

Goods market, retail credit market (deposits market), and securities market (loans to firms) equilibria imply the following:

$$(18) \quad Y_t = C_t + \left[1 + f\left(\frac{I_t}{I_{t-1}}\right)\right] I_t$$

$$(19) \quad D_t = Q_t S_t - N_t$$

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<sup>2</sup> This conditions are implied by the Value function iterations.



$$(20) \quad S_t = I_t + (1 - \delta)K_t$$

These equilibrium conditions plus equations 1 to 17 complete the system of equations used to find the steady state.

### Optimism:

Optimism is introduced through news shocks as in Christiano et. al (2008). The stochastic process for  $\Psi_t$  then is given by:

$$(21) \quad \Psi_t = \rho\Psi_{t-1} + \varepsilon_t + \xi_{t-p}$$

Where  $\varepsilon_t$  and  $\xi_{t-p}$  are i.i.d. non-correlated shocks and  $\xi_{t-p}$  is the news shock. In period t-p, people received news about capital quality in period t, but they cannot tell whether it is true or false. When news turns out to be false, a boom followed by a “financial” crisis occurs. Notice that here the news shock is not modelled as a signal extraction problem. If it were modelled in that way, the qualitative responses of the model to the news shock wouldn’t be different.

### **3. Calibration and crisis experiment**

In order to perform some simulations and analyse the effects of optimism, as defined in the previous section, numerical values are assigned to all the parameters of the model. The discount factor is set to 0.99, a very standard parameterisation that implies a deposit annualised interest rate of around 4.1% in steady state. Following Gertler and Kiyotaki (2010) I set a high value for the Frish labour elasticity to compensate for the lack of labour market frictions<sup>3</sup>. Given this parameter, the weight of labour in utility ( $\chi$ ) is calibrated to match labour supply in steady state equal to 0.2381. Assuming that workers are endowed with one unit of time, this implies that a representative worker works 40 hours a week.

Following Gertler and Kiyotaki (2010) the survival rate of banks is set to 0.972 implying an average bank’s life of 10 years, and  $\theta$  and  $\xi$  are set to match steady state target values for the leverage ratio ( $\phi$ ) of 4 and the interest rate spread ( $R_k - R$ ) of 19 basis points. The later is equivalent to assuming an 1% annual spread and it is consistent with the average historical spread between US commercial papers and US T-bill rates, and between US mortgage and long term US government bonds rates.<sup>4</sup> With respect to capital producers, I assumed a quadratic investment adjustment cost function. This formulation looks

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<sup>3</sup> The results are robust to a more standard calibration of this parameter.

<sup>4</sup> This is easily verifiable by computing the arithmetic average of the spread using the data available through FRED.

simplistic, but other functional forms that fulfil the requirements reported in the last section do not produce qualitatively different results.

Finally, the calibration strategy also looks for generating macroeconomic co-movement. It could be argued that there is no need for this. For instance, Barsky and Sims (2011) found, using a VAR estimation strategy, that for an RBC model, the empirical evidence suggests responses such as the ones suggested by the simple RBC model in Beaudry and Portier (2004). This is, output, employment and investment respond negatively to positive news about tech shocks. Notwithstanding, Görtz et al. (2016) found contrasting evidence when allowing for financial frictions. In particular, they found positive co-movement between output, consumption, and hours, and reductions in credit spreads in response to TFP news. Their findings suggest that in a model of financial frictions, it is important to have co-movement to news shocks plus positive initial effects on consumption.

Table 1.

Calibration: Baseline model

| <i>Households</i>               |        |  |
|---------------------------------|--------|--|
| $L$                             | 0.2381 | Labour supply in steady state              |
| $\beta$                         | 0.9900 | Discount rate                              |
| $\zeta$                         | 0.9000 | Habit parameter                            |
| $\chi$                          | 4.5565 | Relative utility weight of labour          |
| $\varepsilon$                   | 0.1000 | Inverse Frisch elasticity of labour supply |
| <i>Financial intermediaries</i> |        |  |
| $R_k - R$                       | 0.0019 | Steady state spread                        |
| $\Phi$                          | 4.0000 | Leverage ratio in steady state             |
| $\theta$                        | 0.3409 | Fraction of divertible assets              |
| $\xi$                           | 0.0027 | Transfer to entering bankers               |
| $\sigma$                        | 0.972  | Survival rate of the bankers               |
| <i>Intermediate good firms</i>  |        |  |
| $\alpha$                        | 0.330  | Effective capital share                    |
| $\delta$                        | 0.025  | Depreciation rate                          |
| <i>Stochastic Process</i>       |        |  |
| $\rho$                          | 0.660  | Autoregressive capital quality parameter   |

In consequence, Investment adjustment cost and habit formation parameters are set high enough to produce co-movement between employment, investment and consumption as in (Christiano, et al., 2008). Then, the habit formation parameter is set to 0.9 and the marginal adjustment cost is set to 30 times the percentage increase in investment.

A widely accepted alternative in the news literature to get co-movement is to modify the preferences such that the wealth effect is low. This is complimented with investment

adjustment cost and variable capital utilization as in Jaimovich and Rebelo (2009).<sup>5</sup> I did not use this alternative, since within this framework you need to use a very restrictive parameterisation to get co-movement in response to both news on the capital quality and the technology shocks.<sup>6</sup> All the parameters' values are presented in Table 1.

In the next section I present the responses of the model to news about an increase in the value of capital eight periods ahead. The anticipation of the shock leads agents to try to accumulate capital before the shock is realised. The most interesting dynamics are observed when the shock  $\xi_{t-p}$  is not realised. This is a crisis experiment, in the sense that all the decisions made based on the anticipation of the shock need to be corrected. The accumulation of capital and debt turn out to be excessive, once agents learn that the news was wrong. It would become clear that this dynamics creates a debt-investment cycle accompanied by asset liquidation and a recession.

#### **4. Results:**

The analysis of two different settings is reported in the following pages. In both scenarios agents in the economy received news in period one about an increase of 1% in the value of capital eight periods later (i.e. in period nine). This can be interpreted as an increase in either the capital productivity or in the effective units of capital. In the first scenario the shock is realised in period 9, so that decisions made in anticipation turn out to be optimal ex-post. Conversely, in the second setting the shock is not realised and these decisions become sub-optimal ex-post.

To begin with, the effects of the news shock in the first scenario are represented by the impulse response functions reported in Figure 1. Dashed lines account for the responses to the news shock in the model without financial frictions, and solid lines represent the full model responses ("baseline" in what follows).

As can be seen in the graph, financial frictions did not play a major role in the qualitative responses of all the real variables, the asset prices and the expected returns. Quantitatively, the model with financial frictions implies stronger increases in output, investment, employment and asset prices in anticipation of the realizations of the shock. In the absence of financial frictions, banks' optimization implies that net worth needs to remain at zero such that returns on securities are transferred to depositors when interests are paid. This implies that banks use all their deposits to buy securities.

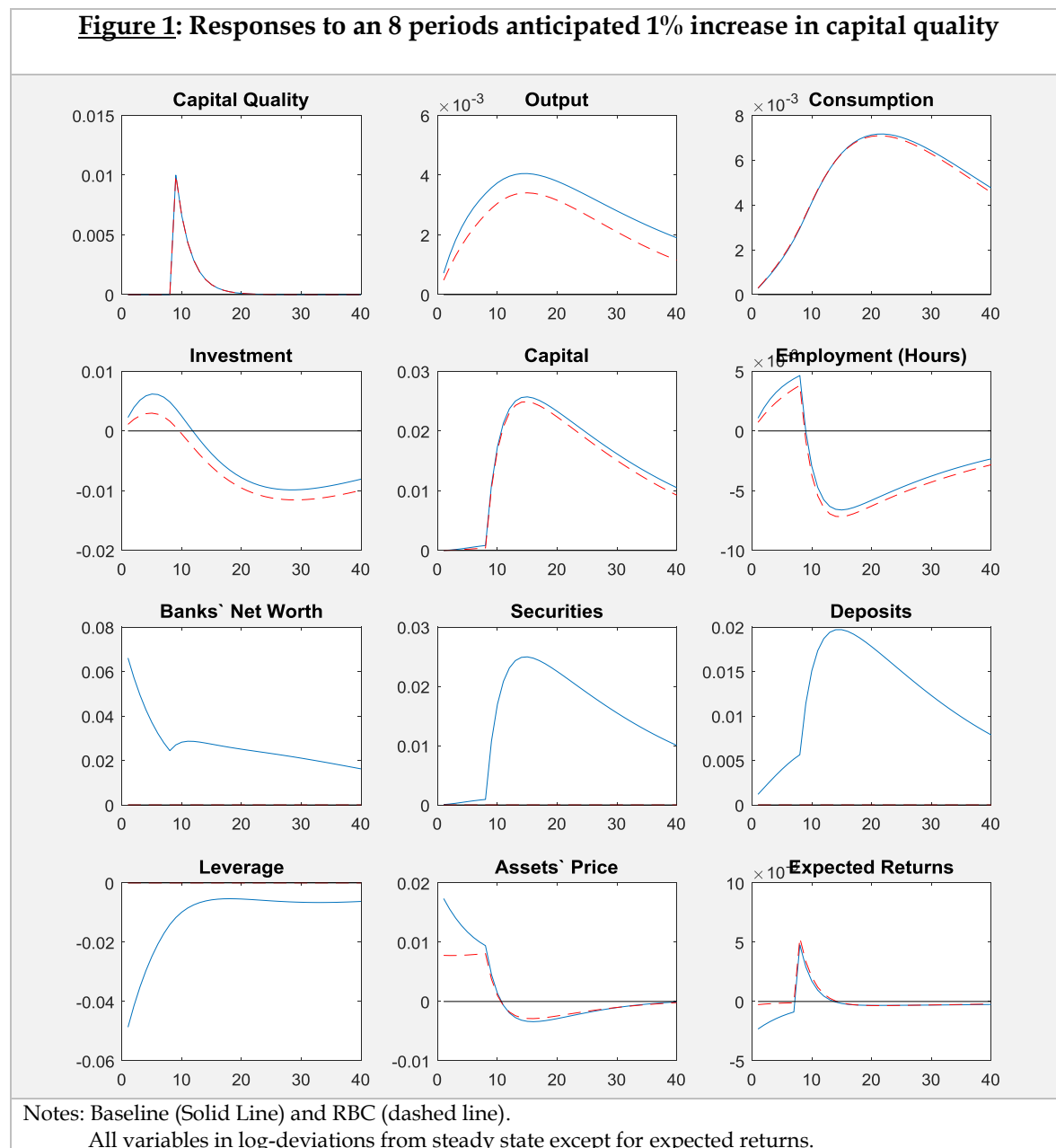
In the baseline model, following the good news about the future, banks demand for securities, capital stock and households' deposits increase gradually. The positive forecast about future returns leads to an increase in the price of securities, which drives banks' net worth upwards. At the same time, thanks to the increase in investment and employment, a

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<sup>5</sup> For a comprehensive review of the alternative ways to deal with the co-movement puzzle, see Wang (2012).

<sup>6</sup> See the appendix for a parameterization that generates co-movement in an RBC model.

boom in production is generated. Consumption also increases, thanks to the strong habit formation.



Unlike an unanticipated shock, people start investing before the shock is realized, reaching the desired level of capital before-hand. This is an increase in savings decisions in response to the perspective of having higher future returns. Also, the effect of the shock on several variables, including capital stock, securities, and employment is rather gradual. This could imply lower financial cost for the banks (compared with a counterfactual onetime purchase), since they spread their demand for securities across a longer period of time.

On the verge of the realization of the shock, expected returns increase strongly and investment slows down. Once the increase in capital quality is realized, investment keeps slowing down and the value of capital (or the effective units of capital) increases. This is equivalent to saying that the capital became more productive and, as a consequence, “effective” units of capital keep increasing even when investment is below its steady state level. In terms of the model, the capital is multiplied by the quality shock increasing in size. Then, less investment is required to keep the capital growing. After some time, capital starts to adjust back to its steady state level.

Regarding employment, motivated by the higher desire to save – invest in anticipation of the shock, households decide to increase their labour supply to accumulate more capital. As a result of higher returns, the initial increase in consumption is followed by a bigger and long-lasting increase. The higher future consumption implies a downwards shift in the labour supply. This implies that employment falls below the steady state after the shock is realized. This is at least partly a consequence of habit formation as point out by Wang (2012).

Concerning production, it increases initially due to capital and labour growth. After the shock is realized a small additional increase in output occurs as capital productivity increases with the shock. Since employment is reduced, output growth also reduces until it returns to its steady state level.

As investment increases, the demand for securities and capital goods goes up and, therefore, the price of capital goods increases as well. It starts to decline before the shock is realized, but once it is realized, after the sudden fall in investment, the price falls further, going below its steady state level. Afterwards, the capital goods price adjusts back, slowly converging towards the steady state level. This fluctuation of asset prices is not strong enough to produce a strong deterioration in the aggregate banks’ net worth.

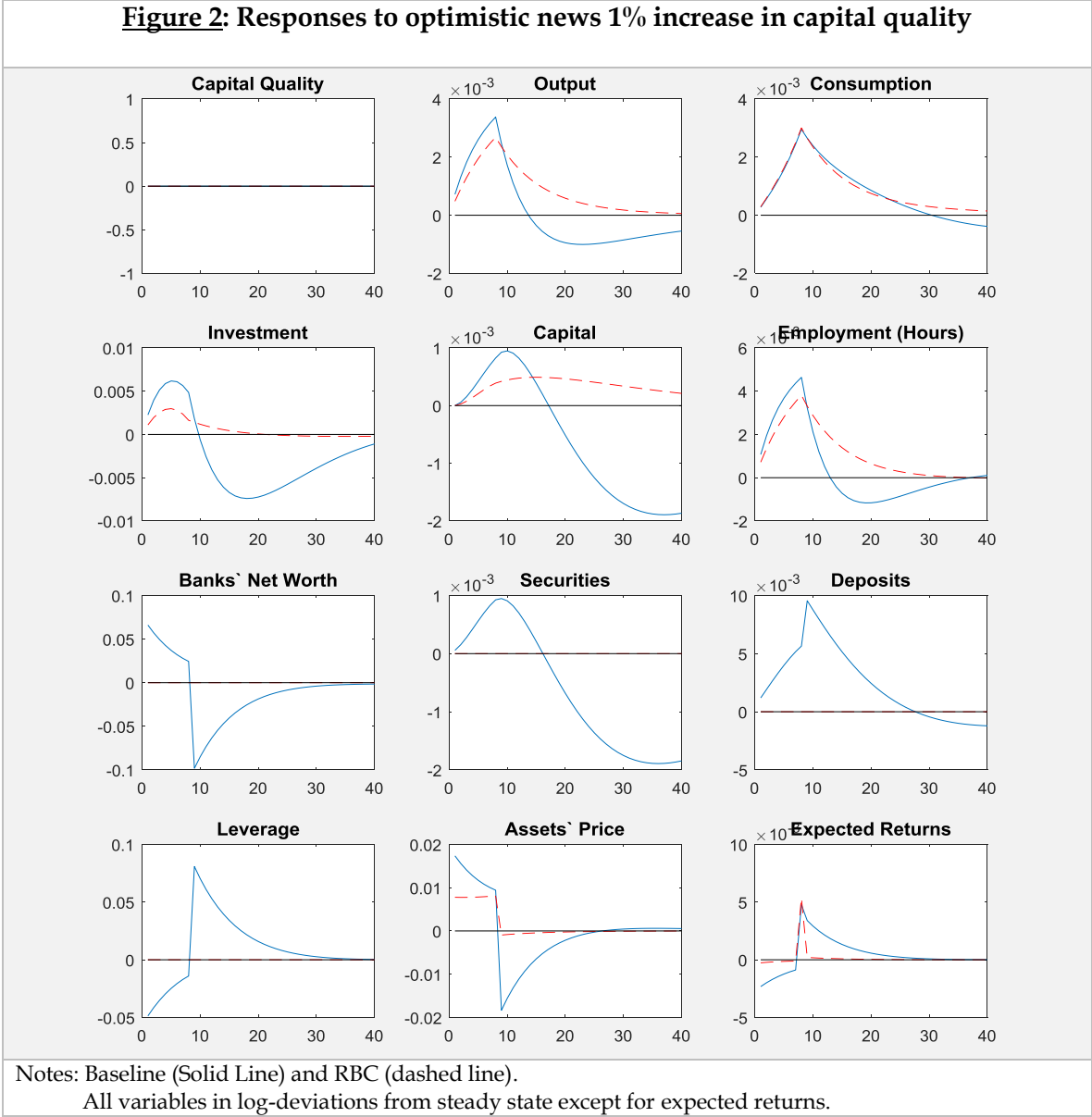
Since households want to save more in anticipation of the news about capital returns, deposits (banks’ debt) increase gradually and leverage starts to increase consequently. Once the shock is realized the debt increases further, then it is gradually paid back. This is equivalent to saying that people are not liquidating assets or creditors are not demanding anticipated payments, due to the higher returns on investment. Alternatively, if we consider debt as one period contracts that can be rolled over, then this can be interpreted as the creditors being willing to continue financing banks.

### *A crisis produced by optimism*

Regarding the case when news turn out to be false (Figure 2), once people learned their mistake they make big adjustments in their investment decisions. This is reflected in a strong reduction in investment. This adjustment happens in a sudden and people start to withdraw their deposits. Because the productivity boost did not happen, capital does not gain value but instead starts to decrease until the liquidation is enough to pay back the debt.

This over-liquidation of assets is the result of financial constraints combined with debt burden. Since banks need to pay back the creditors, but the returns on capital are lower than expected, they need to liquidate capital. However, now the asset prices have plummeted and then the liquidation occurs at fire sale prices implying that more capital needs to be liquidated. Once banks have paid back all their excessive debt, they can accumulate capital again and it slowly comes back to the steady state level.

**Figure 2: Responses to optimistic news 1% increase in capital quality**



The rationale for fire sales is twofold: firstly, the bust in asset prices and secondly, the deleveraging process that results from the inability to get additional funds due to the financial constraints. There is a double causation between the liquidation and asset's prices.

The latter falls due to the reduction in investment and capital that happens once the shock is not realised, and the former gets bigger as the prices plummet.

As a consequence of the assets liquidation and prices bust, banks' net worth falls dramatically, up to almost 10% below the steady state. This adds to the vicious circle of low investment, low asset prices, low banks capacity to buy securities and to fund firms, and fire sales.

Given the sudden reduction in employment and the strong fall in capital, the product falls too, generating a long-lasting recession. This recession is matched with reductions in consumption growth and investment, along with a deleveraging process and a deterioration of banks' balance sheets.

To sum up, the news shock in the baseline model can generate the debt accumulation, asset prices boom, and output boom prior to a crisis, as well as the bust in asset prices, the deleveraging process and the long-lasting recession that characterize financial crises (Reinhart & Rogoff, 2009).

#### *The role of financial frictions*

The dotted lines in Figure 2. represent the responses of the model without financial frictions to unrealised news about an 1% increase in capital quality. It can be noted that the volatility in asset prices is negligible compared to the baseline scenario. The ability to get funding, plus the mild fall in asset prices rule out the fire sales witnessed when financial frictions are present.

As a consequence, once agents learn that the news was wrong, investment, consumption, employment and output return gradually to the steady state and a recession is avoided.<sup>7</sup> Regarding capital stock, in absence of financial frictions liquidation is not necessary and capital slowly adjusts back to its steady state level. In summary, in this framework unjustified optimism is not able to generate a recession in absence of financial constraints. This supports the claim that financial frictions are an important transmission mechanism for news shocks (v.g. Görtz et al., 2016).

### **5. Financial crises and normal recessions**

The capital quality shock used in this paper is a way to introduce exogenous changes to the value of capital (Gertler and Kiyotaki, 2010). Changes in the value of capital affect directly asset prices and banks' net worth. This choice was motivated by the idea of resembling a financial crisis, where asset prices fall noticeably with investment.

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<sup>7</sup> Notice that the impulse responses should be interpreted as deviations from a balanced growth path, and therefore a recession only happens when these functions go below zero.

On the other hand, other models have been able to recreate the fall in banks' net worth typical of a financial crisis using different shocks that are not as easily linked to investment - debt cycles. For instance, Gunn and Johri (2013) modelled financial crises as the result of unrealised news about financial frictions themselves (banks' ability to reclaim debt). This implies that a financial crisis might happen because people were over confident about the health of the banking system. But this lets aside an explanation of the deterioration of the financial institutions health.

The capital quality shock has the advantage that it can be interpreted as a shock to the returns on investment as well as a financial shock. Then the interpretation of a financial crisis occurring because people (including bankers) got over confident about investment returns and this caused a bubble in asset prices, is more easily justified within this paper's framework. Also, it is more compelling than assuming that the banking system was bad beforehand for an undetermined reason.

Besides, if the capital quality shock can be interpreted as a financial crisis, as in Gertler and Kiyotaki (2010). Then, it is worthwhile to check whether the responses to news about it are different to some extent to TFP news driven cycles. This would help to answer the question whether theory can distinguish between a financial and a non-financial recession in a model with financial frictions. Empirically, it is possible to assess the role of particular shocks to economic volatility and to classify episodes as driven mainly by financial factors or not (v.g. Romer & Romer, 2015 and Stock & Watson, 2012)

To check whether the same qualitative results hold when the model is hit by noisy news about a standard technology shock, I assume the following stochastic process for the technology shock.

$$(22) \quad A_t = \rho_A A_{t-1} + v_t + \eta_{t-p}$$

Where  $v_t$  and  $\eta_{t-p}$  are i.i.d. non-correlated shocks and  $\eta_{t-p}$  represents news about technology progress received  $p$  periods ahead. The timing is as follows: in period 1 people receive news about higher TFP to be realised eight periods later. In period nine they realise the news was wrong. This setting makes the result comparable to our crisis experiment. I am assuming a value of 0.99 for the autoregressive parameter ( $\rho_A$ ).

Impulse responses to 1% unrealised news shocks about capital quality (dotted line) and technology shocks (solid line) are reported in Figure 3. It can be seen that output and consumption responses are both qualitatively and quantitatively similar, regardless of the nature of the shock. Something similar happens with the response of employment.

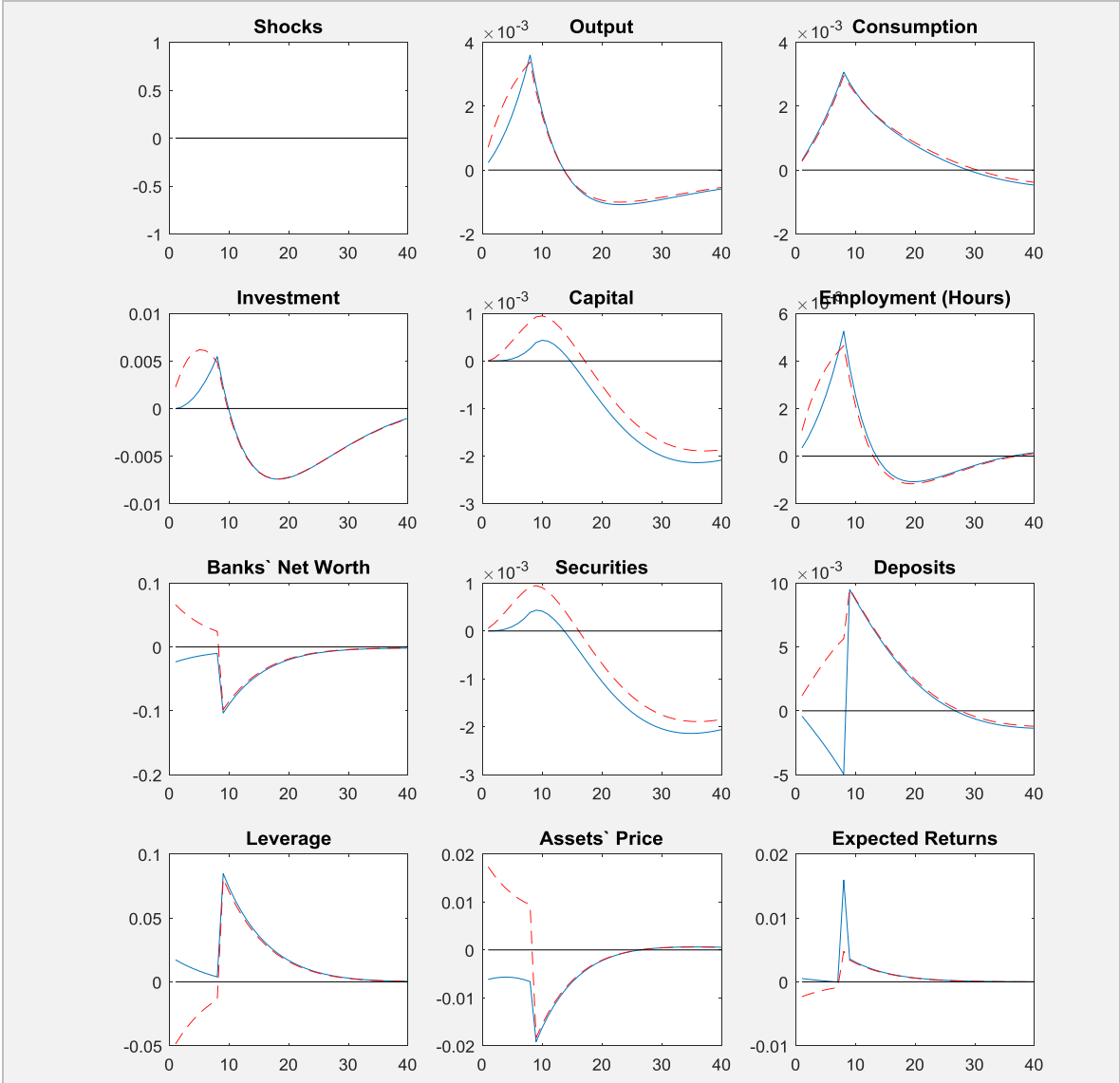
Investment and capital stock exhibit different responses to both shocks. The former grows more during the anticipation period in response to news about capital quality. Nevertheless, investment dynamics does not seem to be significantly different once agents learn they were wrong. This implies a similar adjustment in the capital stock, and therefore a similar magnitude of the liquidation needed to pay back the debt (considering the liquidation as



the difference from the peak value to the lowest value). The same dynamics could be extrapolated to the volume of securities.

Nonetheless, contrary to what one could expect, banks' net worth dynamic responses to news about the two shocks are rather different. In particular, during the expansion it increases with respect to its steady state in response to news about capital quality, while it goes below the steady state in response to technology news.

**Figure 3: Responses to optimistic news in baseline model**



Notes: 1% unrealised increases in capital quality (dashed line) and technology (solid line)  
Log-deviations from steady state except for Returns

These dissimilar responses have to do with the dynamics of asset prices in anticipation of the two shocks. News about capital quality leads to an asset price boom, since expected returns on capital are expected to increase upon realization of the shock. In practice, agents are expecting that one unit of capital in periods one to eight is going to become 1.01 effective units of capital in period nine. Because of the assumption of perfect competition in the securities market, the price dynamics reflect changes in the discounted expected returns and therefore go up with news about higher future capital quality.

Since the demand for investment goods grows less, and more gradually, in response to technology news, asset prices do not respond in the same way as they do to news about capital quality. To understand this better, it is necessary to look at the responses of expected returns when the news turns out to be true (Appendix 1). After the shock is realised, expected returns fall below the steady state in response to technology news, while they converge gradually to the steady state after capital quality news is realised. This implies that, while the TFP shock increases aggregated productivity, this does not necessarily translate into better returns per unit of capital.

As a consequence asset prices go below its steady state level in response to technology shocks, and they fall further once agents realise their expectations were wrong. This last adjustment also happens in response to unrealised news about capital quality, but it is quantitatively stronger. This implies a worse deterioration of banks' net worth in response to news about returns on investment than in response to technology news.

It can be concluded that the main difference between technology news and capital quality news driven business cycles, in this model, has to do with the inability of the former to generate a boom-bust cycle in asset prices and milder debt cycle and deterioration in banks' balance sheets. It is noteworthy, that unjustified optimism about both technology and capital quality generates very similar dynamics in output, consumption, investment and employment. This is supported by empirical evidence that suggests that recessions associated with financial crises are not particularly different (Stock & Watson, 2012). In the next section, I present some robustness checks on the main results to discard that some particular assumptions are generating the results.

## **6. Robustness checks: Co-movement and Frisch elasticity**

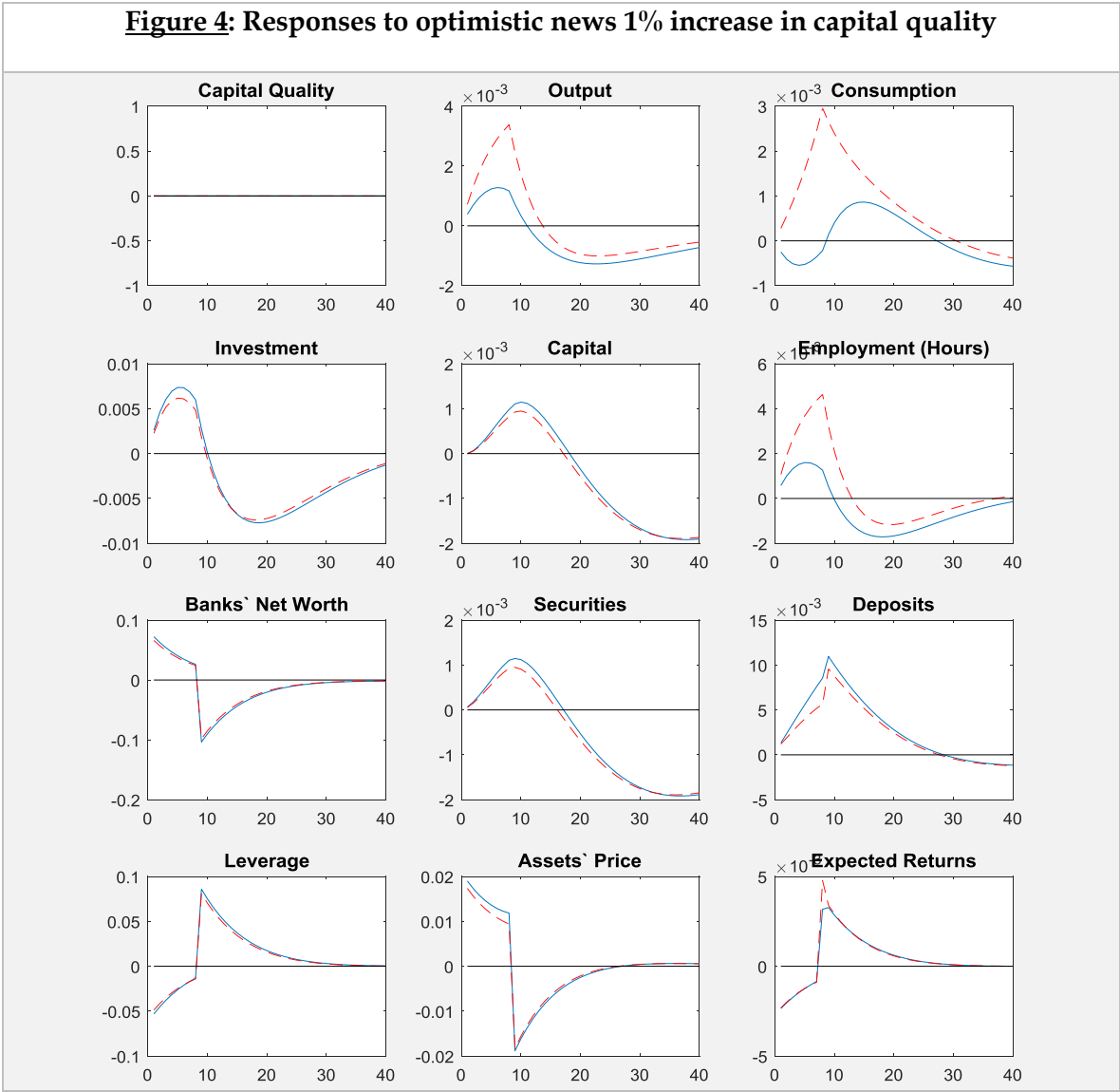
### *Co-movement*

It was mentioned before that co-movement of consumption, investment and employment was a desirable trait of the model given the inclusion of financial frictions and some evidence from the literature (Görtz et al., 2016). This was achieved by setting strong enough habit formation and investment adjustment costs (Christiano et al., 2008). We also observed that this was responsible in part for the fall in employment when the news about capital quality was realised. It is necessary to check that the main results are not affected by this.

That is, wrongly optimistic expectations about future capital returns can generate a boom followed by a recession accompanied by a bust in asset prices, a deleveraging process, capital liquidation and a deterioration of banks net worth.

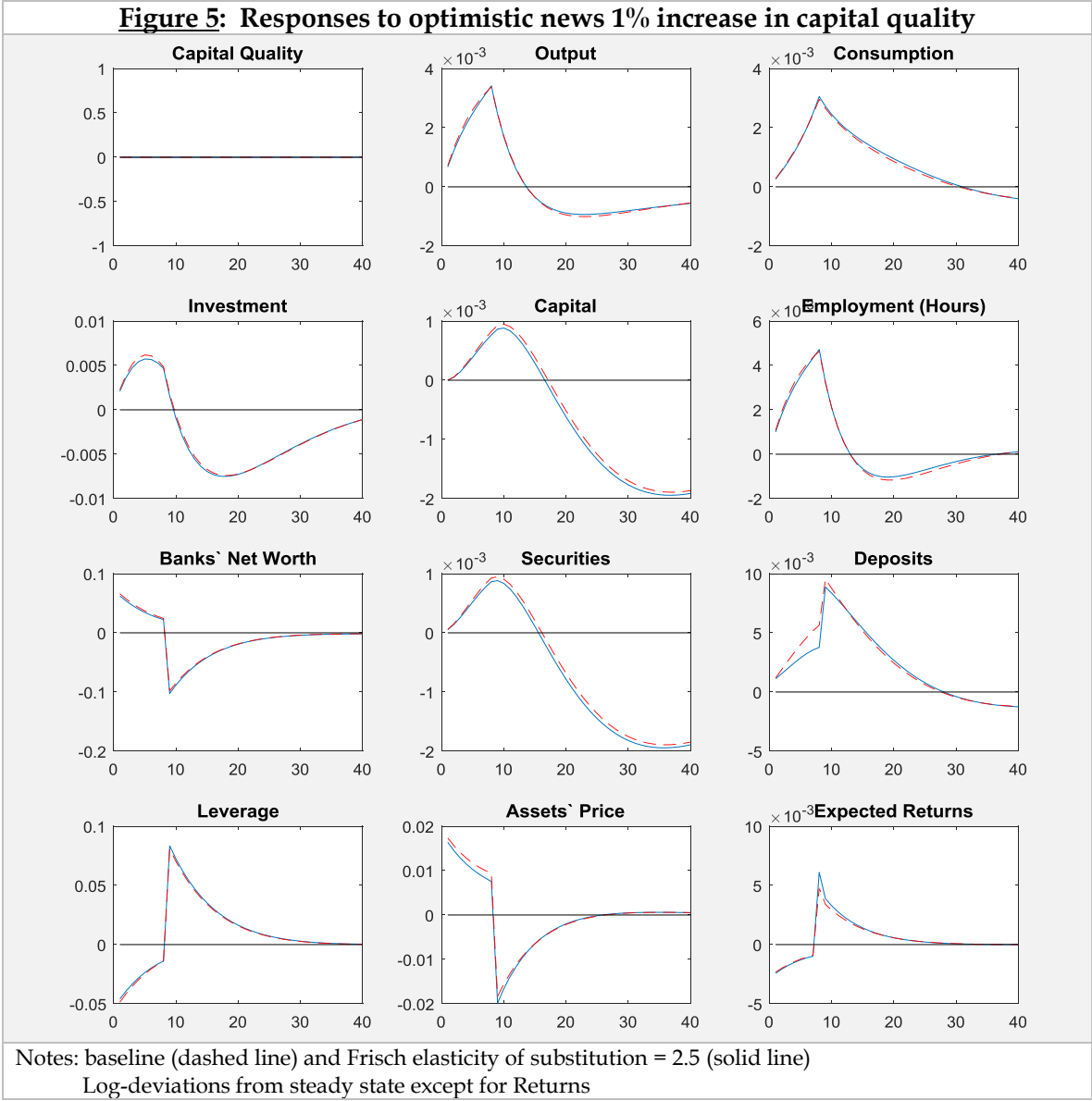
Since the key parameter for this strategy to achieve macroeconomic co-movement is the one related to habit formation (Wang, 2012), setting it to zero should remove its effects. If the results are robust to co-movement, only the qualitative dynamics of consumption should be affected. Responses to an unrealised news shock under this parameterisation, along with the baseline results, are reported in Figure 4. It can be noticed from the graphs that, with the exception of consumption, the qualitative results remain the same when the habit formation parameter ( $\zeta$ ) is set to zero.

**Figure 4: Responses to optimistic news 1% increase in capital quality**



Notes: Baseline (dashed line) and no comovement (solid line)  
Log-deviations from steady state except for Returns

After the positive news about the quality of capital is received, output, employment and investment increase with respect to their steady state level. Also, a boom in asset prices is produced and debt is accumulated. Once agents realise they were wrong, a strong adjustment in investment is required. At the same time, asset prices plummet and fire sales of capital goods are needed to pay back the debt. In this sense a deleveraging process starts and capital is depleted, reducing output and employment.



In summary, when the model is parameterised so that positive co-movement of consumption with respect to employment and investment is not guaranteed, the main result still holds. This is, an optimistic shock about returns on investment is able to generate a boom-bust cycle in asset prices that is accompanied by an output boom followed by a recession, a deterioration of banks' net worth and a deleveraging process.

### Frisch elasticity of substitution

As mentioned earlier, I followed Gertler and Kiyotaki (2010) regarding the parameterization of most of the model. Therefore, I have set a Frisch elasticity of labour supply of 10 to compensate for the lack of frictions in the labour market. This value is much higher than the standard calibrations found in the literature and the macro estimates of this parameter (Peterman, 2016).

Given that other strategies to get co-movement are very sensitive to that parameter, it is necessary to test that the results are not driven by this particular parameterization. To do so, I replicate the result setting the Frisch elasticity of substitution to a more acceptable parameter of 2.5. As can be seen in Figure 5, there are no significant changes in the quantitative nor qualitative responses of the system to news about capital quality. This is also true for the responses to technological news.<sup>8</sup>

## **7. Conclusions**

In this paper, I presented a model where optimistic behaviour about future returns on investment may generate not only the dynamics characterising an economy during a financial crisis, but also the pre-crisis process leading to the run-up in debt and the asset prices boom.

This excessive debt accumulation, in combination with the banks' credit constraints generates to liquidate assets. This implies a reduction in capital that is bigger than its increase during the boom, due to plummeting asset prices and the need to repay the debt with lower than expected returns on capital. In the context of the model, the banks hold the burden of the crisis and their net worth suffers widely due to the fall in the value of assets. However, these costs are not transferred to households since the probability of bankruptcy is not a function of the bank's performance.

These results, are consistent when co-movement of consumption is not imposed, this is, when habit formation is ruled out of the model. I show that with or without habit formation the same qualitative results hold, with the sole exception of consumption dynamics. More importantly, the model can still produce an expansion followed by a recession that is accompanied by a boom-bust cycle in asset prices and a debt run-up followed by a liquidation and deleveraging process.

Comparisons of the responses to unrealised technology and capital quality news under the baseline specification lead to conclude that banks net worth deterioration is notably higher

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<sup>8</sup> See Appendix 2

in response to the former. This is due to the fact that technology news does not generate a boom in asset prices, and the reduction in them that occurs when the shock is not realised is smaller than the bust produced by unjustified optimism about capital quality. This is the only significant difference between the responses to the two shocks, which suggests that in a very standard DSGE model with financial frictions, the effects of news about financial and non-financial shocks produce similar responses in real variables.

The model highlights the importance of expectations about future returns as a factor helping to explain deep and long lasting recession. Further research is needed to explain the relationship between the size of the recession and the speed of recovery that seems to characterize some crises. Future research could explore the time series properties of non-technology shocks like the one used here in order to fully underscore the role of these shocks if any.

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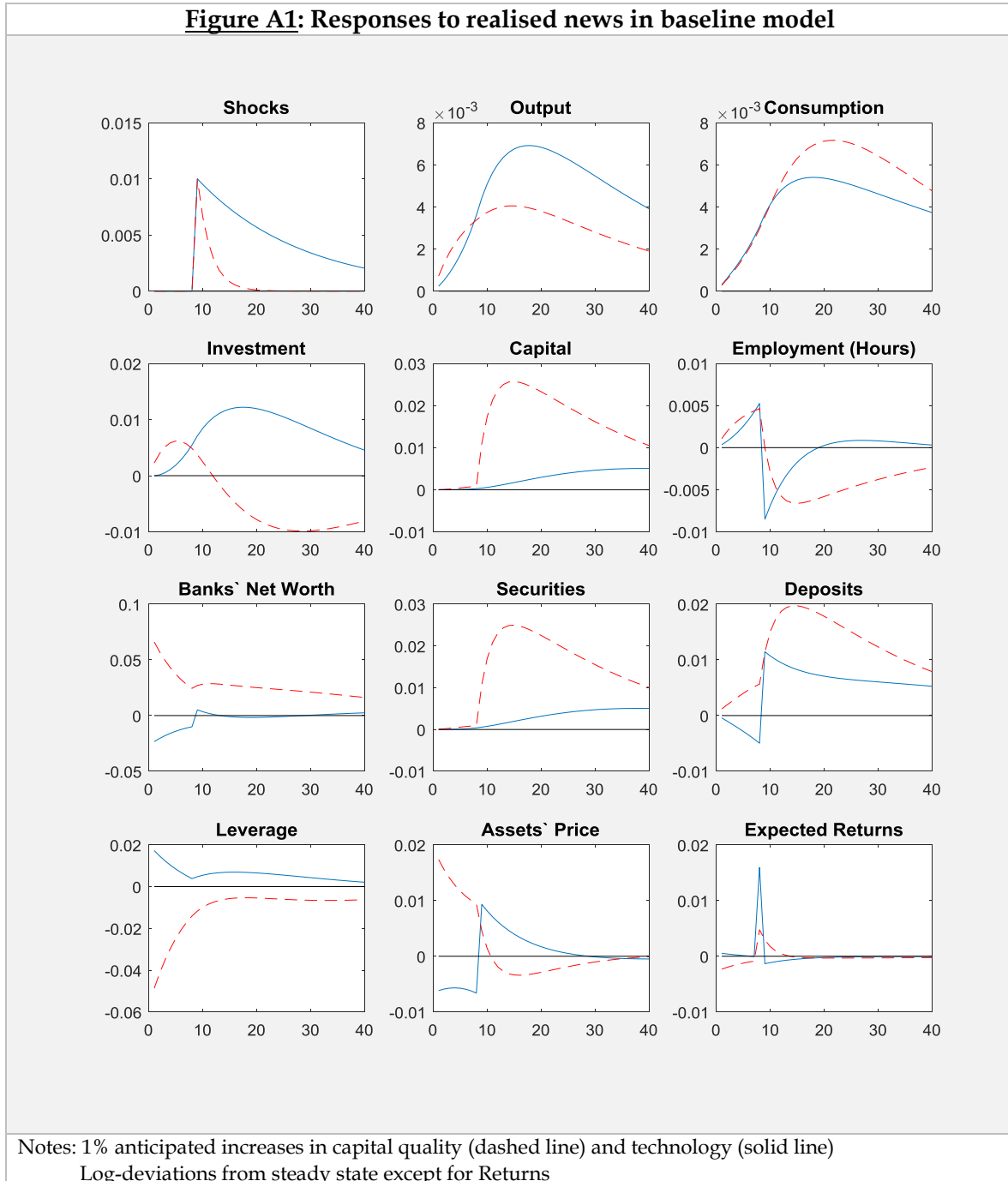
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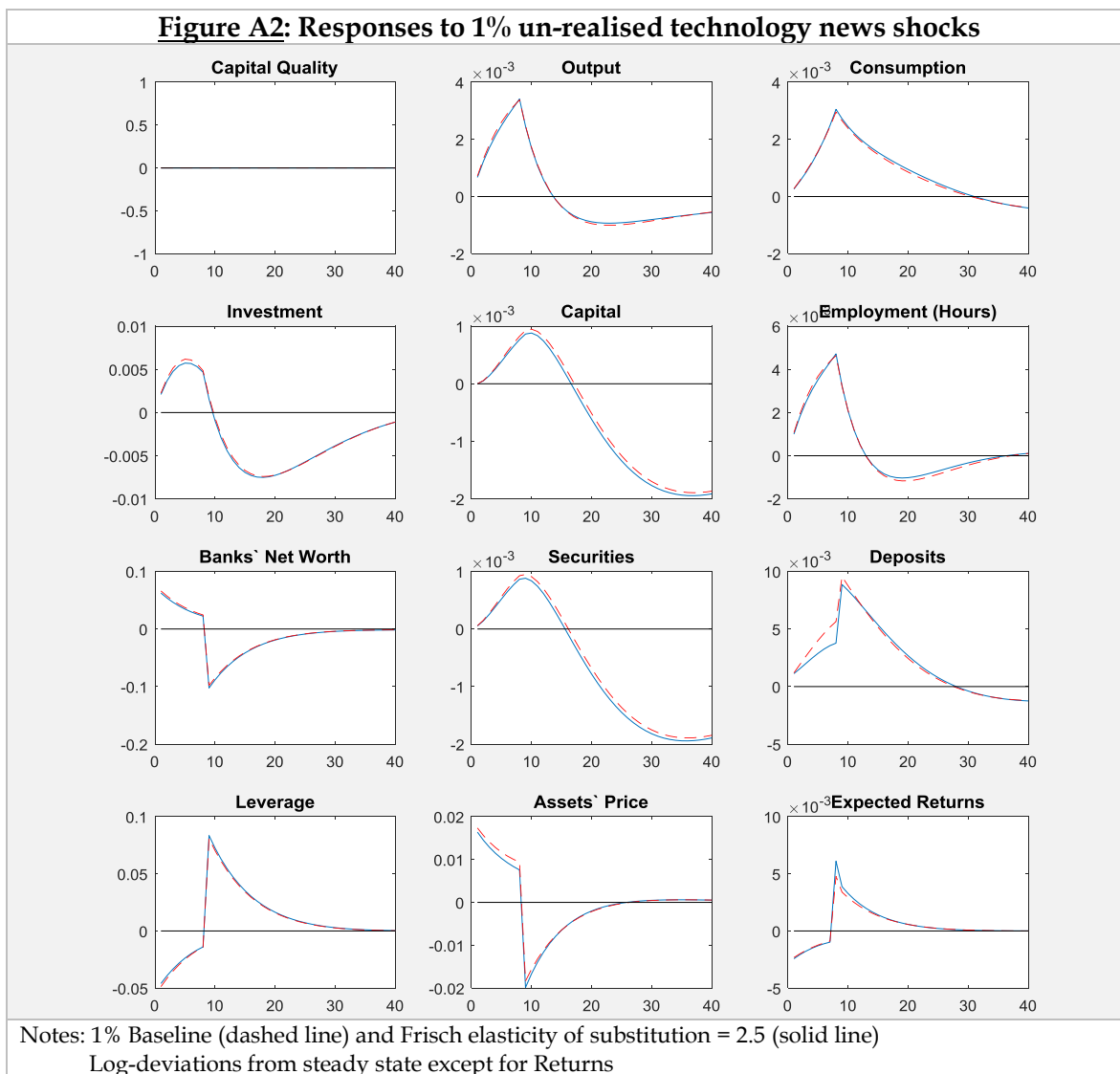
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# APPENDICES

## Appendix 1: Responses to realised technology and capital quality news shocks



**Appendix 2: Responses to unrealised technological news with high and low Frisch Elasticity**



### Appendix 3: the Jaimovich-Rebelo (2009) Approach

Jaimovich and Rebelo (2009) found parameters that generate positive co-movement with positive responses of consumption and employment to TFP and investment specific news shocks. Given their baseline parameterization for a simple RBC model, they reported threshold values for key parameters in Table 1 of their paper. Any other shock is not analysed in this framework and as a consequence, introducing any other shock requires the determination of the threshold values that guarantee co-movement. To do so, I add the capital quality shock to their framework such that the capital accumulation equation is now given by:

$$(A1) \quad K_{t+1} = \Psi_{t+1} \left( K_t (1 - \delta(u_t)) + I_t \left[ 1 - F \left( \frac{I_t}{I_{t-1}} \right) \right] \right)$$

Additionally I ignore the investment specific technology shock. This implies that the first order conditions are now given by:

$$(A2) \quad \lambda_t = (C_t - \chi L_t^\tau X_t)^{-\sigma} + \mu_t \gamma C_t^{\gamma-1} X_{t-1}^{1-\gamma}$$

$$(A3) \quad \lambda_t F_L(u_t K_t, L_t) = \tau \chi L_t^{\tau-1} X_t (C_t - \chi L_t^\tau X_t)^{-\sigma}$$

$$(A4) \quad \chi L_t^\tau (C_t - \chi L_t^\tau X_t)^{-\sigma} + \mu_t = \beta (1 - \gamma) E_t \left\{ \mu_{t+1} \left( \frac{C_{t+1}}{X_t} \right)^\gamma \right\}$$

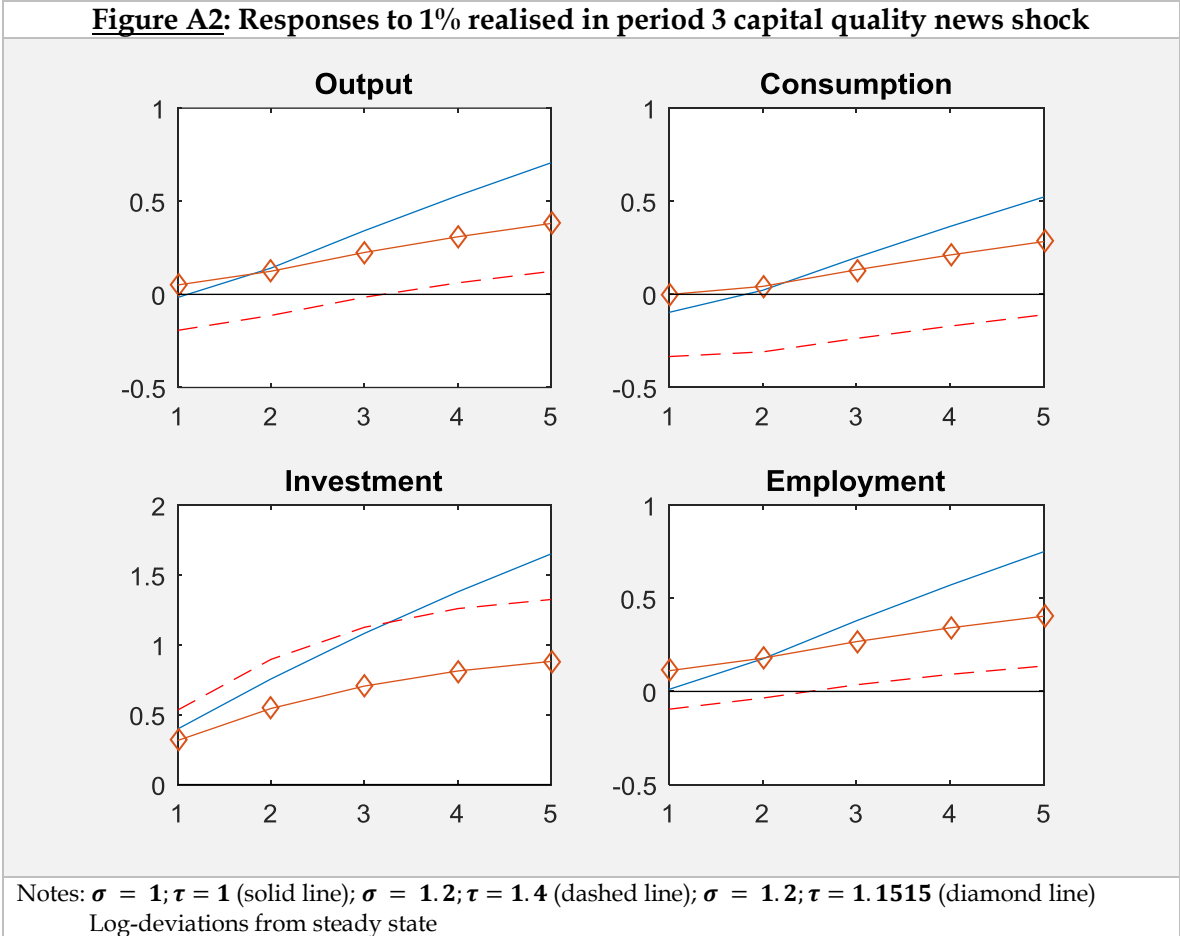
$$(A5) \quad \lambda_t = E_t \left\{ \eta_t \Psi_{t+1} \left( 1 - F \left( \frac{I_t}{I_{t-1}} \right) - \frac{I_t}{I_{t-1}} F' \left( \frac{I_t}{I_{t-1}} \right) \right) + \beta \eta_{t+1} \Psi_{t+2} \left( \frac{I_{t+1}}{I_t} \right)^2 F' \left( \frac{I_{t+1}}{I_t} \right) \right\}$$

$$(A6) \quad \lambda_t F_u(u_t K_t, L_t) = E_t [\eta_t \Psi_{t+1} \delta'(u_t)]$$

$$(A7) \quad \eta_t = \beta E_t [(\Psi_{t+1})^{-1} \{ \lambda_{t+1} F_K(u_{t+1} K_{t+1}, L_{t+1}) + \eta_{t+1} \Psi_{t+2} \delta(u_t) \}]$$

Setting  $\sigma = 1$  the same thresholds reported by Jaimovich and Rebelo in Table 1 produce co-movement in response to technology news. Notwithstanding, the response of investment output and employment to the capital quality news shock requires a high adjustment cost ( $F''(1)$ ), but consumption is un-responsive to all the parameters except the elasticity of labour supply. When this last is set to infinity ( $\tau = 1$ ) and the rest of the parameters are set as in the Jaimovich and Rebelo (2009) baseline, consumption and output respond initially negatively to the news about future increases in capital quality. Therefore, still setting this parameter to this extreme value is not enough to get consumption co-movement.

Co-movement can be achieved by setting  $\sigma > 1$ . In particular, with a value of 1.2 and a minimum of 6.6 for the labour supply elasticity ( $1/(\tau - 1)$ ) we can get co-movement. The graph below shows impulse responses to two periods anticipated capital quality shocks that are realised in period 3 under different parameterizations.



These results are conditional on the anticipation horizon. If news is received more than two quarters before the realisation of the shock, the parameterisation for getting co-movement needs to be more restrictive. Given this, plus the fact that under this strategy there are already several frictions affecting the behaviour of the system, such as investment adjustment cost and variable capital utilization, and the restriction on the wealth effect to guarantee co-movement, I opted for a simpler strategy to get co-movement since it would be less restrictive.