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Hysteresis Effects and Macroeconomics Gains from Unconventional Monetary Policies Stabilization

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JOB MARKET PAPER

Abstract

Based on the Great Recession, this paper investigates the slow recovery-following recessions and the ability of unconventional monetary policies to dampen the adverse effects of shocks. The purpose is to elucidate one of the paradoxes of the business cycle—the slow pace of recovery of macroeconomic indicators and to evaluate the gains from monetary policies initiated by central banks following the financial crisis of 2008. Therefore, the article develops a model by integrating hysteresis mechanisms, modelled by the segmentation of the labour market between insiders and outsiders in the structure of a model with financial frictions to explain the paradox related to production and employment. Financial frictions are incorporated into the model by using a moral hazard problem between financial institutions and households. Calibrated on the U.S. economy, the simulations of the model show that the pace of recovery of output and employment takes more than 6 years to get back to the trend after the shocks. The cost in terms of the welfare of this slow recovery ranges between 0.30% to 5.82% according to the importance of the insiders-outsiders phenomenon. According to the baseline calibration of the model, the simulations also show that credit easing helps to strongly limit the effects and the costs in terms of welfare induced by these hysteresis mechanisms. Output and unemployment begin to converge towards their pre-shock simulations respectively 2.5 years, and 3 years when the central bank intervenes with credit easing. Welfare gains vary from 3.55% to 4.30%.

JEL classification: E23, E24, E32, E58, G01.

Key Words: Great Recession, production, unemployment, financial frictions, hysteresis, insiders, outsiders, unconventional monetary policies, credit easing.

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1 Introduction

Prior to the Great Recession (GR), most standard business cycle models, univocally supported the idea of fluctuating economic activity around a stable trend. Adverse shocks such as financial crises certainly led to a decline in activity compared to its trend, but rapidly back. These models assume a rapid convergence to the steady-state. However, the recovery of activity, or rather the dynamics of production and unemployment following the 2008 financial crisis, has made this idea more or less equivocal. In some advanced countries, output declined and remained below its trend before the crisis—about a decade for the euro area economies and half a dozen years for the United States (see Figure 14). Over the same period, the unemployment rate increased and remained above the pre-crisis rate in both economies (see Figure 15).

The sluggish economic recovery has raised many questions. In particular, attention was focused on the temporary nature of deviations in economic activity around its trend path and the macroeconomic impact of unconventional monetary policies. Indeed, while standard theoretical models predicted the temporary nature of the adverse shocks of the GR (Figure 16), some empirical studies (Ball, 2014; Blanchard et al., 2015; Haltmaier, 2012; Lin, 2016; Yagan, 2019) reported persistent effects induced by these adverse shocks. These studies tend to attribute this persistence of adverse shocks to the emergence of hysteresis effects. Hysteresis suggests that some economic shocks are not necessarily accompanied by a reversibility in the behaviour of economic variables, at least in part, for a given period of time (Ball, 2009). Based on these studies, Cerra and Saxena (2017) argue that, due to hysteresis, the business cycle no longer necessarily appears cyclical (see Figure 17). The lack of ingredients related to hysteresis in the standard models, particularly in the New-Keynesian models with financial frictions, seems to explain why the lasting drop of production and employment has emerged as a paradox after the crisis.

This article is dedicated to this paradox and investigates the ability of the interaction between hysteresis mechanism and financial frictions to account for the lasting drop in output and employment. We also assess the capacity of unconventional monetary measures to mitigate or counteract the effects of hysteresis, since the emergence of hysteresis seems to call into question the relevance of the monetary innovations initiated during the crisis. In this perspective, the article draws on models already proven in the literature for the analysis of imbalances—namely, the New-Keynesian models. These models have been shaped over the years to account for episodes of economic contraction and recovery. Adjustments have been made on the structure of these models—to better understand major episodes of business cycles and to better predict future trends in the economy. Variants of New-Keynesian models with financial friction such as credit constraints or liquidity and rising premiums—show up particularly instructive for the major facts of GR. The works of Kiyotaki and

Moore (1997), Bernanke et al. (1999) and Christiano et al. (2003) provides theoretical arguments and evidence on the importance of credit frictions in amplifying adverse shocks.

In these models, financial factors help to amplify the effects of adverse shocks and contribute to reconciling economic theory with some empirical evidence related to the GR. In this regard, studies like Drehmann et al. (2012), Furceri and Mourougane (2009) and Reinhart and Rogoff (2009) suggest that considering the preponderance of financial activities in advanced countries, financial frictions need to be considered in the environment of models that attempt to explain the business cycle of the GR. Along the line of these studies, Gertler and Karadi (2011) and Kiyotaki and Moore (2012) show through their models adding, for example, bank capital frictions help to understand the severity of the financial crisis. With these frictions, adverse shocks seem to produce some increases in production and employment, but the damages induced on the economic activity are not as persistent as what we saw during the GR. The damages were persistent and adverse shocks have tended to counteract the speed of economic recovery due to the emergence of hysteresis effects (Howard et al., 2011).

The absence of persistent deviations in New-Keynesian models with financial frictions ground a theoretical investigation into the contribution of hysteresis mechanism in terms of their ability to explain the slow economic recovery. From this view, the current paper is geared for its potential contribution, since the economic literature on the dynamics of recoveries following financial recessions tend in analyses to focus on financial frictions. Based on our current knowledge, the analyses are focused more on the characteristics of recessions in terms of severity, which is generally attributable to the depth of the recession, rather than on the dynamics of economic recovery. The revival of the doctrine of hysteresis, on the other hand, offers the possibility of explicitly taking into account the major features of economic recovery, in particular its sluggish nature. In fact, the presence of hysteresis effects calls for a paradigm shift as Cerra and Saxena (2017) points out that adverse shocks cause persistent damage so that the business cycle does not necessarily fluctuate around a trend.

Also, the particularity of hysteresis effects in exacerbating the magnitude and persistence of the effects of adverse shocks has continued to shake the monetary consensus on the macroeconomic impact of central bank actions since the financial crisis. According to this consensus, supported by the monetarists and the New-Keynesian, credit easing should in no way be able to contain the persistent downward trend in output and employment over time. At best, credit easing could mitigate the impact of adverse shocks without driving a real recovery in economic activity. As a result, despite the unconventional monetary measures, output and unemployment experiencing hysteresis effects will remain below their levels before the shock. In addition to this macroeconomic issue, the potential gain in terms of welfare linked to the implementation of these monetary measures tends to

exacerbate the eternal debate on the need for stabilization policies. This is a necessity that a certain part of the literature supported by Lucas Jr (1987, 2003) has endeavored to question by estimating that the gains in terms of welfare resulting from cyclical policies would be almost negligible. On the other hand, another side supported by New-Keynesian strives to highlight the economic benefits of their use because of the relatively large welfare losses from economic fluctuations, especially persistent adverse shocks.

Relying on New Keynesian arguments, empirical work without paying particular attention to unconventional monetary policies suggests a significant impact of monetary policies on persistent shocks. Thus, Jordà et al. (2020b) show through an empirical investigation of data from 17 developed countries over 125 years that monetary policy remains active beyond its immediate impact. Their results indicate that a monetary tightening of 100 basis points leads to a fall in Gross Domestic Product (GDP) of at least 3% below its level before the shock, 12 years after the monetary shock. Jordà et al. (2020a) point out from the data on the U.S. economy that stabilization policies are more than necessary as the welfare costs of adverse shocks become increasingly important. For the latter, these costs evaluated in terms of consumption would be in the order of 10 to 15% against 0.05% for Lucas Jr (2003), and this is particularly due to the recessions coupled with financial crises.

In light of this empirical evidence, this article examines the ability of credit easing to moderate the downward trend in output and the upward trend in unemployment, as well as the potential welfare gains associated with its implementation. It is worth noting that credit easing was one of the major monetary policy measures in the wake of the financial crisis of 2008. In theory, credit easing through the portfolio rebalancing and reporting channels identified in the literature would have strong potential in supporting recoveries in economic activity over time and improving the welfare of economic agents compared to a situation of persistent adverse shocks. In fact, by compensating for the failure of the banking sector to provide liquidity to the economy, the easing of credit could help curb the fall in investment and the contraction of labour demand by firms. In this respect, central bank intervention would tend to be accompanied by a reduction in the intermediation premium and an increase in the prices of financial assets. Since Chen et al. (2012) advocate the virtues of asset purchases by the U.S. Federal Reserve, arguing that these purchases have a positive long-term effect on production, although the effects of these measures remain weak. Their results suggest that 6 years after the asset purchases, production remains 0.25% higher than it would have been in the absence of the purchases. However, at the current state of knowledge, very few theoretical models support the virtues of credit easing against the persistent damage of adverse shocks to output and unemployment. In particular, New Keynesian models do not seem to provide any insight into the ability of credit easing in containing hysteresis effects and moderating the potential welfare losses

that these would inflict on economic agents.

To analyze the implications of hysteresis for production, unemployment, and unconventional monetary policies, this paper develops a variant of New-Keynesian models based on the work of Gertler and Karadi (2011). We choose this model as a base for three reasons. First, the model seems to be the most advanced theoretical model for taking into account the frictions linked to the banking sector, particularly those related to bank lending. Second, it already incorporates the essential ingredients of one of the major measures of unconventional policies — credit easing. Third, it has also been extended several times in the literature for business cycle analysis (Claessens and Kose, 2017). Their approach seems appropriate for modelling the deterioration of productive capacities related with productive capital. However, we think that persistent damage results more from the interaction between the deterioration of productive capital and low labour utilization. Deterioration in productive capital is usually accompanied by a reduction in the demand for labour. Therefore, we extend their model to include a hysteresis mechanism that transits through the labour market. In particular, we integrate Blanchard and Summers (1986) and Galí (2020)'s segmentation of the labour market between insiders and outsiders into their model environment. In the labour market, the insiders are the employed workers and the outsiders the unemployed.

The segmentation between these two types of workers is introduced such as giving the power to insiders to negotiate the wages. With this bargaining power, insiders tend to stiffen employment by focusing solely on safeguarding their jobs to the detriment of outsiders during negotiation rounds. Thus, adverse shocks that reduce the proportion of insiders are accompanied by an increase in the wage bargaining power of the new population of insiders. Therefore, reductions of the number of insiders are likely to reduce the demand of labour by raising its cost. In such an environment, employment (insiders) and unemployment (outsiders) may deviate durably from their level before the crisis, particularly as a result of a deterioration of bank capital. By making banking and labour market frictions interact, this article differs from the work on financial frictions and hysteresis effects. Unlike the study of Gertler and Karadi (2011), which focused on temporary effects, this paper focuses on the persistent effects of adverse shocks. The paper illustrates these persistent effects by displaying how segmentation of the labour market help to amplify and perpetuate the effects of these kinds of shocks. Compared to models with hysteresis effects, especially their New-Keynesian variants such as Galí (2020), the analysis distinguishes itself by examining the scope of hysteresis effects beyond the labour market alone. The simultaneous consideration of the two frictions is more consistent with the major facts of the GR business cycle.

By calibrating the model to the U.S. economy, the assessment of the macroeconomic effects of simultaneously considering these two frictions and their possible implications for unconventional monetary policies is done in three steps. First, we evaluate the amplification and persistence in-

duced by the interaction between the two frictions by comparing the developed model with models devoid of such an interaction. In this regard, the model is simulated with three types of adverse shocks—a monetary shock, an unanticipated decline in the value of capital, and a technology shock. Second, the ability of credit easing to contain the hysteresis effects arising from the interaction between the two frictions is assessed by comparing two types of central bank intervention to non-intervention. The first intervention of the central bank compensates 50% of the banking sector's losses and the second intervention 100% of the losses. Also, the effects of these two measures were evaluated by considering a high and a low degree of hysteresis. Third, the welfare evaluation of unconventional monetary policies is done by comparing the welfare changes induced by these two easing measures with the welfare costs of hysteresis effects.

Model simulations show that the interactions between financial frictions and labour market segmentation between insiders and outsiders contribute to amplifying and persisting the effects of adverse shocks on output and unemployment. Based on these interactions, the results with the three shocks indicate that the fall in output and the rise in unemployment prove to be at least twice as large as in a model with only financial frictions. Moreover, when compared with the results of a model with only financial frictions, the drop of output and the rising of the unemployment rate are at least twice as high for at least 6 years after the adverse shock. In quantitative terms, a monetary tightening of 100 basis points translates into a reduction of about 4% in output and an increase in the unemployment rate of 7 percentage points more 6 years after the monetary shock. For adverse shocks of 1% on the value of capital and technology, output declines by 2% and 0.2%, respectively, and the unemployment rate increases by 3 and 0.3 percentage points, respectively, 6 years after the shocks. Thus, our results are revealed to be instructive about the lasting drop of production and employment during the GR.

Also, the results show that in the presence of a high hysteresis degree, credit easing covering 50% of the banking sector's losses is not able to stem the downward trend in output and the upward trend in unemployment. The downward trend in production persists for about 5 years and the upward trend in unemployment for 7 years. The easing measure consisting of compensating 100 percent of the banking sector's losses helps to strongly limit the effects of hysteresis by curbing the downward trend in production and the rise in unemployment. Output and unemployment begin to converge towards their pre-shock levels 2.5 years, respectively, and 3 years after the central bank intervenes with credit easing. This intensity of easing is particularly effective when the degree of hysteresis is relatively moderate, the rise in unemployment is completely reversed in 4 years, and output returns to its equilibrium state in 3 years.

Welfare analysis shows that easing measures are potentially a source of welfare improvement when the economy faces the emergence of hysteresis effects. Like the macroeconomic effects, the welfare

gains from these measures depend on the degree of the hysteresis effects and the intensity of credit easing. Welfare gains measured as a percentage of consumption without hysteresis effects vary from 0.06% to 0.72% for the credit easing covering 50% of the losses of the banking sector and from 3.55% to 4.30% for the credit easing that covers 100% of the losses, for all degrees of hysteresis. For each credit easing measure, the gain in welfare tends to increase with the degree of hysteresis. Furthermore, in view of the welfare costs of the hysteresis effects, evaluated in relation to the same consumption, credit easing covering 100% of the banking sector's losses is able to fully compensate these losses for most degrees of hysteresis.

The remainder of the paper is organized in seven sections. The second section presents the literature review. The third explains the calibration. The fourth discuss the macroeconomic implications of the interaction between financial frictions and hysteresis mechanisms. The fifth illustrates and discusses the results on the macroeconomic impact of credit easing on hysteresis effects. The sixth presents the welfare changes induced by credit easing measures. The seventh concludes the article.

2 Literature Review

This section reviews the literature on the sluggish recovery of economic activity and the macroeconomic impact of unconventional monetary policies.

2.1 Literature review on the sluggishness of the economic recovery

The business cycle following recessions in most advanced economies has generally had a V-shape since the end of the Second World War. However, that of the GR is distinguished by its slowness with U or even L-shapes. Both empirical and theoretical work have proliferated in an attempt to explain this peculiarity of the business cycle of the GR compared to previous cycles. This literature thus puts forward a certain number of explanatory factors, which can be divided into three main categories: structural causes, the systematic nature of the crisis, and the presence of hysteresis effects.

Advocates of structural causes argue that the slow economic recovery is due to the coincidence of the financial crisis with long-term negative trends that predate the GR. Such a demographic dynamic would lead to a reduction in overall demand, savings, and therefore, productive investment (Lee, 2014). For Gordon (2012), the major structural change behind the slow economic recovery is the decline in the potential for innovation in advanced economies. Furthermore, Blanchard et al. (2014) point out that demographic aging combined with the demographic slowdown is leading

advanced economies into a secular stagnation characterized by insufficient aggregate demand.

Alongside these strong trends, another part of the literature focuses on the sustainability of the financial crisis. This literature led by Reinhart and Kenneth (2012) and Furceri and Mourougane (2009) point out that recessions linked to financial crises tend to be deep and long. Bijapur (2012) notes in this respect that a recession coupled with a financial crisis is likely to curb capital accumulation due to the weakening of the banking sector's capacity to finance investment projects. According to this work, the sluggishness of the economic recovery is far from unique; it is a feature common to financial crises.

However, the tendency to question the singularity of the economic recovery of GR is questioned by Bordo and Haubrich (2017) and supporters of the doctrine of hysteresis. Bordo and Haubrich (2017) point out that, unlike Reinhart and Kenneth (2012), financial crises are not systematically accompanied by slow economic activity. Some market forces such as hysteresis effects tend to sustain falling output and rising unemployment. Formerly developed by Blanchard and Summers (1986) to explain the rise in unemployment in Europe in the 1980s, the recent financial crisis is proving to be a consecration of the hysteresis thesis. They point out that natural unemployment could intensify if cyclical unemployment remains very high. They argued that hysteresis effects could lead to an encircling of cyclical unemployment into structural unemployment. Since then, two main reasons have been put forward to explain the presence of such hysteresis effects. The first suggested by Blanchard and Summers is the tendency of insiders to rigidify employment at a low level by negotiating relatively higher wages. The second is the depreciation of the skills of workers experiencing a long period of unemployment during the crisis (Möller, 1990; Snower, 1994). Ball (2014) concludes that super hysteresis effects are present when he finds an average decline of 8.4% in the output of the economies of the Organisation for Economic Cooperation and Development. Like Ball, Abiad et al. (2009), and Howard et al. (2011) expect output in advanced economies to decline by an average of 10% and 8%, respectively, in the aftermath of the crisis.

2.2 Macroeconomic implications of unconventional monetary policies

The theoretical literature on the macroeconomic impact of credit easing measures provides theoretical arguments on the transmission mechanisms of these measures. These arguments can be structured around two transmission channels: the portfolio rebalancing channel and the signal channel.

The portfolio rebalancing approach in macroeconomics, formalized by Tobin (1969), frames the first part of the theoretical arguments. The approach assumes that there is no perfect sustainability between securities in the portfolios of economic agents. According to this approach, failures such

as the loss of mutual trust between banking sector participants and the economic uncertainty characteristic of GR are likely to further alter the degree of sustainability between different assets (Cúrdia and Woodford, 2010). Interest rates close to the zero bound are also likely to reduce perfect sustainability, particularly between money and other assets (Cúrdia and Woodford, 2010; Eggertsson and Woodford, 2003). Thus, credit easing measures that result in asset purchases induce variations in asset supplies and returns. The prices of assets purchased by the monetary authority rise while their yields fall. These relative variations lead to a reorganization of the portfolio of economic agents, the securities purchased by the central bank are replaced by other assets. These substitutions by exerting pressure on the rise in the price of securities are contributing to a general easing of the financing conditions of the economy. Firms obtain the necessary liquidity for their investments and households consume more due to wealth effects. The resulting increase in aggregate demand is prompting a resumption of economic activity.

The second part of the theoretical arguments is structured around the signal channel, centering on the idea that credit easing measures are tools for transmitting monetary policy information. Through these measures, the monetary institution signals to the market its willingness to keep interest rates at relatively low levels for a sufficiently long period of time (Bauer and Rudebusch, 2014; Bernanke et al., 2004). As a prelude to these low interest rates, agents then revise downwards the interest rates they charge for project financing. This leads to an increase in investments and, by ricochet, to economic recovery.

Along with the theoretical arguments identified above, empirical work has attempted to assess the macroeconomic effects of unconventional monetary policies, particularly credit easing measures. Much of this work has focused on the economies of the United States, the Euro zone, and the United Kingdom. They provide both evidence on the scope of channels and macroeconomic effects. The first studies were part of the approach to rebalancing portfolios. In a study which has become famous, Gagnon et al. (2011) shows that credit easing measures lead to a reduction in long- term interest rates and risk premiums. Securities purchase transactions covering the period 2008 to 2010 are associated with a reduction in risk premiums of 30 to 100 basis points and long-term interest rates of 91 to 113 basis points. Similar operations carried out in the United Kingdom from 2009 to 2010 led to similar reductions in premiums and interest rates. Other studies (D'Amico and King, 2013; Joyce et al., 2011; Rosa and Tambalotti, 2020; Wright, 2012) following the same methodological approach of Gagnon et al. (2011) prove that credit easing measures actually lead to lower risk premiums and long-term interest rates.

In addition, studies have sought to test the validity of the effects of credit easing measures on interest rates and risk premiums by emphasizing the signal channel. Bauer and Rudebusch (2014) in an econometric approach show that the actions of the US central bank from 2001 to 2003 in the

form of credit facility announcements were associated with reductions of 21 to 56 basis points in long-term interest rates and 68 to 70 basis points in risk premiums. These findings are supported by a number of studies (Bauer et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011; Woodford, 2012).

Based on this evidence, work is underway to establish a bridge between the effects of easing measures on asset prices and certain macroeconomic variables. Baumeister and Benati (2013) thus establish a positive relationship between asset price increases and economic growth and inflation based on counterfactual simulations. Weale and Wieladek (2016) find that purchases equivalent to 1% of gross domestic product (GDP) are associated in the United States with an increase in product of 0.36% of real GDP and inflation of 0.38%. Similarly, equivalent purchases in the United Kingdom lead to an increase of 0.18% and 0.3% respectively in real GDP and inflation. Fuhrer et al. (2011) focus in turn on purchases of securities in the United States from 2010 to 2011. They conclude from a vector autoregression model that purchases over the period induced a 75 to 80 basis point increase in real GDP, a 0.3 to 0.4 basis point decline in the unemployment rate and an increase in employment of about 700,000 new jobs. Chung et al. (2012) establish on the basis of an autoregressive model that the asset purchase operations carried out from 2009 to 2012 led to an increase in real GDP of 3% over the first two years and job creation of around 3 million, and this over approximately 4 years.

Lessons from studies on the sluggish economic recovery and unconventional monetary policies' impact

Considering the empirical evidence, the slowness of the economic recovery seems to be explained more by the presence of hysteresis effects. At the same time, the theoretical investigation—in particular the New Keynesian models centred on the analysis of economic cycles following recessions—seems to ignore the scope of the mechanisms of hysteresis. These models tend to focus on the characteristics of recessions by highlighting the depth or severity taking into account financial frictions. However, such approaches do not allow explicit consideration of the lingering effects of adverse shocks. In view of these limits and the fact that the economic literature emphasizes the possibility of capturing more persistence through certain hysteresis mechanisms, this paper intends to explore one of these mechanisms through the labour market. From this perspective, this paper intends to explore the scope of the interaction between financial frictions and hysteresis mechanisms passing through the labour market. This interaction could be virtuous because models with financial frictions centred on productive capital tend to illustrate amplification without demonstrating any notable persistence. Also, because theoretical models that take into account the effects of hys-

teresis disregard productive capital so that they manage to highlight a certain persistence, they are limited in describing well the major characteristics of GR in the occurrence sustained amplification and persistence.

Also, considering that aggregate demand affects the trajectory of the economy over time through the effects of hysteresis, unconventional monetary policies could help contain the effects of hysteresis through aggregate demand. Jordà et al. (2020b) have shown, for example, that monetary policy influence's long-term economic activity. Their results show that a one percentage point increase in interest rates leads to a decline in the GDP of 3.49% approximately 12 years after monetary tightening. Jordà et al. (2020b) have also developed a theoretical model to account for the empirical evidence. However, at the current state of knowledge, the theoretical investigation has not yet explored the implications of monetary non-neutrality for unconventional monetary policies, although the literature on hysteresis effects offers some bridges to this effect.

In this perspective, this paper is based on the models already proven in the analysis of financial crises—the New-Keynesian models with financial frictions in order to integrate a hysteresis mechanism passing through the work—the segmentation between insiders and outsiders. The choice of this mechanism is based on the fact that it is one of the hysteresis mechanisms whose plausibility in the data seems to be best established by empirical work. In practice, this segmentation could be representative of any labour market mechanism that may be negatively correlated with wages, such as the existence of unions, overtime, or rotations. Holmlund and Zetterberg (1991)'s data covering the period 1960 and 1980 illustrate the preponderant power of insiders in determining wages in the major production sectors in the United States. In the same sense, Blanchflower et al. (1990) provide similar evidence for the United Kingdom for both public and private service. Bakas and Makhlouf (2020) in extending the analysis to OECD countries also conclude that labour market segmentation between insiders and outsiders is empirically entrenched as a lever for persistence. Basis of this more or less unequivocal evidence, the present article develops the following variant of New-Keynesian models where friction interacts with this form of segmentation.

3 The Basic Model

This section develops and presents the environment of the variant of New Keynesian models intended to analyze the implications of the mechanisms of hysteresis in New-Keynesian settings with financial frictions. The variant developed in this text is based on the model with financial frictions of Gertler and Karadi (2011) and extends the latter by integrating the segmentation of the labour

market between insiders and outsiders, as presented by Blanchard and Summers (1986) and Galí (2020). With segmentation, wages are determined at the end of negotiations between employed workers (insiders) and firms, the outsiders appear as passive agents. The predominance of insiders in wage negotiations constrains the firms' demand for labour, as insiders strive in negotiations to maintain their level of employment without any consideration for recruiting outsiders in such an environment, the level of employment depends on the size of the insiders. The shocks affecting the latter reduce the demand for labour, in the absence of any measure, this reduction contributes to rigidifying employment to a low level. As a result of shocks, rising unemployment and weak production tend to persist for a long time. In addition to the persistence of the effects of shocks, taking into account financial frictions like Gertler and Karadi (2011), namely the constraints of mobilizing funds, leads to the amplification of the effects of shocks. The constraint of mobilizing funds is introduced into the model by an agency problem between the banking sector and the households at the origin of bank deposits. The rest of the model has the classic ingredients of the New-Keynesian models, monopolistic competition to introduce price rigidities, capital producers to highlight the importance of adjustment costs, and retail firms.

The basic model environment thus consists of five sectors: the banking sector, households, the production sector of intermediate goods, the sector of production of capital, and the sector of sale of goods. This basic model will later be extended to include credit easing in order to analyze the ability of this measure to contain the emergence of hysteresis effects.

3.1 The Banking Sector and Financial Frictions

The banking sector contains all of the financial and banking institutions of the economy. These institutions are identical and their management is entrusted to a banker at each period. The profits earned by each financial institution are paid to the household where the banker comes from. The latter is assured of continuing its intermediation activities with a probability ϕ. The proportion of bankers to all households is a constant in each period so that the capital accumulated by outgoing bankers at the end of one period is returned at the start of the following period to the returning member. Financial intermediation for each banker consists of making household deposits D_t in the form of loans to non-financial firms. In return, these firms issue assets in recognition of the contracted debt, denoted A_{bt}, the relative price of which is denoted Q_t. Household deposits earn an R_t return at the end of each period, while loans are made to firms at the R_{bt} rate. Members of households in the economy can be either bankers or workers. Thus, the banker manages the activities of financial institutions. He may be tempted to divert part of the institution's assets to the benefit of his household. An agency problem is introduced to capture this eventuality.

The banker's mandate is to maximize the financial institution's equity according to the following function:

$$V_{bt} = max\ E_0 \sum_{t=0}^{\infty} (1-\phi)\, \phi^t \beta^t \Lambda_{t,t+1} \left(F_{bt+1}\right)$$

under constraint:

$$F_{bt+1} = R_{bt+1} Q_t A_{bt} - R_{t+1} D_t \tag{1}$$

$$V_{bt} \geq \lambda Q_t A_{bt} \tag{2}$$

Equation (1) indicates that at the end of a management period, the resources or equity, F_{bt} of each financial institution resulting from the difference between its earnings on assets and the interest paid to households. Equation (2) is the constraint of household participation in the financing of the banking institution. λ is the proportion of assets likely to be misappropriated by the banker during his financial year. $\Lambda_{t,t+1}$ is the marginal ratio of the utility.

Considering the balance sheet of each banking institution at each period: $Q_t A_{bt} = F_{bt} + D_{bt}$, Equation (1) can be written as follows:

$$F_{bt+1} = \left(R_{bt+1} - R_{t+1}\right) Q_t A_{bt} + R_{t+1} F_{bt} \tag{3}$$

$(R_{bt+1} - R_{t+1})$ is the premium of financial intermediation. Thus, at the end of an intermediation period, equity capital has two components: the net gain on assets $(Q_t A_{bt})$ and the income earned on F_{bt} committed equity during the financial year. The goal of the financial institution is then to maximize the expected value of each of the two components of its equity in each period. Let υ_t be the marginal gain from the increase in assets and η_t the gain from capital investment in the form of a loan. V_{bt} can then be written as a linear function of the two components:

$$V_{bt} = \upsilon_t Q_t A_{bt} + \eta_t F_{bt} \tag{4}$$

Financial institutions have a strong incentive to increase lending in order to increase their own resources. However, the possibility that the manager monopolizes part of these resources limits this trend. The participation constraint limits the ability of financial institutions to acquire assets.

By saturating the participation constraint $\eta_t F_{bt} + \upsilon_t Q_t A_{bt} = \lambda Q_t A_{bt}$, the maximum volume of assets likely to be acquired is as follows:

$$Q_t A_{bt} = \frac{\eta_t}{\lambda - \upsilon_t} F_{bt} \tag{5}$$

This last equation is used to define the expression of the ratio between assets and equity of the financial institution:

$$Q_t A_{bt} / F_{bt} = \frac{\eta_t}{\lambda - \upsilon_t} = \psi_t \tag{6}$$

Equation (5) can then be rewritten equation (3) as follows:

$$F_{bt+1} = \left[\left(R_{bt+1} - R_{t+1} \right) \psi_t + R_{t+1} \right] F_{bt} \tag{7}$$

Equations (5) and (6) allow us to obtain the expression of the rate of increase in equity and assets:

$$z_{t+1} = \frac{F_{bt+1}}{F_{bt}} = (R_{kt+1} - R_{t+1})\psi_t + R_{t+1} \tag{8}$$

$$x_{t+1} = \frac{Q_{t+1} A_{t+1}}{Q_t A_t} = \frac{\psi_{t+1}}{\psi_t} z_{t+1} \tag{9}$$

By combining this last equation and the equations (8) and (9):

$$V_{bt} = (1-\phi)\beta\Lambda_{t,t+1} \left[(R_{bt+1} - R_{t+1}) Q_t A_{bt} + R_{t+1} F_{bt} \right] + \phi\beta\Lambda_{t,t+1} (\upsilon_{t+1} x_{t+1} Q_t A_{bt} + \eta_{t+1} z_{t+1} F_{bt}) \tag{10}$$

So the expressions of υ_t and η_t are:

$$\upsilon_t = E_t \left\{ (1-\phi)\beta\Lambda_{t,t+1} (R_{bt+1} - R_{t+1}) + \phi\beta\Lambda_{t,t+1} x_{t+1} \upsilon_{t+1} \right\} \tag{11}$$

$$\eta_t = E_t \left\{ (1-\phi) + \phi\beta\Lambda_{t,t+1} z_{t+1} \eta_{t+1} \right\} \tag{12}$$

The banking sector is made up in each period of two types of firms: entrants and survivors. Considering F_t as the set of resources of the banking sector, F_t can be written as the sum of the resources

of the incoming institutions, F_{et} and of the survivors F_{st}:

$$F_t = F_{et} + F_{st} \tag{13}$$

The fraction of financial institutions that survive between two periods, $t-1$ and t being equal to ϕ, then

$$F_{st} = \theta \left[(R_{bt} - R_t) \psi_{t-1} + R_t \right] F_{t-1} \tag{14}$$

The proportion of bankers who leave the banking sector is $(1-\phi)$, so the total volume of their assets is $(1-\phi)Q_t A_{t-1}$. Under the assumption that the household transfers a fraction $\frac{\varsigma}{1-\phi}$ of this value to the member entering the banking sector, then:

$$F_{et} = \varsigma Q_t A_{t-1} \tag{15}$$

The combination of the equations (14) and (15) gives the dynamics of the resources of the banking sector:

$$F_t = \theta \left[(R_{bt} - R_t) \psi_{t-1} + R_t \right] F_{t-1} + \varsigma Q_t A_{t-1} \tag{16}$$

3.2 Households and Hysteresis Mechanisms

3.2.1 Consumer preferences

The economy is made up of several identical households, each housing has a continuum of members, standardized to the unit. Consumption and savings decisions are made at the household level. In terms of consumption, the family unit of the household serves as insurance and preferences are assumed to be separable. Thus, belonging to the household ensures the same level of consumption for each member regardless of their status in the labour market. To save, each household makes deposits in a banking institution other than its own.

In each household the members are specialized to perform a specific service s, with s $\in$ (0,1) offering their labour force to firms in the production sector. Employment for each service s, N_{st} is demand driven. Thus, each household considers N_{st} as given so that N_{st} is assigned within each household to members with low labour disutility among those with the s specialization. For each household, the disutility is χe^{φ} when the latter is used and 0 otherwise, with $\chi > 0$ and $\varphi > 0$,

respectively the weight of the leisure in the function utility and the Frisch elasticity of labour supply. In each period, the utility of a representative household is given by the integral of the utilities of its members:

$$U(C_t, N_{st}) = \left(logC_t - \chi \int_0^1 \int_0^{N_t(s)} e^{\varphi} deds \right)$$

Given these preferences, each household maximizes

$$max \;\; E_0 \sum_{t=0}^{\infty} \beta^t (logC_t - \chi \int_0^1 \frac{N_{st}^{1+\varphi}}{1+\varphi} ds)$$

under constraint:

$$P_t C_t + D_{t+1} = R_t D_t + \int_0^1 W_{st} N_{st} ds + \Pi_t \tag{17}$$

with C_t the aggregate household consumption, β is the discount factor, D_t household deposits, R_t, the interest rate on deposits, W_{st} is the nominal wage for a service s and Π_t the net profit made by the household in the production and banking sectors.

The first order conditions for consumption and savings decisions are:

$$\Omega_t = \frac{\beta^t}{C_t} \tag{18}$$

$$\Lambda_{t,t+1} = \frac{\Omega_{t+1}}{\Omega_t} \tag{19}$$

$$E_t \Lambda_{t,t+1} R_{t+1} = 1 \tag{20}$$

where Ω_t is the marginal utility of household consumption.

3.2.2 Rationing of the desire to work and the emergence of unemployment

As employment is determined by demand, positions are allocated to individuals with the same specialization in a household-based on disutility:

$$\frac{W_{st}}{P_t} \geqslant \chi C_t e^{\varphi} \tag{21}$$

According to this equation, individuals of the same specialization are then discriminated based on their marginal disutility at work so that members with low disutility inherit positions until: $\frac{W_{st}}{P_t} = C_t e^{\varphi}$. This equation also determines the nominal reservation wage for any service s. At the same reservation wage, the other members with the same specialization would have liked to offer their labour force, L_{st}, provided that:

$$\frac{W_{st}}{P_t} = C_t L_{st}^{\varphi} \tag{22}$$

However, the latter find themselves rationed in their desire to work. This rationing tends to divide the market for specific services between employed members, and members whose desire to work are not considered. The consequence at the global scale of the economy is then segmentation of the labour market between these two entities of the labour force. Thus, according to Figure (1), unemployment emerges, because the labour market closes while part of the labour force remains rationed. This rationing takes the form of a gap between the demand for labour (l_t) and the supply of labour (n_t). Subsequently, unemployment is more explicitly introduced into the model by aggregating labour forces and employment levels in each sectoral occupation. In doing so, the aggregate employment, N_t of the economy is an aggregation of the different employment volumes: $N_t = \int_0^1 N_{st} ds$. The labour supply or the available labour force is L_t, the aggregation of the labour force, L_{st} available by sector: $L_t = \int_0^1 L_{st} ds$.

To better understand the proportion of employed members among the workforce, the unemployment rate is now considered instead of the number of unemployed. For simplicity, the unemployment rate is defined by taking the log of the variables of L_t and N_t. For reasons of harmonization, the other variables related to the definition of unemployment are presented in log. The logs of the variables are represented by lowercase letters. The unemployment rate (u_t) is then defined as the difference between the log of available labour $(l_t = logL_t)$ and that of employment $(n_t = logN_t)$.

$$u_t = l_t - n_t \tag{23}$$

where w and p are respectively the logs of the nominal wage (W) and of the general price level (P), and (w-p) therefore represents the real wage.

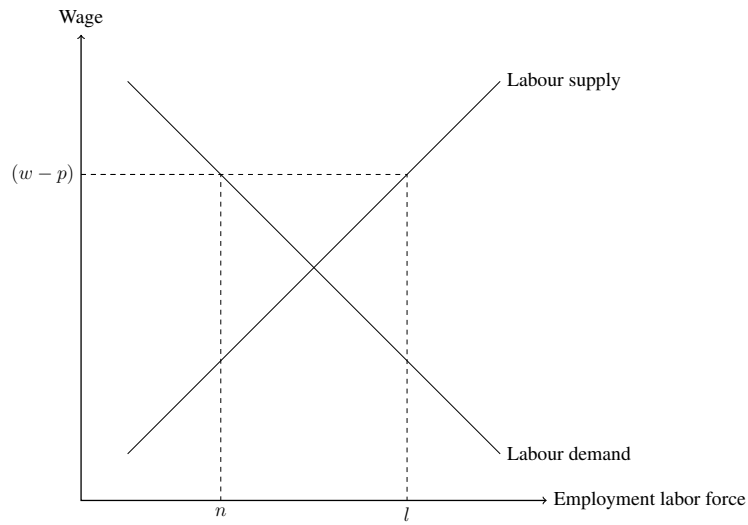

Figure 1: Rationing of desire for work and introduction of unemployment

3.2.3 Segmentation of the labour market and wages Determination

This subsection introduces the mechanisms of hysteresis through the ability of insiders to stiffen employment to the detriment of outsiders through wage determination. The lines also contrast the way wages are set by this channel with the modus operandi of wages in standard New-Keynesian models.

In their labour supply, members of households with the same specialization are organized into structures responsible for negotiating sector wages. These structures carry out at each phase of wage renegotiation a salary revision for each sector s, w_{st} the log of W_{st}. During these negotiations sessions, the mandated structure negotiates the salary w^*_{st} considering the current and future demand for their work offers.

$$n_{st+k|t} = -\epsilon_w \left(w^*_{st} - w_{t+k}\right) + n_{t+k} \tag{24}$$

$n_{st+k|t}$ is the employment in log of the workers who re-optimize at period t, n_{t+k} the employment aggregated in log and $\epsilon_w > 1$, the elasticity of substitution between the different labour services.

At the aggregate level, Calvo rigidity is supposed to describe wage rigidities in the sense that in each period, only a proportion of $(1-\theta_w)$ of sectors make wage revisions:

$$w_t = \theta_w w_{t-1} + (1 - \theta_w)\, w_t^* \tag{25}$$

where w_t is the log of the nominal wage W_t and w_t^* the log of the average wage of the $(1 - \theta_w)$ sectors.

The rationing of the desire to work means that in each industry, the labour force is segmented between insiders (employed members), and outsiders (unemployed members). With this segmentation, insiders find themselves in the majority in wage bargaining structures. According to Blanchard and Summers (1986) and Galí (2015), this over-representation gives insiders a notable power in fixing wages. In each round of wage bargaining, insiders are concerned with safeguarding their jobs, not facilitating employment for outsiders.

Thus, with the segmentation of the labour market between insiders and outsiders, the sectoral negotiation structures set, in concert with the firms, the wage w_{st}^* so as to preserve the use of insiders remaining at the time of negotiation.

$$(1 - \beta\theta_w) \sum_{k=0}^{\infty} (\beta\theta_w)^k\, E_t \{n_{st+k}\} = n_{st}^* \tag{26}$$

where n_{st}^* is the proportion of insiders during the wage review in a sector s, n_{st+k} is given by the equation (24). This willingness of insiders to maintain the level of their employment tends to hamper the systematic decline of unemployment following adverse shocks.

This modus operandi of wage fixation contrasts with that operate in standard Keynesian models. In these models, the structures responsible for wage negotiations revise wages by maximizing the utility of the representative household by considering both the utility of all members whether they are employed or not. The fixing of insiders to their use means that the adverse shocks that reduce the proportion of insiders tend to increase the bargaining power of the new population of insiders who in turn will attempt to set a new wage, with a view to consolidating their employment. By combining the equations (25) and (26), the renegotiated wage in a sector s in log is written as:

$$w_{st}^* = -\frac{1}{\varepsilon_w} n_{st}^* + (1 - \beta\theta_w) \sum_{t=0}^{\infty} (\beta\theta_w)^k\, E_t \left\{ w_{t+k} + \frac{1}{\epsilon_w} n_{t+k} \right\} \tag{27}$$

Thus, according to this equation, the proportion of insiders is negatively correlated with the wage

in each sector. The lower the proportion of insiders, the higher the remuneration. The shocks that reduce the number of workers in activity consequently increase the cost of the demand for services by firms in this sector. By increasing the cost of labour, the insiders tend to generate a certain persistence of unemployment at each negotiation cycle following adverse shocks. Following Blanchard and Summers (1986), the proportion of insiders with the segmentation of the labour market between insiders and outsiders is given by:

$$n_{st}^{*} = \gamma n_{st-1} + (1-\gamma)n^{*} \tag{28}$$

$n^{*} = n$ is the employment rate of the standard long-term sector; it is assumed to be identical for all sectors. The γ parameter represents the weight of the insiders in determining the n_{st}^{*} job at the start of a salary negotiation. It determines the extent to which job changes are likely to affect the demand for labour in the sector. γ is also the hysteresis parameter, i.e., the capacity of insiders to rigidify employment. By integrating (28) into the equation (27), the average wage of the sectors of activity is:

$$w_t^{*} = -\frac{1}{\varepsilon_w}\hat{n}_{t-1}^{*} + (1-\beta\theta_w)\sum_{t=0}^{\infty}(\beta\theta_w)^k E_t\left\{w_{t+k} + \frac{1}{\epsilon_w}\hat{n}_{t+k}\right\} \tag{29}$$

with $\hat{n}_t^{*} = n_t^{*} - n$ and $\hat{n}_t = n_t - n$ and n the steady state of the labour demand.

A combination of the equations (29) and (25) allows for obtaining the hysterical Phillips curve or the segmentation insiders and outsiders:

$$\pi_t^{w} = \beta E_t \pi_{t+1}^{w} + (1-\gamma)\lambda(1-\beta\theta_w)\hat{n}_t + \gamma\lambda\Delta n_t \tag{30}$$

with $\lambda = \frac{1-\theta_w}{\theta_w \epsilon_w}$. The Hysteresis curve is a general form of the Phillips curve where the variations in employment (Δn_t) and the deviations of employment from its equilibrium level ($\hat{n}_t$) are the two sources of wage fluctuations. The weight of these two sources depends on the hysteresis parameter γ.

In an extreme case where the structure responsible for negotiating wages does not attribute any importance to outsiders, the hysteresis parameter $\gamma = 1$, the hysteresis curve is written as:

$$\pi_t^{w} = \beta E_t \pi_{t+1}^{w} + \lambda\Delta n_t \tag{31}$$

According to this equation, employment is entirely determined by changes in the population of

insiders. Consequently, an adverse shock temporarily affecting this population is likely to have persistent effects on employment. However, when wages are determined using the New-Keynesian model approach, without hysteresis, the Phillips curve is:

$$\pi_t^w = \beta E_t \pi_{t+1}^w + (1-\gamma)\lambda(1-\beta\theta_w)\hat{n}_t \tag{32}$$

Employment then tends to fluctuate around an equilibrium trend, regardless of the adverse shock.

3.3 The Intermediate Goods Production Sector

The production sector is introduced to consider the interaction between the factors of production—capital, labour and the banking sector. The production of intermediate goods is carried out by competitive firms using capital and labour. The products are sold to producers of final goods operating in an environment of monopolistic competition.

Firms raise K_t of production capital by borrowing without constraint from the banking sector. The recognition of debt gives rise to the issue of an asset A_t, the price of which is in relation to the government bond is Q_t. The value of the assets acquired is therefore equal to the value of the securities issued ($Q_t K_{t+1} = Q_t A_t$). The capital acquired depreciates according to its use in the production process. Depreciated capital is restored by capital producers at a unit cost. The quality of capital varies exogenously according to economic conditions.

The problem for firms in the absence of adjustment costs is static and consists of maximizing the function:

$$\underset{\{U_t, N_t\}}{max}\, P_{It} Z_t (U_t \xi_t K_t)^\alpha N_t^{1-\alpha} - \delta(U_t)\xi_t K_t - W_t N_t$$

The first order conditions are:

$$\alpha P_{It} \frac{Y_t}{U_t} = \delta^{'}(U_t)\xi_t K_t \tag{33}$$

$$P_{It}(1-\alpha)\frac{Y_t}{N_t} = W_t \tag{34}$$

with $Y_t = Z_t(U_t \xi_t K_t)^\alpha N_t^{1-\alpha}$, P_{It} is the price of the intermediate good, $\delta(U_t)$ the endogenous rate

of depreciation of the capital, ξ_t is the quality of the capital, $\delta(U_t)\xi_t K_t$ the cost of capital renovation and z_t the exogenous productivity shock. Following Merton (1973) and Gertler and Karadi (2011), ξ_t is used to assess exogenous variations in the value of productive capital. An adverse shock on ξ_t represents a reduction in the value of productive capital. The exogenous productivity shock is assumed to follow a log autoregressive process:

$$z_t = \rho_z z_{t-1} + \epsilon_z, \epsilon_z \sim N(0, \sigma_z^2) \tag{35}$$

The competitive environment supposes the repayment by the firms of a return after production to the financial institutions. In equilibrium, the rate of return on capital is equal to the rate of return on the risk-free bond, R_{bt+1} is then equal:

$$R_{bt+1} = \frac{\left[\alpha P_{It} \frac{Y_{t+1}}{K_{t+1}} + (Q_{t+1} - \delta(U_{t+1})\xi_{t+1})\right]}{Q_t} \tag{36}$$

The exogenous value of productive capital is a random process:

$$log\xi_t = \rho_\xi log\xi_{t-1} + \epsilon_\xi, \epsilon_\xi \sim N(0, \sigma_\xi^2) \tag{37}$$

3.4 Capital Production Sector

The capital-producing sector allows the introduction of a price for investment based on adjustment costs. Adjustment costs ensure the systematic non-reconstitution of the capital stock following an adverse shock so that production firms cannot increase production capacity as quickly. The production of capital is ensured by firms that operate in perfect competition. Households own these firms. They build new capital by using capital of the intermediate firms. The cost of acquiring used capital is one unit and the cost of acquiring new capital is Q_t.

The problem of capital producers is to maximize:

$$\underset{\{I_{nt}\}}{max}\, E_0 \sum_{t=0}^{\infty} \beta \Lambda_{t,t+1} \left\{ (Q_t - 1)\, I_{nt} - \frac{\varpi}{2} \left(\frac{I_{nt} + I_t}{I_{nt-1} + I_t} \right)^2 (I_{nt} + I_t) \right\}$$

under constraint

$$I_{nt} = I_t - \delta(\mu_t)\xi_t K_t \tag{38}$$

$$K_{t+1} = \xi_t K_t + I_{nt} \tag{39}$$

$$\delta(U_t) = \Xi + \frac{\Gamma}{1+\kappa} U^{1+\kappa} \tag{40}$$

where I_t is the investment, I_{nt} the net investment, Ξ, ϖ, Γ, κ are parameters. The optimality conditions of the producers of capital allow us to obtain the expression of Q_t:

$$Q_t = 1 + \frac{\varpi}{2}(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}})^2 + \varpi(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}})^2 - \varpi E_t R_{t+1}^{-t-1}(\frac{I_{nt+1} + I_{ss}}{I_{nt} + I_{ss}})(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}}) \tag{41}$$

3.5 The Final Good Sales Sector

The final good is a unitary continuum of goods produced by firms in the sales sector, which uses the output of intermediate firms as a factor of production. Retail sales firms operate in an environment of monopolistic competition. Let Y_{it} be the output of a sales firm and ϵ_p the elasticity of substitution between the different final goods, the final product is as follows:

$$Y_t = \left[\int_0^1 Y_{it}^{\frac{\epsilon_p - 1}{\epsilon_p}} di\right]^{\frac{\epsilon_p}{\epsilon_p - 1}}$$

The first order conditions for the producer of the final good allow us to obtain the demand function Y_{it} and the general price level P_t:

$$Y_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\epsilon_p} Y_t \tag{42}$$

$$P_t = \left[\int_0^1 P_{it}^{1-\epsilon_p} di\right]^{\frac{1}{1-\epsilon_p}} \tag{43}$$

Retail firms produce differentiated goods. For simplicity, a retail firm uses one and only one intermediate good as a raw material. Nominal price stickiness at the Calvo (1983) is assumed. At this form of rigidity, each firm has the probability $(1 - \theta_p)$ to adjust its price so that at each period a

proportion $(1-\theta_p)$ revises their prices and the other proportion θ_p keeps their prices unchanged.

$$P_t = \left[(1-\theta_p)\left(P_t^*\right)^{1-\epsilon_p} + \theta_p\left(P_{t-1}\right)^{1-\epsilon_p}\right]^{\frac{1}{1-\epsilon_p}}$$

The marginal cost of production of a retail firm is the price of the intermediate good used in its production, P_{It}. Price rigidity and the ability to index the price to inflation led to the following problem of maximizing retail firms:

$$\underset{P_t^*}{max} \sum_{k=0}^{\infty} E_t(\theta_p)^k \Lambda_{t,t+k+1}^{-k-1} \left\{P_t^* Y_{it+k} - P_{It+k} Y_{it+k}\right\}$$

subject to:

$$Y_{it+k} = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\epsilon_p} Y_{t+k}$$

3.6 Monetary Policy

Monetary policy is conducted according to a simple Taylor rule:

$$R_t = (1-\rho)\left[R + \kappa_\pi \pi_t + \kappa_y \Delta y_t\right] + \rho R_{t-1} + \epsilon_t$$

where R_t is the nominal interest rate, ϵ_t the exogenous monetary shock, and ρ smoothing parameter.

4 Calibration

Table 1 displays the parameterization of the model of US economy on a quarterly basis. The banking sector parameters are set by choosing the value of some of the parameters outside the

model, on the one hand, and by determining the values of the others in such a way that they correspond to certain values in the steady state, on the other hand. Thus, the probability of survival of bankers ϕ is chosen to correspond to the probability of the existence of financial institutions over a decade; the value is set at 0.972 according to Gertler and Karadi (2011) and Bernanke et al. (1999). The moral hazard parameter λ is determined so that the ratio of bank assets and capital $\phi_t = \frac{\eta_t}{\lambda - \upsilon_t}$ corresponds to the average ratio of the US economy before the crisis of 2008. Gertler and Karadi (2011) estimate the share of external financing in the resources of the banking sector at 25% in the United States, which corresponds to a steady state ratio of 4. The value of λ is determined from equations (11) and (12) considering the ratio of 4 and an intermediation premium $(R_{bt} - R_t)$ of 100 basis points at the following steady state Gertler and Karadi (2011). The fraction of funds transferred to the new bankers is also determined from the equation (16) by also considering the ratio of bank assets and capital and the intermediation premium of 100 basis points.

For the other standard parameters, the values are determined according to the literature and certain steady state conditions. The discount factor β is set to 0.99 to match with a steady state quarterly interest rate of 1%. The labour disutility χ is set at 3.406 from equations (22) and (34), that the representative household allocates about one third of its available time to work in the steady state. The Frisch elasticity of labour supply φ is chosen to match the value of 0.20 according to Chen et al. (2012). The substitution elasticity in the labour market ϵ_w is set at 4.5 to correspond with *markups* of 1.28 in the steady state, according to Galí (2020). The parameter θ_w is set at 0.75, reflecting an average duration of four quarters for wages. Also, for a basic illustration of hysteresis effects, the hysteresis parameter γ is set to 0.99. Other values of γ are considered later in order to further highlight the extent of market segmentation between insiders and outsiders in the amplification and persistence of adverse shocks.

The parameters of the goods-producing sector are fixed such that the share of capital income α in production is equal to 0.33, the stationary rate of depreciation of capital $\delta(U)$ at 0.025, which corresponds to an annual depreciation of 10%. The capital is supposed to depreciate by 80% exogenously and by 20% according to its rate of use. Thus, the exogenous depreciation rate of capital Ξ is 0.02 in a steady state and that related to use is 0.005. Considering that the depreciation of capital is proportional to its use (confers the equation (40), normalizing the capital utilization rate U to 1 allows us to determine the elasticity of capital depreciation. By setting the share of the utilization Γ at 0.035 as per Gertler and Karadi (2011), a deduction from the equation (40) sets the value of the elasticity of depreciation κ at 7.2. The elasticity of the ϖ cost of capital adjustment in the capital-producing sector is set at 1.728. For the final goods-producing sector, the elasticity of substitution of ϵ_p goods is set at 4.167 to correspond to markups of 1.32 at the steady state following Gertler and Karadi (2011) and the Calvo index of prices rigidities θ_p at 0.75 according to

Galí (2015). The parameters of the Taylor rule are set using the coefficients proposed by Clarida et al. (2000) and Gertler and Karadi (2011). The central bank's sensitivity to the output gap κ_y is set at 0.125, to inflation κ_π at 1.5, and the smoothing parameter ρ at 0.80. Finally, the unemployment rate u in the steady state is determined by the relationship $\frac{u}{\varphi} = ln\frac{\epsilon_w}{\epsilon_w - 1}$. By deduction with respect to the parameter values φ and ϵ_w, the stationary unemployment rate is fixed at 5.02%.

Parameter	Value	Description
ϕ	0.972	Probability of survival of the banker
λ	0.381	Moral hazard parameter
ς	0.002	Fraction of funds transferred to new bankers
β	0.99	Discount factor
χ	3.406	Labour weight in utility
φ	0.20	Frisch elasticity
ϵ_w	4.5	Elasticity of substitution of labour
θ_w	0.75	Calvo index of wage rigidities
γ	0.99	Hysteresis parameter
α	0.33	Capital share
$\delta(U)$	0.025	Steady state depreciation rate
Ξ	0.020	Exogenous capital depreciation rate
Γ	0.035	Share of use of capital in depreciation
U	1	Steady state capital utilization rate
κ	7.2	Elasticity of depreciation of the utilization rate
ρ_z	0.95	Autoregressive parameter of the productivity shock
ρ_ξ	0.95	Autoregressive parameter of the exogenous shock on the value of capital
ϖ	1.728	Elasticity of capital adjustment cost
ϵ_p	4.167	Elasticity of substitution of goods
θ_p	0.75	Calvo index of prices rigidities
ρ	0.80	Lagged interest rate parameter
κ_π	1.5	Inflation parameter of Taylor rule
κ_y	0.125	Output gap parameter of Taylor rule
$\frac{G}{Y}$	0.20	Steady state share of government expenditure

Table 1: Calibration

5 Macroeconomic Implications of Hysteresis Mechanisms

This section displays the macroeconomic implications of hysteresis effects arising from the interplay between insider and outsider segmentation and financial frictions. To illustrate the contribution

of hysteresis mechanisms in the models already tested in the analysis of the major facts of the GR, the results of the model developed in this paper are contrasted with the results of the model with financial frictions. Thus, in order to highlight the sustained and lasting decline in production and employment, comparisons are made in such a way as to prove the capacity of hysteresis effects to amplify and make adverse shocks persistent. This evidence is reported in two stages. First, the amplification and persistence of adverse shocks are illustrated by comparing the results of a model with hysteresis (HE) without financial frictions (FF) with those of a model with financial frictions without hysteresis effects (HE). Second, the significance of the interaction between hysteresis effects and financial frictions in the amplification and adverse shocks is demonstrated by illustrating the simulation results of a model with hysteresis effects (HE) and financial frictions (FF).

5.1 Amplifications and persistence of adverse shock effects

The ability of segmentation between insiders and outsiders to provide amplification and persistence to the effects of adverse shocks are established by considering the extreme case where insiders determine the bulk of the volume of employment through wage negotiations, which corresponds to $\gamma = 0.99$. The evidence is reported through three types of adverse shocks: a monetary tightening, an unanticipated decline in the value of productive capital and a negative technology shock.

Figure 2 shows the evidence for monetary tightening relative to an unanticipated 100 basis point increase in the interest rate. In the model with financial frictions without any hysteresis mechanism, labelled (FF without HE) as in the model with hysteresis effects without financial frictions, labelled (HE without FF), monetary tightening has the impact of reducing labour demand and production. On the other hand, the magnitude of these declines proves to be relatively greater in the HE model without FF. Decreases in production and labour demand are about 5%. Such evidence illustrates the hysteresis effects that affect the labour market through the segmentation of the market between insiders and outsiders constitute important levers of endogenous amplification of monetary shocks. The reduction in the number of insiders tends to accentuate the fall in output in the same way as financial frictions such as the liquidity constraints of the banking sector. Low output is partly the result of rising unemployment.

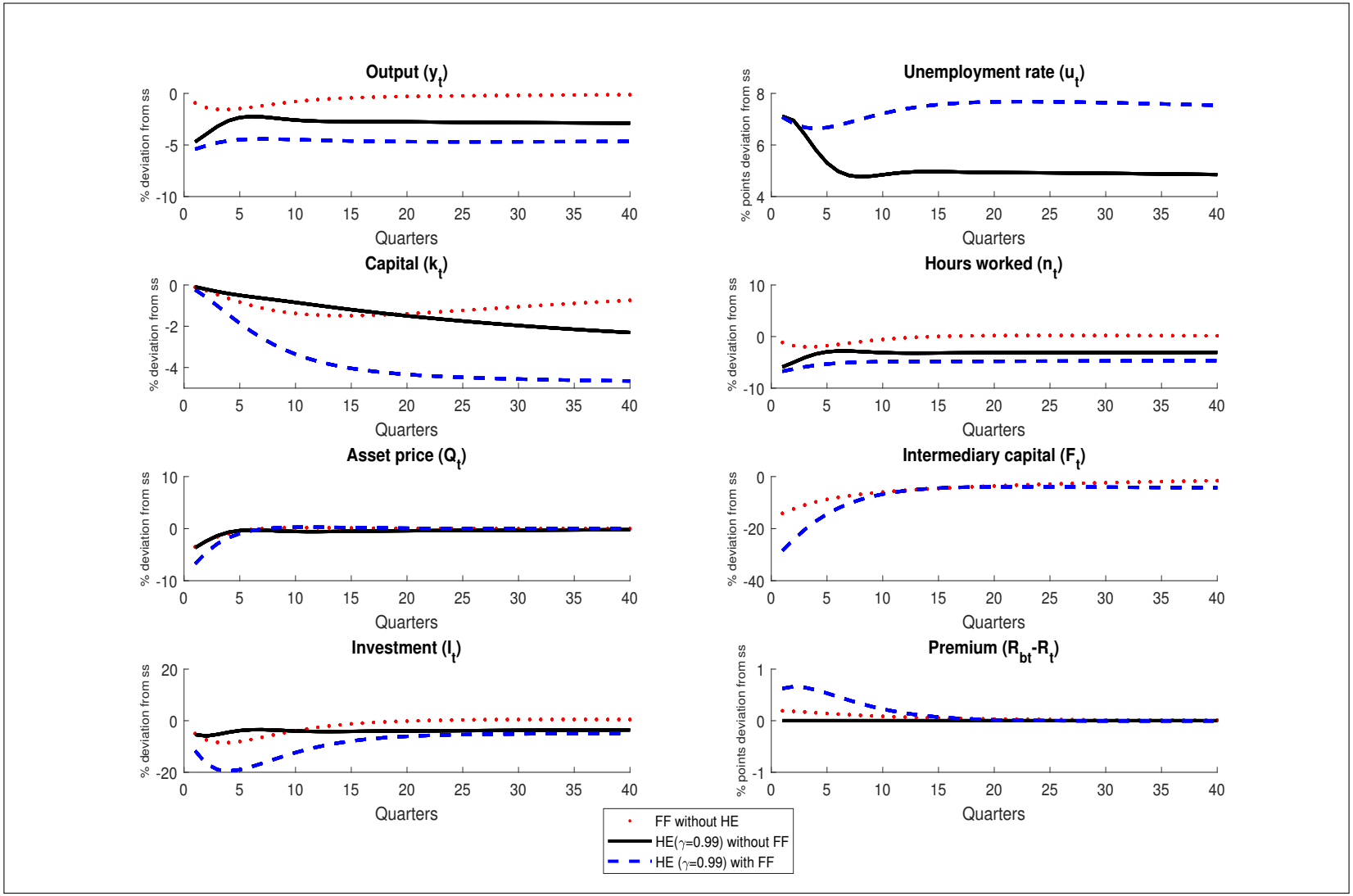

Figure 2: Impulse responses (IRs) of the main variables to an unanticipated interest rate increase of 100 basis points with $\gamma = 0.99$. The red dotted lines show the IRs with financial frictions (FF), the black dashed lines show those with hysteresis effects (HE) and, the blue solid lines show those with HE and FF.

In addition to the amplification of adverse shocks, the comparison of the results of the HE model without FF with those of the model with FF without HE shows that the hysteresis mechanism of the model is an important source of the persistence of the effects of adverse shocks. With the tendency of insiders to rigidify employment, monetary tightening leads to a fall in labour demand of about 2.5%, almost 10 years after the shock. However, the same effects tend to be absorbed about 3 years later in the FF model without HE. These results corroborate the evidence from Jordà et al. (2020b) on the capacity of hysteresis effects to produce a lasting decline in Gross Domestic Product (GDP). To this effect, the authors find that a 100-basis point increase in short-term interest rates is associated with a 3.69% decline in GDP 12 years after the monetary shock. This result that is better corroborated by the results of the model with hysteresis effects and financial frictions (HE with FF), which is discussed in the following lines. With hysteresis effects, rising unemployment and falling output tend to be mutually reinforcing, rising unemployment contributes to weakening output, and weak output tends to exacerbate unemployment.

Figure 3 illustrates the impulse responses of key model variables to an unanticipated 1% decline in the value of productive capital (ϵ_ξ). As with the monetary shock, the HE model without FF, sustain the effects of adverse shocks just like the FF model without HE. This evidence also shows that hysteresis mechanisms are capable of sustaining and even exacerbating shocks such as financial friction. The fall in output and labour demand at impact is identical in both models. However, unlike the monetary shock, shocks to the value of capital first affect the demand for capital and then affect output and the demand for labour. The effects are found to be relatively more pronounced in the model with financial frictions than in the model with hysteresis effects during the first three years after the fall in the value of capital. Financial frictions tend to be more supportive of shocks that pass through the capital-producing sector. Thereafter, the effects spread to the labour market because of the tendency of insiders to rigidify employment.

Simulation results also show persistence in the HE model without FF. While the effects of the shock are gradually absorbed in the FF model without HE, the fall in production and demand persists in the model with hysteresis. These results underline that, independently of the shock, persistence is the exclusive property of the hysteresis mechanisms. In the presence of the hysteresis effects, the fall in output and the rise in unemployment are reciprocally maintained.

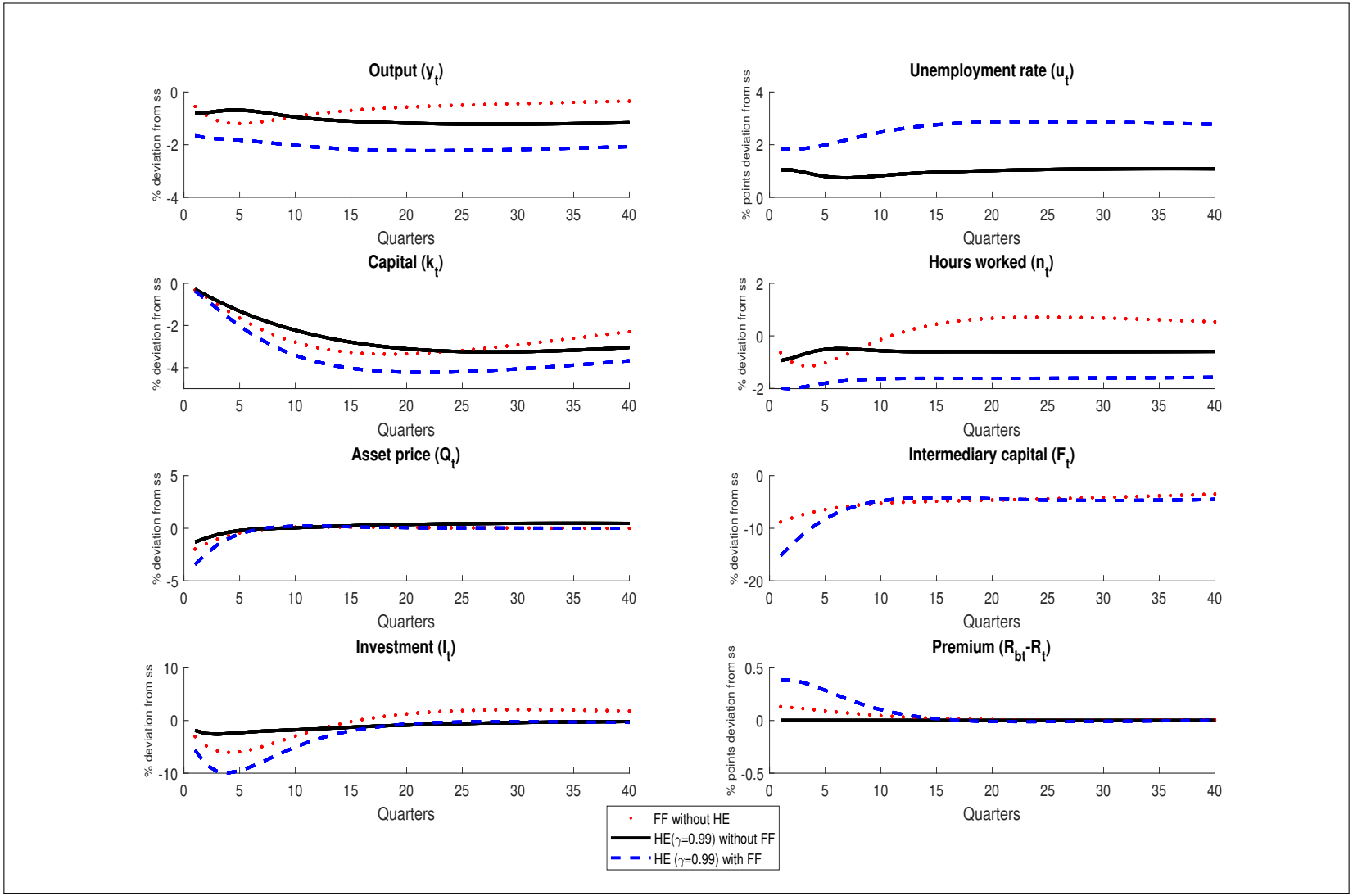

Figure 3: Impulse responses (IRs) of the main variables to an exogenous fall of 1% in the value of productive capital with $\gamma = 0.99$. The red dotted lines show the IRs with financial frictions (FF), the black dashed lines show those with hysteresis effects (HE) and, the blue solid lines show those with HE and FF.

Figure 4 shows the evidence of the simulations following a negative technological shock of 1%. Contrary to the two previous shocks, technological decline does not result in a reduction in the number of insiders in the HE model without FF, so that the effects on output and unemployment are limited. In both models, households respond to the technological decline by increasing their labour supply, which tends to offset the effect of the technology shock on output. The impact of the shock is also limited in the HE model without FF. These results show that the size of the insiders is the main source of amplification of adverse shocks in the HE model without FF. The larger the contraction of the insiders, the larger the effect on output and unemployment, as illustrated by the evidence with monetary tightening.

However, following the impact of the shock, the fall in physical capital sustain the fall in output in the model with hysteresis effects, which in turn leads to a slight downward adjustment of the insiders. On the other hand, following the impact of the shock, the fall in physical capital maintains the fall in output in the hysteresis model, which in turn leads to a slight downward adjustment of the insiders. As with the other two shocks, the fall in output and the rise in unemployment are sustained by this slight adjustment in the size of the insiders.

Overall, the results of the simulations show that the segmentation of the labour market between insiders and outsiders is an important source of hysteresis. Changes in the population of insiders are likely to moderate, sustain, or amplify the effects of adverse shocks. The tendency of this insider population to perpetuate employment resulting from adverse shocks confers the property of persistence to labour market segmentation. Thus, in the presence of hysteresis effects, recessions that result in a sharp decline in the insider population result in a relatively sustained and long-lasting decline, as was the case with GR. Moreover, the persistence and amplification property of hysteresis effects go beyond adverse shocks. Hysteresis effects are also likely to act in the same way on forces that endogenously generate an economic contraction. Financial frictions were a case in point during the financial crisis of 2007, and this chapter provides some evidence to that effect.

Moreover, compared with other shocks, the effect of this shock is relatively larger. This importance is explained by the fact that this type of shock is potentially the one that most exacerbates financial frictions with the significant decline in productive investment due to the sharp increase in the intermediation premium. This significant decline in investment helps to strengthen the capacity of insiders to rigidify employment in the face of relatively high unemployment and relatively low output.

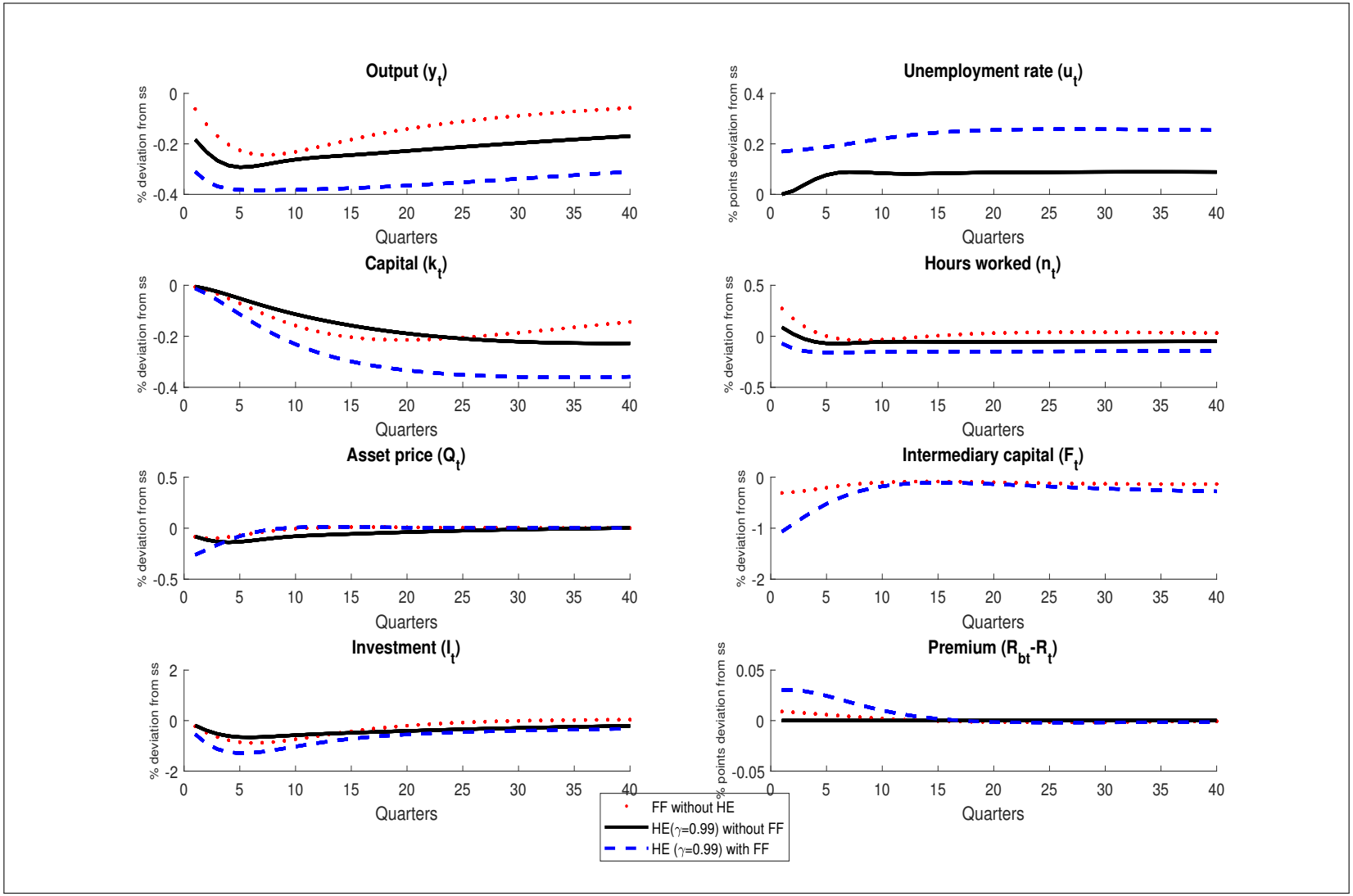

Figure 4: Impulse responses (IRs) of the main variables to a negative technological shock of 1% with $\gamma = 0.99$. The red dotted lines show the IRs with financial frictions (FF), the black dashed lines show those with hysteresis effects (HE) and, the blue solid lines show those with HE and FF.

5.2 Hysteresis effects and financial frictions

Based on the results of simulations of the HE without FF and FF without HE models, this subsection shows the extent of interactions between hysteresis effects and financial frictions in the amplification and persistence of adverse shocks. The results of the reference model labelled HE with FF are compared with the results of the other HE models without FF and FF without HE. Figures 2, 3, and 4 illustrate that the interaction of hysteresis mechanisms and financial frictions contributes to the amplification of adverse shocks. The impact of the latter on output and unemployment is at least twice as important in a model with hysteresis mechanisms and financial frictions interacting as in a model with financial frictions without hysteresis effects. Indeed, in the HE models with FF, adverse shocks result in a decrease in bank capital and an increase in the intermediation premium. This contributes to a reduction in investment in productive capital and thus a fall in production. As illustrated above, the segmentation of the labour market between insiders and outsiders then tends to amplify these different effects, resulting in a sustained fall in output and employment. In addition to the amplification, labour market segmentation sustains a fall in output and an increase in unemployment, about twice as great 10 years after the adverse shock, compared to the evidence of a model with financial frictions. For example, an unanticipated interest rate increase of 100 basis points translates in the model where financial frictions and hysteresis effects interact into a drop of about 4% in output 10 years after the shock. This result corroborates with that of Jordà et al. (2020b) on the importance of hysteresis effects in the amplification and persistence of adverse shocks.

Furthermore, to grasp the importance of labour market segmentation between insiders and outsiders in the amplification and persistence of adverse shocks, a less extreme case of hysteresis, $\gamma = 1/2$ is considered. As the evidence is similar, only the results for the monetary shock are presented in the main body of the paper, those for the other two shocks are reported in the appendix. The evidence in Figure 5 shows that a reduction of $\gamma = 1/2$ translates into lower persistence and amplification in the effects of the monetary shock in the model where financial frictions and hysteresis effects interact. The fall in output passes from 4% with $\gamma = 0.99$ to 2.5% with $\gamma = 1/2$. Unemployment rises from 7 percentages points to 5 percentages points. Also, after 5 years, the effect of the monetary shock tends to absorb for production and employment. The collapse of the hysteresis mechanism is also accompanied by a decrease in the amplification and persistence of adverse shocks to technology and the value of physical capital (see Figures (18 and 19) in the Appendix).

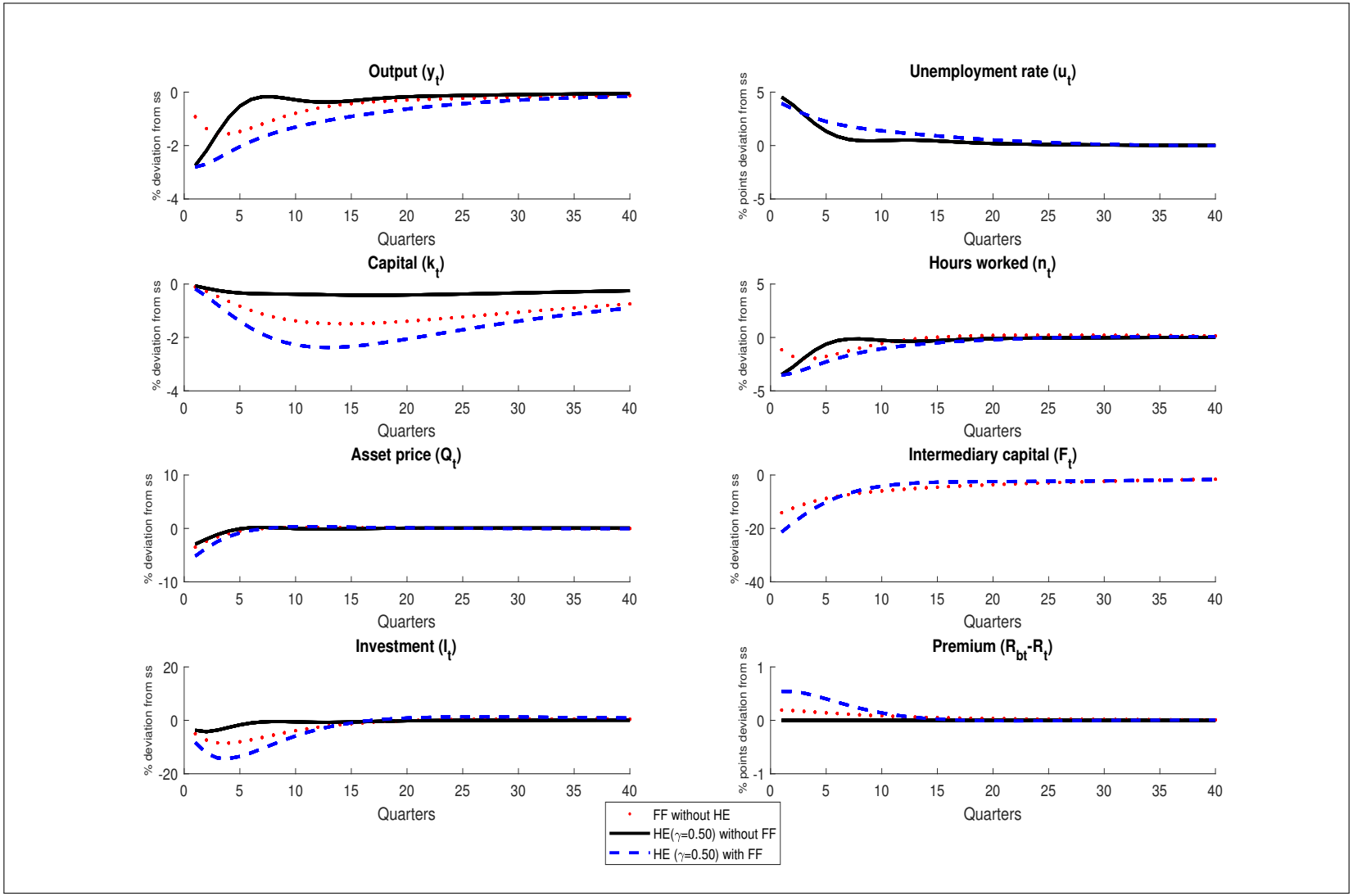

Figure 5: Impulse responses (IRs) of the main variables to an unanticipated interest rate increase of 100 basis points with $\gamma = 0.50$. The red dotted lines show the IRs with financial frictions (FF), the black dashed lines show those with hysteresis effects (HE) and, the blue solid lines show those with HE and FF.

These results certainly underline the importance of segmentation in the amplification and persistence of adverse shocks, but also the importance of financial frictions. Indeed, the lower the degree of hysteresis, the closer the effects on the variables of the model with interaction tend to be to those of the model with only financial frictions. Figures 6, 20, and 21 in the appendix—where the degree of hysteresis has been reduced to γ =0.25— illustrate this quite well. Compared to the impulse responses of the model with only hysteresis effects, the model where the interaction between financial frictions and segmentation remains illustrates amplification only due to financial frictions. With the exception of the technology shock, the impulse responses of the model with financial frictions alone tend to be on the same trajectory as those of the model with interaction for this degree of hysteresis (see Figures 6 and 20 in the Appendix).

Overall, the results show that the persistence of adverse shocks can be explained by the interaction between the financial and labour market frictions. The interaction tends to worsen the prospects for recovery in economic activity by hampering the decline in unemployment and investment. Being relatively consistent with the large and sustained fall in output and employment during GR, the results also argue for simultaneous consideration of these two types of frictions in New-Keynesian models. Their simultaneous integration in the structure of these models is likely to bring both persistence and amplification ingredients. The concomitance is essential due to the fact that, from the lessons of the analysis, the persistence is dependent on the amplification mechanisms. This is further emphasized as models centred on financial frictions do not allow for an ample characterization of the persistence of the effects of adverse shocks, just as models based solely on labour market segmentation prove to be limited in the amplification of the same shocks.

In addition to highlighting the importance of the interaction of these two frictions for New-Keynesian models, the present analysis identifies significant frictions in the labour market as one of the mechanisms likely to bring about a high degree of persistence in consumption patterns. This degree of persistence, as pointed out by Smets and Wouters (2007), is also an empirical regularity that New-Keynesian models must reproduce. This is a degree of persistence that also holds for most aggregate activity variables, and such frictions driven by the segmentation between insiders and outsiders could serve to elucidate in part why some economies have been affected more than others as a result of the financial crisis. The impact of the crisis on some southern European countries such as Spain, Italy, and Greece could be explained in this respect by the importance of trade union power. This power could be likened to the ability of insiders to set wages in the model where $\gamma = 0.99$. In doing so, rising unemployment and low investment in these countries may have contributed to some extent to reduce the prospects for economic recovery.

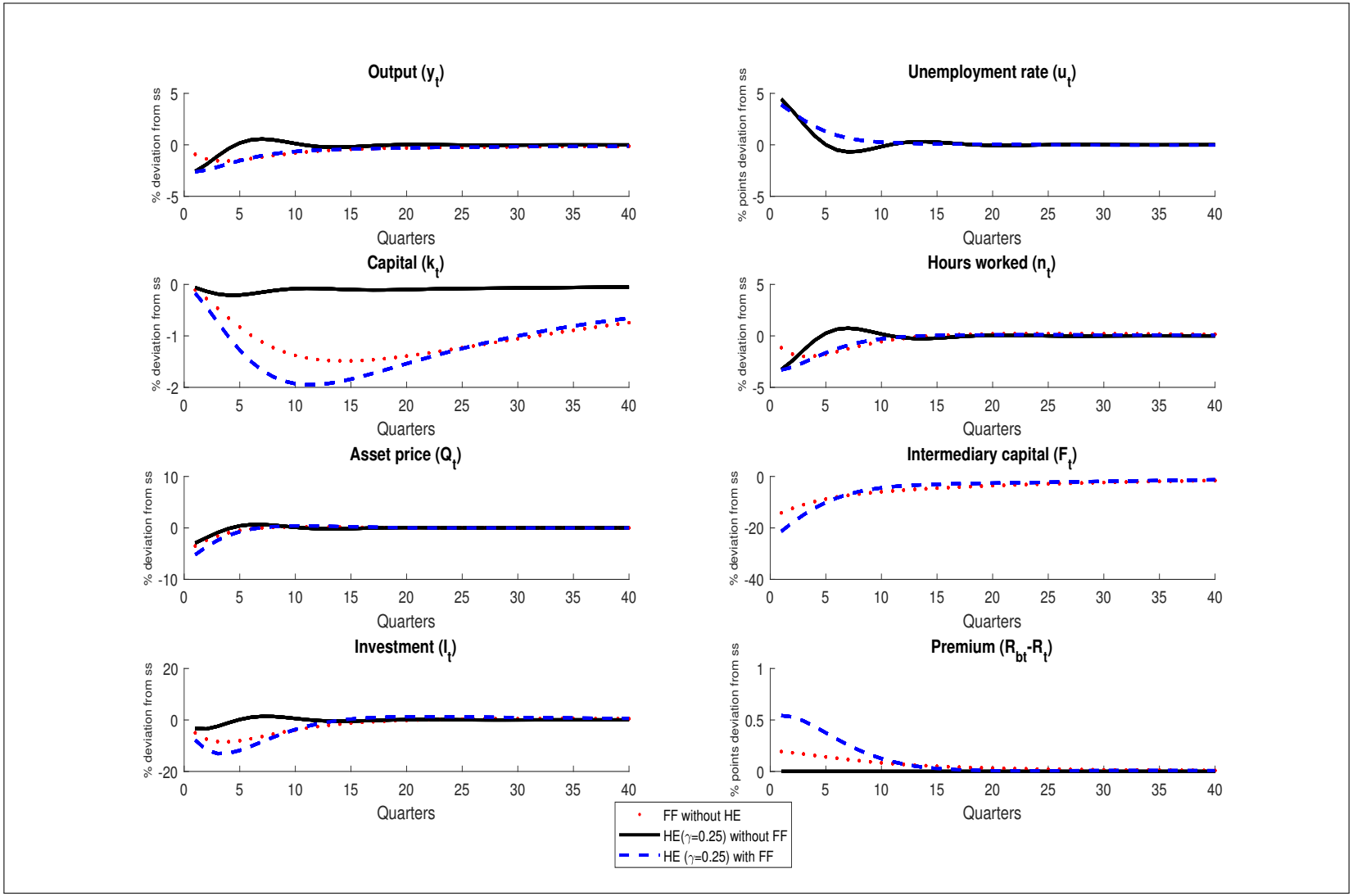

Figure 6: Impulse responses (IRs) of the main variables to an unanticipated interest rate increase of 100 basis points with $\gamma = 0.25$. The red dotted lines show the IRs with financial frictions (FF), the black dashed lines show those with hysteresis effects (HE) and, the blue solid lines show those with HE and FF.

6 Hysteresis Effects and Unconventional Monetary Policies

This section extends the basic model by incorporating credit easing into the Gertler and Karadi (2011) in order to assess the ability of unconventional monetary policies to contain hysteresis effects.

6.1 The central bank—credit easing

In the model environment, the central bank supports the financial sector by extending credit directly to non-financial firms. They perform financial intermediation in the same way as the financial sector. Loans are granted to firms in return for their issuance of debt recognition certificates. Let $Q_t A_{gt}$ be the value of the assets resulting from the financial intermediation of the central bank and $Q_t A_t$ the total value of the assets issued in the economy. Considering the intermediation of the financial sector and that of the central bank, the total value of the economy's assets is as follows:

$$Q_t A_t = Q_t A_{gt} + Q_t A_{bt} \tag{44}$$

with A_t the total volume of securities in the economy, A_{gt} the volume of central bank securities, A_{bt} the volume of securities in the private banking sector and, Q_t the relative price of assets.

Considering that the central bank insures a fraction of the total value of the assets, $Q_t A_{gt}$ is written:

$$Q_t A_{gt} = \omega_t Q_t A_t \tag{45}$$

The combination of equations (5) and (45) makes it possible to rewrite the equation (44) as follows:

$$\begin{aligned} Q_t A_t &= \omega_t Q_t A_t + \psi_t F_t \\ &= \psi_{cet} F_t \end{aligned}$$

with ψ_{cet} the ratio of total credit to the economy to equity (F_t) :

$$\psi_{cet} = \frac{1}{1-\omega_t}\psi_t \tag{46}$$

ψ_{cet} is an increasing function of the intensity of credit easing ω_t. If the financial sector fails, the central bank can thus ensure the financing of the economy. Although the central bank is not

constrained in its ability to mobilize funds, its financial intermediation according to Gertler and Karadi (2011) is assumed to be less efficient than that of the banking sector. Efficiency costs are therefore associated with each of its interventions. The assessment of welfare gains will take into account on these costs.

The central bank's financial intermediation is financed by public funds from lump-sum taxes T_t and income from loans to the economy:

$$G_t + \tau\omega_t Q_t A_t = T_t + (R_{bt} - R_t)\omega_{t-1} Q_{t-1} A_{t-1} \tag{47}$$

G as government spending and τ the efficiency costs. At steady state $G_t = T_t$. With these public funds, the central bank conducts the credit easing policy according to the following rule:

$$\omega_t = \omega + \varsigma[(R_{bt+1} - R_{t+1}) - (R_b - R)] \tag{48}$$

with ω as the intensity of credit easing in the steady state and $R_b - R$, the premium of intermediation in the steady state. The ς parameter measures the sensitivity of the central bank to the deviation of the intermediation premium from its equilibrium value. The higher the parameter ς, the greater the credit easing is.

6.2 Hysteresis effects and credit easing

The macroeconomic scope of credit easing is presented in two phases. The first stage presents the effects of credit easing on output and unemployment in an environment of hysteresis marked by extreme labour market segmentation$\gamma = 0.99$. The second step illustrates the effects on the same variables in a context of moderate labour market segmentation $\gamma = \frac{1}{2}$ and $\frac{1}{4}$.

6.2.1 Credit easing and extreme labour market segmentation

This first part of the presentation of the results discusses the scope of credit easing (CA) against the hysteresis effects resulting from the extreme segmentation of the labour market between insiders and outsiders, $\gamma = 0.99$. Hysteresis effects are brought about by an unanticipated 1% drop in the value of productive capital. Using the monetary policy rule of equation (48), the central bank can mitigate the effects of the shock on the value of capital by regulating the intensity of credit easing through the ς parameter. Through credit easing, the central bank compensates for losses of

intermediation funds from the banking sector by providing additional liquidity. Figure 7 compares the impulse responses of two interventions where the central bank compensates 50% and 100% of the losses of intermediation funds to a situation where it refrains from intervening, i.e., 0% compensation. The dashed blue line illustrates the responses of the variables to the shock on the value of capital without any credit easing by the central bank ($CA = 0\%\Delta F$). The dotted red line represents the responses to an easing consisting of compensating for about 50% of the banking sector's intermediation losses. The continuous black line shows the responses to an easing aimed at compensating for 100% of intermediation losses.

Compared to the situation of non-intervention, the two credit easing measures contribute to moderating the hysteresis effects of the shock on the value of capital. They compensate for different degrees for the adverse shock by moderating the fall in asset prices, the increase in the intermediation premium and the fall in the stock of productive capital. By limiting the fall in productive capital, the measures limit the capabilities of insiders to rigidify employment by favouring an easing of wages. The demand for labour then tends to increase, which limits the contraction of the population of insiders, and by ricochet attenuates the amplification of hysteresis effects.

While the mechanism through which these two measures is identical, the effects in terms of impact seem to depend on the intensity of the relaxation measures. The easing of credit to cover the 50% loss of intermediation funds is barely enough to counter the effects of the shock. With this intensity, the intervention of the central bank only manages to circumscribe the downward trend of the capital stock, although relatively less than non-intervention, 5 years after the shock. This persistent downtrend, combined with the relative contraction of insiders (i.e., the fall in labour demand), leads in its wake to a downward trend in production and an upward trend in unemployment. Output tends to follow an increasingly lower trajectory and does not stabilize at a lower level than before the shock until about 7 years after the easing measure is triggered. The unemployment rate also tends to persist on an upward trend, stabilizing at a higher level than before the shock about 6 years after the shock. This suggests that this intensity of credit easing is not enough to stem the impact and persistence of the damage of adverse shocks on output and unemployment. However, the second measure—that of fully compensating for the losses of intermediation funds—manages in 2 years to limit the fall in the capital stock, thus strongly moderating the fall in hours worked.

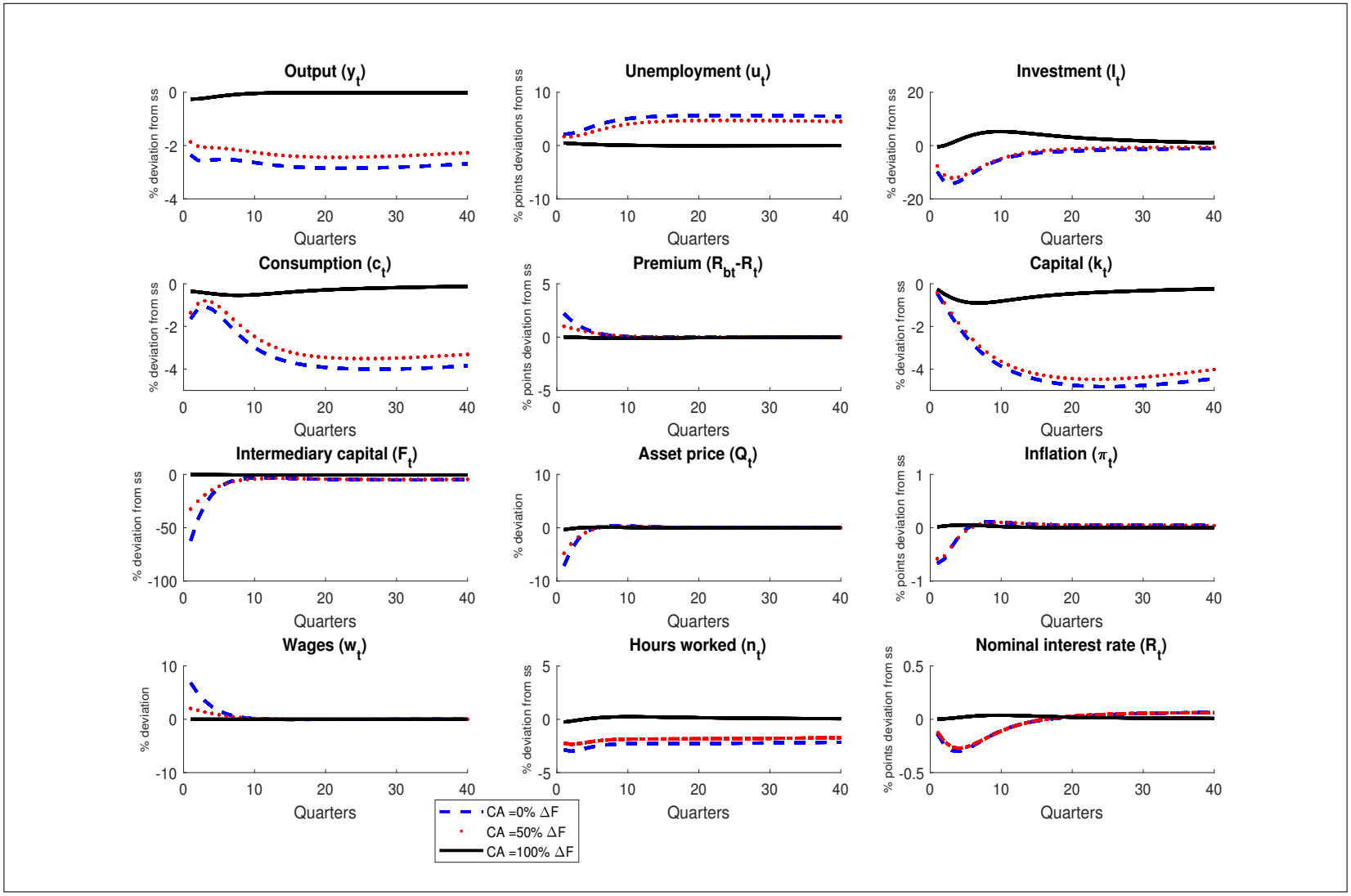

Figure 7: Impulse responses of credit easing to the hysteresis effects of an exogenous fall of 1% in the value of productive capital with $\gamma = 0.99$.

Output is not only relatively close to its pre-shock level but also sustained a relatively upward trend just 2 and ½ years after the intervention. Unemployment also tends to fall 3 years after the intervention and finally stabilizes at a level relatively close to the pre-crisis level. With this intensity, credit easing plays a strong role in influencing the hysteresis effects of the physical capital shock by mitigating their impact and by influencing a major change in the path of output and unemployment. This evidence points to the ability of credit easing to create an upward and downward path for output and unemployment respectively in the wake of adverse shocks from the presence of hysteresis effects. However, despite the extent of this intensity of credit easing, unemployment and output fail to return to their levels 10 years after the adverse shock. This relatively limited effectiveness of credit easing could be explained by the extreme segmentation, comparable in this model to what Ball (2014) calls super hysteresis effects. With such effects, the inflection of the unemployment and output curve through the channel of monetary policy requires more time. To further gauge the scope of credit easing against hysteresis effects, an intermediate segmentation $\gamma = \frac{1}{2}$ is considered in the next subsection.

6.2.2 Credit easing and moderate labour market segmentation

Figure 8 shows the impulse responses of the variables according to the different intensities of credit easing in the presence of moderate hysteresis effects; $\gamma = \frac{1}{2}$ always resulting from the adverse shock of 1% on the value of capital. As with the extreme segmentation of the labour market, credit easing to compensate for 50% of intermediation losses is just relatively better in terms of non-intervention than in terms of impact. With this intensity, the trajectories of production and unemployment are like their trajectories in the absence of easing. However, the intensity of credit easing covering 100% of the loss of intermediation funds appears relatively more effective compared to extreme segmentation. Indeed, with this intensity, the intervention of the central bank contains the fall of capital stock in two years and restores the capital stock one year later. By containing and restoring the capital stock relatively quickly, the measure strongly mitigates the contraction in labour demand, which helps to accelerate the convergence of output and unemployment to their pre-shock levels. Unemployment fully declines in 4 years and output returns to equilibrium about 3 years after the central bank intervention. The easing of credit seems very effective as a means of regulating adverse shocks in the presence of moderate hysteresis effects. The convergence time of output and unemployment towards equilibrium is even halved, from 3 years to less than 1 year and ½ when the segmentation is changed from$\gamma = \frac{1}{2}$ to $\gamma = \frac{1}{4}$.

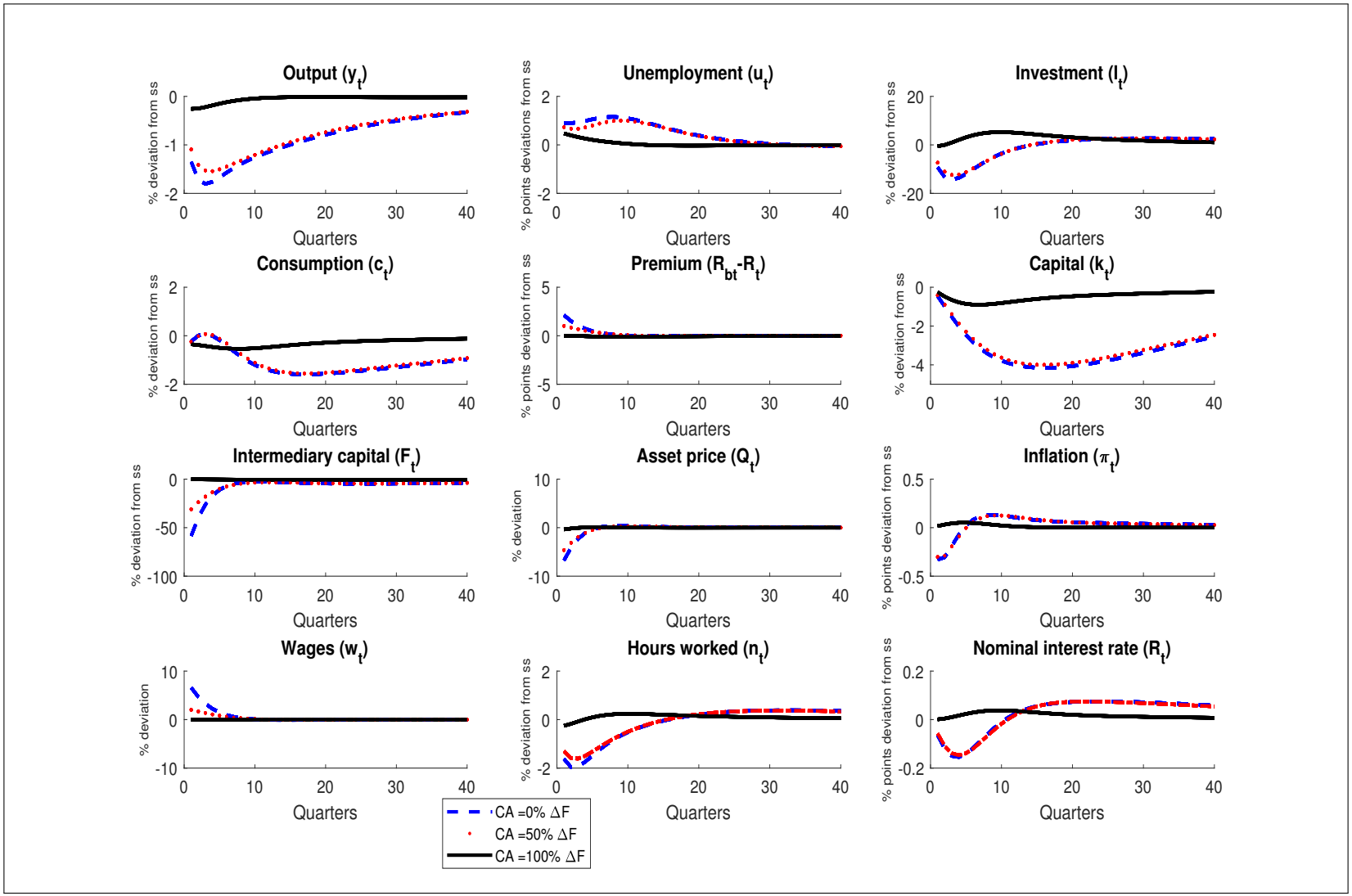

Figure 8: Impulse responses of credit easing to the hysteresis effects of an exogenous fall of 1% in the value of productive capital with $\gamma = \frac{1}{2}$.

Figure 9 illustrates this rapid convergence of credit easing when the intensity covers 100% of financial intermediation's loss of funds, in the presence of small hysteresis effects. This evidence clearly shows that credit easing has a significant impact against hysteresis effects, but its absolute effectiveness depends on the nature of the hysteresis mechanisms. Credit easing measures contribute to strongly moderating the effects of adverse shocks in an economy where labour market segmentation is very extreme. On the other hand, they help to curb the same effects and, in a relatively short time, to restore output and unemployment to their pre-shock levels. However, the results underline that whatever the nature of the hysteresis mechanism, credit easing must be supported in order to quickly counter the contraction of insiders and, by ricochet, the emergence of hysteresis effects.

Overall, the results show that monetary policy through credit easing is able to support the economic recovery both in the short term and in the long term. When hysteresis effects are moderate, the easing quickly restores output and employment balances. In the presence of super hysteresis effects, sustained easing boosts the dynamics of economic recovery quickly over time. This confirms the results of Cerra and Saxena (2017) and Jordà et al. (2020b) on the long-term scope of monetary measures.

Thus, the results could help to explain why the United States and the euro area have had different trajectories in terms of economic recoveries from the soot of GR. While credit easing has been substantial in the United States, as noted above Galí (2015), the moderate nature of the segmentation would further explain the relatively rapid recovery of economic activity driven by monetary measures. The weak performance of the same measures in the euro area would be due to the relatively extreme segmentation of the labour market and the moderate size of credit easing.

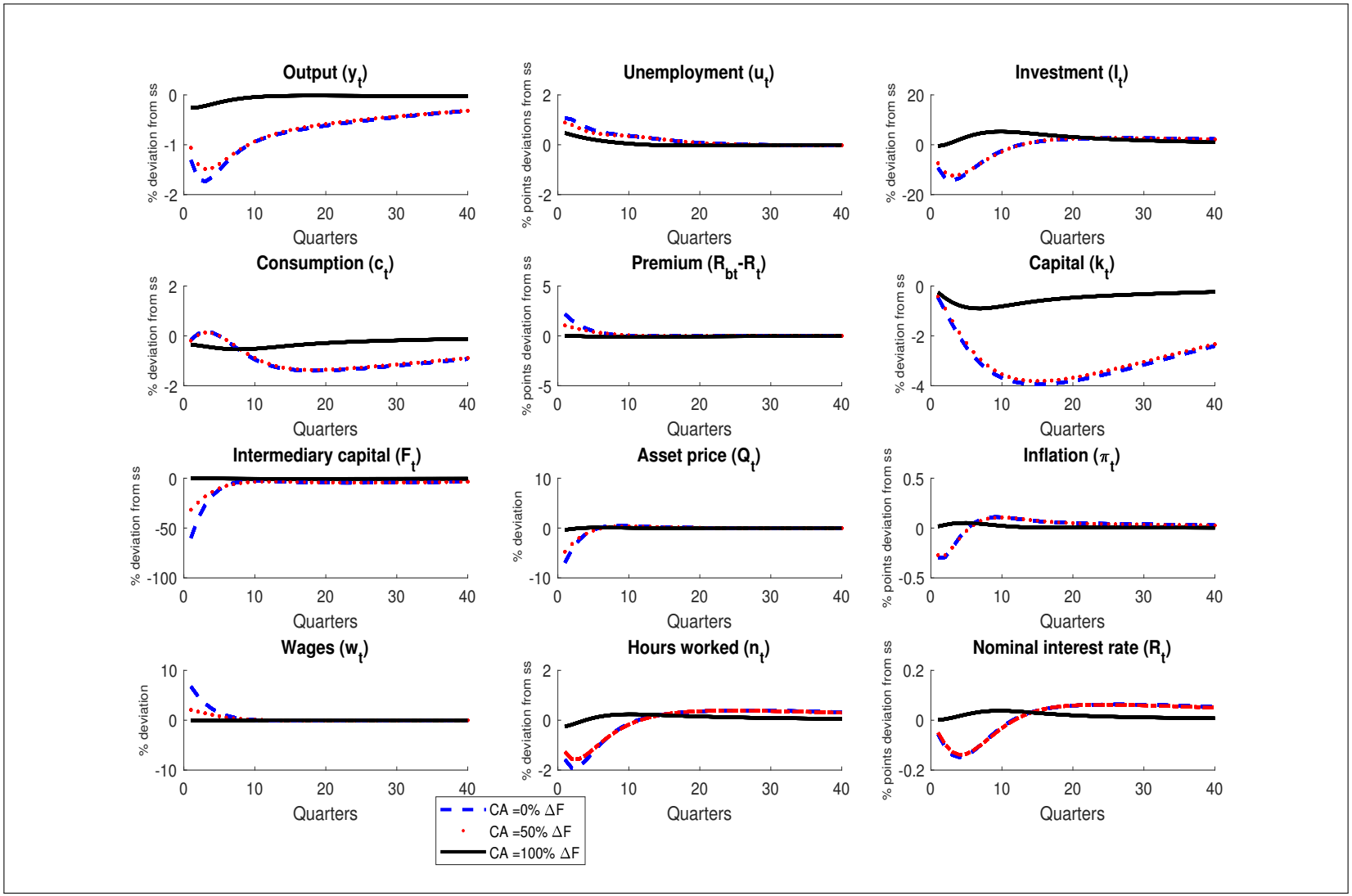

Figure 9: Impulse responses of credit easing to the hysteresis effects of an exogenous fall of 1% in the value of productive capital with $\gamma = \frac{1}{4}$.

7 Welfare and Credit Easing

This section analyzes the relationship between easing credit and economic welfare. In this regard, the section assesses the welfare associated with the three measures of credit easing considered above and compares them to the welfare associated with an environment devoid of financial frictions and segmentation in the labour market. As a reminder, these three measures are: $CA = 0\% \triangle F$, $CA = 50\% \triangle F$, and $CA = 100\% \triangle F$ where CA denotes the easing of credit, and $\triangle F$ the losses of the banking sector. Welfare for the three credit easing measures is assessed using the model developed in section 3. Also, the welfare associated with the easing measures $CA = 50\% \triangle F$, and $CA = 100\% \triangle F$ is determined by considering two levels of efficiency costs: $\tau = 0$ and $\tau = 100$ basis points. The welfare resulting from the model without friction and without segmentation is the reference welfare, and it is determined by considering the same model.

According to the literature, the costs or welfare gains associated with each easing measure are evaluated relative to the reference welfare by a constant fraction of the consumption unit associated with it. To do this, the evaluation of the costs or gains are made by considering the preferences below:

$$W = E_0 \sum_{t=0}^{\infty} \beta^t (logC_t - \chi \frac{N_t^{1+\varphi}}{1+\varphi})$$

With these preferences, the welfare gain or cost of each easing measure is determined by λ_{ca}, a fraction of the consumption of the reference welfare steady state such as:

$$E_0 \sum_{t=0}^{\infty} \beta^t (log((1+\lambda_{ca})C_t) - \chi \frac{N_t^{1+\varphi}}{1+\varphi}) = E_0 \sum_{t=0}^{\infty} \beta^t (logC_t - \chi \frac{N_t^{1+\varphi}}{1+\varphi}) \tag{49}$$

According to equation (49), the welfare variations induced by each monetary measure are such that the consumption associated with it is multiplied by $(1 + \lambda_{ca})$ in each period so that the household is indifferent between this measure and the absence of frictions and segmentation given the labour supply. λ_{ca} called in the literature, the equivalent variation is then the constant fraction of the consumption of the steady state associated with the reference welfare. Also, according to equation (49), a relaxation measure would be costly in terms of welfare if λ_{ca} >0 and beneficial in terms of welfare otherwise (λ_{ca} <0).

The welfare assessment is done numerically by taking Taylor's second-order approximation. Ac-

cording to Kim et al. (2008) and Benigno and Woodford (2012), this approach has the advantage of allowing a better assessment of welfare by taking into account the effects of uncertainty compared to the first-order approximation. By defining more specifically the reference welfare by $W_{re} = E_0 \sum_{t=0}^{\infty} \beta^t (logC_t - \chi \frac{N_t^{1+\varphi}}{1+\varphi})$ and the welfare resulting from any measure of credit easing by $W_{ca} = E_0 \sum_{t=0}^{\infty} \beta^t (log((1+\lambda_{ca})C_t) - \chi \frac{N_t^{1+\varphi}}{1+\varphi})$, λ_{ca} is determined by the following equation:

$$W_{ca} = \frac{1}{1-\beta} log(1+\lambda_{ca}) + W_{re}$$

Consequently,

$$\lambda_{ca} = exp((1-\beta)(W_{ca} - W_{re})) - 1 \tag{50}$$

Thus, from this equation, it is possible to evaluate from the 3 measures of credit easing the welfare costs linked to the hysteresis effects and the potential welfare gains of the two levels of central bank intervention. Indeed, when $AC = 0\% \triangle F$, the central bank abstains from any intervention despite the presence of hysteresis effects, contrasted with the well-being associated with this abstention with welfare without the interaction between segmentation and financial frictions allow for highlighting the costs of hysteresis effects. The potential gain from the other two easing measures can then be easily assessed against such costs.

7.1 Welfare costs of hysteresis effects and welfare from credit easing

Figures 10 and 11 and Tables 2 and 3 in the appendix present the welfare associated with the three measures of credit easing and also this for the efficiency costs $\tau = 0$ and $\tau = 100$ basis points. For each measure, welfare is measured as a percentage of consumption associated with the steady state of the model without financial frictions and labour market segmentation. The solid or black line reports the variation in welfare induced by the measurement $CA = 100\% \triangle F$, the dashed or red line that of $CA = 50\% \triangle F$ and the dotted line or blue the one resulting from $CA = 0\% \triangle F$.

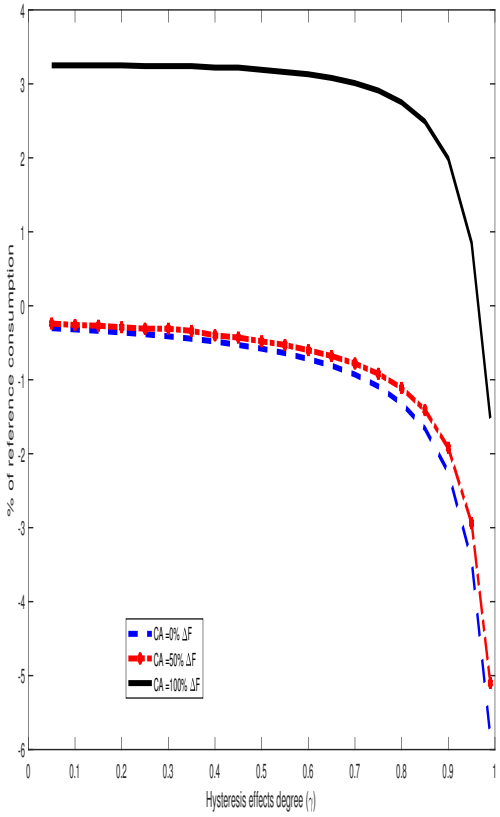

Figure 10: Welfare costs of hysteresis effects and welfare change induced by credit easing for $\tau = 0$ basis point.

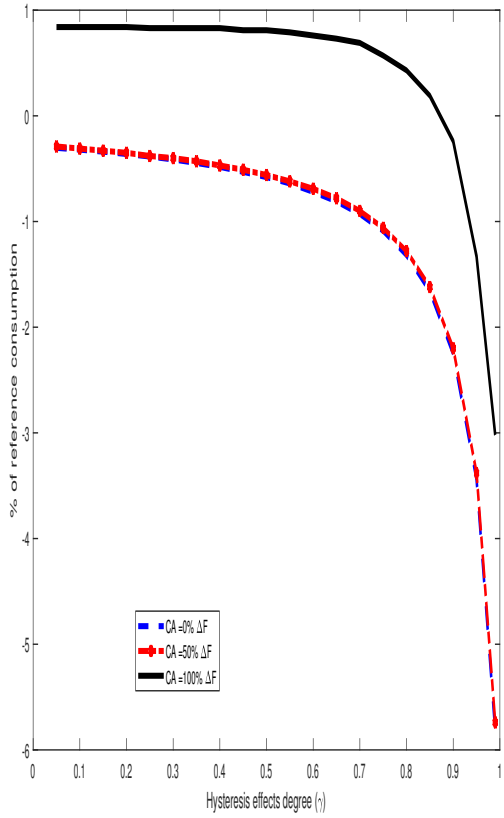

Figure 11: Welfare costs of hysteresis effects and welfare change induced by credit easing for $\tau = 100$ basis points.

The two figures show that in the absence of credit easing (C$= 0\% \triangle$F), the emergence of hysteresis effects following the shock on the quality of capital results in a deterioration of welfare. As indicated above, these negative variations represent the welfare costs of hysteresis effects. The costs are, moreover, identical for the two efficiency cost values considered, as there is no credit easing measure. The negative variations show that consumers are then willing to sacrifice some of their consumption in order to avoid hysteresis effects. For the levels of hysteresis considered, the loss of welfare ranges from 0.30% to 5.82%. The losses tend to increase with the degree of hysteresis. When the degree of hysteresis is below 0.7, the losses of welfare amount to at most 1.0%. For degrees of hysteresis between 0.75 and 0.85, the losses of welfare are around 1.00% to 1.66%. For hysteresis levels between 0.90 and 0.95, the costs are in the range of 2 to 3%. On the other hand, when the degree of hysteresis is at the maximum considered, the losses amount to 5.82%. Compared to the results of Lucas Jr (2003) on the welfare costs of consumption deviations, which he estimates at 0.05%, the welfare losses of hysteresis effects are not negligible. The size of the

losses could be explained by the persistent nature of the effects of adverse shocks. This would explain why the costs are relatively large for hysteresis degrees ranging from 0.90 to 0.99. Thus, except for these degrees of hysteresis, the welfare costs of low degrees of hysteresis are quite like the assessments of Jordà et al. (2020a).

Compared to the reference consumption, the figures and tables indicate that the easing measure $CA = 50\% \triangle F$ is also not a superior alternative, and this for the two values of efficiency costs. In other words, consumers would not be willing to implement it when they are in the baseline. However, compared to the well-being losses associated with non-intervention, these are found to be moderate with this form of relaxation. The easing measure $CA = 100\% \triangle F$, for its part, seems for certain degrees of hysteresis to provide a clear improvement in terms of welfare compared to the baseline situation.

Considering that the objective of the analysis is also to assess the welfare changes induced by relaxation measures in the presence of hysteresis effects, the sub-section below presents the potential welfare gains of these measures. The gains of the two easing measures ($CA = 50\% \triangle$F and $CA = 100\% \triangle$F) for the two efficiency costs are given by the differences between their respective curves and the curve evaluating the welfare costs of hysteresis effects. This differentiation has the advantage of highlighting the potential willingness of consumers to finance relaxation measures in order to avoid the emergence of hysteresis effects.

7.2 Welfare gains from credit easing policies against hysteresis effects

Figures 12 and 13 illustrate the welfare gains of the easing measures $CA = 50\% \triangle F$ and $CA = 100\% \triangle F$ for the two efficiency costs, depending on the degrees of hysteresis. The solid or black line shows the gains of the measure $CA = 100\% \triangle F$ and the dotted or red line those of the measure $CA = 50\% \triangle F$. This shows that for both efficiency costs, the welfare changes induced by the two easing measures are positive. Such changes reflect a clear welfare improvement in relation to hysteresis effects. On the other hand, for the degrees of hysteresis considered, the magnitude of the benefits derived from the two credit easing measures depends on their associated efficiency costs. The gains are more significant when both easing measures are done with zero efficiency costs ((τ =0). Gains range from 0.06% to 0.72% for the $CA = 50\% \triangle F$ and from 3.55% to 4.30% for the $CA = 100\% \triangle F$. Considering efficiency costs of 100 basis points, the gains drop from 0.01% to 0.08% for the $CA = 50\% \triangle F$ and 1.14% to 2.80% for the $CA = 100\% \triangle F$. These gains help to legitimize the importance of flexibility measures despite their costly nature. This importance could be explained by the high welfare losses caused by the emergence of hysteresis effects.

Also, Figures 12 and 13 indicate that regardless of the relaxation measures, consumers are willing to pay to avoid significant hysteresis effects. In fact, the welfare gains of relaxation measures tend to increase with the degree of hysteresis. In the absence of efficiency costs, the benefits of $CA = 50\% \triangle$F for a degree of hysteresis of 0.99 appears 12 times higher than those for a degree of hysteresis of 0.05. When the efficiency costs of 100 basis points are taken into account, the gain of the first degree of hysteresis is 8 times that of the second. These differences in gains support the idea of the importance of the welfare costs of hysteresis effects to the extent that the welfare losses for a hysteresis degree of 0.99 are 19 times greater than those for a hysteresis degree of 0.05.

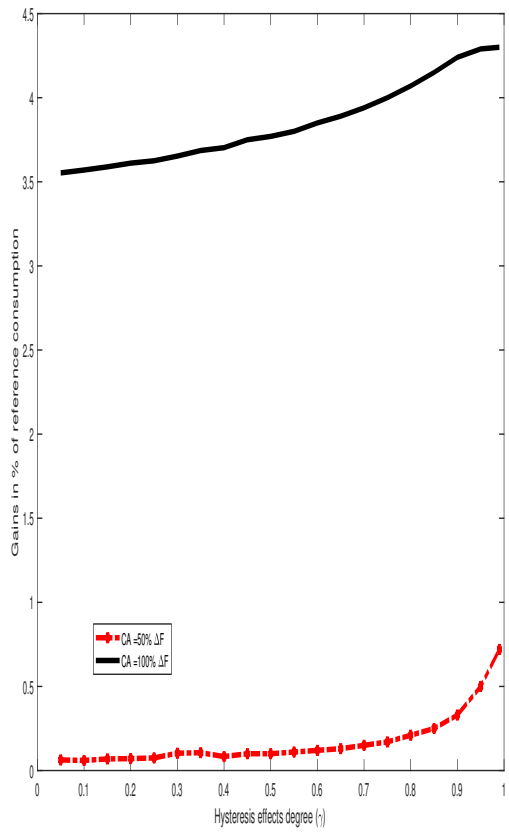

Figure 12: Welfare gains from credit easing policies against hysteresis effects for $\tau = 0$ basis point.

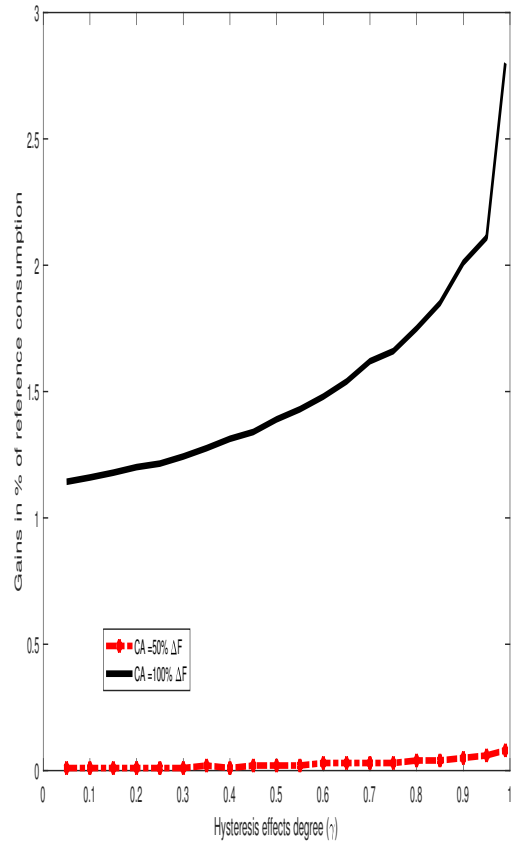

Figure 13: Welfare gains from credit easing policies against hysteresis effects for $\tau = 100$ basis point.

However, the differences in welfare gains between degrees of hysteresis are more moderate with the measure of $CA = 100\% \triangle F$. The welfare gain for a hysteresis degree of 0.99 is almost 1.5 times higher than for a hysteresis degree of 0.05 in the absence of efficiency costs. For efficiency costs of 100 basis points, the gain for the last degree of hysteresis is approximately 2.5 times less than

the gain for the first degree of hysteresis. These small differences in welfare between the different degrees of hysteresis could be because this measure, even in the absence of hysteresis effects, is a superior alternative to the reference consumption. In doing so, consumers assess the scope of this measure in terms of hysteresis effects.

Overall, flexibility measures with reasonable efficiency costs help to reduce welfare losses induced by hysteresis effects. For each degree of hysteresis, welfare tends to increase with the intensity of credit easing. Credit easing that fully covers losses in the banking sector appears to be a powerful instrument for increasing welfare in an economy facing a persistent decline in output. The improvements in welfare combined with the positive macroeconomic effects illustrated above underline the extent to which credit easing and, beyond that, policies to regulate demand in the short run are more than necessary. In the presence of hysteresis effects, these measures are simply indispensable in order to limit significant welfare losses.

8 Conclusion

Following the Great Recession, most countries experienced a persistent fall of macroeconomics indicators following the financial crisis of 2008 and had to implement the zero lower bound. Both output and employment remained almost a decade below their pre-crisis trend level. Persistent effects of adverse shocks have highlighted the presence of hysteresis effects following adverse shocks. Because of hysteresis, the lasting and sustained decline in production and employment has become a paradox, because it is out of phase with the predictions of New-Keynesian standard models. This phase shift tends to revive nowadays the divergences relating to the functioning of market economies, making the consecration of the effects of hysteresis a potentially fruitful research program in the area of knowledge acquisition.

This paper addresses this misalignment by investigating the macroeconomic effects of hysteresis mechanisms and the ability of unconventional monetary policies to dampen these hysteresis effects. By investigating hysteresis mechanisms, the objective of the paper is to elucidate the paradox of the sustained decline in output and employment and to assess the stabilization and welfare gains from the implementation of unconventional monetary policies. The article also intends through this investigation to partly fill the gap in the business cycle analysis models - in this case, the New Keynesian models with the major features of GR. In this respect, the challenge of integrating certain hysteresis mechanisms into the New-Keynesian models has been addressed.

In view of these objectives, the paper has chosen to follow the same methodological approach as the New-Keynesian models—the Dynamic and Stochastic General Equilibrium Approach (DSGE)—by

integrating the segmentation of the labour market between insiders and outsiders into a New-Keynesian model where the central bank practices credit easing in response to financial frictions. In the variant of the developed New-Keynesian model, the central bank responds to financial frictions driven by liquidity constraints in the banking sector by practicing financial intermediation. To elucidate the paradox of a sustained decline in output and employment, the model was simulated with three types of adverse shocks: a monetary tightening, an unanticipated decline in the value of capital, and a technology shock. To assess the impact of unconventional monetary policies on hysteresis effects, three central bank credit easing interventions were considered : (i) the central bank does not cover any losses in the banking sector (ii) the central bank covers 50% of the losses and (iii) the central bank covers 100% of the losses.

By calibrating the model on the U.S. economy, the results of the simulations indicate that the segmentation of the labour market contributes both to amplifying and persisting the effects of adverse shocks, which induce a reduction in insiders. The results show that the interaction between financial frictions and hysteresis effects tend to cause a decrease in production and an increase in unemployment at least twice as large as those resulting from a model with financial frictions, and this for each of the shocks. Also, with the interaction, the fall in production and the rise in unemployment are at least twice as low 10 years after the shock. The segmentation of the labour market between insiders and outsiders appears to be an important source of amplification and persistence of the endogenous effects of financial frictions following exogenous shocks. Considering their interaction in a single model thus makes it possible to elucidate the sustained and lasting decline in production and employment following the financial crisis.

In addition, with the three interventions, the macroeconomic scope of the credit easing was determined first, and its impact on economic welfare was determined second. The macroeconomic scope was highlighted by contrast, with the impulse responses of the interventions covering (50% and 100%) of the impulse responses of non-intervention. This comparison shows that such credit easing measures tend to halt or even boost economic recovery dynamics in the presence of hysteresis effects, even if their effectiveness depends on the intensity of the degree of hysteresis. In the presence of an extreme segmentation of the labour market, the easing of credit covering 50% of bank losses certainly contributes to moderating the effects of hysteresis but does not succeed in stopping the downward trend in production and the rise in unemployment in the long term. On the other hand, the easing of credit covering 100% of losses not only strongly moderates these trends, but also tends to stimulate an increase in production in 2 years and a fall in unemployment in 3 years. The rise in unemployment following the adverse shock is entirely absorbed in 4 years and production regains its equilibrium level in 3 years.

For the assessment of the welfare associated with credit easing, the welfare associated with each of

the two intervention measures 50% and 100% is contrasted with the welfare of non-intervention. Thus, in the absence of central bank intervention in the presence of hysteresis, the welfare variation induced by this abstention relative to the welfare without hysteresis corresponds to the welfare costs of the hysteresis effects. These costs tend to increase with the degree of hysteresis and range from 0.3% to 5.82% for hysteresis ranging from 0.05 to 0.99. Compared to these costs, the implementation of the two intervention measures is likely to either moderate the losses in well-being or to compensate them entirely. Credit easing covering 50% of banking sector losses moderates them with a relative welfare gain of between 0.06% and 0.72%. Credit easing covering 100% of losses fully compensates for most degrees of hysteresis except for 0.99. Welfare gains range from 3.55% to 4.30%. Such welfare gains confirm the superiority of this form of credit easing.

The importance of insiders in propagating the effects of adverse shocks recommends that policymakers pay attention to the labour market consequences of financial crises. Appropriate macroeconomic policies should consist of measures that can halt the decline in the insider population. In this perspective, credit easing could be a first-choice instrument. Depending on its intensity, its use is likely to moderate the extent and duration of the fall in output and the rise in unemployment. This will help to moderate the fall in investment and asset prices. Firms will thus be able to maintain their demand for labour and the necessary investments. With more aggressiveness, it is even possible to revive economic activity with a relatively rapid and sustained recovery. With hindsight, and in view of the unprecedented recovery of economic activity in the United States following very sustained credit easing measures, it is likely that this success is partly a practical case of the theoretical virtues of the model developed. Moreover, the unprecedented U.S. success contrasts, moreover, with the relatively limited economic performance of the euro zone—contrast that is partly due to the softness of credit easing in this economic zone.

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A Production and unemployment in euro area and the United States following the crisis.

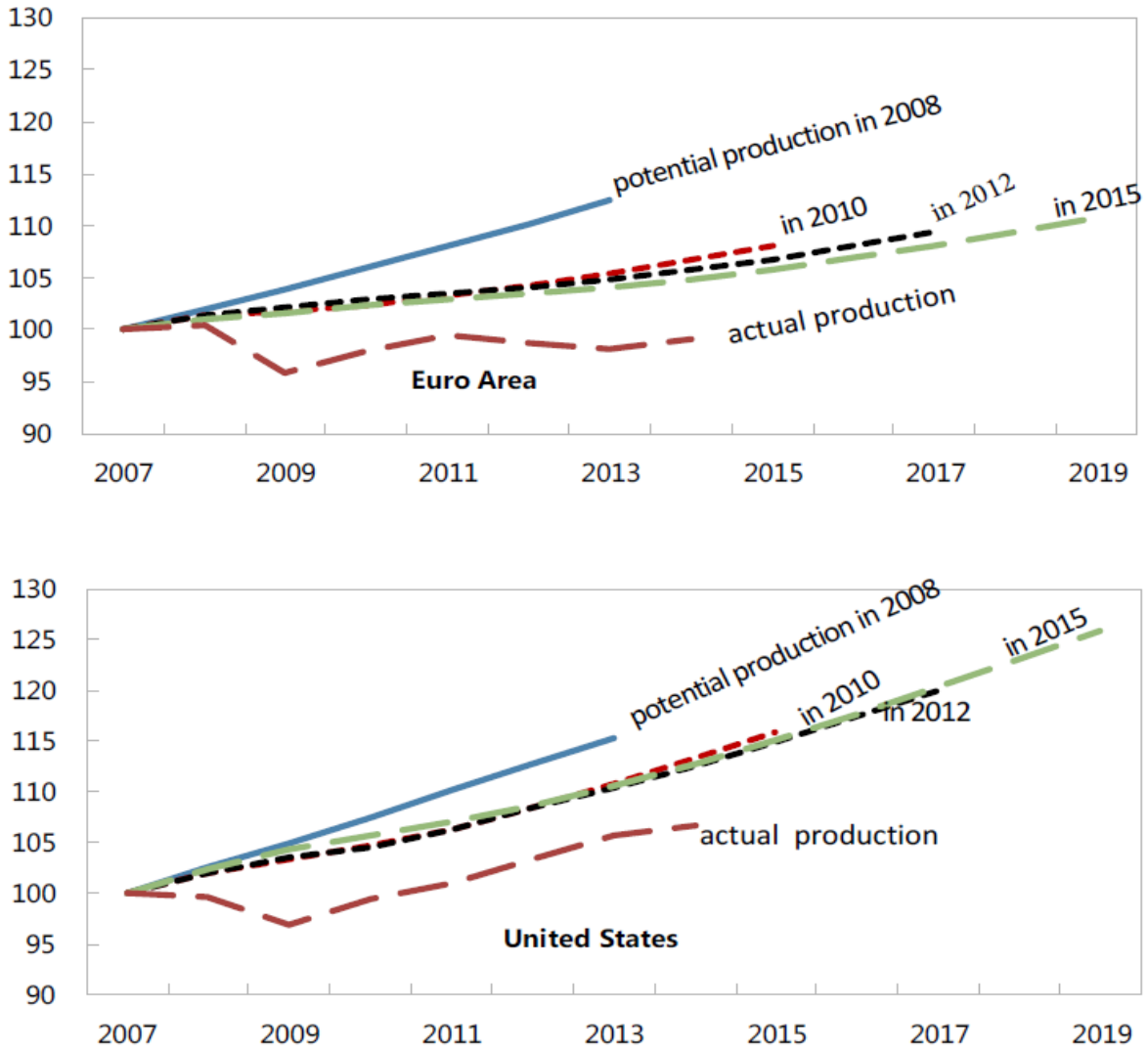

Figure 14: Actual and potential output evolution in the euro area and the United States following the financial crisis in 2008 (in index, 2007 basis)

Sources: World Economic Outlook, IMF

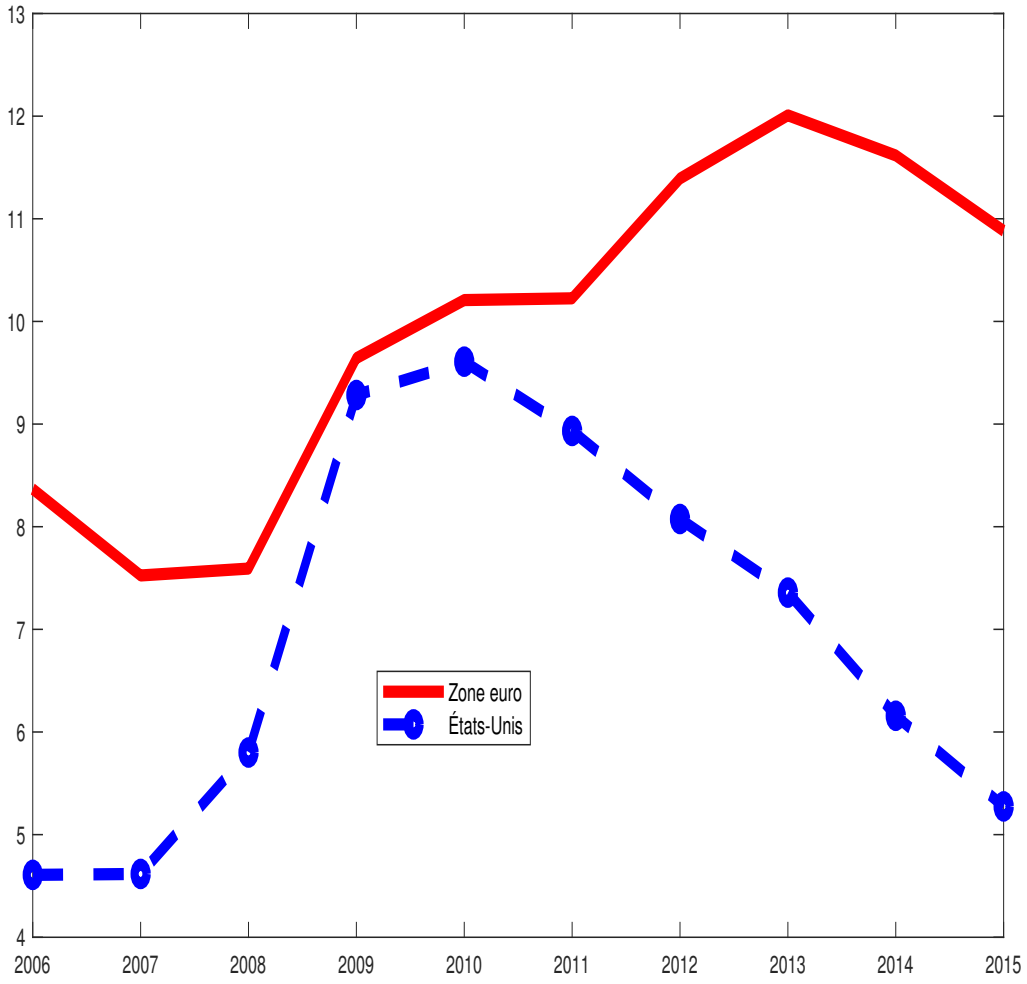

Figure 15: Unemployment rates in the euro area and the United States.

Sources: World Economic Outlook, IMF

B Business cycle

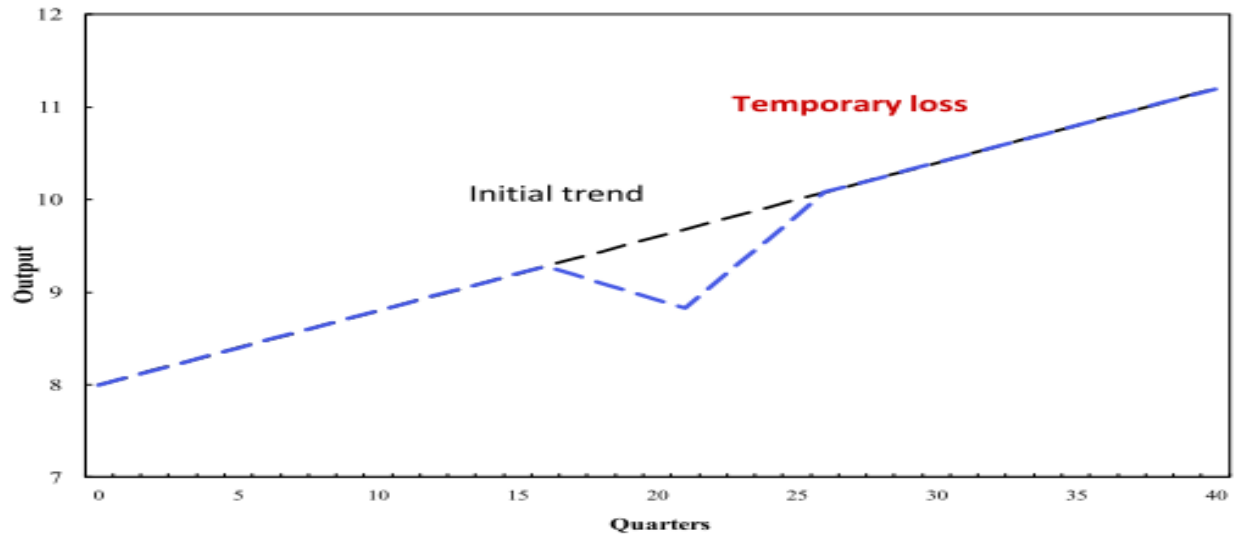

Figure 16: Traditional approaches of the business cycle

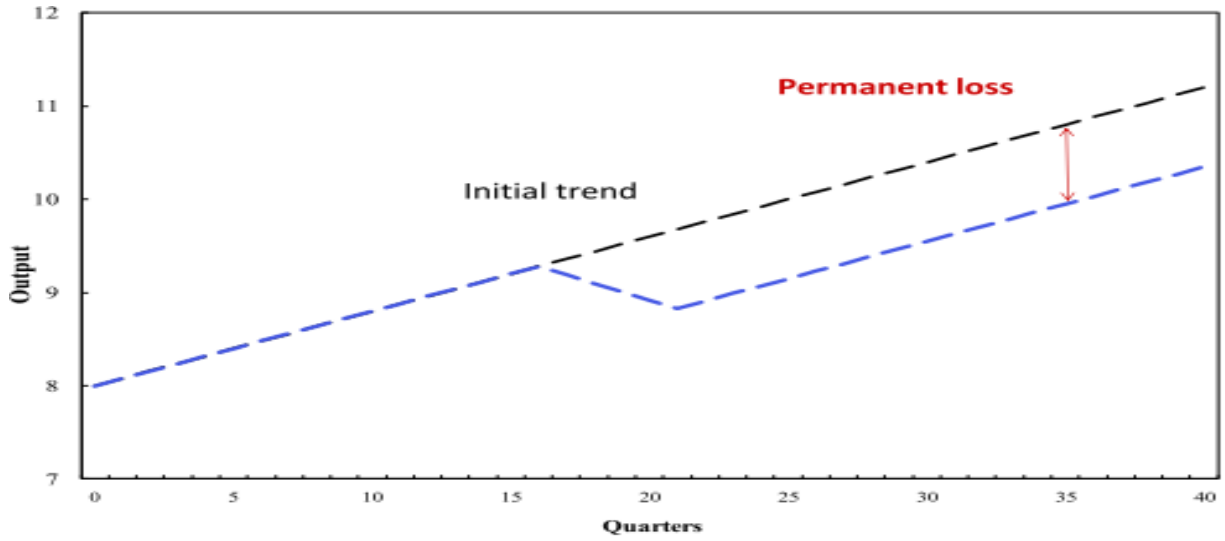

Figure 17: Business cycle with hysteresis effects

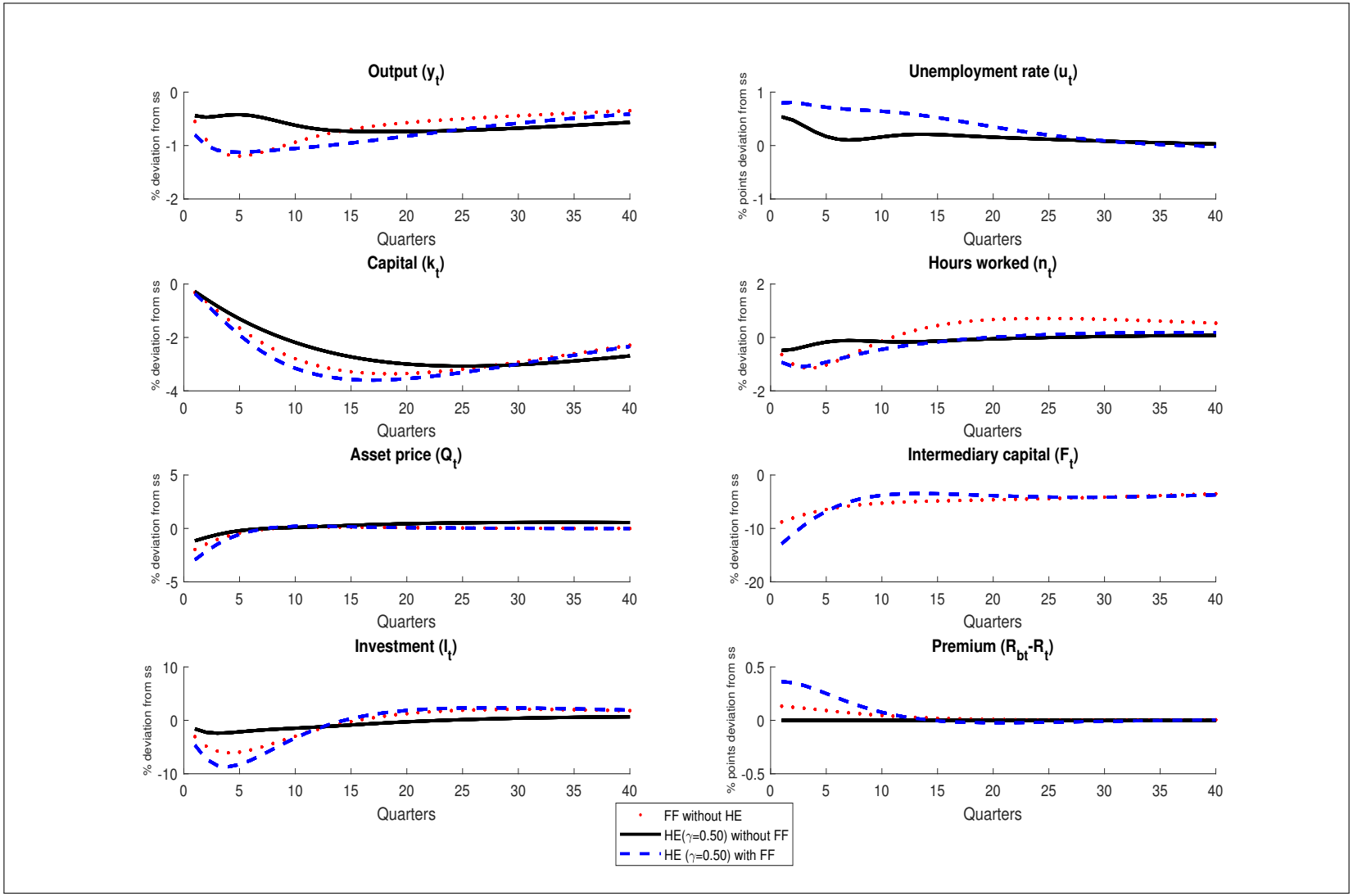

Figure 18: Impulse responses (IRs) of the main variables to a negative technological shock of 1% with $\gamma = 0.50$. The red dotted line shows the IRs with financial frictions (FF), the black dashed line shows those with hysteresis effects (HE) and, the blue solid line shows those with HE and FF.

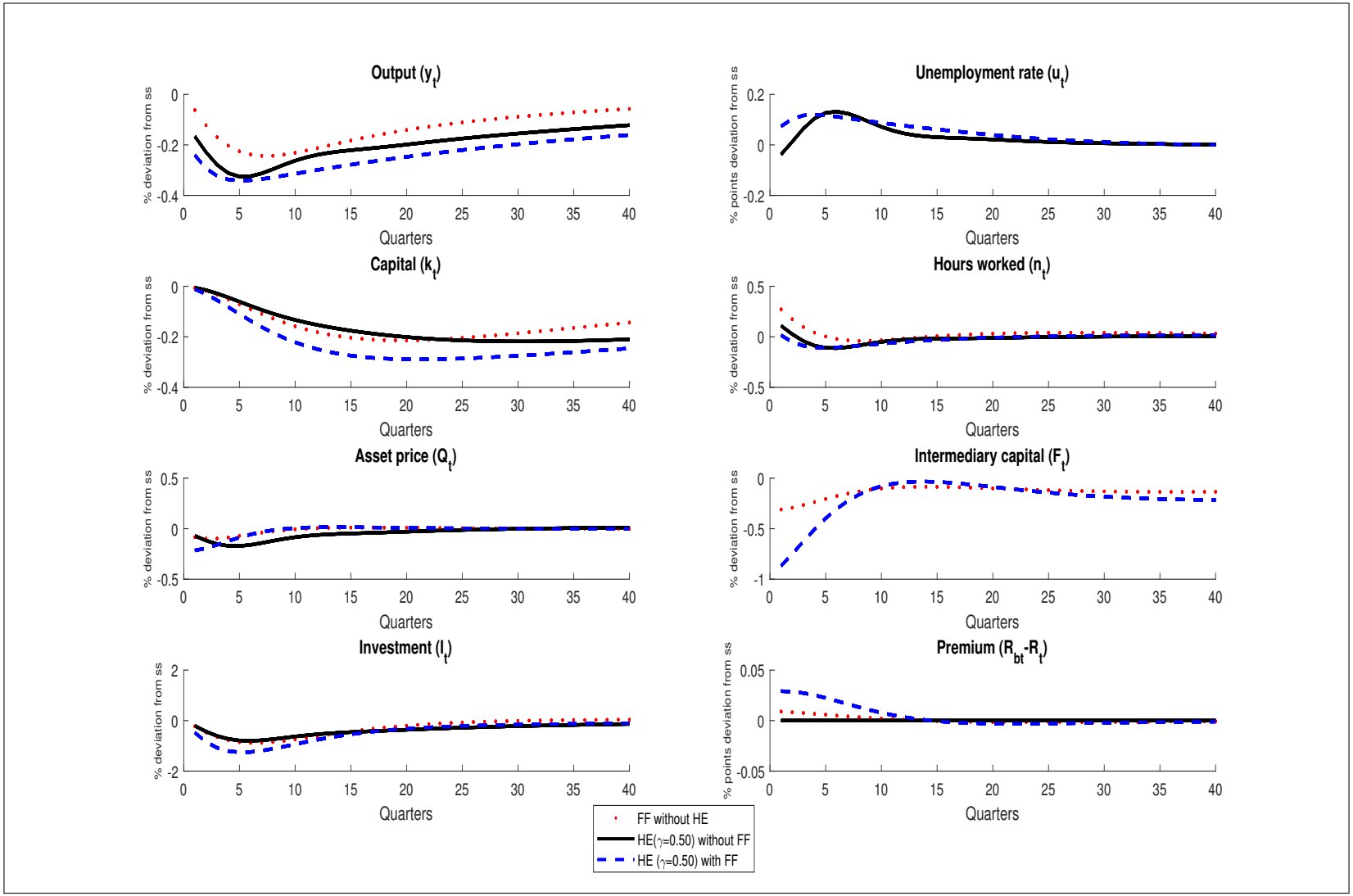

Figure 19: Impulse responses (IRs) of the main variables to an exogenous fall of 1% in the value of productive capital with $\gamma = 0.50$. The red dotted line shows the IRs with financial frictions (FF), the black dashed line shows those with hysteresis effects (HE) and, the blue solid line shows those with HE and FF.

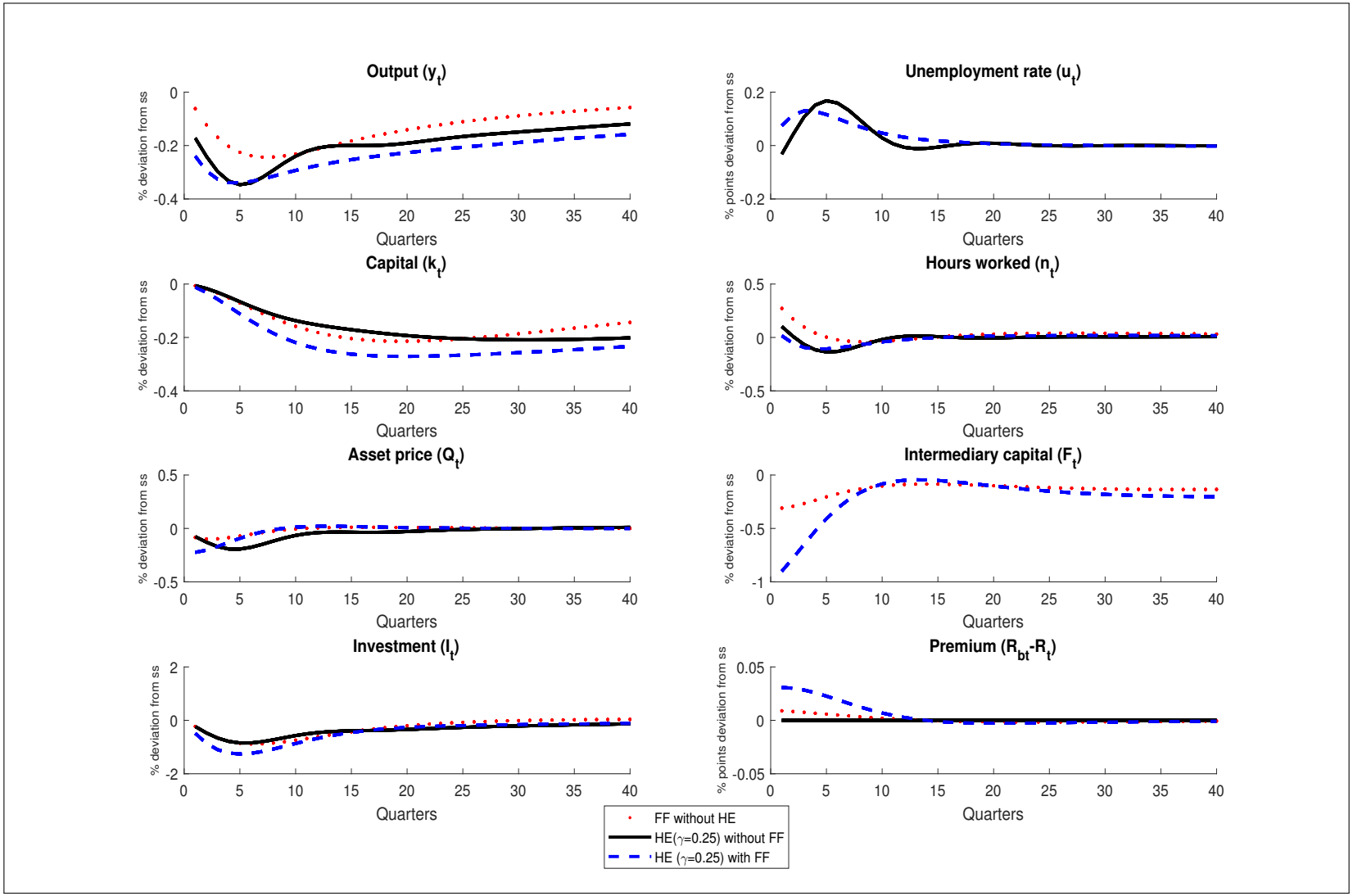

Figure 20: Impulse responses (IRs) of the main variables to a negative technological shock of 1% with $\gamma = 0.25$. The red dotted line shows the IRs with financial frictions (FF), the black dashed line shows those with hysteresis effects (HE) and, the blue solid line shows those with HE and FF.

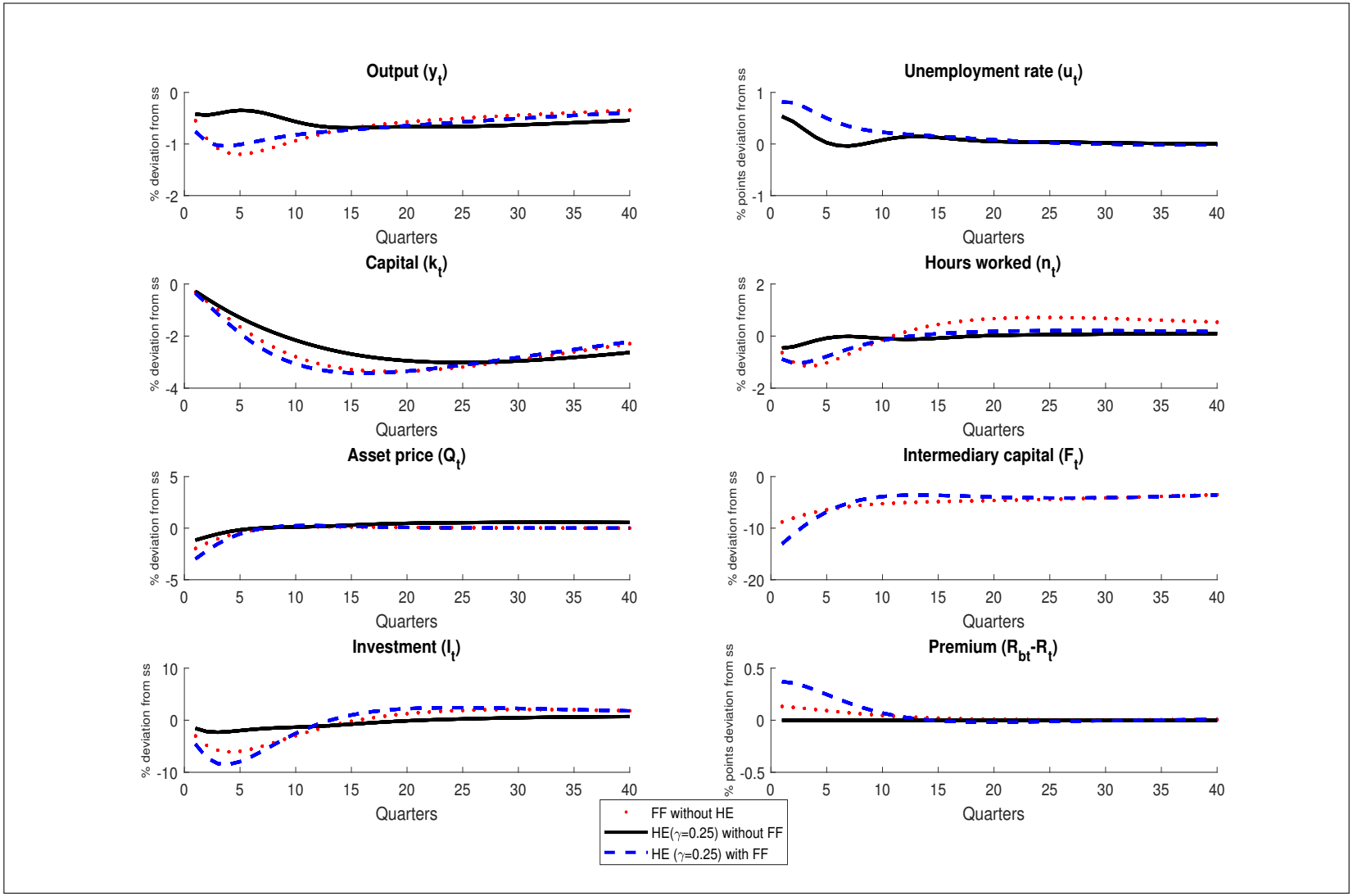

Figure 21: Impulse responses (IRs) of the main variables to an exogenous fall of 1% in the value of productive capital with $\gamma = 0.25$. The red dotted line shows the IRs with financial frictions (FF), the black dashed line shows those with hysteresis effects (HE) and the blue solid line shows those with HE and FF.

C Welfare and credit easing

The degree of hysteresis effects (γ)	$CA = 0\% \triangle F$	$CA = 50\% \triangle F$	$CA = 100\% \triangle F$
0.05	-0.30	-0.24	3.25
0.1	-0.32	-0.26	3.25
0.15	-0.34	-0.27	3.25
0.20	-0.36	-0.29	3.25
0.25	-0.39	-0.31	3.24
0.30	-0.41	-0.31	3.24
0.35	-0.45	-0.34	3.24
0.40	-0.48	-0.40	3.22
0.45	-0.53	-0.43	3.22
0.50	-0.58	-0.48	3.19
0.55	-0.64	-0.53	3.16
0.60	-0.72	-0.60	3.13
0.65	-0.81	-0.68	3.08
0.70	-0.93	-0.78	3.01
0.75	-1.09	-0.92	2.91
0.80	-1.32	-1.11	2.75
0.85	-1.66	-1.41	2.49
0.90	-2.25	-1.92	1.99
0.95	-3.44	-2.94	0.85
0.99	-5.82	-5.10	-1.52

Table 2: Welfare costs of hysteresis effects and welfare change induced by credit easing for $\tau = 0$ basis points. Welfare is measured as a percentage of reference consumption

The degree of hysteresis effects (γ)	$CA = 0\% \triangle F$	$CA = 50\% \triangle F$	$CA = 100\% \triangle F$
0.05	-0.30	-0.29	0.84
0.1	-0.32	-0.31	0.84
0.15	-0.34	-0.33	0.84
0.20	-0.36	-0.35	0.84
0.25	-0.39	-0.38	0.83
0.30	-0.41	-0.40	0.83
0.35	-0.45	-0.43	0.83
0.40	-0.48	-0.47	0.83
0.45	-0.53	-0.51	0.81
0.50	-0.58	-0.56	0.81
0.55	-0.64	-0.62	0.79
0.60	-0.72	-0.69	0.76
0.65	-0.81	-0.78	0.73
0.70	-0.93	-0.90	0.69
0.75	-1.09	-1.06	0.57
0.80	-1.32	-1.28	0.43
0.85	-1.66	-1.62	0.19
0.90	-2.25	-2.20	-0.24
0.95	-3.44	-3.38	-1.33
0.99	-5.82	-5.74	-3.02

Table 3: Welfare costs of hysteresis effects and welfare change induced by credit easing for $\tau = 100$ basis points. Welfare is measured as a percentage of reference consumption