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Hysteresis Effects and Financial Frictions

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Abstract

In the aftermath of the 2008 financial crisis, production and employment in advanced economies fell significantly, and remained below their pre-crisis potential level for almost a decade. A recent literature argues that market forces seem to have maintained or amplified this downward trend through hysteresis effects. Particularly intuitive arguments about the emergence of hysteresis effects through financial friction are provided by this literature. However, based on the current state of our knowledge, the theoretical models on hysteresis disregard this important dimension to the understanding of hysteresis. This article contributes to the literature by developing a New-Keynesian model where financial frictions amplify the lingering effects of economic shocks. By calibrating the model on the euro area, the results show that a deterioration of bank capital following a capital quality shock similar to the crisis of high-risk loans generates both persistence and more severity in the fall of production and in the rise of unemployment—more so than the classical models of hysteresis. The impact of shocks is magnified due to the reduction of physical capital in response to a weakening of the financing capacity of investment projects by the banking sector.

JEL classification: E23, E24, E32, G01.

Key Words: Production, unemployment, financial frictions, hysteresis, insider-outsider model.

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1 Introduction

With the Great Recession, some advanced economies, particularly those in the euro area, experienced both pronounced and persistent macroeconomic imbalances. Production declined and remained below its pre-crisis trend and potential level for almost a decade (Figure 4). Over the same period, the unemployment rate increased to above the pre-crisis rate (Figure 5). Since then, the persisting downward trend in production and rising unemployment has revived divergences in the functioning of market economies. Divergences exist between proponents of the existence of a fixed point at which the economy would return spontaneously under the effect of a series of recall forces and the supporters of possible market malfunctions. Relying on the neoclassical theory of full employment, the former describes these trends in production and unemployment as paradoxical (Lin et al., 2016), while the latter advance the thesis of hysteresis or hysteresis effects to explain these stylized facts (Galí, 2015). Hysteresis implies that some economic shocks are not necessarily accompanied by reversibility in the behavior of economic variables, at least in part, for a given period of time (Ball, 2014).

Clearly, rebalancing by market forces after the Great Recession has been less systematic. For Ball (2009), market forces seem to have maintained the fall in production and a rise in unemployment due to the presence of hysteresis effects. Formerly developed by Blanchard and Summers (1986) to explain the rise of unemployment in Europe in the 1980s, the recent financial crisis is proving to be a consecration of the thesis of hysteresis. They pointed out that natural unemployment could increase if cyclical unemployment remained very high. They argued that the effects of hysteresis could generate encysted cyclical unemployment into structural unemployment. Since then, two main reasons have been put forward for 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 long unemployment during the crisis (Möller, 1990; Snower et al., 1994).

These theoretical arguments have been used in the literature to justify not only the persistence of unemployment but also the lasting decline in production in advanced countries following the crisis. Theoretical works (Acharya et al., 2017; Blanchard and Summers, 1986; Dosi et al., 2017; Galí, 2015,1) are based on one or both of the hysteresis mechanisms already established in the literature. However, the perpetual nature of the effects of the crisis does not carry significant severity. While obviously, hysteresis effects following the recent crisis appear this time relatively more pronounced. So much so that Ball (2014) concludes the presence of super hysteresis effects when he notes an average decrease of 8.4% in the output of the economies of the organization of cooperation and economic development. Questions arose about the ability of standard models with hysteresis to reproduce both the magnitude and duration of the effects of the recent financial crisis. Since, like

[Abiad et al. \(2009\)](#); [Ball \(2009\)](#); [Howard et al. \(2011\)](#) respectively predicted an average decrease of 10% and 8% of production in advanced economies as a result of the crisis.

In this perspective, an investigation into the effects of hysteresis makes sense and augurs its potential for contribution. Particularly intuitive arguments point to the no-less important role of financial factors in the emergence of hysteresis effects. Indeed, in most advanced economies the financial sector has become relatively more prominent in the production structure. In the United States, for example, the share of the financial sector in the Gross Domestic Product more than doubled from 4% in 1970 to 8% in 2007 ([Reinhart and Rogoff, 2009](#)). For the latter, financial crises are likely to have lasting and profound effects on output, employment, and asset prices, according to their predominance in the economy. [Furceri and Mourougane \(2009\)](#) and [Bijapur \(2012\)](#) add that a recession coupled with a financial crisis is likely to curb capital accumulation due to the weakening of the financing capacity of investment projects in the banking sector. The standard mechanisms of hysteresis seem then limited to account for the major features of the behavior of production and unemployment. The hypothesis that emerges is that financial friction amplifies the persistent effect by the fall of the investment. A combination of these channels with financial frictions (such as the deterioration of bank capital)—one of the features of the recent crisis—suggests better understanding. Thus, by integrating financial frictions with hysteresis models, the latter manages to amplify the persistent effects of economic shocks approximately twice as much as those without financial frictions. Since, by calibrating the model on the euro area, a simulation with a shock on the value of capital, particularly similar to the crisis of high-risk loans, generates a persistence twice as large as that of conventional models of hysteresis in the trends of bearish production and bullish unemployment. A model with hysteresis without financial frictions leads to an amorphous persistence, whereas a model provided with financial frictions without hysteresis shows very little persistence.

The basic purpose of this paper is to highlight the role of financial frictions in economic fluctuations. More specifically, this has been partly to explain the extent and persistence of the behavior of output and unemployment in advanced economies. As a result, the article is part of the problem of hysteresis effects by providing a New-Keynesian theoretical corpus that is more apt to produce both persistence and more severity in the effects of economic shocks. At the present state of our knowledge, the integration of financial frictions into New-Keynesian theoretical frameworks with hysteresis has not been the subject of any previous study. This integration, by amplifying the lingering effects of these models, enhances their ability to produce super hysteresis effects. In addition, the paper sheds light on the behavioral differences in output and unemployment in the euro area and the United States. The hysteresis mechanism of this paper is in many ways a reflection of the regulations currently enforced in the European labor market. When financial frictions are embedded in this type of mechanism, the lingering effects of production and unemployment are more pronounced. Whereas in the absence of such a mechanism of hysteresis and therefore of regula-

tion, the persistence of the effects of economic shocks is rather weak, although the magnitude of the shocks remains the same. This situation describes fairly well the behavior of US production and unemployment as a result of the crisis.

In order to compare the illustrations of New-Keynesian frameworks with hysteresis of the evidences of the crisis, the study was part of a stochastic dynamic general equilibrium approach by integrating the banking sector into the basic model with hysteresis of [Galí \(2016\)](#). Building on this basic framework, the approach innovates by introducing physical capital and the costs of adjustments in the persistence mechanism. These two aspects are very often ignored in standard models with hysteresis. The banking sector is integrated according to the approach of [Gertler and Karadi \(2011\)](#). This approach has the advantage of allowing endogenous integration of liquidity constraints in the banking sector. These constraints are introduced by a principal agent problem between the manager and the owners of the banking institution. In this way, the possibility for the manager to grab a portion of the bank capital at any time introduces a certain limit in the ability of the banking sector to mobilize funds from households.

The rest of the article is organized in four sections. The first presents the literature review. The second is devoted to the model. The third highlights the results. The fourth brings some elements of the conclusion.

2 Model

The article reinforces the ability of New Keynesian executives to explain the supposedly paradoxical persisting trends in output and unemployment following the Great Recession. New-Keynesian frameworks with hysteresis like that of [Galí \(2016\)](#) can partly capture such tendencies. This is how the model of this paper is structured around this corpus. Financial frictions as a source of hysteresis effects are integrated into the model according to the approach of [Gertler and Karadi \(2011\)](#). This approach considers two frictions: the deterioration of bank capital and the constraints of mobilizing funds from the banking sector to households. The deterioration of bank capital is induced by a shock similar to that of the crisis of high-risk loans. Fund mobilization constraints are taken into account by an agent-principal problem between the manager of the banking institution and the household to which the bank belongs. The effects of hysteresis emerge from these financial frictions.

The model is structured around five agents. The banking sector makes it possible to integrate financial frictions. Channels of transmission of hysteresis effects are captured by households, producers of intermediate goods, and capital. Producers of final goods ensure that nominal rigidities are taken into account.

2.1 Banking Sector

The banking sector contains all of the financial and banking institutions in the economy. These institutions are identical, and their management is entrusted to a banker at each period. The profits obtained by each financial institution are paid to the household from which the banker originates. The latter is assured of continuing its intermediation activities with a probability of ϕ . The ratio of bankers to all households is a constant in each period so that the capital accumulated by the outgoing bankers at the end of a period is returned at the beginning of the following period to the returning member. The financial intermediation for each banker consists of granting household deposits, D_t , in the form of loans to non-financial firms. On the other hand, these firms issue in recognition of the contracted debt assets, rated A_{bt} , the relative price of which is denoted Q_t . Household deposits report an R_t yield at the end of each period, while loans are made at R_{bt} rates at the end of each period. Household members in the economy can be either bankers or workers. Thus, the banker manages the activities of financial institutions. It may be tempting to divert some of the institution's assets to the benefit of the household. An agency problem is introduced to seize this eventuality.

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

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

under constraint:

$$F_{bt+1} = R_{bt+1} Q_t A_{bt} - R_{t+1} D_t \quad (1)$$

$$V_{bt} \geq \lambda Q_t A_{bt} \quad (2)$$

Equation (1) indicates that at the end of a period, resources or equity, F_b , each financial institution results from the difference between its gains on assets and 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 diverted by the banker during its exercise. 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:

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

$(R_{bt+1} - R_{t+1})$ is the premium for financial intermediation. Thus, at the end of an intermediation

period, the shareholders' equity has two components: the net gain on assets ($(Q_t A_{bt})$) and the income obtained on equity committed F_{bt} during the financial year. The objective of the financial institution is then to maximize the expected value of each of the two components of its own funds each period. Then, v_t there is the marginal gain from the increase in assets and the one of equity capital in the form of a loan. V_b can then be written as a linear function of the two components:

$$V_{bt} = v_t Q_t A_{bt} + \eta_t F_{bt} \quad (4)$$

Financial institutions have a strong incentive to increase lending in order to increase their own resources. However, the ability of the manager to capture some of these resources limits this trend. The participation constraint limits the asset acquisition capacity of financial institutions. By saturating the participation constraint $\eta_t F_{bt} + v_t Q_t A_{bt} = \lambda Q_t A_{bt}$, the maximum volume of assets that can be acquired is as follows:

$$Q_t A_{bt} = \frac{\eta_t}{\lambda - v_t} F_{bt} \quad (5)$$

This last equation makes it possible to define the expression of the ratio between the assets and the equity of the financial institution:

$$Q_t A_{bt} / F_{bt} = \frac{\eta_t}{\lambda - v_t} = \psi_t \quad (6)$$

Equation (3) can then be rewritten as follows:

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

Equations (5) and (7) provide the expression rate of increase in capital and assets:

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

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

The objective function of the financial institution at a period t can then be written:

$$V_{bt} = (1 - \phi) \beta \Lambda_{t,t+1} [(R_{bt+1} - R_{t+1}) Q_t A_{bt} + R_{t+1} F_{bt}] + \phi \beta \Lambda_{t,t+1} (v_{t+1} Q_{t+1} A_{bt+1} + \eta_{t+1} F_{bt+1})$$

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

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

Thus, the expressions of v_t and η_t are:

$$v_t = E_t \{ (1 - \phi)\beta\Lambda_{t,t+1}(R_{bt+1} - R_{t+1}) + \phi\beta\Lambda_{t,t+1}x_{t+1}v_{t+1} \} \quad (11)$$

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

The banking sector is constituted in each period by two types of firms: the entrants and the survivors. Considering F as all of the resources of the banking sector, F can be written as the sum of the resources of the incoming institutions, F_e and the survivors F_s :

$$F_t = F_{et} + F_{st} \quad (13)$$

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

$$F_{st} = \theta [(R_{bt} - R_t) \phi_{t-1} + R_t] F_{t-1} \quad (14)$$

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

$$F_{et} = \varsigma(1 - \phi)Q_t S_{t-1} \quad (15)$$

2.2 Households

This environment is characterized by a large number of identical households. Each household has a unitary continuum of members exercising either in the labor market or in the banking sector. The proportion of workers in each household is p . Households consume and save their income in financial institutions they do not own and in government bonds. In each household, members exercising in the labor market offer specific work s . Employment is assumed to be demand-driven. However, the specialization of workers gives them market power in wage bargaining. This heterogeneity makes it possible to integrate the rigidity of wages and consequently the hysteresis with [Blanchard and Summers \(1986\)](#). Before going back to these two aspects, the problem of the household and the conditions of the first order are as follows:

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

The choice of separable preferences implies the same level of consumption per household member regardless of employment. β is the discount factor and φ, χ are parameters. N_{st} is the labor supply s of the household member and C_t the aggregate consumption of the household. This consumption is composed of a unitary continuum of goods of which C_{it} is the consumed quantity of good i and ϵ_p the elasticity of substitution between these different goods:

$$C_t = \left(\int_0^1 C_{it}^{\frac{\epsilon_p-1}{\epsilon_p}} di \right)^{\frac{\epsilon_p}{\epsilon_p-1}} \quad (16)$$

Assuming that bank deposits give the household a risk-free return R_t , D_t note the total volume of household assets. If wr_{st} is the real wage of a service s , then Π_t is the net profit of the household in financial and non-financial firms. The budget constraint of a household in real terms of the household is:

$$C_t + D_{t+1} = R_t D_t + \Pi_t + \int_0^m wr_{st} N_{st} ds - T_t \quad (17)$$

If Ω_t is the marginal utility of household consumption, the first-order conditions for savings and household consumption are as follows:

$$\Omega_t = \frac{\beta^t}{C_t} \quad (18)$$

$$\Lambda_{t,t+1} = \frac{\Omega_{t+1}}{\Omega_t} \quad (19)$$

$$E_t \Lambda_{t,t+1} R_{t+1} = 1 \quad (20)$$

Under the assumption that employment is determined by demand, the first-order conditions of the household for work differ slightly from those of the standard approach. This hypothesis has the advantage of allowing the integration of unemployment into the model.

2.2.1 Characterization of Unemployment

In an environment where the demand for labor dictates supply, members of a household in a specific labor market offer to their services to the point where the real wage equates their disutility to work. If we let L_{st} be the marginal supply of a service s , then the condition market arbitrage is as follows:

$$wr_{st} = \chi C_t L_{st}^\varphi \quad (21)$$

In defining L_t and N_t respectively the supply and the aggregate demand for labor, the unemployment rate of the economy, u_t is the difference between the log of supply and the demand for labor. The demand for work is determined by non-financial firms.

$$u_t = l_t - n_t \quad (22)$$

2.2.2 Wage Rigidity and Hysteresis

Calvo rigidity is assumed to prevail over every type of labor market. Thus, each period a proportion $(1 - \theta_w)$ of workers on a specific sector s are able to renegotiate their wages. In accordance with the approach of the variables are log-linearized in this section. By defining W_t as the aggregate nominal wage, the form linearized around zero including inflation ($\pi_t^w = w_t - w_{t-1}$) none of the general indexes of wages is as follows:

$$w_t = \theta_w w_{t-1} + (1 - \theta_w) w_t^* \quad (23)$$

with w_t the log of the nominal wage ($W = P * wr$) and w_t^* the log of the newly negotiated wage by the proportion of workers $(1 - \theta_w)$ of all sectors of the labor market. At the sector level (by type of service s), the new salary w_{st}^* is traded at a period t by the workers taking into account the current and future demand for their labor supply according to the following equation:

$$n_{st+k|t} = -\epsilon_w (w_{st}^* - w_{t+k}) + n_{t+k} \quad (24)$$

$n_{t+k|t}$ is the log job of workers who re-optimize at period t , n_{t+k} employment aggregated in log and ϵ_w the elasticity of substitution between the different work services.

The formation of wages at a given date according to equation (23) is essentially the responsibility of the workers active in the sector during this period. Workers whose services are not solicited during the period are then excluded from wage bargaining. The Insider-Outsider model originally developed by [Blanchard and Summers \(1986\)](#) and taken over by [Galí \(2015\)](#) offers a formalization of this segmentation of work. With reference to the wording proposed by the latter, w_{st}^* is negotiated by the Insiders according to the condition next:

$$(1 - \beta\theta_w) \sum_{k=0}^{\infty} (\beta\theta_w)^k E_t \{n_{st+k}\} = n_{st}^* \quad (25)$$

n_{st}^* is the proportion of Insiders during the wage revision in a sector s . By combining equations

(23) and (24), the wage renegotiated in a sector s in the log is written:

$$w_{st}^* = -\frac{1}{\varepsilon_w} n_{st}^* + (1 - \beta\theta_w) \sum_{t=0}^{\infty} (\beta\theta_w)^k E_t \left\{ w_{t+k} + \frac{1}{\varepsilon_w} n_{t+k} \right\} \quad (26)$$

The proportion of insiders is negatively correlated with the hourly rate in a sector. The lower the proportion of insiders, the lower the earnings. Shocks that can reduce the number of active workers increase the cost of service demand by firms in this sector. The model of [Blanchard and Summers \(1986\)](#) proposes for this purpose an intuitive formalization of this tendency of insiders to rigidify employment. This phenomenon is known in the literature under the concept of hysteresis.

By integrating (26) into equation (25), the newly negotiated wage in log w_{st} is written more formally as follows:

$$w_t^* = -\frac{1}{\varepsilon_w} \hat{n}_{t-1}^* + (1 - \beta\theta_w) \sum_{t=0}^{\infty} (\beta\theta_w)^k E_t \left\{ w_{t+k} + \frac{1}{\varepsilon_w} \hat{n}_{t+k} \right\} \quad (27)$$

with $\hat{n}_t^* = n_t^* - n$ and $\hat{n}_t = n_t - n$. With n the demand for work at equilibrium. A combination of equations (27) and (22) gives a hysterical Phillips curve:

$$\pi_t^w = \beta E_t \pi_{t+1}^w + (1 - \gamma) \lambda (1 - \beta\theta_w) \hat{n}_t + \gamma \lambda \Delta n_t \quad (28)$$

where $\lambda = \frac{1 - \theta_w}{\theta_w \varepsilon_w}$

This equation describes Insiders (variations in employment, Δn_t) and Outsiders (the gap between employment and its equilibrium level, $\hat{n}_t$) as the sources of fluctuations in wages. The relative weight of each of these two groups in salary adjustments depends on the parameter γ . When γ tends to 1, Outsiders tend to be excluded from wage negotiations.

2.3 The Production of Intermediate Goods

Intermediate goods are produced by competitive firms using capital and labor. Their productions are sold to producers of final goods operating in an environment of monopolistic competition. These firms obtain production capital by indebtedness without constraint to financial institutions. Debt recognition gives rise to the issuance of A_t assets, whose relative price in relation to the government bond is Q_t . The value of the capital acquired is therefore equal to the value of securities issued ($Q_t K_{t+1} = Q_t A_t$). The capital acquired depreciates function its use in the production process. The depreciated capital is restored by the capital producers at a unit cost. The quality of capital varies exogenously depending on economic conditions. The problem of firms in the absence of adjustment costs is static and consists of maximizing the following function:

$$\max_{\{U_t, N_t\}} P_{It} A_t (U_t \xi_t K_t)^\alpha N_t^{1-\alpha} - \delta(U_t) \xi_t K_t - W_t N_t$$

The first order conditions are:

$$\alpha P_{It} \frac{Y_t}{U_t} = \delta'(U_t) \xi_t K_t \quad (29)$$

$$P_{It} (1 - \alpha) \frac{Y_t}{N_t} = W_t \quad (30)$$

P_{It} is the price of the intermediate good, $\delta(U_t)$ the rate of endogenous depreciation of capital, ξ_t It is the quality of capital and $\delta(U_t) \xi_t K_t$ is the capital renovation cost. The competitive environment involves the repayment by firms of the return of capital after production to financial institutions. At equilibrium, the rate of return of capital is equal to the rate of return of the risk-free bond, R_{bt+1} , which is then equal to:

$$R_{bt+1} = \frac{[\alpha P_{It} \frac{Y_{t+1}}{K_{t+1}} + (Q_{t+1} - \delta(U_{t+1}) \xi_{t+1})]}{Q_t} \quad (31)$$

2.4 Production and Renovation of Capital

The production of capital is ensured by firms that operate in perfect competition. Households own these firms. They build new capital from the used capital of intermediate firms. The cost of acquiring the used capital is one unit and that of the new capital is Q_t . There is supposed to be an adjustment cost in the production of the new capital. The problem of capital producers is to maximize:

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

$$I_{nt} = I_t - \delta(\mu_t) \xi K_t \quad (32)$$

$$\delta(U_t) = \Xi + \frac{\Gamma}{1 + \kappa} U^{1+\kappa} \quad (33)$$

$$K_{t+1} = \xi_t K_t + I_{nt} \quad (34)$$

I_t is the investment, I_{nt} the net investment, Ξ , ϖ , Γ , κ are parameters. The optimality conditions of the capital producers make it possible to obtain the expression of Q_t .

$$Q_t = 1 + \frac{\varpi}{2} \left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} \right)^2 + \varpi \left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} \right)^2 - \varpi E_t R_{t+1}^{-t-1} \left(\frac{I_{nt+1} + I_{ss}}{I_{nt} + I_{ss}} \right) \left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} \right) \quad (35)$$

2.5 Producers of the Final Good

The final good is a unitary continuum of goods produced by retail firms that use 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 production of a firm of details and ϵ_p the elasticity of substitution between the different goods of details, 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 conditions of the first order for the producer of the final good make it possible to obtain the function the demand Y_{it} and the general level of the prices P_t :

$$Y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\epsilon_p} Y_t \quad (36)$$

$$P_t = \left[\int_0^1 P_{it}^{1-\epsilon_p} di \right]^{\frac{1}{1-\epsilon_p}} \quad (37)$$

Retail sales firms produce differentiated goods. For simplicity, a retail firm uses one and only one intermediate good as a raw material. It is assumed nominal price rigidity at [Christiano et al. \(2005\)](#) and an ability of firms to index their prices on the evolution of previous inflation.

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

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 price indexing capacity on inflation leads to a problem of maximizing firms details as follows:

$$\max_{P_t^*} \sum_{k=0}^{\infty} E_t (\theta_p)^k R_{t,t+k+1}^{-k-1} \left\{ P_t^* \prod_{j=1}^k (1 + \pi_{t+j-1})^{\gamma_P} Y_{it+k} - P_{It+k} Y_{it+k} \right\}$$

Subject to :

$$Y_{it+k} = \left(\frac{P_t^*}{P_{t+k}} \right)^{-\epsilon_p} Y_{t+k} \quad (38)$$

The conditions of first order give:

$$\sum_{k=0}^{\infty} E_t(\theta_p)^k \beta^k \Lambda_{t,t+1} \left[\frac{P_t^*}{P_{t+k}} \prod_{j=1}^k (1 + \pi_{t+j-1})^{\gamma_p} - \frac{\epsilon_p}{\epsilon_p - 1} P_{It+k} \right] Y_{it+k} = 0 \quad (39)$$

2.6 Calibration

The values of the parameters are assigned from the equilibrium conditions of the model and the microeconomic and macroeconomic evidence established in the literature for the eurozone. The assignment is made so as to obtain a quarterly model. The values are reported in Table 1. The values of the banking sector parameters ϕ , λ and ω are identical to those of [Gertler and Karadi \(2011\)](#). This choice stems from the evidence provided by [Smets and Wouters \(2003\)](#) regarding the similarity of the European and US banking sector. The parameters of the household environment are calibrated as follows. The value of the discount factor β is set on the basis of the average annual interest rate of 1.26% observed in the euro area during the period 2008-2017. The value of the inverse of Frisch's elasticity φ is similar to that estimated by [Smets and Wouters \(2003\)](#) for the euro area. The elasticity of substitution between the different varieties of ϵ_w work or services is determined from Galí's (2011) relationship ¹ between Frisch's elasticity and the unemployment rate. The unemployment rate is the average annual rate of 10% observed in the euro area over the period 2008-2017. Following the proposition of [King and Rebelo \(1999\)](#) for logarithmic preferences, the parameter χ is set conditionally to the value of α . The rigidity of wages at Calvo is identical to that of the labor market literature of the euro area. The hysteresis parameter on the labor market γ is set to allow comparisons with standard New-Keynesian frameworks with hysteresis. For the intermediate goods sector, the share of capital in the output α , the elasticity of utilization of capital κ , the marginal rate of endogenous depreciation Γ , and the rate of exogenous depreciation Ξ take values similar to those in the literature. The calibration of the parameters of the final good production sector is in line with that of [Galí \(2016\)](#) on the eurozone for the elasticity of substitution between Ep goods and the price rigidity ϵ_p . The calibration of the elasticity of substitution ϵ_p and the price rigidity θ_p of the final goods production sector, as well as the parameters of the Taylor rule, is in line with that of [Galí \(2016\)](#) on the eurozone.

¹ $\varphi u = \ln \frac{\epsilon_w}{\epsilon_w - 1}$, u rate of unemployment

Banking sector		
ϕ	0.90	Probability of survival of bankers
λ	0.381	Moral alea parameter
ω	0.002	Fraction of funds transferred to new bankers
Households		
β	0.99	Discount factor
χ	3.47	Job Disutility Parameter
φ	2	Inverse of the elasticity of Frisch
ϵ_w	5.5	Elasticity of substitution in the labor market
θ_w	0.75	Parameter of wage rigidity
γ	0.99	Proportion of <i>Insiders</i> on the labor market
Intermediate goods sector		
α	0.33	Share of capital in production
Ξ	0.02	Exogenous depreciation rate of capital
Γ	0.035	Marginal Propensity of Depreciation of Effective Capital
κ	7.2	Elasticity of Use of Capital
Capital production sector		
ϖ	1.728	Elasticity of subtraction between goods
Production sector of the final good		
ϵ_p	3.8	Elasticity of subtraction between goods
θ_p	0.75	Price rigidity parameter
γ_P	0.241	Price Indexing Parameter
Public sector		
ρ	0.90	Taylor rule smoothing parameter
κ_π	1.500	Sensitivity parameter with respect to inflation
κ_y	0.125	Sensitivity parameter relative to output gap

Table 1: Calibration

3 Results of Quantitative analysis

The ability of the model to generate persistence through the banking channel is quantified through a number of simulations. In particular, the effects of persistence related to the deterioration of banking capital following each of the following negative shocks have been evaluated successively: technological shock, monetary shock, and shock on the value of capital. These shocks were chosen in view of their recurrence in the literature relating to the fluctuations of the Great Recession. Indeed, the decline in total factor productivity is widely documented during the period of the crisis, even if it precedes the crisis. The proximity of key interest rates around the zero bound at the beginning of the crisis has rapidly reduced the ability of central banks to further relax their monetary policies, making it a very restrictive first step. Meanwhile, the fact that the real estate crisis or that of high-risk loans is equivalent to a capital loss in the above model is one of the highlights of the crisis.

3.1 Technological Shock

The first quantitative evaluation of the model is established with a one-point technological shock and the impulse functions are presented in Figure 1. These functions show that financial frictions tend not only to amplify and further shock than standard models with hysteresis. The decline in production and the rise in unemployment are more pronounced with more persistent dynamics. But such evidence beyond the scale is very intuitive and allows us to grasp the channels at the heart of the emergence of hysteresis effects. Indeed, the negative technological shock generates a slight increase in the intermediation premium, increasing the cost of the investment. Second, the decline in investment or demand for assets leads to a fall in the price of assets, thus causing deterioration of bank capital. From this deterioration comes a persistent reduction in the capital stock of the economy, ultimately resulting in the fall in production. The fall in production ends up reducing the demand for labor, causing a rise in unemployment. Compared to standard models with hysteresis without financial frictions, the propagation of a technological shock is amplified by the fall in bank capital and subsequently sustained by the decline in capital accumulation. This decrease is induced by the reduction of the financing capacity of investment projects. These shreds of evidence provide a better understanding of hysteresis effects elucidating persistent effects that may be attributable to financial factors. These factors are hitherto ignored by most New-Keynesian models with hysteresis, limiting their ability to assess the major facts of the crisis.

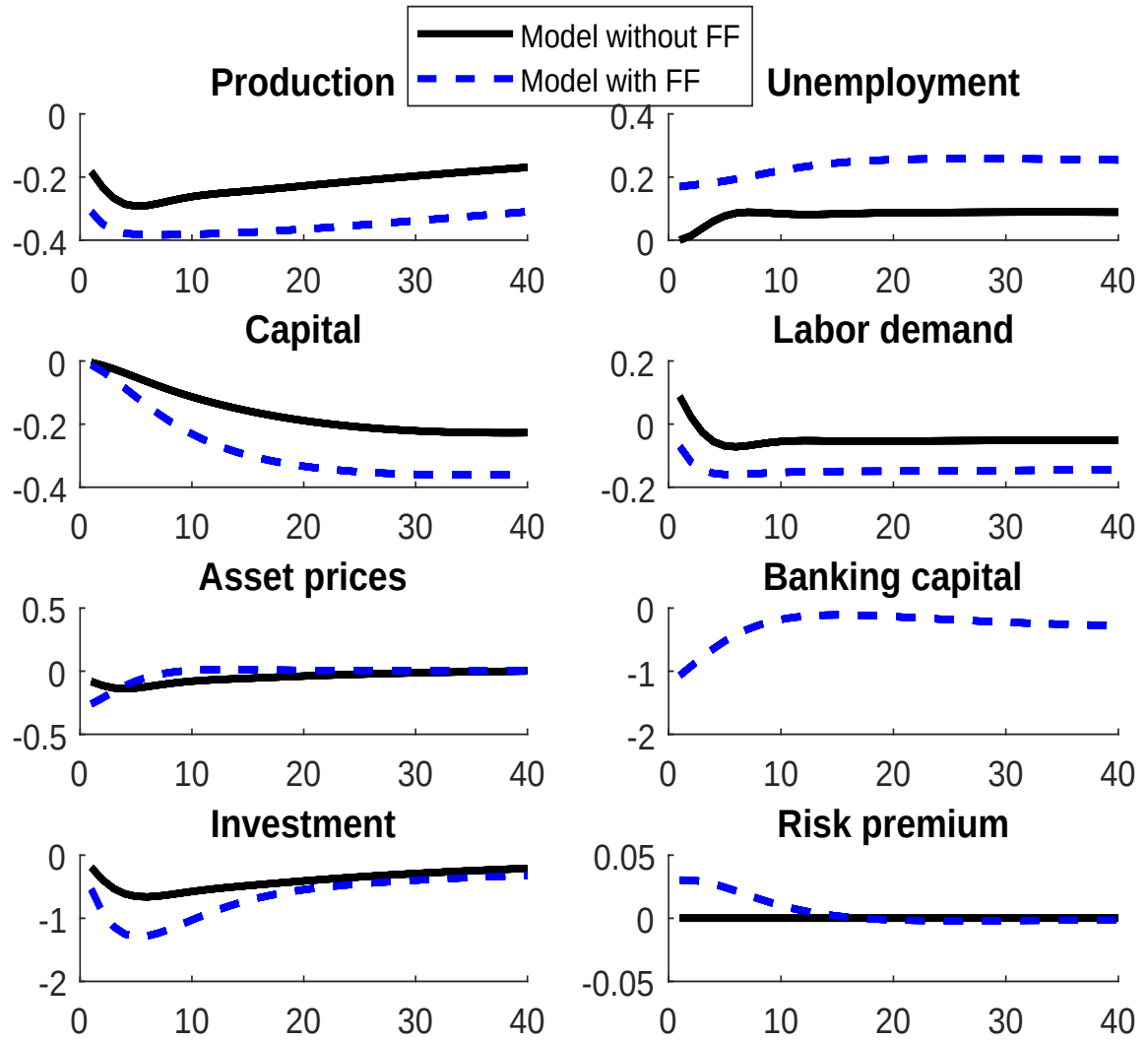


Figure 1: Impulse Responses to 1% negative technology shock.

3.2 Monetary Shock

As a result of the technology shock, the model's ability to create persistence is appreciated by a monetary shock. The role of this type of shock in economic fluctuations is well anchored in the literature as evidenced by the work of Christiano et al. (2005). The evidence provided by the model in response to a rise in the interest rate by one basis point is illustrated in Figure 2. They show that a restrictive monetary policy of rising interest rates, comparable to the disability of central banks to further reduce rates when they are very close to the zero lower bound, generates an increase in the intermediation premium. For models without financial frictions, investment falls more sharply, reducing demand for securities and asset prices. As a result, bank capital deteriorates just as with the technological shock. The decline in production is triggered again by the decline in the accumulation of productive capital. However, compared to models with hysteresis, this decline is magnified and maintained by the deterioration of bank capital. The weakness of production subsequently reduces the demand for work, with the result that unemployment rises, which is sustained by the weakness of the production through the job offer. Finally, the shreds of evidence on the monetary shock show that the financial frictions generate and maintain the fall in production and the rise in unemployment. At the same time, they illustrate that the extent of the persistent trend depends on the extent of bank capital deterioration. However, the simulation with the monetary shock is not intended to reproduce the magnitude of the fall in production and rising unemployment of European data. This is especially since the financial crisis was not really followed by monetary restraint, as most central banks had to relax their policies by resorting to unconventional monetary policies. It was rather a question of characterizing once again the part of the hysteresis effects of the production and the unemployment likely to be attributable to the financial frictions.

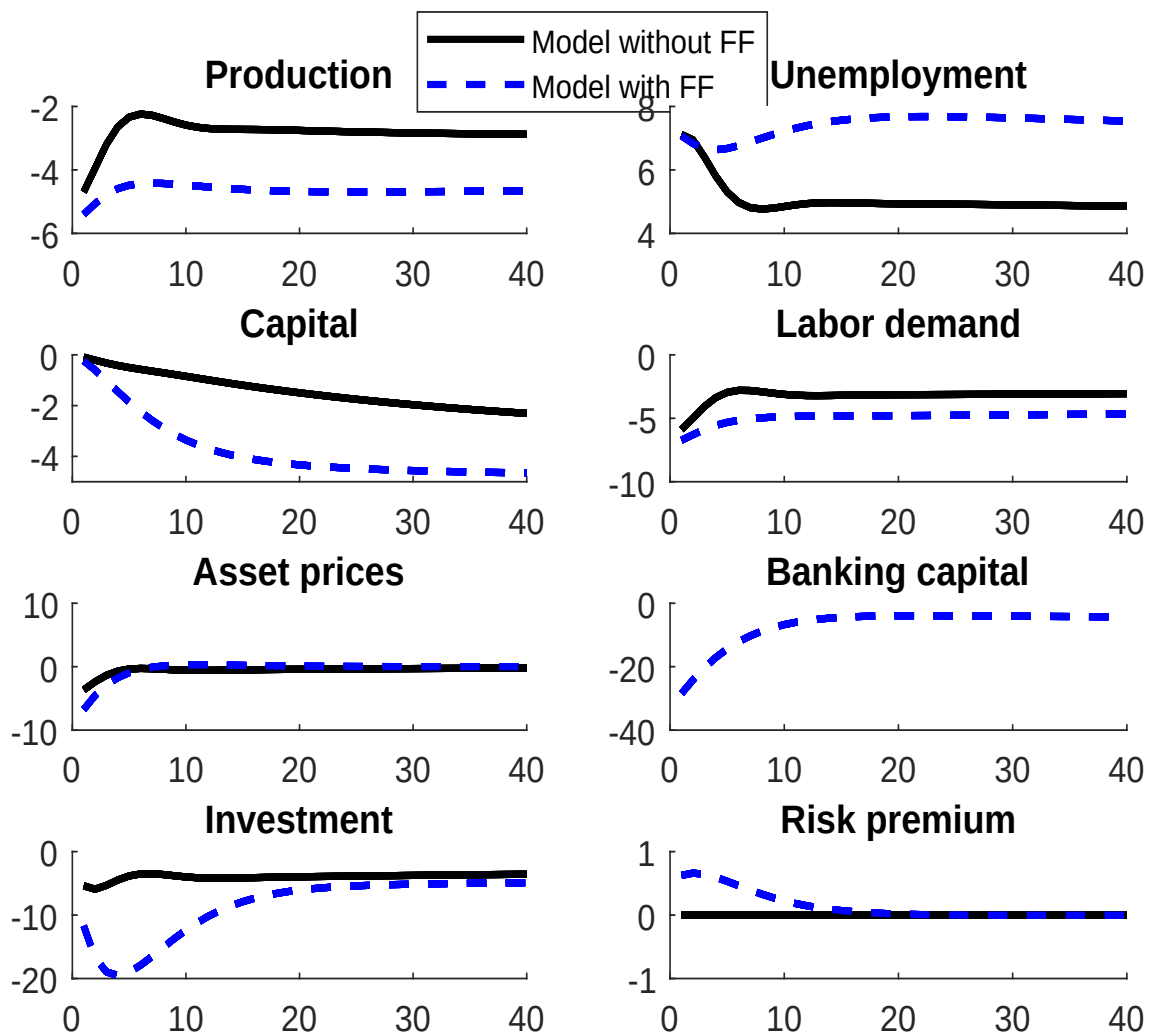


Figure 2: Impulse responses to monetary shock.

3.3 Shock on the Value of Capital

The housing crisis was one of the causes of the Great Recession. As such, the model's ability to generate persistence across financial factors is evaluated with a shock similar to the loss of value of real estate assets. Since this was a loss of value and not the physical destruction of capital, a negative shock of one percent on the value of productive capital is used as a proxy for the real estate crisis. Indeed, as collateral for bank loans, simulations with a productive capital model can capture some aspects of the real estate shock. Figure 3 illustrates the evidence of this simulation. In line with the mechanism described with the two previous shocks, the model generates both a persistent decline in effective output of around nine basis points and a sustained rise in unemployment of around ten basis points.

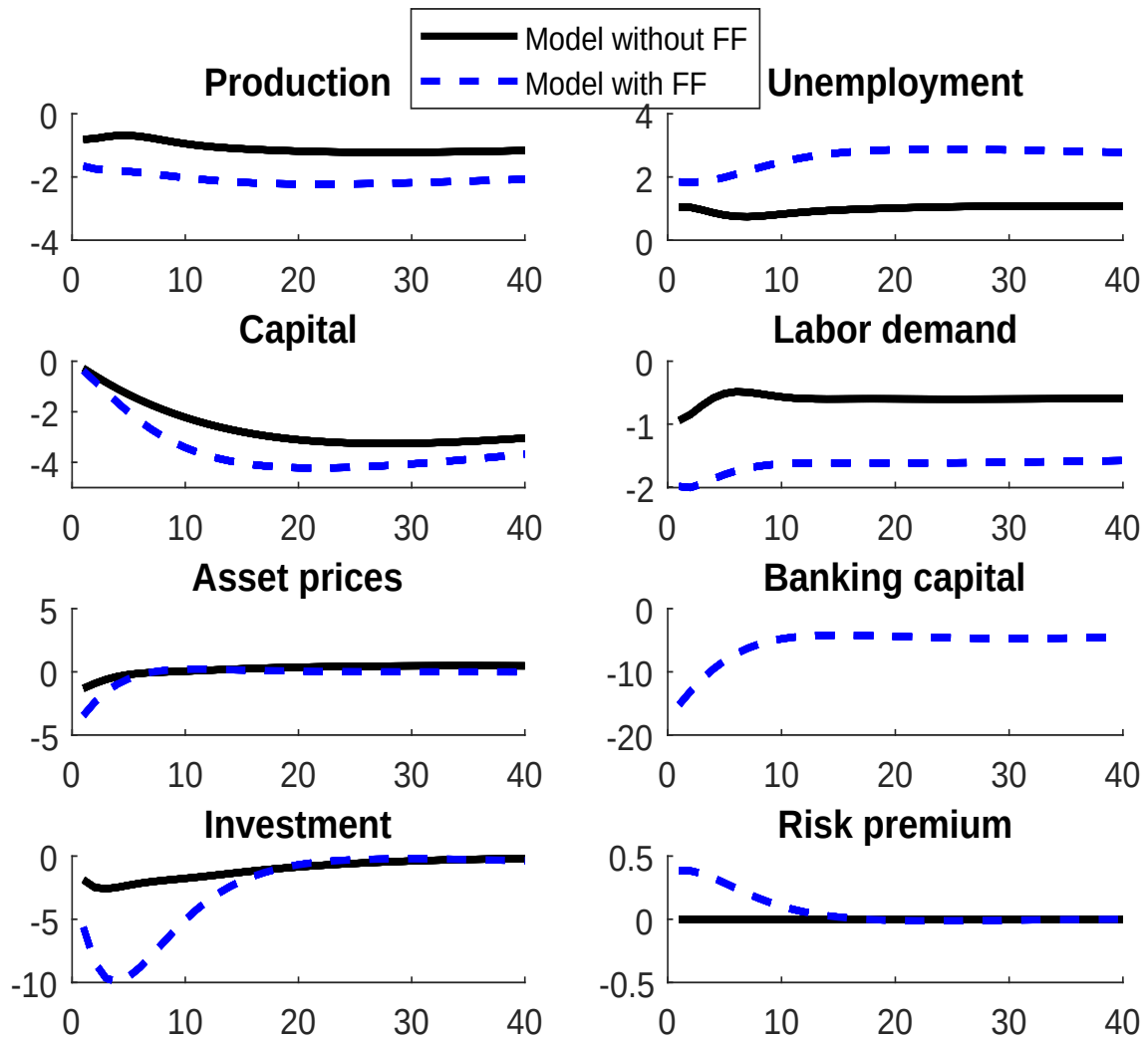


Figure 3: Impulse responses to 1% negative shock on the value of capital.

4 Conclusion

After the recent financial crisis, most advanced economies, particularly those in the euro area, found themselves caught up in economic dynamics marked on the one hand by a significant and lasting decline in production and on the other hand by an unemployment rate as high as ever. This paper is interested in these stylized facts, described as paradoxes in the literature, by developing a theoretical corpus capable of both amplifying and making persistent the effects of economic shocks.

The simulations show that the integration of financial frictions into standard hysteresis frameworks generates a mechanism of amplification of economic shocks through the decline in the accumulation of physical capital due to the deterioration of bank capital. The amplified effects are then sustained by the hysteresis mechanism in the labor market. This mechanism implies that sluggish production generates such a long-term decline in the demand for labor when certain rigidities hinder the reduction of wages. The model also makes it possible to understand the differences in production and unemployment behavior in the United States and the eurozone. A theoretical framework with frictions and hysteresis explains better the stylized facts of the eurozone while those of the United States can be understood better in a theoretical framework with only financial frictions.

The results of these quantitative assessments give rise to two economic policy implications. First, they imply that economic stimulus following the recession should consist of support to the banking sector in order to restore their ability to finance investment projects. The adoption of unconventional monetary policies seems to be one of these measures. Secondly, reforms aimed at reducing corporate wage costs should be made. Thus, the implementation of unconventional monetary policies in the euro area without reforms in the labor market would not necessarily yield the desired effects.

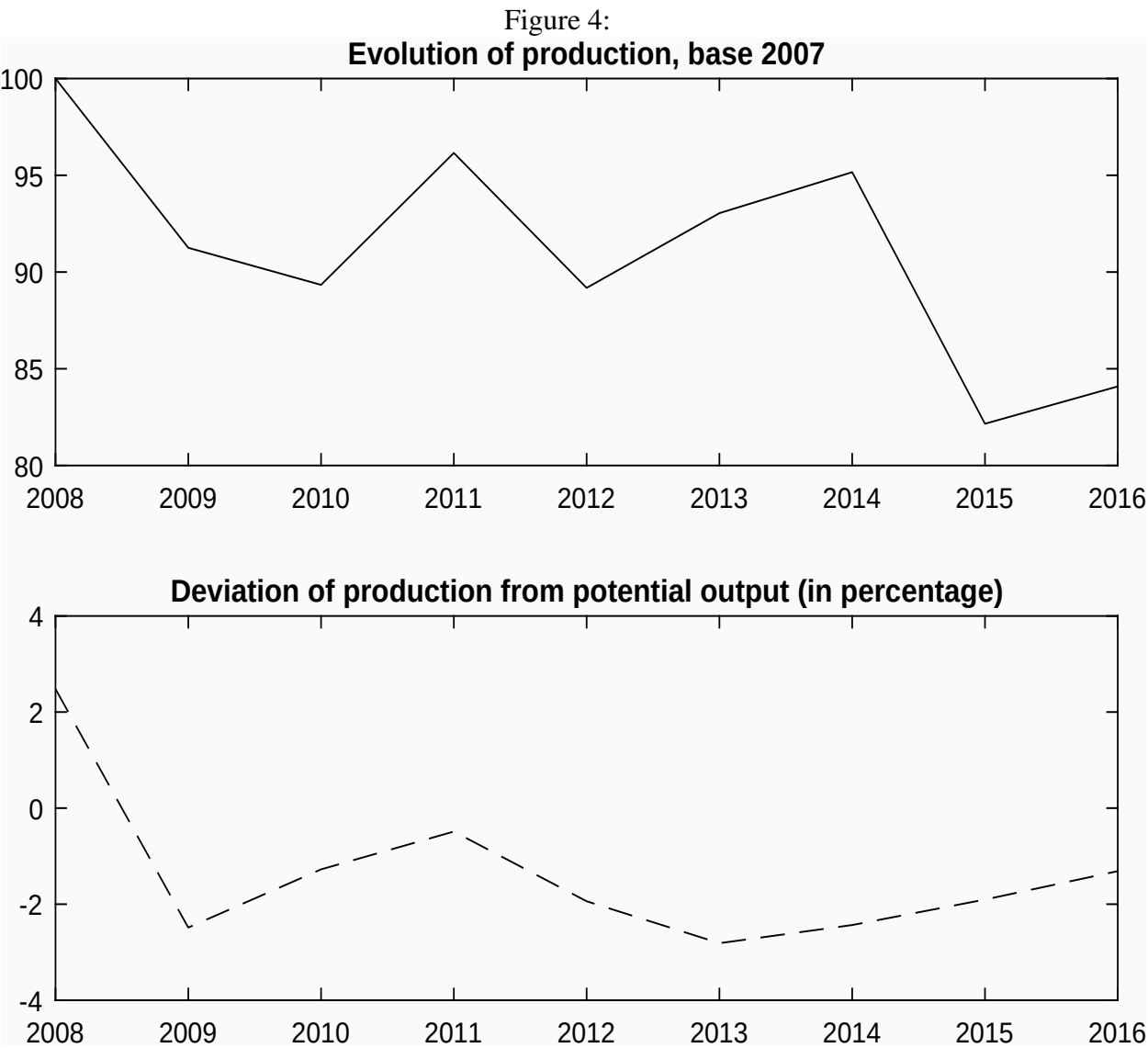
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Appendix

A Highlights of the Great Recession



Source: IMF, WEO data

Figure 5:
Unemployment rate



Source: IMF, WEO data