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Missing Disinflation and Human Capital Depreciation

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Abstract

In line with New-Keynesian predictions and certain historical trajectories that tracked by inflation during past crises, the context of the Great Recession should have spurred a sharp decline in inflation or even deflation. On the contrary, the sensitivity of inflation to changes in unemployment has diminished, giving rise to the paradox of missing disinflation. By investigating this paradox, this article develops a variant of the New-Keynesian models where mechanisms of human capital depreciation are implemented. In the model, rising unemployment translates into a relatively large increase in long-term unemployment. Unemployed people with low levels of human capital become dominant and more workers are now likely to suffer from the depreciation of human capital. The depreciation weakens the intensity with which the unemployed prospect new jobs and moderates the decline in wages and prices. Calibrated on the U.S. economy, model simulations show that this model variant compares relatively better the highlights of missing disinflation than a New-Keynesian without depreciation of human capital. In response to adverse preferences and monetary shocks of the same size, the disinflation is cut down by a factor of 3 to 4 compared to the New-Keynesian models without the human capital depreciation mechanism.

JEL classification: E31, E32, J24.

Key words: Missing disinflation, deflation, human capital depreciation, unemployment, Great Recession

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1 Introduction

The Great Recession (GR), in addition to persistent effects in output and employment, has led to a decline in the sensitivity of inflation to the economic cycle. The decline in inflation in most advanced economies and particularly in the United States has been relatively moderate despite the significant rise in the unemployment rate (Figure 1).

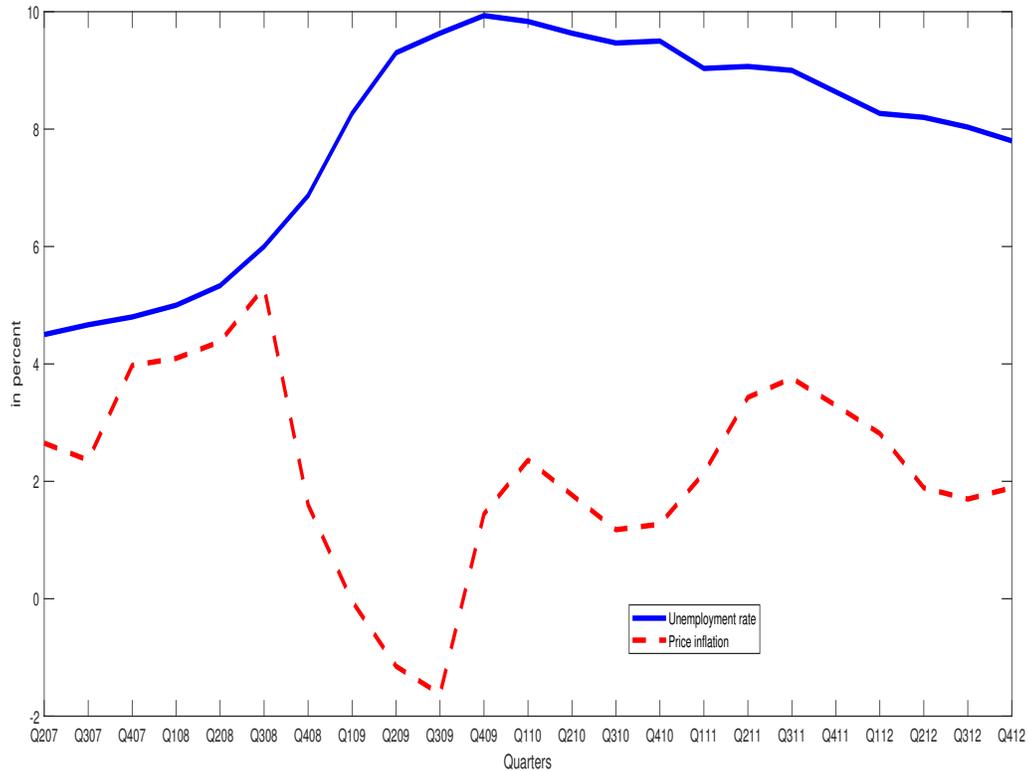


Figure 1: Inflation measured by the CPI and unemployment rate in the US.

Source: OCDE

In line with certain historical trajectories followed by inflation in previous crises, the context of GR should have led to a sharp fall in inflation or even deflation (Blanchard et al., 2015). For example, GR disinflation has been relatively less sustained than the disinflations that followed the recessions of July 1990 and March 2001 (Figure 2). In addition, the rise in unemployment during these two crises was less important than that of the GR. The rise in unemployment was effectively 5.6% to 7.5% for the 1990 recession, 4% to 6% for the crisis of 2001, and 4.6% to 9.6% for GR (OECD, 2018). Matheson et al. (2013) argue that the crisis of 2008 should have led to a deflation of around 3% in the United States.

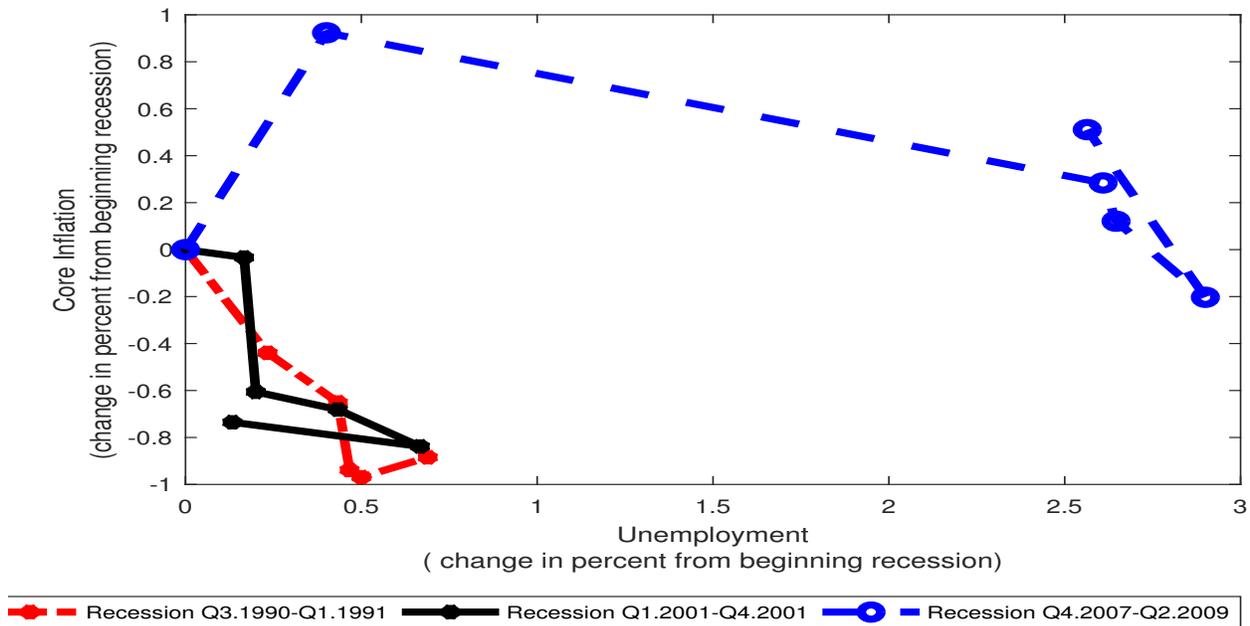


Figure 2: Changes of inflation and unemployment relative to the onset of recessions Q31990-Q11991, Q12001-Q42001 and Q42007-Q22009 in the United States.

Source: World Economic Outlook, IMF

The misalignment of the moderate decline in inflation with the predictions of New Keynesian executives has turned into a paradox—that of missing disinflation. In fact, these Keynesian predictions—based on the Phillips curve—predicted deflation with the significant rise in unemployment following the financial crisis. In this regard, changes in the Phillips curve have been reported by some empirical work (Ball and Mazumder, 2019; Blanchard et al., 2015; Matheson et al., 2013; Stock, 2011). For most of these studies, the Phillips curve is still valid, but the relationship between inflation and unemployment following GR is different from that traditionally accepted in New Keynesian frameworks. In particular, the work illustrates a flattening of the Phillips curve and consequently a weakening of the sensitivity of inflation to changes in unemployment. In view of the importance of unemployment and inflation and the relationship for both the design of economic policies and the structure of certain theoretical models, this paradox has been the subject of intense analysis. A number of arguments were then advanced to explain the change in the relationship between inflation and unemployment.

Among these arguments, two main reasons have crystallized the attention of the works. For some of these studies (Ball and Mazumder, 2011; Blanchard et al., 2015; Matheson et al., 2013), the gain in credibility acquired by central banks since the 1990s has helped to contain deflation by strengthening the expectations of economic agents during the crisis. Economic agents, workers, and firms have tended with the anchoring of expectations to be weighted in wage adjustments, thus

containing deflationary pressures. For other works (Gordon, 2013), the weakening of the relationship between inflation and unemployment lies in the rise of long-term unemployment during GR. With this type of unemployment, economic activity tends to lose its influence on the dynamics of wages and prices.

However, at the current state of knowledge of this analysis, the most well-proven theoretical frames of reference—namely, New-Keynesian models—seem devoid of mechanisms capable of accounting for this paradox despite these arguments. In this regard, this article intends to strengthen the structure of the New-Keynesian models by developing a variant of these models to account for the missing disinflation. Certain studies based on the argument of the anchoring of expectations have tried to strengthen the capacity of New-Keynesian tools to account for the paradox of missing disinflation. For example, by considering that the increase in oil prices over the period 2009-2011 has increased agents' expectations, [Coibion and Gorodnichenko \(2015\)](#) establish in part the compatibility of the Phillips curve with moderate disinflation by integrating into it the dynamics of expectations. With the anchoring of anticipation, the addition of anticipation results in a less mechanical adjustment than that of a traditional Phillips curve. The results of their approach give some relevance to expectations in the dynamics of inflation. The argument of anchoring expectations is certainly not negligible, but the missing disinflation is possibly the product of the effect of a combination of the different arguments. Apart from the rise in the price of oil, GR does not seem to enshrine a major change in expectations. Expectations were even anchored and universalized well before the crisis ([Rogoff, 2003](#)).

This article questions the scope and relevance of the long-term unemployment argument for inflation dynamics. From this perspective, the paper integrates and assesses the implications of a second hysteresis mechanism—the depreciation of human capital—identified in the literature because of the rise in long-term unemployment for the sensitivity of inflation to changes in economic activity. It is worth noting that the context of GR seems to have sanctioned an important change in the structure of unemployment in developed countries. The long-term unemployment rate, measured by the proportion of those unemployed for at least 12 months among all unemployed, increased relatively during the GR in the United States ([Figure 3](#)). Following the crisis, this rate more than doubled compared to the recessions of 1990 and 2001.

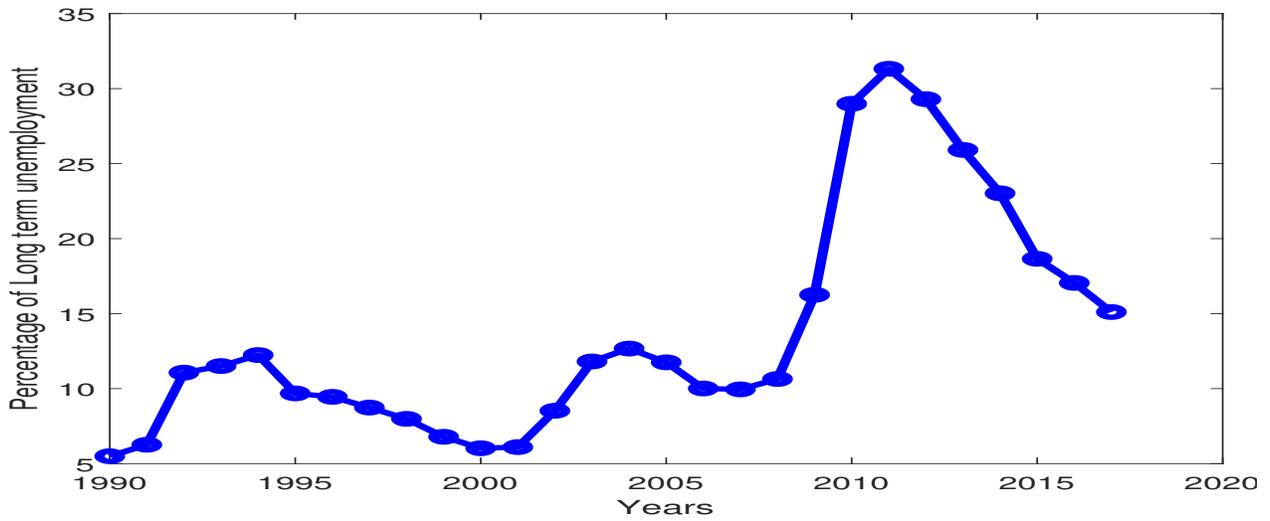


Figure 3: Long-term unemployment (people who have been unemployed for 12 months or more and who are available for work) in United States

Source: OCDE

Thus, the deviation of the Beveridge curve from the origin shown in Figure 4 seems to indicate a possible shift from cyclical to long-term unemployment. Since the 1990s, long-term unemployment has never been higher in the United States.

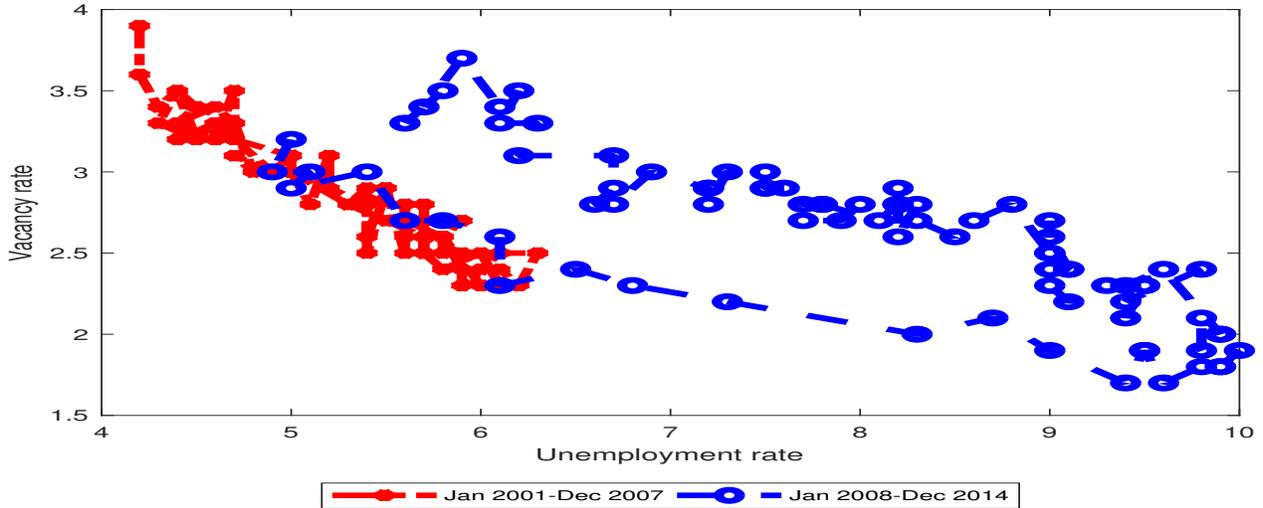


Figure 4: Beveridge curve between 2001-2007 and 2008-2014

Source: Labour Market Statistics Office (United States)

Despite these changes, the argument for rising long-term unemployment has received very little attention from New Keynesian models. However, some studies argue the negative impact of this type of unemployment on the human capital of workers (Acharya et al., 2019; Jackman and Layard, 1991; Pissarides, 1992). For these studies, long-term unemployment tends to be associated with a depreciation of human capital with the consequent lack of consolidation or even degradation of skills and know-how linked to the labour market. The works of Esteban-Pretel (2005), Esteban-Pretel and Faraglia (2010) and Laureys (2014), for example, report evidence of losses in productivity linked to the depreciation of human capital in the propagation of macroeconomic shocks. In addition to the negative impact on productivity, the literature also emphasizes the effects induced by the depreciation of human capital on job prospecting abilities or skills.

Along with these induced effects, the occurrence of human capital depreciation (HCD) results in the presence of workers and unemployed with different levels of human capital or skills. This heterogeneity of human capital could affect the degree of competition in the labour market, in the sense that the long-term unemployed with relatively low levels of human capital would compete for less for exploration intensity and productivity with employed workers. Thus, a significant increase in long-term unemployment could be likely to reduce the influence of the unemployed suffering from the depreciation of human capital on the wages of employed workers. Figure 5 seems to corroborate regarding the moderate fall in wages in the United States following the financial crisis of 2008. Unemployment through the loss of influence on wages would in turn lose part of its influence on the prices of goods and services.

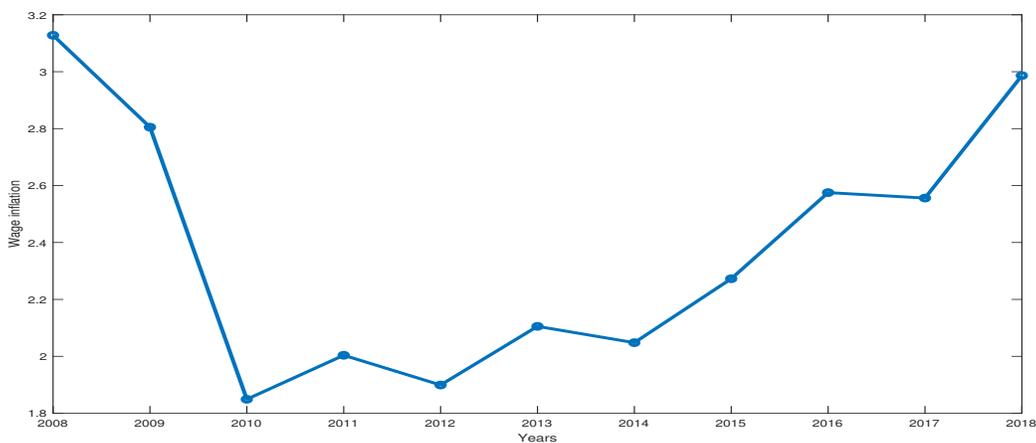


Figure 5: Average hourly earnings of all employees
Source: Federal Reserve Bank of St. Louis

In view of this potentially promising mechanism and the significant rise in unemployment, this article develops a variant of the New-Keynesian models where the depreciation of human capital

affects both the matching of workers to firms and productivity. This accounts for the paradox of missing disinflation. The model is an extension of the [Esteban-Pretel and Faraglia \(2010\)](#) model in which the heterogeneity of human capital in the match has been integrated following the approach of [Kehoe et al. \(2019\)](#). Unlike the [Esteban-Pretel and Faraglia \(2010\)](#), model which only includes the effects of the depreciation of human capital on productivity, the structure of the model in this analysis includes the effects of this depreciation on-the-job search skills of workers. Moreover, unlike the [Esteban-Pretel and Faraglia \(2010\)](#) model where the depreciation of human capital systematically results in lower wages and prices, the effect of the depreciation on the latter results from the interaction of the two aspects in the present model. As a result of the depreciation of human capital, the decline in the intensity of the job search by workers tends to moderate the downward trend in wages and prices. Also, the developed model is distinguished from that of [Kehoe et al. \(2019\)](#) by modelling the effect of the depreciation of human capital instead of that of the accumulation of human capital on the labour search intensity of workers or the unemployed. Unlike their model, which focuses on the effects of work experience driven by workers, that of this article echoes the implications of the depreciation of human capital on the matching chances of the short and long-term unemployed. With the human capital depreciation mechanism, the rise in long-term unemployment results in the emergence of the unemployed with a low level of human capital supposed to compete with employed workers. Due to the weakness of their human capital, these long-term unemployed find it difficult to match jobs because they are relatively less competitive. The weakness of their capital consequently erodes their influence on the wages of employed workers and the prices of the goods produced by the latter.

In the environment of the developed model, for simplicity, the heterogeneity in the distribution of human capital is modelled by considering two levels of human capital: low and high. Depreciation is approximated by a constant loss of human capital when the worker is unemployed. This loss is introduced into the matching function and that of production in order to simultaneously capture the effects of HCD on job search intensity and productivity. This environment is contrasted with a New-Keynesian model with a homogeneous distribution of human capital and a standard matching function. By calibrating the model on the US economy, the simulation results show that this model variant reproduces the highlights of the missing disinflation relatively better than the New-Keynesian standard Model. The effects of HCD on the productivity and job search capacity of workers lead to a reduction in labour market participation, and in turn to a moderation of the downward trend in wages and prices. In response to adverse preferences and monetary shocks of the same size, disinflation in the model with human capital depreciation is 3 to 4 times less important than in a New-Keynesian model without HCD mechanisms. With long-term unemployment, the human capital of agents depreciates due to a lack of opportunity to consolidate and update their work skills. With the corrosion of their know-how, the long-term unemployed lose their influence

on the wages of the agents who remain in employment and, in turn, on the price of the goods produced.

The remainder of the article is organized as follows. Section 2 presents the empirical evidence of HCD. Section 3 discusses the model. Section 4 details the calibration of the model. Section 5 reports and discusses the results of the numerical simulations. Section 6 concludes the article.

2 Human Capital and Long-term Unemployment

Under certain circumstances, long-term unemployment contributes in negatively affecting one or more factors in the labour supply of workers by altering their human capital. The alteration may take the form of depreciation that may manifest itself in the form of stigma or scars on human capital arising from the experience of unemployment. The stigma that the literature refers to is the scarring effects of unemployment. Labour supply factors weakened by these effects include job search intensity, skills, or knowledge and the degree of reporting of job seekers ([Arulampalam et al., 2001](#)). In this regard, this section presents empirical evidence of the emergence of such effects during the GR.

The experience of long-term unemployment tends to be associated with a reduction in the job search intensity due to discouragement or reduced motivation to seek new jobs ([Ayllón, 2013](#); [Cockx and Picchio, 2013](#)). The proportion of the labour force affected by this decline is known in the literature as workers marginally attached to the labour market. This proportion is the labour force that is available and willing to work but is not or not actively seeking work ([Lee and Parasnis, 2014](#)). In the same study, they point out that the proportion of marginally attached workers is substantially high in advanced economies, particularly in the Organisation for Economic Co-operation and Development (OECD) countries, where it represented about 0.5% of the labour force in 2012. Looking also at the dynamics of the proportion of such workers in the United States, [Van Zandweghe \(2012\)](#) reports that the proportion of the marginally attached labour force rose from an average of 1.5 million over the period 1994-2007 to an average of 2.2 million over the period 2008-2011, an increase of 50% after GR. For the same periods, he alludes to 100% increase in the proportion of discouraged workers, a proportion that [DeLoach and Kurt \(2013\)](#) estimate at around 1 million people in February 2011. The literature also highlights the impact of the effect of discouraged workers on labour market participation. [Van Zandweghe \(2012\)](#), for example, using the Beveridge-Nelson decomposition, argues that long-term unemployment explains 90% of the 1.9 percentage point decline in the United States labour force participation rate from 2007 to 2011. [DeLoach and Kurt \(2013\)](#) also argue in their study that the time spent looking for work fell by an average of 35%

over the same period.

In addition to the effects on job-search intensity, HCD is also the progressive degradation of workers' skills, knowledge, or know-how. This deterioration also results in a lower signal to employers of the long-term unemployed. Employers generally rely on the quality of the signal to discriminate between good and bad future employees, both in terms of recruitment and pay (Tumino, 2015). The literature review shows that the loss of skills and signalling manifests itself in lower productivity and lower chances of employment for the unemployed. When evaluating productivity losses in terms of wages, Tumino (2015) expects losses of between 8 and 10%. His results also show that the long-term unemployed are 6–9% less likely to be employed compared to employed workers with similar characteristics.

Thus, long-term unemployment through its HCD-induced effects can influence certain labour supply factors. Such influences could have implications for labour market dynamics for wages and, therefore, for prices following a significant rise in this type of unemployment. This is a perspective that this article intends to explore by developing a variant of New-Keynesian models where the depreciation of human capital affects both the matching and productivity of job seekers. This is especially since, at the current state of knowledge, this perspective has not been explicitly investigated.

3 The Model

The model is a variant of the New-Keynesian theoretical corpus in which the economic environment is made up of families, firms producing goods, and monetary authority. Families are composed of an infinity of members materialized by a unitary interval. In each period, one member may be employed in the productive sector or unemployed. When a member is unemployed, his or her human capital is likely to depreciate according to his or her status as unemployed. This status may be that of a short-term or long-term unemployed person. Short-term unemployed status is a member who is unemployed at the beginning of a given period while in employment at the end of the previous period. The long-term unemployed is a household member who has been unemployed for at least two successive periods. Based on the evidence in the literature on the effects of long-term unemployment, the existence of a difference in the level of human capital is assumed between these two types of unemployed. The short-term unemployed are thus considered as workers with a high level of capital and the long-term unemployed as workers with a low level of human capital.

The presence of these two types of workers can affect the labour market, since a re-composition of the structure of unemployment with a preponderance of long-term unemployed is likely to lead

to a decrease in participation in the labour market and a decrease in productivity. The mechanism linking the depreciation of human capital and participation in the labour market is represented by a matching technology whose specificity is to capture the differences in job search intensity between the two groups of workers. The link between capital depreciation and productivity is captured by a technology of production of goods that incorporates the differences in the level of human capital between the two groups of workers.

The rest of the model's environment is similar to the basic New-Keynesian frameworks with the presence of monopoly competition and price rigidity, with a few exceptions. Also, the model shares the highlights of the labour market friction patterns with the determination of wages through Nash bargaining and the presence of matching technology. The presence of the monetary authority is also there to understand the impact of its orientations on the dynamics of inflation.

3.1 The Families

The family environment provides a framework for formalizing decisions about consumption, savings, and participation in the labour market. Families are identical and each family is made up of a continuum of members materialized by a unit interval. Consumption and savings decisions are assumed to be made at the family level and labour market participation decisions at the individual level.

3.1.1 Family's problem

In this economy, the family framework constitutes consumer insurance against the risk of unemployment for each member. Thus, consumption and savings decisions are taken at the family level. In order to focus on the interaction between labour market participation and price dynamics, the intensive margin is disregarded. The representative family saves by investing in a one-period bond, B_t . The consumption, C_t of the family is made up of a set of differentiated goods and the domestic production carried out by members not employed in the production sector.

$$C_t = C_t^m + (1 - n_t)d_t$$

where C_t^m is the set of differentiated goods and $(1 - n_t)d_t$ is the household production achieved by the portion of unemployed members, n_t is the total number of members employed in the production

sector, and d_t is the household production. The set of differentiated goods is an aggregation à la Dixit-Stiglitz:

$$C_t^m = \left[\int_0^1 C_t^m(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where $C_t^m(j)$ is the production realized by the firm j and ε the elasticity of substitution between the differentiated goods. At the family level, consumption and savings decisions are made by solving the value function:

$$V(B_t, \xi_t) = \xi_t \log(C_t) + \beta E_t V(B_{t+1}, \xi_{t+1})$$

under the constraint of:

$$B_t + P_t C_t = P_t (W_t + (1 - n_t) d_t) + (1 + i_{t-1}) B_{t-1} + \Pi_t \quad (1)$$

$$C_t = C_t^m + (1 - n_t) d_t \quad (2)$$

$$\log \xi_t = \rho \log \xi_{t-1} + \varepsilon_t \quad (3)$$

where β is the discount factor, i_t the nominal interest rate, Π_t the nominal profits from goods-producing sectors, ξ_t the exogenous preference factor assumed to follow an AR(1), $\varepsilon_t \sim N(0, \sigma^2)$ the preference shock, ρ the autoregressive parameter, and P_t the general price level defined as the price index $P_t(j)$ of differentiated goods:

$$P_t = \left[\int_0^1 P_t(j)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \quad (4)$$

The maximization of C_t^m under the constraint of $\int_0^1 P_t(j) C_t^m(j) dj$ gives the demand for each differentiated good j

$$C_t^m(j) = \left[\frac{P_t(j)}{P_t} \right]^{-\varepsilon} C_t^m \quad (5)$$

The Euler equation derived from the resolution of the value function is:

$$\frac{1}{C_t} = \beta(1 + r_t) E_t \left(\frac{\xi_{t+1} P_t}{\xi_t P_{t+1} C_{t+1}} \right) \quad (6)$$

The stochastic discount factor for discounting nominal incomes for the period $t + 1$ in the economy is:

$$Q_{t,t+1} = \beta E_t \left(\frac{C_t P_t}{C_{t+1} P_{t+1}} \right) \quad (7)$$

3.1.2 An Individual Consumer's Problem

In each period, one member is either employed in the production sector or unemployed. Labour market participation is a function of the level of human capital. For the sake of simplicity, it is assumed that members have only two levels of human capital. This can be high or low. Two groups of labour market participants are considered: the short-term unemployed and the long-term unemployed. Both groups interact with production firms by offering their labour force. In each period, family members have one of two options: (i) participation in the labour market or (ii) household production. Participation in the labour market is a function of the human capital of the household member. To simplify, the distribution of human capital specific to the labour market in each family is assumed to take two values. Thus, each member has a high human capital \bar{h} or a low human capital \underline{h} . Members with \bar{h} capital at the start of the period t are agents employed at the period $t - 1$. On the other hand, members who remained unemployed during the period $t - 1$ are reduced to the period t by a capital level \underline{h} . Depreciation occurs when the capital goes from \bar{h} to \underline{h} following a period of unemployment by a member. The value of the two options is then a function of the type of capital held by the family member. Thus, the value of the option to be employed $N_t(h_t)$ in the production sector for a representative member with capital h_t at periods t is the sum of the wage received $w_t(h_t)$ and the present value of future options, which can either be remaining employed with a probability $(1 - \sigma)$ or being at unemployment with a probability σ . In each period, a proportion σ of jobs are exogenously shed. The value of this option for a member with a \bar{h} is written:

$$N_t(\bar{h}) = w_t(\bar{h}) + \beta E_t Q_{t,t+1} \left[(1 - \sigma) N_{t+1}(\bar{h}) + \sigma U_{t+1}(\bar{h}) \right] \quad (8)$$

and that of a member with \underline{h}

$$N_t(\underline{h}) = w_t(\underline{h}) + \beta E_t Q_{t,t+1} \left[(1 - \sigma) N_{t+1}(\bar{h}) + \sigma U_{t+1}(\underline{h}) \right] \quad (9)$$

The value of the option to be unemployed $U_t(h_t)$ is equal to the domestic production realized by the member and the present value of future options. The value of this option for a holder of \bar{h} is presented as:

$$U_t(\bar{h}) = d_t(\bar{h}) + \beta E_t Q_{t,t+1} \left[(1 - \sigma) N_{t+1}(\bar{h}) + \sigma U_{t+1}(\bar{h}) \right] \quad (10)$$

and that of a member with \underline{h} :

$$U_t(\underline{h}) = d_t(\underline{h}) + \beta E_t Q_{t,t+1} \left[(1 - \sigma) N_{t+1}(\underline{h}) + \sigma U_{t+1}(\underline{h}) \right] \quad (11)$$

3.2 Intermediate Goods Firms

Intermediate goods are produced in the economy by a continuum of firms represented by a unit interval. These firms operate in a competitive environment by expressing a demand for labour from family members and by selling their products at the price P_t^I to the producers of final goods. At each period, the representative firm solicits work offers from family members by posting vacant positions v_t . The cost of posting a vacancy is κ . As a result of matching, the firm's output is subject to the specific human capital level of family members engaged in its production process. Matching takes place when vacancies posted by the firm match with certain family members. The distribution of the human capital of the representative firm is similar to that characterizing the representative family. The representative firm carries out its production with technology:

$$y_t = A_t(n_t^e \bar{h} + n_t^f \underline{h}) \quad (12)$$

with A_t the total factor productivity, n_t^e the number of employees with human capital \bar{h} and n_t^f those with capital \underline{h} . The effective job offer made by the representative firm and the level of overall productivity are given by the equations (13) and (14)

$$n_t = n_t^e + n_t^f \quad (13)$$

$$A_t = \rho_a A_{t-1} + \epsilon_t^a \quad (14)$$

with ρ_a the autoregressive parameter and ϵ_a the supposed technological innovation $N(0, \sigma_a)$.

The problem of the representative firm is to solve at each period the objective function:

$$E_t \sum_{k=0}^{\infty} Q_{t,t+k} \left\{ \frac{P_{t+k}^I}{P_{t+k}} A_t (n_{t+k}^e \bar{h} + n_{t+k}^f \underline{h}) - n_{t+k}^e w_{t+k}^e - n_{t+k}^f w_{t+k}^f - \kappa v_{t+k} \right\} \\ \{n_{t+k}^e, n_{t+k}^f, v_{t+k}\}$$

under constraint:

$$n_{t+k}^e = (1 - \sigma)(n_{t+k-1}^e + n_{t+k-1}^f) + \lambda_{mt+k}^e u_{t+k}^e v_{t+k} \quad (15)$$

$$n_{t+k}^f = (1 - \sigma)n_{t+k}^f + \lambda_{mt+k}^f u_{t+k}^f v_{t+k} \quad (16)$$

with w_{t+k}^e the salary paid to capital employees \bar{h} , w_{t+k}^f the salary paid to employees with capital \underline{h} , u_{t+k}^e and u_{t+k}^f the unemployed having respectively the capital levels \bar{h} and \underline{h} . The laws of motion for these expressions are:

$$u_{t+k}^e = \sigma (n_{t-1}^e + n_{t-1}^f) + (1 - \lambda_{mt+k-1}^e) u_{t+k-1} \quad (17)$$

$$u_{t+k}^f = \sigma n_{t+k-1}^f + (1 - \lambda_{mt+k-1}^f) (u_{t+k-1}^f + u_{t+k-1}^e) \quad (18)$$

λ_m^e and λ_m^f are the matching probabilities of family members having respectively the capital levels \bar{h} and \underline{h} . The expressions of these probabilities are developed later in the document. The total number of unemployed in the economy is

$$u_t = u_t^e + u_t^f$$

The profit made by the firm is then the difference between its real income and its real costs. The actual costs include the amount of wages for both types of workers and the costs incurred for posting vacancies. Considering ψ_{and} and ψ_{ft} the Lagrange multipliers of equations (15) and (16) and $p_t = \frac{u_t^f}{u_t}$ the proportion of long-term unemployed in total unemployment, solving the firm's problem at periods t gives the following first order conditions:

$$\kappa = \psi_{et}\lambda_{mt}^e(1 - p_t) + \psi_{ft}\lambda_{mt}^f p_t \quad (19)$$

$$\psi_{et} = \frac{P_t^I}{P_t} A_t \bar{h} - w_t^e + (1 - \sigma) E_t Q_{t,t+1} \psi_{et+1} \quad (20)$$

$$\psi_{ft} = \frac{P_t^I}{P_t} A_t \underline{h} - w_t^f + (1 - \sigma) E_t Q_{t,t+1} (\psi_{et+1} + \psi_{ft+1}) \quad (21)$$

In addition, the value of opening a vacant position, assessed in terms of the consumption of period t is:

$$V_t(\bar{h}, \underline{h}) = -\kappa + \lambda_{ft}^e J_t(\bar{h}) + \lambda_{ft}^f J_t(\underline{h}) + (1 - \lambda_{ft}^e)(1 - \lambda_{ft}^f) E_t Q_{t,t+1} V_{t+1} \quad (22)$$

with $J_t(\bar{h})$ and $J_t(\underline{h})$ the respective values of the pairing with workers \bar{h} and \underline{h} :

$$J_t(\bar{h}) = A_t \bar{h} - w_t^e + (1 - \sigma) E_t Q_{t,t+1} J_{t+1}(\bar{h}) \quad (23)$$

$$J_t(\underline{h}) = A_t \underline{h} - w_t^f + (1 - \sigma) E_t Q_{t,t+1} J_{t+1}(\underline{h}) \quad (24)$$

and λ_{ft}^e and λ_{ft}^f the matching probabilities of the vacant position to workers \bar{h} and \underline{h} . The expressions for these probabilities are developed in the subsection on matching technology.

3.3 Matching and Nash Bargaining

According to the literature, the search for employment by workers in this model is subject to certain frictions in the sense that, at each period, the firms responsible for the production of intermediate goods make recruitment announcements in order to fill the vacant positions v_t . Family members, regardless of their human capital level, compete for the same vacant positions. With this in mind, they go to great lengths to seek out vacancies, subsequently apply, and possibly pass job interviews. In view of these frictions, and following [Diamond \(1982\)](#) and [Chen et al. \(2011\)](#), the m_t matching flow depends essentially on the s_t job search intensity multiplied by the number of job seekers u_t and v_t vacancies. Moreover, assuming that the matching function m_t , as suggested by [Kehoe et al. \(2019\)](#), is dependent on the distribution of the human capital of job seekers, m_t is defined so to make the job search intensity s_t a function of h . The functional form of m_t is also specified according to [Kehoe et al. \(2019\)](#) in order to ensure that the job matching rate available is between 0 and 1. Therefore, m_t occurs as the following:

$$m_t(v_t, u_t, h_t) = B_t s_t(h_t) \frac{u_t v_t}{[u_t^\eta + v_t^\eta]^{\frac{1}{\eta}}} \quad (25)$$

with B_t measures the degree of matching efficiency and η the elasticity of vacancies. By setting $\theta_t = \frac{v_t}{u_t}$ the ratio between the vacant positions, v_t and the total number of unemployed, u_t the probability for a family member with a capital level h_t to match a vacant position:

$$\lambda_{mt} = \frac{m_t}{u_t} = B_t s_t(h_t) \frac{\theta_t}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}}$$

and the probability that the vacant position of a firm matches a job seeker with h_t as the level of human capital:

$$\lambda_{ft} = \frac{B_t s_t(h_t)}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}}$$

λ_{wt} and λ_{ft} positively depend on the human capital of the applicant. By normalizing, the specific search intensity $s(h_t)$ of members with a level \bar{h} at 1 and assuming a depreciation rate δ of human

capital, the probabilities λ_{mt}^e and λ_{mt}^f are written:

$$\lambda_{mt}^e = B_t \frac{\theta_t}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}} \quad (26)$$

$$\lambda_{mt}^f = B(1 - \delta) \frac{\theta_t}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}} \quad (27)$$

and the expressions of the probabilities λ_{ft}^e and λ_{ft}^f are:

$$\lambda_{ft}^e = \frac{B_t}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}} \quad (28)$$

$$\lambda_{ft}^f = \frac{B_t(1 - \delta)}{(1 + \theta_t^\eta)^{\frac{1}{\eta}}} \quad (29)$$

In the model environment, salary negotiations are held at each period between firms and workers to determine the remuneration of each of the parties involved in the matching process. Like the literature, negotiations consist of a Nash-style sharing of the surplus $S_t(h) = N_t(h_t) - U_t(h_t) + J_t(h_t) - V_t(h_t)$ of the pairing. This sharing gives the worker a constant fraction b of the surplus, and the wage negotiation problem arises:

$$\max_{w_t(h_t)} (N_t(h_t) - U_t(h_t))^b (J_t(h_t) - V_t(h_t))^{1-b}$$

Since the free market entry condition implies that $V_t(h_t) = 0$ at equilibrium, the first order conditions are:

$$bS_t(h_t) = N_t(h_t) - U_t(h_t) \quad (30)$$

$$(1 - b)S_t(h_t) = J_t(h_t) \quad (31)$$

The combination of the equations (8), (9), (10), (11), (23), (24), (30), and (31) are used to determine the wages w_t^e and w_t^f of the two groups of workers:

$$w_t^e = b [A\bar{h} + (1 - \sigma)Q_{t,t+1}J_{t+1}(\bar{h})] + (1 - b) [d_t(\bar{h}) + Q_{t,t+1} \{ \lambda_{m_{t+1}}^e N_{t+1}(\bar{h}) - (1 - \sigma)N_{t+1}(\bar{h}) + (1 - \lambda_{m_{t+1}}^f) U_{t+1}(\bar{h}) - \sigma U_{t+1}(\bar{h}) \}] \quad (32)$$

$$w_t^f = b[A\bar{h} + (1 - \sigma)J_{t+1}(\underline{h})] + (1 - b) [d_t(\underline{h}) + Q_{t,t+1} \{ (1 - \sigma)N_{t+1}(\underline{h}) - \lambda_{m_{t+1}}^f N_{t+1}(\underline{h}) - \sigma U_{t+1}(\underline{h}) - (1 - \lambda_{m_{t+1}}) U_{t+1}(\underline{h}) \}] \quad (33)$$

3.4 Retail Firms

The final goods production sector is integrated into the structure of the model to capture the standard ingredients of New-Keynesian in formalizing inflation. The final goods produced in the economy are used by a continuum of firms operating in a monopoly environment to produce final goods. The differentiated goods thus produced are sold to family members. The continuum of firms is represented by a unit interval and each differentiated good is produced by remanufacturing an intermediate good according to the following technology:

$$Y_t(j) = y_t(j) \quad (34)$$

$Y_t(j)$ is the final good produced by the firm j and $y_t(j)$ the quantity of intermediate good used as a factor of production by the same firm j . The demand for final goods sent by the representative family Y_t to the producers of the sector is a Dixit-Stiglitz aggregation of the differentiated goods $Y_t(j)$

$$Y_t = \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

The price adjustment is supposed to be done à la Calvo so that in each period, a fraction $(1 - \theta_p)$ of the firms in the sector adjusts their prices while a proportion θ_p keeps prices unchanged. When a firm has the opportunity to adjust its price, it chooses P_t^* to maximize the objective function below:

$$\sum_{k=0}^{\infty} \theta_p^k E_t \left[Q_{t,t+k} \left(P_t^* - P_{t+k}^I \right) Y_{t,t+k}(j) \right]$$

under the constraint of the demand for the good j in $t + k$ when the adjustment takes place in t

$$Y_{t,t+k}(j) = \left[\frac{P_t(j)}{P_{t+k}} \right]^{-\varepsilon} Y_{t+k} \quad (35)$$

with P_{t+k} the general price level at period $t + k$, P_{t+k}^I the nominal marginal cost or the price of the intermediate good. Furthermore, the general price level in the economy is given by the rule of [Calvo \(1983\)](#)

$$P_t = \left[\theta_p (P_{t-1})^{1-\varepsilon} + (1 - \theta_p) (P_t^*)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \quad (36)$$

where θ_p is the proportion of firms whose prices remain unchanged.

3.5 Monetary Policy

The Central Bank conducts its policy in the economy using the nominal interest rate instrument. It sets a target value based on inflation and output. The interest rate is influenced by a monetary shock ϵ_t^m following a normal distribution $(0, \sigma_m)$. The target value of the rate is then given by the following Taylor rule:

$$R_t = (R_{t-1})^{\rho_m} \left(\frac{P_t}{P_{t-1}} \right)^{\gamma_\pi (1-\rho_m)} \left(\frac{Y_t}{Y} \right)^{\gamma_y (1-\rho_m)} e^{\epsilon_t^m} \quad (37)$$

with γ_{pi} and γ_y , both positive and representing respectively the central bank's sensitivities to inflation and to the deviation of output from its equilibrium level and ρ_m the autoregressive parameter.

4 Calibration

This section presents the model calibration process. The calibration of the model is made based on semi-annual data of the U.S. economy. The choice of the semester is explained by the fact that it is reasonably assumed that a worker once unemployed is likely to incur some depreciation in his human capital after 6 months. As the results of the model are to be contrasted with those of a New-Keynesian model lacking a HCD mechanism, this calibration also applies to this model,

except for the parameters relating to the HCD and the steady-state values of certain endogenous variables. This model without HCD mechanism is also a variant of the developed model. It is obtained by homogenizing the distribution of HC so that $\bar{h} = \underline{h} = 1$. As an illustration, with homogenization, the production function in this model takes the form $Y_t = A_t n_t$ and the match is no longer dependent on the distribution of HC.

The model has 11 more or less standard parameters. The values are assigned to them according to certain works or in such a way as to reproduce the empirical values of certain variables in a stationary state. Thus, the discount factor β is set at 0.98 to agree with a steady-state annual real interest rate of 4%. Following [Christiano et al. \(2015\)](#), the elasticity of substitution in the goods market ε takes the value 6 to correspond to markups of 1.20. The duration of the prices being on average 4 quarters on average ([Galí, 2015](#)), the price rigidity parameter θ_p is fixed at 0.5. The autoregressive parameters of the monetary shocks ρ_m , preferably ρ and technological ρ_a , are fixed at 0.95. The parameters of the Taylor rule γ_{pi} and γ_y match the same values as [Gertler and Karadi \(2011\)](#), taking the values of 1.5 and 0.5 respectively. According to [Mortensen and Pissarides \(1994\)](#), the bargaining power of workers b is set at 0.5. The elasticity of the vacancies η changes to 0.61 following [Kehoe et al. \(2019\)](#). Based on [Laureys \(2014\)](#), the exogenous job destruction rate σ is set at 0.12.

In addition to these parameters, the calibration was applied to some variables. The aggregate factor productivity A and the matching efficiency B are each normalized to 1 at steady state. According to [Shimer \(2008\)](#), the matching probabilities of the short-term unemployed λ_m^e and the long-term λ_m^f at the stationary state are respectively at 0.31 and 0.19. From the steady-state value of λ_m^e , the value of the ratio of vacancies to the number of steady-state unemployed is deduced from the equation (28) and stands at 0.93, a value quite close to the unit value of [Shimer \(2005\)](#). In the absence of empirical data on the value of the rate of depreciation of human capital δ , its value is determined by combining the equations (26) and (27) and the values at 1's steady state of λ_m^e and λ_m^f . Solving these equations sets the depreciation rate δ to 0.20. The sensitivity of the model relative to the values of δ will be done in the results section. Following [Laureys \(2014\)](#) and [Galí \(2015\)](#), the steady state employment rate is set at 0.95 and the unemployment rate at 0.05. The long-term unemployed are assumed to be stationary represented as in the work of 20% of the unemployed. At steady state, domestic production d represents 40 % ([Shimer, 2005](#)) of production and the cost of vacancies κ at 15 % ([Kehoe et al., 2019](#)).

Symbole	Value	Definition
β	0.98	Discount factor
ϵ	6	Elasticity of substitution
θ_p	0.5	Calvo index of prices rigidities
ρ	0.95	Autoregressive parameter of the preference shock
γ_π	1.5	Inflation parameter of Taylor rule
γ_y	0.5	Output gap parameter of Taylor rule
ρ_a	0.95	Autoregressive parameter of the productivity shock
ρ_m	0.95	Autoregressive parameter of the monetary shock
η	0.61	Matching function elasticity
b	0.5	Worker's bargaining share
σ	0.12	Exogenous job destruction
δ	0.20	Human capital depreciation rate
B	1	Steady state of matching efficiency
A	1	Aggregate factor productivity
p	0.20	Steady state long-term unemployed proportion
λ_m^e	0.19	Job matching probability of short-term unemployed
λ_m^f	0.31	Job matching probability of long-term unemployed
u	0.05	Steady state unemployment rate
d	0.40	Steady state share of home production
κ	0.15	Cost of vacancies
θ	0.93	Steady state labour market tightness

Table 1: Calibration

5 Results

This section presents the results of numerical simulations carried out with two demand shocks: a preference shock and a monetary shock. The shocks are oriented to reflect adverse shocks to the economy. As indicated above, the results of the model with the HCD are compared with those of a New Keynesian model without the HCD mechanism in order to highlight the implications of the phenomenon of depreciation. The model without HCD is labelled for the NK-WHCD model suite and the one developed model HCD. The impulse responses are such that the blue lines represent those of the NK-WHCD model and the red lines represent those of the HCD model.

In order to illustrate the implications of the HCD, this section presents and successively discusses the scope of the HCD for disinflation, the wage inflation mechanism through which the HCD affects disinflation and highlights the sensitivity of disinflation to a change in the rate of HCD.

5.1 Human Capital Depreciation and Disinflation

Figures 6 and 7 show the range of the HCD for disinflation from two shocks of the same size. This range is illustrated by comparing the impulse responses of the HCD model with those of the NK-WHCD model. The first shock relates to an exogenous fall in preferences of 1% (Figure 6) and the second to an unanticipated interest rate tightening of 1% (Figure 7).

The results from both models indicate that the two adverse shocks translate into higher unemployment rates, lower inflation, and higher unemployment rates for the low-skilled and high-skilled unemployed. However, the disinflation resulting from the two shocks is relatively lower in the HCD model than in the NK-WHCD model, although the increase in the unemployment rate is higher in the HCD model. With the preference shock, an increase in the unemployment rate of 1% is accompanied by a disinflation of 0.30% in the HCD model, while in the NK-HCD model, an increase in the unemployment rate of 0.7% tends to be accompanied by a disinflation of 1% (Figure 6). These results indicate that disinflation is about 4 times less in an economy where unemployment is accompanied by HCD than in an economy where unemployment does not induce any HCD. The disinflation associated with this shock in the HCD model is quite close to that found in [Blanchard et al. \(2015\)](#), where it shows that nowadays a 1% increase in unemployment translates into a 0.2% decrease in inflation. Also, the disinflation in the NK-HCD model is to some extent contiguous with the estimates of [Ball and Mazumder \(2011\)](#), who approximate that before GR, a 1% increase in unemployment tends to reduce inflation by 2.5%.

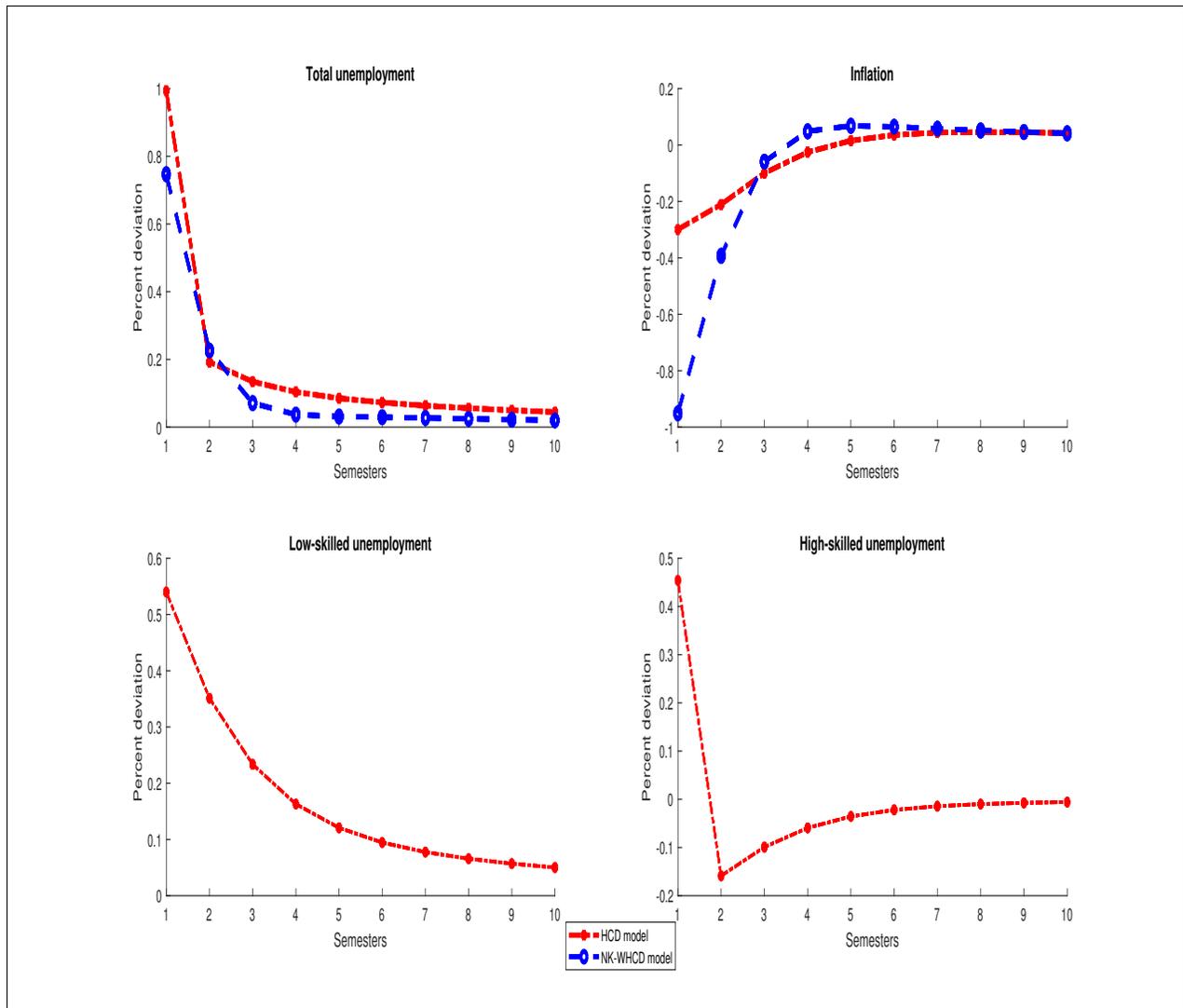


Figure 6: Impulse Responses of the key variables to 1% negative of preference shock

The impulse responses associated with the monetary shock also illustrate the same scope of the HCD for disinflation. With this shock, an increase in the unemployment rate of 1.55% leads to a disinflation of 0.75% in the HCD model while in the NK-WHCD model an unemployment rate increase of 1.10% results in a disinflation of 1.80% (Figure 7). Disinflation is 3 times less in the HCD model than in the NK-WHCD model. Like the preference shock, the results associated with this shock point to a decline in the sensitivity of inflation to changes in unemployment when depreciation mechanisms are implemented. Moderate disinflation is likely to corroborate the results of [Matheson et al. \(2013\)](#) and [Coibion and Gorodnichenko \(2015\)](#) on the collapse of the Phillips curve.

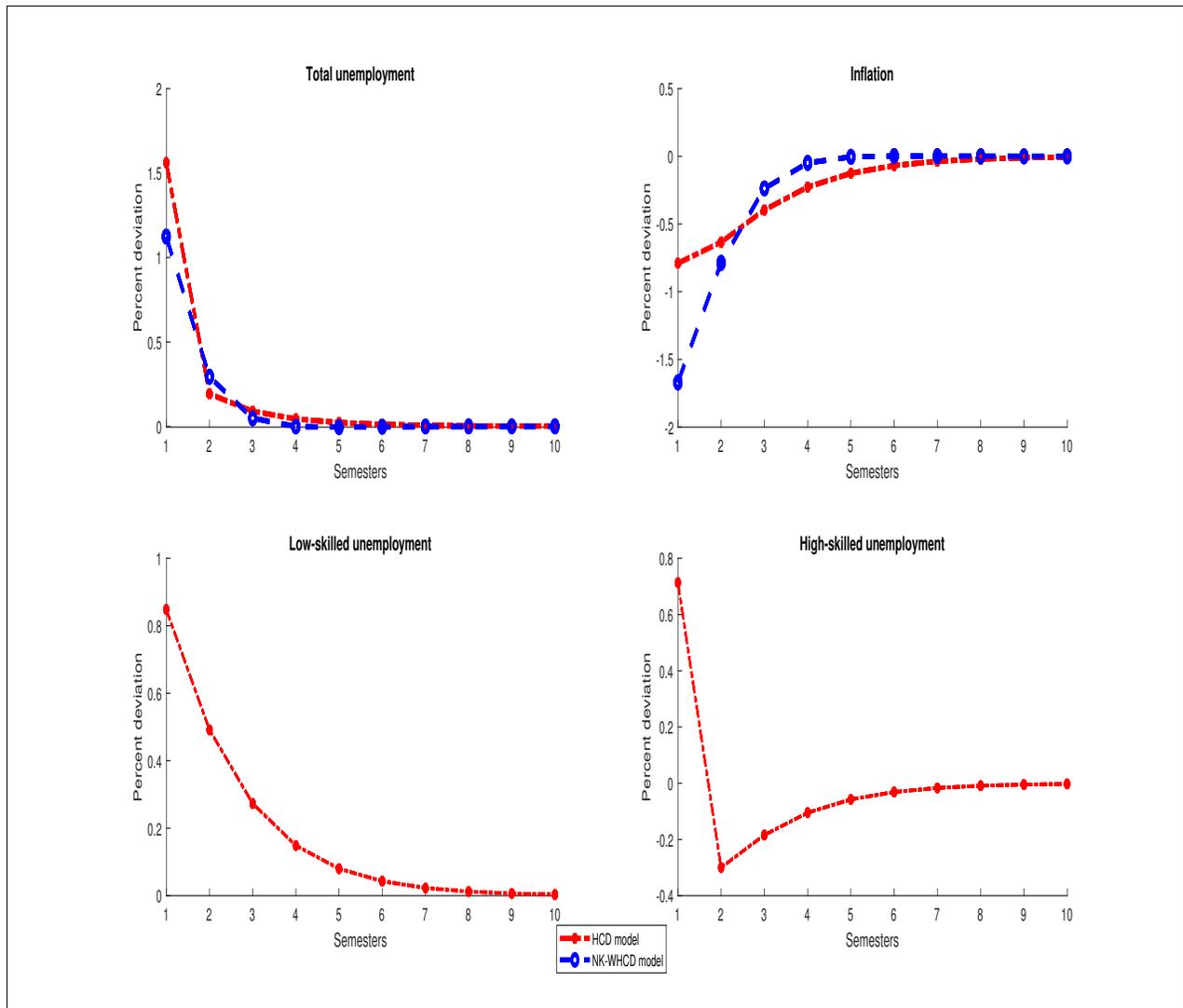


Figure 7: Impulse Responses of the key variables to 1% positive monetary shock.

From the results of these two shocks, it follows that while an increase in unemployment does result in a disinflationary episode, the increase in unemployment associated with shocks that are accompanied by a depreciation of human capital is relatively moderate. This moderation is explained by the fact that human capital depreciation tends to weaken both competition among potential workers and the competitiveness of some of them in the labour market. As competition and competitiveness weaken, unemployment loses some of its influence on the wages of employed workers and, in turn, on the prices of the goods produced. To further support the wage moderation mechanism, a subsection is devoted below to the scope of the HCD's work on wage inflation. In the meantime, it should be noted that the erosion of labour market competition in the HCD model is because rising unemployment creates two categories of unemployed with different job search skills and intensities. For a given unemployment rate, as shown in Figures 6 and 7, competition is more favourable for the

short-term unemployed because of their relatively high human capital. They experience relatively less unemployment than the long-term unemployed. For example, for an increase in the unemployment rate of 1%, the unemployment rate of the long-term unemployed increases by 0.55% and the short-term unemployed by 0.45% (Figure 6). Also, with their high level of human capital, the short-term unemployed prove to be more competitive than the long-term unemployed, as firms would be tempted to use the level of capital to discriminate between good and bad workers. Figure 6, for example, attests to this relative competitiveness.

Considering these results on moderate disinflation when unemployment is associated with HCD, the missing disinflation could be explained by the fact that in GR, some numbers of workers after losing their jobs experience some depreciation of their human capital. As a result of these depreciations, unemployment would have lost some of its influence on price dynamics through the wage channel. This channel is discussed in the subsection below.

5.2 Human Capital Depreciation and Wage Inflation

This subsection explains the wage inflation mechanism by which HCD tends to weaken the sensitivity of inflation to changes in unemployment. To this end, for the two shocks mentioned above, Figures 8 and 9 compare the impulse responses of wage inflation in the HCD and NK-HCD models. The impulse responses show that wage disinflation is associated with both shocks, however, the wage decline in the HCD model is found to be more weighted than in the NK-HCD model. In the HCD model, wage disinflation is 0.8% with the preference shock and 1.5% with the monetary shock, while it is 2.20% for the first shock and 3.5% for the second in the NK-WHCD model. These results highlight that an increase in unemployment associated with a depreciation of human capital is about 2.33 to 2.75 times more moderate than one without depreciation. Thus, unemployment by reducing competition among potential workers and the competitiveness of some of them (the long-term unemployed) due to depreciation tends to reduce their impact on employee wages. And this is likely to reduce the effect of such unemployment on the prices of goods produced by these workers. Thus, the missing disinflation would be partly a consequence of the human capital losses associated with the large increase in long-term unemployment during the GR. These losses may have reduced the job-search intensity and productivity of the long-term unemployed, and hence competitiveness and competition in the labour market.

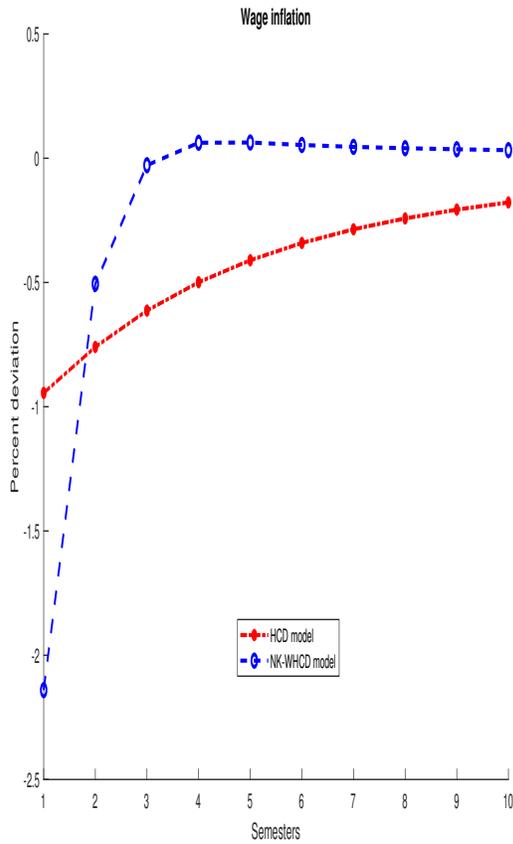


Figure 8: Impulse Responses of wage inflation to 1% negative of preference shock

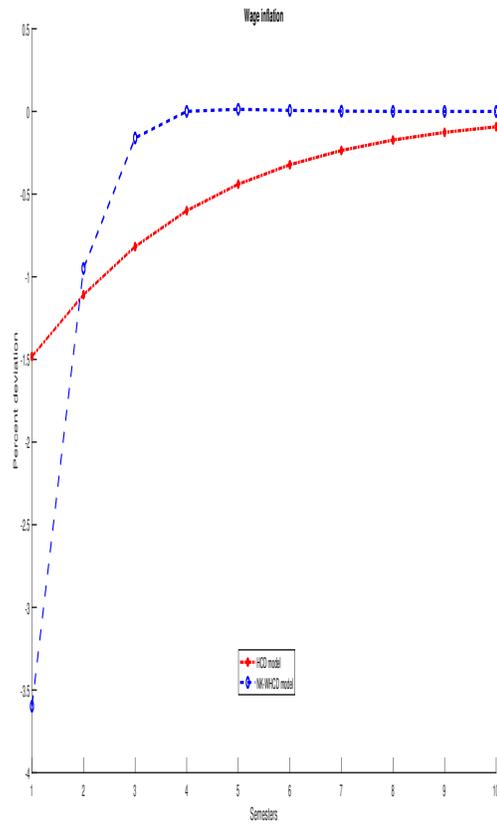


Figure 9: Impulse Responses of wage inflation to 1% positive monetary shock.

Furthermore, the results argue in favour of simultaneously taking into account in New Keynesian models the heterogeneity of HCD in matching and in productivity in order to account for missing disinflation. With these two heterogeneities, the HCD weakens the intensity of the job search and dissuades firms from hiring long-term unemployed. Thus, depreciation affects two key factors in the labour supply that are quite difficult to separate: prospecting and skills both through signals and productivity. However, it is appropriate to question the relative importance of each of the heterogeneities in the model developed. This article does not explicitly analyze the question, but considering that workers are remunerated up to the level of productivity, some estimate of the relative share of these mechanisms could be established. Based on this assumption, it can then be deduced that the heterogeneity in productivity would explain the missing disinflation to the tune of 69 % to 78 %. These proportions are obtained by relating, for the two shocks, the value of the attenuation of wage disinflation to the total attenuation resulting from the depreciation (i.e., 2.75 out of 4 for the preference shock and 2.33 out of 3 for the monetary shock). Despite the preponderance of heterogeneity in production, it should be noted that the mitigation of disinflation

is the result of the combination of the two mechanisms of heterogeneity. This combination is the one that underlies the transmission of the effects of HCD to labour supply factors. To illustrate it further, the following subsection highlights the sensitivity of the results to the depreciation rate by halving it.

5.3 Disinflation and Human Capital Depreciation Amplitude

To further capture the scope of the HCD, this subsection assesses the sensitivity of moderate disinflation to a change in the rate of depreciation of human capital. This sensitivity is evaluated by reducing the depreciation rate from 20% to 10%. Figures 10 and 11 show the impact of this change for the same shocks.

With the change in the depreciation rate, the attenuation of disinflation goes from 4 to 2.50 for the preference shock (Figure 10) and from 3 to 1.86 for the monetary shock (Figure 11).

These results show the extent to which the depreciation of human capital can induce a more or less important change in the relationship between unemployment and inflation. Unemployment episodes marked with very little change in long-term unemployment would be more disinflationary than episodes affected by a substantial increase in long-term unemployment. The rise in unemployment during the GR would be among the last, which is why disinflation appeared moderate compared to the trajectories followed by inflation well before the crisis of 2007-2008. This is a result of moderation at the cost of a small adjustment in wages. Therefore, the missing disinflation would be the result of singular unemployment, this is a singularity that requires New-Keynesian models to simultaneously take into account in their environment ingredients relating to heterogeneity in matching and in productivity.

6 Conclusion

Based on the significant rise in unemployment following the financial crisis of 2007-2008, this chapter examines the paradox of missing disinflation. This is because the behaviour of inflation has been found to be out of step with New-Keynesian predictions and the historical paths followed by inflation during past recessions. In relation to these predictions and trajectories, inflation has been shown to be less sensitive to changes in unemployment. The weakening of its sensitivity during GR then raises many questions in the literature.

In this regard, and inspired by the context of GR, particularly marked by the unprecedented rise

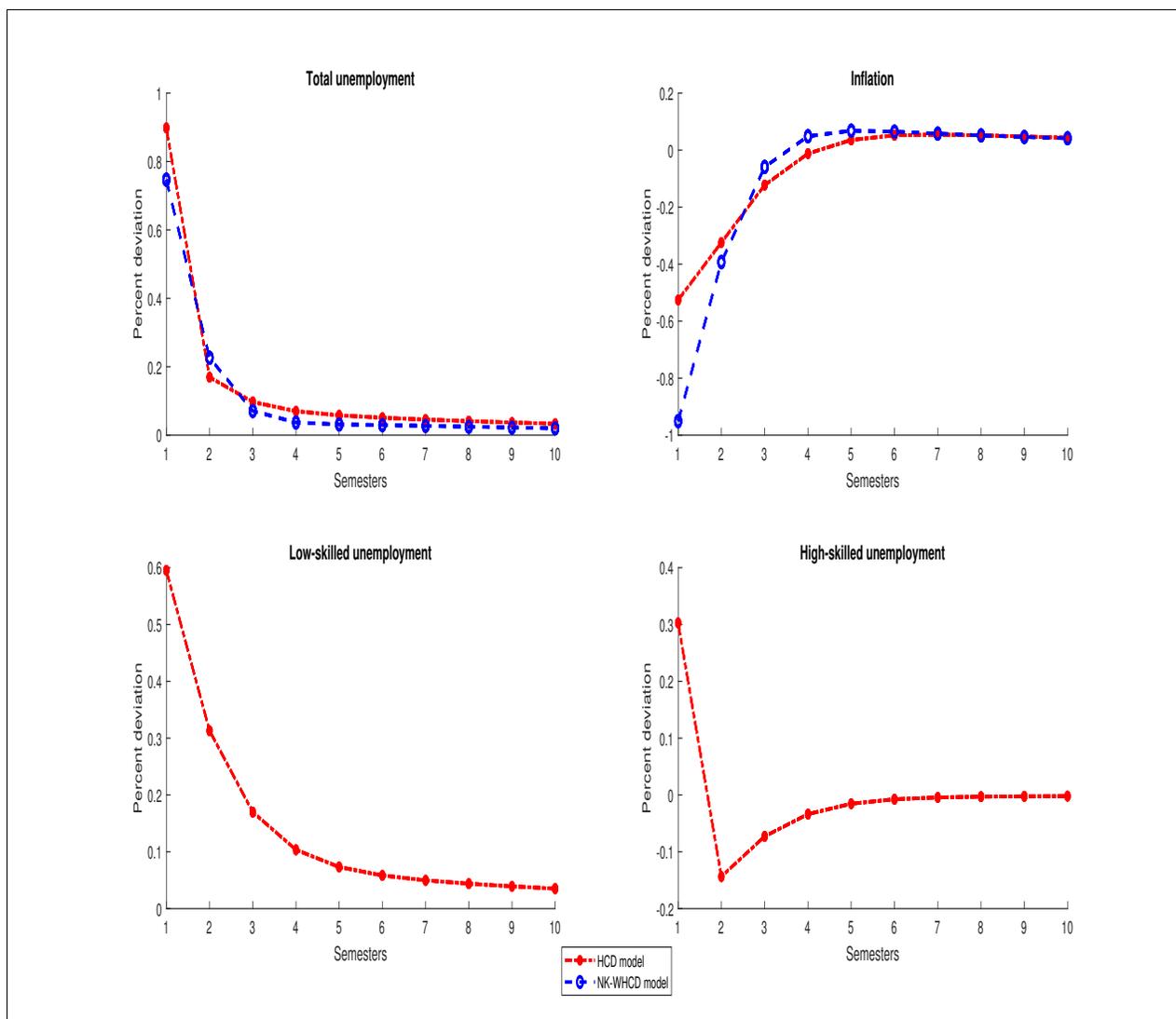


Figure 10: Impulse Responses of the key variables to 1% negative of preference shock

in long-term unemployment in the United States, wanted through this article endeavours to investigate the impact of the depreciation of human capital on the movements of inflation. The choice of depreciation stems from the idea that long-term unemployment results from a lack of consolidation or even loss of skills. In this perspective, the thesis is part of a theoretical approach by developing a variant of New-Keynesian models where human capital depreciation mechanisms are at work. These mechanisms were introduced into a New-Keynesian model with pairing frictions by integrating into the latter the heterogeneity of human capital in the pairing and in productivity. In particular, the heterogeneity has resulted in the presence of workers and the short and long term unemployed. The temporal dissimilarity is expressed in the model as a difference in the distribution of human capital, the latter being high for the short-term unemployed and low for the long-term.

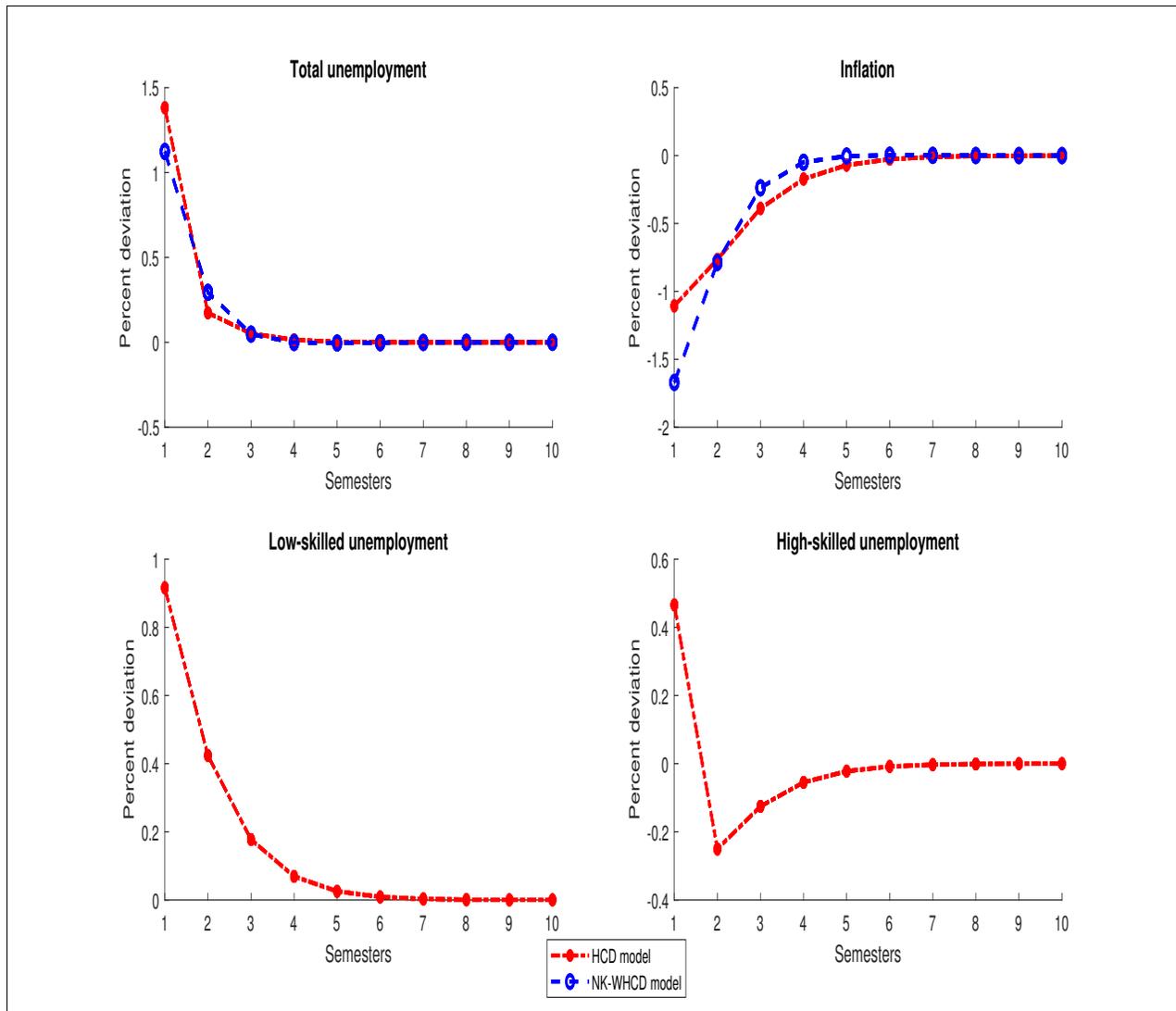


Figure 11: Impulse Responses of the key variables to 1% positive monetary shock.

By calibrating the model on the US economy, the results of the simulations with two adverse demand shocks of the same size show that the depreciation of human capital contributes to moderating the disinflation following such shocks. Compared to a model without a depreciation mechanism, the model developed is 3 to 4 times less disinflationary. Mitigation comes through the decrease in job search intensity and competitiveness among potential workers for both short and long term workers. The fall in the two labour supply factors—exploration intensity and productivity—is more pronounced for the long-term unemployed than for the short-term. In doing so, a relatively large proportion of the long-term unemployed tend to lose some of their influence on the wages of employees and in turn, the prices of the goods produced by them. To this end, the simulation results show that wage disinflation with depreciation mechanisms is relatively moderate compared to wage disinflation of a model without such mechanisms. The depreciation of human capital through these

two factors then causes unemployment to lose part of its influence on the prices of goods. The missing disinflation would then reflect an episode of unemployment marked by a relatively significant depreciation of human capital induced by the rise in long-term unemployment.

These results, therefore, have significant implications for the structure of New-Keynesian models. To bridge the gap in their predictions with respect to the low sensitivity of inflation, these models would benefit from integrating into their environment the ingredients of the depreciation of human capital. The extension could consist of considering both the heterogeneity of the distribution of human capital in matching and in productivity. The heterogeneity with two distributions of human capital is already offering interesting results. However, continuous distributions could be considered, and in view of the sensitivity of the results to the depreciation rate, this perspective would merit a more explicit investigation.

In addition to the predictions, the extension would be likely to enhance the effectiveness of economic policies derived from New-Keynesian theoretical frameworks, as a number of recommendations follow from the results of this analysis. First, the depreciation of human capital should be understood as an imperfection that challenges labour market flexibility. It impedes by negatively affecting two key factors in labour supply—job-search intensity and productivity. In doing so, a certain proportion of potential workers find themselves marginally attached to the labour market and the production sector. Given that the analysis points out that wages adjust very little despite these imperfections, policymakers are encouraged to take measures to curb the rise in long-term unemployment. Firms could be encouraged to retain a large proportion of their employees in return for wage subsidies, tax exemptions, or preferential access to credit. Second, the low sensitivity of inflation calls for a refocusing of monetary policies on unemployment dynamics. Monetary easing that is very substantial and not harmful to inflation could be initiated by central banks to support the production sector. Unconventional monetary policies could provide the stimulus needed for recovery.

Beyond GR and financial recessions, the results and policy recommendations from this article could be instructive for managing the health crisis of the Covid-19 pandemic. Containment measures are certainly necessary, but those accompanied by a partial or temporary shutdown of production activity should be extremely limited in time in order to contain the rise in long-term unemployment. To this end, the risk of depreciation of human capital must be a parameter to be taken into account in the management of the health crisis, especially since the success of the stimulus measures will depend on the flexibility of the labour market.

References

- Acharya, S., Bengui, J., Dogra, K., and Wee, S. L. (2019). Slow recoveries and unemployment traps: Monetary policy in a time of hysteresis.
- Arulampalam, W., Gregg, P., and Gregory, M. (2001). Introduction: unemployment scarring. *The Economic Journal*, 111(475):F577–F584.
- Ayllón, S. (2013). Unemployment persistence: not only stigma but discouragement too. *Applied Economics Letters*, 20(1):67–71.
- Ball, L. and Mazumder, S. (2019). A Phillips curve with anchored expectations and short-term unemployment. *Journal of Money, Credit and Banking*, 51(1):111–137.
- Ball, L. M. and Mazumder, S. (2011). Inflation dynamics and the Great Recession. Technical report, National Bureau of Economic Research.
- Blanchard, O., Cerutti, E., and Summers, L. (2015). Inflation and activity—two explorations and their monetary policy implications. Technical report, National Bureau of Economic Research.
- Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3):383–398.
- Chen, B.-L., Chen, H.-J., and Wang, P. (2011). Labor-market frictions, human capital accumulation, and long-run growth: positive analysis and policy evaluation. *International Economic Review*, 52(1):131–160.
- Christiano, L. J., Eichenbaum, M. S., and Trabandt, M. (2015). Understanding the Great Recession. *American Economic Journal: Macroeconomics*, 7(1):110–167.
- Cockx, B. and Picchio, M. (2013). Scarring effects of remaining unemployed for long-term unemployed school-leavers. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 176(4):951–980.
- Coibion, O. and Gorodnichenko, Y. (2015). Is the Phillips curve alive and well after all? Inflation expectations and the missing disinflation. *American Economic Journal: Macroeconomics*, 7(1):197–232.
- DeLoach, S. B. and Kurt, M. (2013). Discouraging workers: estimating the impacts of macroeconomic shocks on the search intensity of the unemployed. *Journal of Labor Research*, 34(4):433–454.
- Diamond, P. A. (1982). Wage determination and efficiency in search equilibrium. *The Review of Economic Studies*, 49(2):217–227.
- Esteban-Pretel, J. (2005). The effects of the loss of skills on unemployment fluctuations. Technical report, CIRJE, Faculty of Economics, University of Tokyo.
- Esteban-Pretel, J. and Faraglia, E. (2010). Monetary shocks in a model with skill loss. *Journal of Money, Credit and Banking*, 42(7):1235–1265.

- Galí, J. (2015). Hysteresis and the European unemployment problem revisited. Technical report, National Bureau of Economic Research.
- Gertler, M. and Karadi, P. (2011). A model of unconventional monetary policy. *Journal of Monetary Economics*, 58(1):17–34.
- Gordon, R. J. (2013). The Phillips curve is alive and well: inflation and the NAIRU during the slow recovery. Technical report, National Bureau of Economic Research.
- Jackman, R. and Layard, R. (1991). Does long-term unemployment reduce a person's chance of a job? A time series test. *Economica*, 58(229):93–106.
- Kehoe, P. J., Midrigan, V., and Pastorino, E. (2019). Debt constraints and employment. *Journal of Political Economy*, 127(4):1926–1991.
- Laureys, L. (2014). Optimal monetary policy in the presence of human capital depreciation during unemployment. Technical report, London School of Economics and Political Science, LSE Library.
- Lee, G. H. and Parasnis, J. (2014). Discouraged workers in developed countries and added workers in developing countries? Unemployment rate and labour force participation. *Economic Modelling*, 41:90–98.
- Matheson, T., Sandri, D., and Simon, J. (2013). The dog that didn't bark: has inflation been muzzled or was it just sleeping. *IMF World Economic Outlook*, pages 1–17.
- Mortensen, D. T. and Pissarides, C. A. (1994). Job creation and job destruction in the theory of unemployment. *The Review of Economic Studies*, 61(3):397–415.
- Pissarides, C. A. (1992). Loss of skill during unemployment and the persistence of employment shocks. *The Quarterly Journal of Economics*, 107(4):1371–1391.
- Rogoff, K. (2003). Globalization and global disinflation. *Economic Review (Kansas City)*, 88(4):45–80.
- Shimer, R. (2005). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review*, 95(1):25–49.
- Shimer, R. (2008). The probability of finding a job. *American Economic Review*, 98(2):268–73.
- Stock, J. (2011). Discussion of Ball and Mazumder, "inflation dynamics and the Great Recession." *Brookings Papers on Economic Activity*.
- Tumino, A. (2015). The scarring effect of unemployment from the early '90s to the Great Recession. Technical report, ISER Working Paper Series.
- Van Zandweghe, W. (2012). Interpreting the recent decline in labor force participation. *Economic Review-Federal Reserve Bank of Kansas City*, page 5.