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Demographic change and unemployment: what do macroeconometric models predict?

Abstract

Declining natality and mortality are reshaping demographic patterns in most industrialized countries. We investigate the case of France where, after a few decades of sustained growth, active population is likely to stop growing and could eventually start decreasing. This will coincide with a boom for the retired population. The purpose of this paper is to examine the consequences of both phenomena for the labour market. We tackle the issue using two approaches: WS-PS models and Phillips curve models. Effects may be short or long-run; they may stem directly from changes in labour supply or from changes in contributions required to finance pensions. In this study, we bring them altogether using the macroeconometric model Mésange. We find that favorable effects can be expected in the short run. However, they are likely to be of a relatively small importance and transitory. In the medium and long run, the WS-PS framework suggests that increases in taxes induced by ageing could lead to more unemployment. This long run effect vanishes under the Phillips specification. On the whole, the final effect upon unemployment depends on agents' bargaining preferences during wage negotiations: the further from labor cost they negotiate (thus the closer to net income), the higher the risk that demographic change ultimately leads to more unemployment.

Keywords: ageing, labor market, macroeconomic models

Évolutions démographiques et chômage : que prédisent les modèles macroéconométriques ?

Résumé

Le recul de la natalité et celui de la mortalité modifient la structure démographique de la majeure partie des pays industrialisés. Nous nous intéressons particulièrement au cas français, où, après plusieurs décennies de croissance assez soutenue, la population active devrait voir sa progression ralentir voire s'inverser. Ce retournement s'accompagnera d'une croissance rapide de la population en âge d'être retraitée. L'objectif de ce texte est d'examiner les conséquences de ces deux phénomènes pour le marché du travail. On compare deux modélisations de ce marché du travail : l'approche WS-PS et l'approche de la courbe de Phillips. On sépare les effets temporaires et permanents, les effets qui résultent du seul freinage de l'offre de travail et ceux qui résultent de la hausse des prélèvements requis pour faire face au vieillissement. Le recours au modèle macroéconométrique Mésange permet de prendre en compte l'ensemble des effets de bouclage et d'en préciser le calendrier. Des effets positifs sont attendus à court terme, mais ils seront de faible amplitude et transitoires. L'approche WS-PS fait apparaître des effets négatifs durables : la hausse des prélèvements provoquée par le vieillissement augmente le chômage à long terme. Cet effet de long terme disparaît si l'on revient à la spécification de type Phillips. Globalement, les effets à long terme dépendent du contenu de la négociation salariale. Plus l'objectif des salariés est éloigné du coût global du travail (et plus il est proche du salaire net), plus on risque d'avoir un effet défavorable du retournement démographique sur le chômage.

Mots-clés : vieillissement, marché du travail, modèles macroéconomiques

Classification JEL : E17, E24, J21

Contents

1 Introduction

France, like the vast majority of industrialized countries, will experience important changes in both total and active population structures within the next fifty years, as predicted by demographers for a long time: baby-boom workers - the most critical cohort in the population - approaching retirement, life expectancy getting higher, natality stagnating or declining. These trends will lead to a strong slowdown and eventually a downtrend for the active population, combined with a rapid rise of the pensioner/worker ratio[1].

While demographers wonder how future unemployment will affect activity, economists tend to invert the question: how labor market will equilibrate under the new demographic situation. One optimistic view is that, as older workers leave, vacancies become available for younger or unemployed workers, giving Europe a chance to get rid of its persistent mass unemployment. On the other hand, pessimistic opinions flourish around the idea that older workers simply join the mass of retirees, jeopardizing the equilibrium of the current pension scheme. To finance these new expenses, government will have to raise taxes, weighing on labor costs.

No single theory is capable of explaining the persistence and the importance of current European unemployment; rather, each approach contributes to the theoretical bulk and becomes part of the toolkit any macroeconomist can summon to tackle an issue. Blanchet (2001), Aglietta, Blanchet and Héran (2002), or Cadiou, Genet and Guérin (2002) invoke the different theories and shed some light on pivotal effects of demography on unemployment. However, identified effects are sometimes contradictory and their relative strengths are difficult to assess. In a nutshell, a short-run mechanical favorable effect emerges, whose importance differs according to the assumptions adopted. In the long run, if one admits that labor taxes weigh on unemployment and that higher expenses have to be matched by higher taxes, the next half-of-century demographic changes are doomed to boost unemployment.

We found few attempts to detail and quantify these effects in the literature. The matching model developed for this purpose in Domingues dos Santos (2001) is remarkable and gives interesting insights about the long-term situation: it details the mechanisms and also takes into account increasing pension expenses. However, the exclusive focus on the equilibrium does not provide significant leverage regarding transitional effects. On the other hand, the small model developed in Blanchet (2001) and based on a Phillips curve captures some transitional effects, but is not applicable to describe the long run.

This work investigates different formal descriptions of the labor market (mainly WS-PS and Phillips), describes their conceptual assumptions and identifies their predictions concerning the impact of demographic change on unemployment. We build calibrated models to evaluate the relative strengths of the various effects. A demographic shock is introduced in our calibrated models in a stylized form. We decompose it into two shocks:

1. The first is referred to as the "pure" demographic shock as it only involves demographic variables. To keep things simple, we consider a drop in the population growth (in these simple models, active and total population are not distinguished).

2. The second is a complementary shock on taxes, following from fiscal considerations. In these simple models, fiscal matters will be the only side affected by the change in

[1]See official projections (Nauze-Fichet, Lerais, and Lhermitte, 2003).

population structure.

Our calibrated models suggest that a "pure" demographic shock would have little impact on the equilibrium unemployment rate, lowering it under most favorable assumptions by 0.5 to 1.0 point, for each 1 point drop in population growth. In the long run, fiscal constraints effects could be stronger than pure demographic ones.

These calibrated models are essentially supply-side models and, even when a demand is specified, it is not particularly affected by demographic shocks. The impact of demography on demand is a discussed matter[2]. We use the macroeconometric model Mésange to sum up the identified effects, to take feedback effects and demand side into account. Moreover, the model's public finances block is interestingly realistic and constraints on the deficit may be specified. Labor market may be modelled either according to a WS-PS or to a Phillips framework. The results obtained with the former are similar to those identified with the small calibrated model: less unemployment in the short run and more in the long run. Within the Phillips framework, long-term unemployment is not affected by labor taxation.

The remainder of the paper is organized as follows. In the second section, we justify and build a small WS-PS model. The third section shows that introducing nominal rigidities leads to a form close to a Phillips specification, and then derives a Phillips curve model. In the fourth section, we use the macroeconometric model Mésange. The fifth section concludes.

[2] Blanchet (2002) and Cadiou, Genet and Guérin (2002) show how difficult it may be to conclude on the impact on domestic demand or savings dynamics.

2 The WS-PS framework: permanent but weak effects

We briefly recall some fundamental properties of the WS-PS approach[3]

2.1 Theoretical foundations

2.1.1 The wage-price loop describes both production and wage bargaining

The wage-price loop is a combination of a price setting (PS) and a wage setting equations (WS). The PS curve takes production constraints into account. In a small open economy with constant returns to scale, the real wage is fixed by this equation. Log-linearizing PS can be written[4]

$$p_t = \alpha(w_t - e_t) + (1 - \alpha)r_t \tag{1}$$

where p_t is the log of value added prices and w_t the log of nominal labor cost, e_t the log of labor efficiency, α the share of wages in value added and r_t the capital cost, that we assume exogenously fixed by the rest of the world.

The WS curve results from wage bargaining between workers and firms (or their representatives). This negotiation describes how the surplus coming from the match between an employer and an employee will be shared. This surplus depends on production conditions (like wage and productivity), future perspectives of the match and the players' status-quo situations (i.e. how much they get if they do not agree to match). For workers, status-quo depends on unemployment allowances and future possibilities to get a job. In the traditional WS-PS framework that we develop, workers are assumed to negotiate on the net wage.

2.1.2 Workers' expected utility

$\mathcal{W}_t$ denotes the intertemporal expected utility of a worker and $\mathcal{U}_t$ that of an unemployed worker at date t. We note a_t the worker's probability to find a job, W_t the labor cost, PC_t the consumption price, Cfs_t the fiscal wedge (defined as the ratio of labor cost to worker's purchasing power), Z_t the substitution income for an unemployed worker, $1 - q$ the probability for a worker to remain in the firm for the next period, and β the discount rate. The following intertemporal relation then stands:

$$\mathcal{W}_t - \mathcal{U}_t = \frac{W_t}{Cfs_t PC_t} - \frac{Z_t}{PC_t} + \beta(1 - q)(1 - a_{t+1})(\mathcal{W}_{t+1} - \mathcal{U}_{t+1}) \tag{2}$$

At a given date, intertemporal utility surplus of the worker due to the match comes from two factors. First, the worker gets the immediate surplus $\frac{W_t}{Cfs_t PC_t} - \frac{Z_t}{PC_t}$. Second, for the following period, two cases may arise. The worker may be kept by the firm with a probability $1 - q$. In this case, he will only get at this period the intertemporal surplus $(\mathcal{W}_{t+1} - \mathcal{U}_{t+1})$ if the unemployed does not get any job at $t+1$ (which occurs with probability $1 - a_{t+1}$). The match may however be split, with probability q. Then, there is no surplus at $t + 1$, as the former worker and the unemployed workers are in the same situation, looking for jobs[5].

[3] Analyses driven in this section owe to Cahuc and Zylberberg (1999). A provides computational details.
[4] In the remaining of the text, small cap x stands for the logarithm of a variable X.
[5] See A for details.

2.1.3 Wage bargaining process

WS is mainly about describing the wage bargaining process between employer and employee. γ denotes workers' bargaining power, whereas firms' bargaining power is normalized to one. Denoting Π_t the firm's profit and L_t the firm employment, it can be shown that bargaining leads to the following equation:

$$\mathcal{W}_t - \mathcal{U}_t = \frac{\gamma}{(1-a_t)} \frac{\Pi_t}{L_t Cfs_t PC_t}$$

The relation means that each employee gains (from a status-quo situation, which is unemployment[6]) a surplus proportional to the real profit per worker. The stronger the worker's bargaining power, the higher the proportion dedicated to him. With a power equal to zero, for example, the firm will grab the whole surplus. The proportion also depends on the probability a_t of finding a job for a job-seeker, as good labor opportunities allow unemployed workers to be more confident, when they turn down a bad offer, to find better ones later.

In the case of a Cobb-Douglas production function, we know that the ratio between wages and profit is a constant $\alpha = \frac{W_t L_t}{\Pi_t}$. This leads to the relation:

$$\mathcal{W}_t - \mathcal{U}_t = \frac{\gamma}{\alpha(1-a_t)} \frac{W_t}{Cfs_t PC_t}$$

Substituting this previous relation in the one expliciting intertemporal utilities dynamics, we obtain the WS curve:

$$\frac{W_{t+1}}{W_t} \frac{Cfs_t}{Cfs_{t+1}} \frac{PC_t}{PC_{t+1}} = \frac{1}{\beta(1-q)} \left[\frac{1}{1-a_t} - \frac{\alpha}{\gamma}(1 - \frac{Z_t Cfs_t}{W_t}) \right] \tag{3}$$

This equation is a one-to-one relation between the exit rate from unemployment and wage. Workers' future perspective depends more on the probability of remaining unemployed than on the unemployment rate itself. Expliciting inflows and outflows from unemployment allows one to bind exit and entry rates with past and present unemployment and demographic trends. Entry and exit rates into and from the active population are denoted n^e and n^x. A new wage curve is (see A for computational details):

$$\frac{W_{t+1}}{W_t} \frac{Cfs_t}{Cfs_{t+1}} \frac{PC_t}{PC_{t+1}} = \frac{1}{\beta(1-q)} \left[\frac{(1-n_t^x)(1-q)u_{t-1} + n_t^e + q(1-n_t^x)}{(1+n_t^e - n_t^x)u_t} - \frac{\alpha}{\gamma}(1 - \frac{Z_t Cfs_t}{W_t}) \right] \tag{4}$$

2.1.4 A steady-state equilibrium

Here we derive a steady-state version of the last equation. Let us assume that the adjustment between consumption prices and value-added prices is immediate. Then PS fixes the real wage growth at the efficiency growth rate g. Assuming that flows in the labor market are stationary (so that past and present unemployment rates equal) and considering that the fiscal wedge is kept constant, the wage curve is reduced to a decreasing relation between wage and unemployment[7].

$$\beta(1-q)(1+g) = \frac{(1-n^x)(1-q)u + n^e + q(1-n^x)}{(1+n^e-n^x)u} - \frac{\alpha}{\gamma}\left(1 - \frac{ZCfs}{W}\right) \tag{5}$$

[6] To be precise, workers status-quo is to be back in the job-seekers pool. Thus, we admit that, if the negotiations were to fail, workers would have the opportunity to look for another job in the same period. See details in A

[7] It is sometimes found as such in the literature, see Beffy and L'Angevin (2005), L'Horty and Sobczak (1996).

A log-linearized version is:

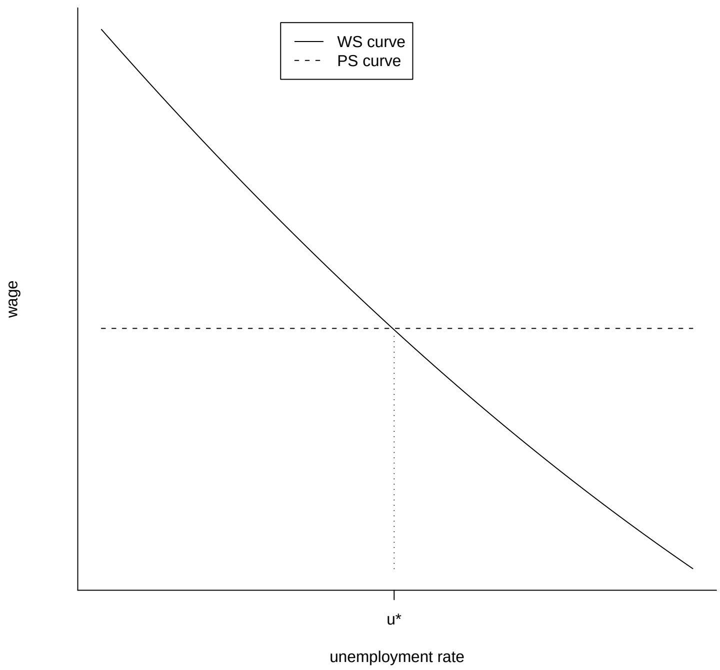
$$w = cfs + z - \beta_u(n^e, n^x)u + C(n^e, n^x) \tag{6}$$

where $\beta_u(n^e, n^x)$ and $C(n^e, n^x)$ are functions of exogenous parameters such as the workforce entry and exit rates n^e and n^x. The fiscal wedge is brought into the equation due to the assumption that workers negotiate on the net wage. This means that households perceive taxes as net income loss (i.e. no Ricardian equivalence).

Figure 1 presents the equilibrium between the PS equation (1) and the log-linearized form of WS (6) in a (unemployment,wage) plan. This figure displays an equilibrium unemployment rate u^*, such that:

$$u^* = \frac{1}{\beta_u(n^e, n^x)}\left[\frac{1-\alpha}{\alpha}(r-p) + cfs + (z-p-e) + C(n^e, n^x)\right]$$

Figure 1: Equilibrium on the labor market, WS and PS equations, equilibrium unemployment rate



2.2 Impact of demography on the steady-state WS-PS equilibrium

We hereafter analyze the movement of the steady-state equilibrium when the population growth rate is shocked down. Active population may decrease either from a decrease in its entry rate n^e or from an increase in its exit rate n^x, which are likely to have different effects on unemployment. We draw on the static system formed by eqs. (1) and (6).

Figure 2: Long-term consequences of a slowdown in the active population entry rate

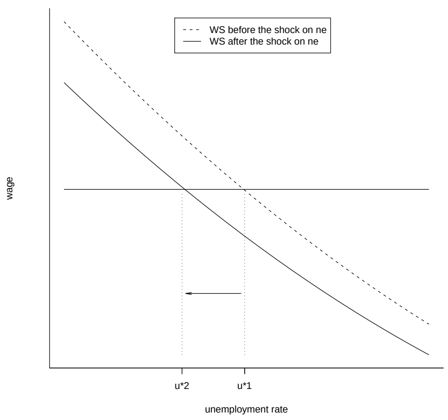
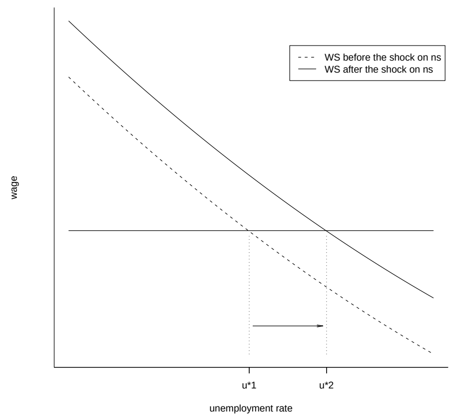


Figure 3: Long-term consequences of an increase in the active population exit rate



2.2.1 A lower entry rate induces a drop in the equilibrium unemployment rate

In a (unemployment, wage) plan, figure 2 shows the moves of WS and PS curves after a drop in the active population entry rate n^e, n^x being constant. On the supply side of the economy, PS is not affected by demography. For a given level of wage (and conditionally on the level of taxes and allowances), the WS curve fixes a, the exit rate from unemployment, and effects go through the flow equation (14) – in A. Mechanically, when the active population entry rate decreases, inflows of new jobseekers are less numerous and unemployment drops. The WS curve moves to the left and the new equilibrium unemployment rate is lower.

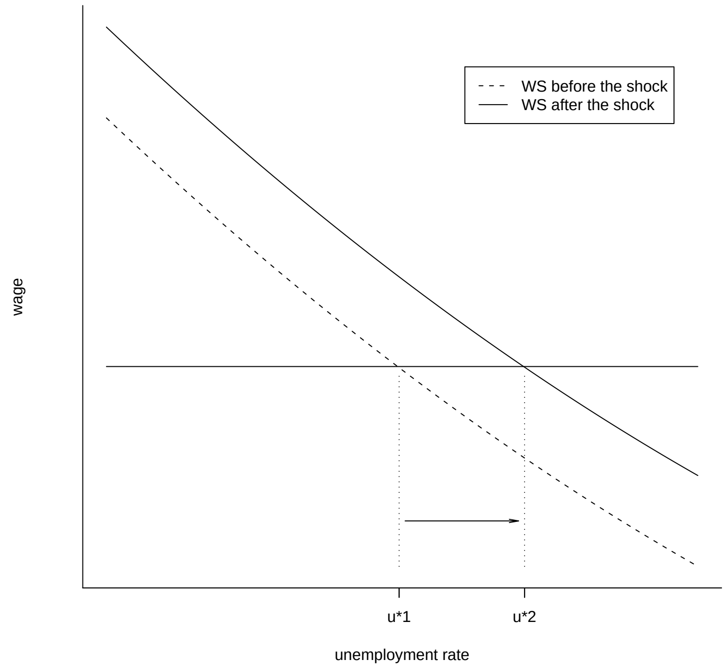
2.2.2 A higher exit rate increases the equilibrium unemployment rate

In a (unemployment, wage) plan, figure 3 shows the moves of the WS and PS curves after an increase in the active population exit rate n^x, n^e being constant. Once again, PS remains unaffected, and for a given level of wage, the WS curve fixes a, the exit rate from unemployment, and the effect goes through the flow equation (14) – in A. The effect is difficult to capture and results from the fact that a higher n^x with a fixed n^e corresponds to complex changes for the internal structure of the labor force. A formal proof is given by eq. (17) in A, the partial derivative of the unemployment w.r.t. n^x. The WS curve moves to the right and the new equilibrium unemployment rate is higher.

2.2.3 Public finances constraints due to population ageing could weigh on equilibrium unemployment

In the WS-PS approach, equilibrium unemployment depends on the fiscal wedge. An increase in the fiscal wedge moves the WS curve up in the (unemployment, wage) plan. Should the PS curve remain unchanged, this induces a higher equilibrium unemployment rate, as figure 4 shows.

Figure 4: Long-term consequences of a fiscal wedge shock: the WS curve moves up



2.3 Quantification of the long-term effects in a WS-PS framework

Analytically, the combined effects of the two possible demographic shocks and a fiscal wedge shock on the unemployment rate are ambiguous. In order to quantify them, we calibrate a model with a public finances constraint. We assume a constant fiscal wedge and a constant ratio B of unemployment allowances on real wages (such that $Z_t = BW_t$). The steady-state equilibrium is defined as:

$$\beta(1-q)(1+g) = \frac{(1-n^x)(1-q)u + n^e + q(1-n^x)}{(1+n^e-n^x)u} - \frac{\alpha}{\gamma}(1-BCfs)$$

The equilibrium unemployment can be derived as:

$$u^* = \frac{q(1-n^x)+n^e}{(1+n^e-n^x)[\beta(1-q)(1+g)+\frac{\alpha}{\gamma}(1-BCfs)]-(1-n^x)(1-q)}$$

We calibrate this last expression with values given in table 1. Key values of the model are taken from classical textbooks, while γ, which is usually considered as difficult to measure, is chosen to adjust the equilibrium unemployment rate close to its current value. The shocks in the calibrated model are *caeteris paribus*.

2.3.1 Pure demographic shocks

In the eighties and nineties, average active population growth has been close to a yearly 0.5%. INSEE projections suggest that French active population growth rate will be stable between yearly -0.25% and -0.3% after 2030. Active population entry and exit rates, on

Table 1: Calibrated parameters for the WS-PS model

Description	Parameter	Value	Source
Job destruction rate	q	0.15	Cahuc-Zylberberg (2004)
Discount rate	β	0.95	Cahuc-Zylberberg (2004)
Equilibrium total wages on value-added ratio	α	0.66	Barro and Sala-I-Martin (1995)
Workers' bargaining power	γ	0.1	adjusted
Unemployment replacement ratio	B	0.35	Cahuc-Zylberberg (2004)
Labor efficiency growth rate	g	2%	Barro and Sala-I-Martin (1995)
Baseline fiscal wedge[8]	Cfs	1.8	Mésange
Baseline act. pop. entry rate	n^e	5%	see infra
Baseline act. pop. exit rate	n^x	5%	see infra

the other hand, are not available directly in any official sources, neither past figures nor projections. Combining surveys and official figures of active population[9], we estimate these rates to be around 5% in 2005. We find that even high shocks on demographic trends have very little incidence on the unemployment rate. However, table 2 reports that an active population shock passing through entry rates has a much more notable (favorable) impact on unemployment than a shock passing through exit rates.

Table 2: Impact of demographic shocks on the steady-state unemployment rate

	n^e		
n^x	4.5%	5%	5.5%
4.5%	7.67	7.82	7.97
5%	7.68	7.83	7.98
5.5%	7.69	7.84	7.99

For example, if $n_s = 5\%$ and n_e shifts from 5.5% to 4.5%, unemployment decreases by 0.3 point. However, if $n_e = 5\%$ and n_s increases from 4.5% to 5.5%, active population is affected in the same way, while unemployment increases this time by only 0.02 point.

The demographic transformation that most European countries will face in the next fifty years involve both entry and exit rates. In the French case, natality and migrations are expected to remain stable whereas active population changes will in large part be caused by the retirement of the numerous baby-boomers. Thus, we expect n^e to remain stable and n^x to surge. This has positive but negligible effects on unemployment, our calibrated model shows.

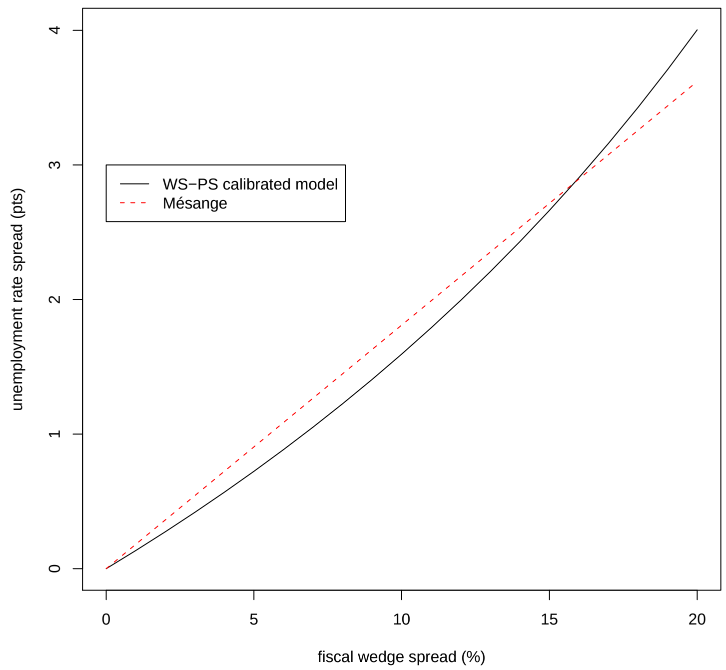
2.3.2 An increase of the fiscal wedge

Eq. (4) shows that the relation between the unemployment rate and the fiscal wedge depends on the value of the wedge itself. The elasticity of the unemployment rate to the

[9]We use "Enquête Emploi" panel data to measure transitions between activity and inactivity. Then, we divide transition counts by active population figures.

fiscal wedge is displayed in figure 5, keeping the same calibration (and considering a zero population growth). On the x-axis is the percentage gap between the fiscal wedge and the reference fiscal wedge (i.e. for a reference of 1.8, the 10% value refers to a 1.98 fiscal wedge). On the y-axis, we plot the impact of the wedge modification on the unemployment rate. We compare our calibrated model with the Mésange model.

Figure 5: Elasticity of unemployment to the fiscal wedge



The impact of fiscal wedge increases on the equilibrium unemployment rate is far from negligible. When the fiscal wedge increases by 15%[10], the unemployment rate rises by 2.6 points.

To sum up, modelling the price-wage loop according to a WS-PS model suggests that:

1. Slower population growth has ambiguous but small effects on unemployment.
2. The incidence of ageing on public finances induces a rise in the fiscal wedge which weighs on unemployment. This second effect dominates.

3 The Phillips framework: transitional effects

3.1 A small model with a Phillips curve

A Phillips curve can be derived from a WS wage curve and a bargaining framework. However, Phillips curves are just reduced forms, and the coefficients of the equations usually

[10]An increase of this range is observed in Mésange simulations, presented later.

do not take the population growth rate or the fiscal wedge into account. Thus, the long-term unemployment rate will not be affected by demography. In this simple model, we are more interested in the short-term dynamics, which will be induced by introducing the demand-side of the economy. We calibrate our model in order to draw some qualitative and quantitative insight.

3.1.1 Model description

We consider a three-block model[11] that we present here briefly.

1. Maximizing producers' profit leads to the PS curve. We assume monopolistic competition[12] with a linear production function in labor force $y_t = e_t l_t$. A constant mark-up μ can be derived and we obtain the following equation:
$$p_t = \mu + w_t - e_t.$$
2. The wage curve is a Phillips curve. Wages w_t depend on the unemployment rate u_t, present inflation Δp_t, past inflation and the rate of technical progress Δe_t:
$$\Delta w_t = \lambda_0 + \lambda_1 \Delta p_t + (1 - \lambda_1)\Delta p_{t-1} - \lambda_2 u_t + \lambda_3 \Delta e_t$$
3. The aggregate demand depends on m, the log money supply and on p, the log price of the unique good of the economy:
$$y_t = m_t - p_t.$$

This model can be regarded as a system of two variables: unemployment rate[13] and inflation. In the long run, there exists an unemployment rate consistent with a constant inflation rate:
$$\bar{u} = \frac{\lambda_0}{\lambda_2} - \frac{1 - \lambda_3}{\lambda_2}\Delta e$$
The steady-state level of inflation is given by:
$$\bar{\Pi} = \Delta m - \Delta n - \Delta e$$

In the short run, interactions between the unemployment rate and inflation are driven by two equations. The first one is derived from Phillips and PS curves, i.e., from the way wages and prices are decided in the economy:
$$(1 - \lambda_1)(\Pi_t - \Pi_{t-1}) + \lambda_2(u_t - \bar{u}) = 0 \tag{7}$$
The second one reflects the equilibrium in the goods market: supply and demand are equal.
$$\Pi_t - \bar{\Pi} = \Delta u_t \tag{8}$$

Finally, the system dynamics around the steady state is the following:
$$\begin{pmatrix} \Pi_t - \bar{\Pi} \\ u_t - \bar{u} \end{pmatrix} = \frac{1 - \lambda_1}{\lambda_2 + 1 - \lambda_1} \begin{pmatrix} 1 & -\frac{\lambda_2}{1-\lambda_1} \\ 1 & 1 \end{pmatrix} \begin{pmatrix} \Pi_{t-1} - \bar{\Pi} \\ u_{t-1} - \bar{u} \end{pmatrix}.$$

[11] See Cahuc and Zylberberg (1996).

[12] cf. Romer (1990) for a simple case of monopolistic competition model, where a constant mark-up can be derived.

[13] Note that the first-order approximation $u_t = n_t - l_t$ is consistent with our log-linearized model.

3.1.2 Consequences of a demographic shock: qualitative analysis

We consider a “pure” demographic shock, without any reacting economic policies: the rate of population growth is assumed to drop from n_0 to n_1 (inferior to n_0). We concentrate on the short run, and uniquely on the direct effects. In the long run, parameters and technical progress are unchanged and so is the unemployment rate.

Equilibrium on the goods market is achieved through the equality between aggregate demand and supply. When population growth decreases, equilibrium on the labor market is affected by the decrease in the labor force. Then, two processes compete to turn back to equilibrium. First, some unemployed workers find jobs. Second, prices of the goods increase and contrain the demand.

The dynamics of this system are represented in figure 6, showing curves (7) and (8) in a plan (u_t, Π_t), assuming past variables (u_{t-1}, Π_{t-1}) fixed.

Figure 6-(a) presents the pre-shock situation, where the system is assumed to be at the steady state. At the date of the shock (denoted as t_1 in the figure), the curve (7) does not move, as the steady state unemployment rate is not affected yet. On the other hand, the curve (8) moves up, as shows figure 6-(b). This move is caused by the decrease in potential supply. In the short run, in order to maintain the production level, firms hire unemployed workers, and unemployment drops while wages are driven up. At the very first period, both unemployment and inflation are affected. At the second period, as indexation of prices to wages is not immediate, inflation continues to increase. Figure 6-(c) shows how combined curve movement behaves. Figure 6-(d) shows the final equilibrium, after the system has converged to the new steady state inflation level.

Note that these results are obtained under the assumption of constancy of Δm (no reaction to inflation from the monetary authorities).

3.1.3 Consequences of a demographic shock: quantitative analysis

In a calibrated model initially at equilibrium, we introduce a demographic shock and simulate the dynamics.

A decrease of one percentage point in the population growth rate leads to a 0.4% decrease in the unemployment rate for one period, as shown in figure 7. This favorable effect is counterbalanced by an increase of inflation (as shows figure 8), which totally offsets the former effects after 5 periods. The remainder of the dynamics displays a fluctuating convergence to a new equilibrium characterized, everything else equal, by an unchanged unemployment rate and an higher inflation.

The same exercise can be repeated with a different demographic shock. In this other simulation, population growth still loses one percentage point, not at once but over ten periods (0.1 point per period). The consequences of such a progressive shock are showed in figures 9 and 10. The consequences on unemployment are even less notable than in the immediate-shock case, but the effects last longer.

Note that these results depend on the hypothesis of exogeneity of money supply. If we suppose that the monetary authorities react to the rise of inflation, even the small transi-

Figure 6: Short term impact of a demographic shock in a small Phillips model

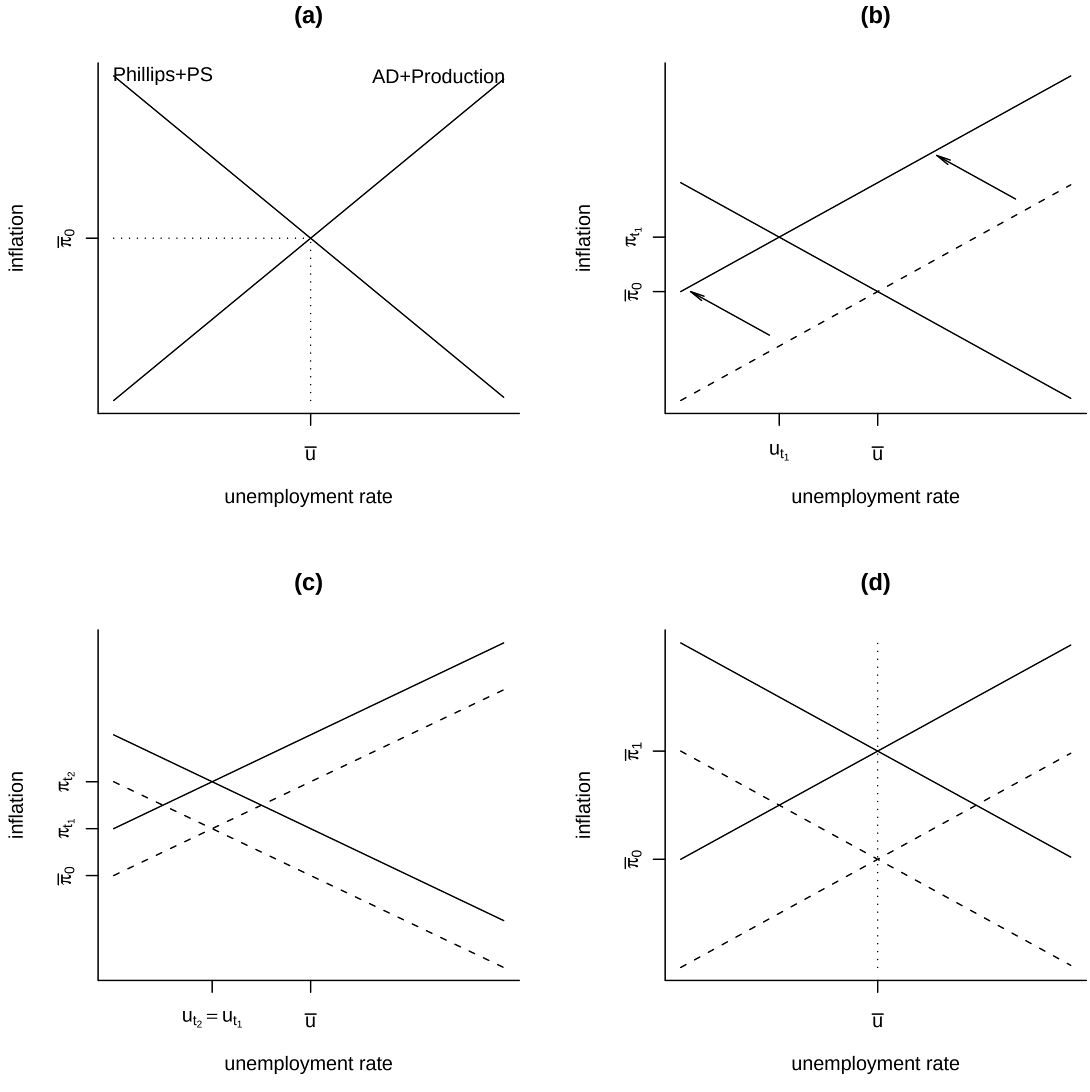


Figure 7: Consequences of a negative demographic shock on unemployment

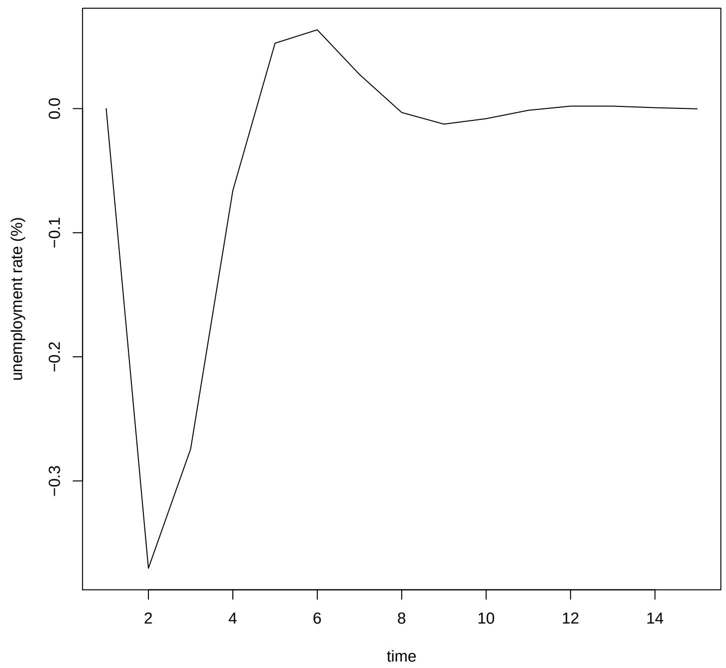


Figure 8: Consequences of a negative demographic shock on inflation and unemployment

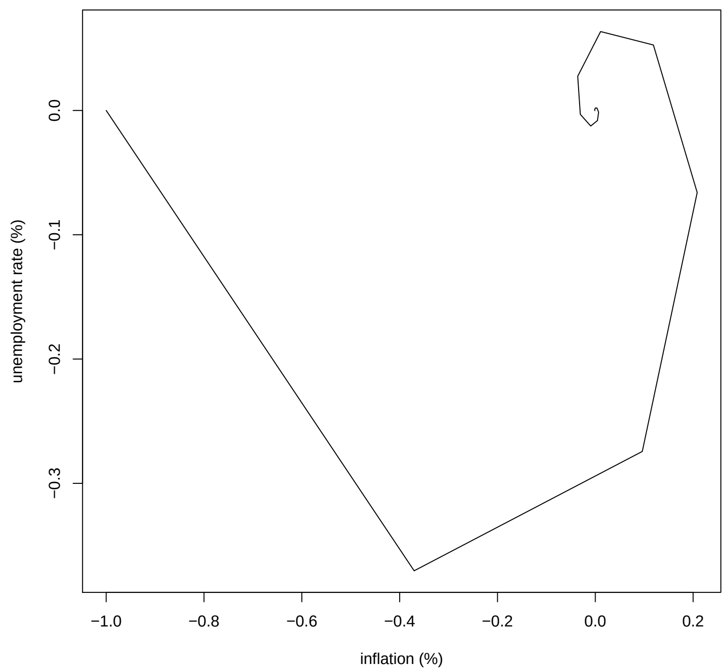
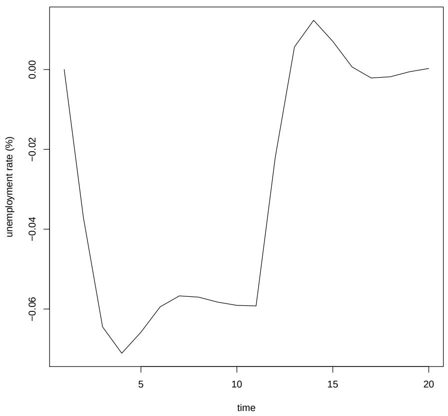
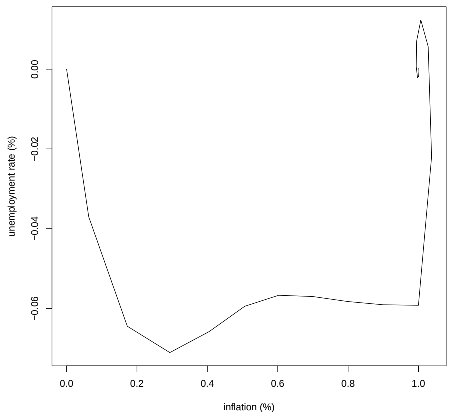


Figure 9: Consequences of a progressive shock on unemployment



Source: Authors computations.

Figure 10: Consequences of a progressive shock on unemployment and inflation



Source: Authors computations.

tory beneficial effects of demography on unemployment would disappear. Another crucial hypothesis is the non-immediate adjustment of prices to wage dynamics.

To sum up, in a small Phillips model with a demand side, slower population growth has no impact on unemployment in the long run. In the short run, a small and transitory decrease in the unemployment rate is to be expected, alongside with more inflation.

3.2 Summary: Effects identified within the Phillips and WS-PS frameworks

The analysis conveyed through the WS-PS and Phillips approaches[14] conclude that:

- In a supply WS-PS model, some permanent demographic effects related to wage bargaining are likely to exert an effect on the unemployment rate. If the exit rate is fixed in the long run by the production conditions, a decrease in the entry rate reduces the unemployment rate. At the same time, increased financing needs lead to a rise in the labor tax and thus to a higher long-term unemployment rate in the economy.
- Temporary effects are easier to identify through Phillips approach. They result from short-term interactions between unemployment and wages. The labor supply shortage due to the shock brings about both a drop in unemployment and a rise in inflation.

4 A macroeconometric model: Mésange

4.1 Introduction

Simple theoretical models are useful to identify the basic mechanisms. Calibrated models are useful to quantify them. However, none of them offers an exhaustive view of the economy. We hereafter use the macroeconometric model Mésange to have a global overview of the effects on the economy. We are fully aware of the drawbacks underlined by the economic

[14]Remember that the main difference between the two frameworks is whether structural variables such as labor taxation or demography are actual determinants of the long term unemployment rate.

theory and by modelling practitioners about macroeconometric models[15], the most important of which is certainly the Lucas critique[16]. In a nutshell, the Lucas critique is concerned about the relevance of estimated relations. Estimated coefficients should not be considered as structural as they are at most statistical correlations and their stability, whether in the long run or when the economic environment changes, is never warranted. In the present study, we accept to pay the price of this uncertainty and consider it as a second order matter.

This section develops as follows. Subsection 2 presents how prices and wages are modelled in Mésange. Subsection 3 sets precise modelling hypotheses. Subsection 4 details short and long term dynamics, adopting the WS-PS approach. Subsection 5 decomposes demographic effects. Subsection 6 analyses the Phillips approach.

4.2 Prices and wages modelling in Mésange

4.2.1 Theoretical framework

Mésange is a macroeconometric model for the French economy (Allard-Prigent et alii (2002)), conceived by economists at the Forecasting Directorate of the French Ministry of Economy and Finance and the INSEE. In the short run, demand behavior prevails whereas medium and long run equilibrium is driven by the supply-side and achieved though prices adjustment. During its conception, particular stress was put on the labor market: the wage curve can either be WS or Phillips.

From (6), we can bring in consumption prices to obtain:

$$w - p = cfs + (pc - p) + (z - pc) - \beta_u u + C$$

At this stage, it is assumed that unemployment benefits are indexed in real terms (related to consumption prices) on the exogenous labor productivity e[17], which also determinates the growth rate of real wages by the PS curve. It follows that

$$w - p = cfs + (pc - p) + e - \beta_u u + C$$

The equilibrium unemployment rate is expressed by

$$u^* = \frac{1}{\beta_u}\left[\frac{1-\alpha}{\alpha}(r-p) + cfs + (pc - p)\right]$$

α being the labor share in the Cobb-Douglas production function and r the interest rate.

In the WS-PS framework, the equilibrium unemployment is determined by the fiscal wedge, that is, the ratio between consumption prices and value-added prices, and by the real capital cost. Of particular interest is the comparison between the micro-founded WS approach and the more pragmatic Phillips approach.

[15] Amongst hundreds of relevant references on this topic, one may get a good idea about pros and cons of each type of macro models in Diebold (1998).

[16] cf Lucas(1976).

[17] As is stated by Sterdyniak et alii (1997), the hypothesis is far from natural, as it is crucial for long term stationarity of the unemployment rate in this kind of models. For Blanchard and Katz (1997), this condition is necessary for consistency: every other hypothesis lets a trend related to productivity in the expression of the equibrium unemployment rate.

4.2.2 The wage equations in the model

The wage equations that we use in practical terms in our model are the following[18]:

- WS equation:

$$\begin{aligned}\Delta w^s &= a_1 \Delta w^s_{-1} + a_2 \Delta w^s_{-2} + a_3 \Delta w^s_{-3} \\ &+ b_0 \Delta pc + (1 - a_1 - a_2 - a_3 - b_0) \Delta pc_{-1} + \alpha_{te} \Delta (pc - p) + \alpha_u \Delta u \\ &+ \mu \left(w_{-1} - pc_{-1} + \beta u_{-2} - cfs_{-1} - eff_{-1} \right). \end{aligned} \tag{9}$$

- Phillips equation:

$$\Delta w = \beta_u u + a_0 \Delta pc + a_1 \Delta pc_{-1} + a_2 \Delta pc_{-2} + \beta_{te} \Delta (p - pc). \tag{10}$$

The WS equation is written with an error correction term, but short-term dynamics will lead to Phillips effects. Note that the coefficient β_u and the constants (omitted on the last equations) are estimated without taking into account their possible dependence on population growth. The Phillips equation is written with no long-term constraint. It is consistent with the fact that the Phillips approach admits no structural determinants for the unemployment rate in the long run.

4.3 Projections hypotheses

Beffy et alii (2003) is an example of how Mésange can be used in projection. In this study, we mainly retain the same hypotheses. Demography is present at different levels in the model.

- We use active population projections from the INSEE that take into account the impact of the 2003 pensions scheme reform[19]. We add an estimated complementary flexion effect on activity rates, to make them depend on the endogenous unemployment rate.
- We use projections provided by the micro-simulation model Destinie[20] for the number of retirees and for retirement allowances, which take the effects of the 2003 retirement scheme reform into account.
- We assume that intensification in trade exchanges will not continue in the future at the same rate as observed in the past. Ageing is likely to affect also our trade partners, reducing their growth potential. This leads us to assume a deceleration in the world demand.

Further macro assumptions are necessary[21]. Foreign prices play a role to fix the nominal anchor of the model. We assume a yearly growth rate of 2%. The labor productivity growth rate has decelerated in the beginning of the nineties, in particular in services (Baron et alii,

[18] A detailed presentation can be found in D.

[19] The methodology used to obtain these projections is available in Lerais, Nauze-Fichet, Lhermitte (2003). These official projections were corrected to take into account the major pensions scheme reform that was enacted in 2003. Estimations of the reform effect have been taken from the “Rapport Economique Social et Financier” (2004). A new set of complete projections should be available later in 2006.

[20] The Destinie model is detailed is the INSEE working paper nb.9913.

[21] See C for more details about the used projections assumptions.

2003). We assume that this deceleration is mainly a sequel of policies aimed at increasing the labor share in growth, and not an intrinsic drop in the productivity trend. Therefore, we keep a productivity trend in the long run close to the one observed in the eighties (namely, a yearly 2.3% growth).

In a first step, we make the conventional assumption that future public deficits will not exceed a threshold fixed at 1.5% of GDP[22]. The threshold is imposed from 2009. Excesses in public deficit are financed by increases in taxes[23]. Until the end of 2004, we use quarterly series from the French Quarterly Accounts[24]. Simulation starts at the first quarter of 2005.

4.4 Projections using the WS-PS framework

4.4.1 Short and medium run: upward pressure on prices and high unemployment

The equilibrium level of the unemployment rate is around 7.5% until 2012[25] and the unemployment rate is above its equilibrium value, around 9%. This leads to slow domestic prices. The mechanical drop in unemployment stimulates GDP in the first years. However, in the medium run, there is an increasing spread between foreign and domestic prices, as the dynamics of the former is exogenous in the model. This increasing spread undermines employment and accounts for almost 1 point of the equilibrium unemployment rate between 2005 and 2009.

4.4.2 Long run: Raising taxes depresses labor market situation

From 2009, the 1.5% public deficit threshold is binding and public finances are sustained by CSG tax increases. The CSG rate rises by 4.2 points between 2009 and 2017. This rise accounts for 1.7 more points for the equilibrium employment rate, close to 9.6% in 2017.

Growth potential is defined as a function of the equilibrium unemployment, labor efficiency growth and active population growth. Labor efficiency growth is assumed to remain constant at 2.3%. In 2040, the yearly active population is assumed to decrease by 0.1% per year. Finally, the equilibrium unemployment rate evolves as shown by figure 12. Continuingly increasing labor tax (+3.7 points for CSG between 2017 and 2040) exerts upward pressure on the equilibrium unemployment rate. Growth potential is close to 2.0% in the long run.

To sum up, the Mésange simulations within a WS-PS framework suggest that demographic effects will follow a precise schedule. First, until 2017, a sharp drop in unemployment is caused both by the transitory beneficial effect of the active population dynamics and a mechanical return of the unemployment rate to its initially lower equilibrium level. Then, from 2018 on, the equilibrium unemployment could reincrease due to an increased price

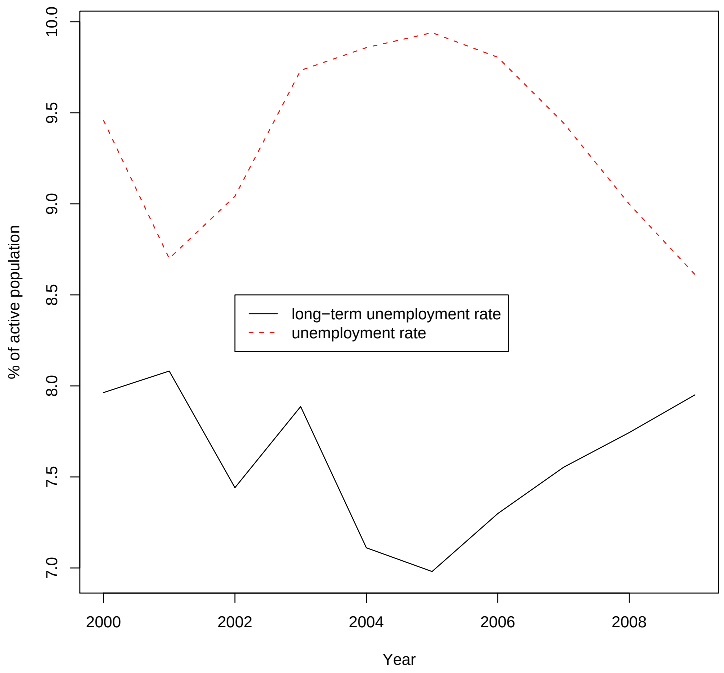
[22]We relax this assumption in E, with an analysis carried on with a less strict threshold of 3%. It is there showed that the impact of ageing is qualitatively the same, but that the schedule of events is modified.

[23]We use Contribution Sociale Généralisée (CSG) as our fiscal instrument, for it is the one based on the largest ground, which includes labor as well as capital income.

[24]We use National Accounts series in base 1995.

[25]We recall that in the our framework, the equilibrium level of the unemployment rate is defined by the unemployment canceling the error correction component of the wage equation. It is thus a variable quantity, written as a function of other endogenous variables of the model. D provides more details.

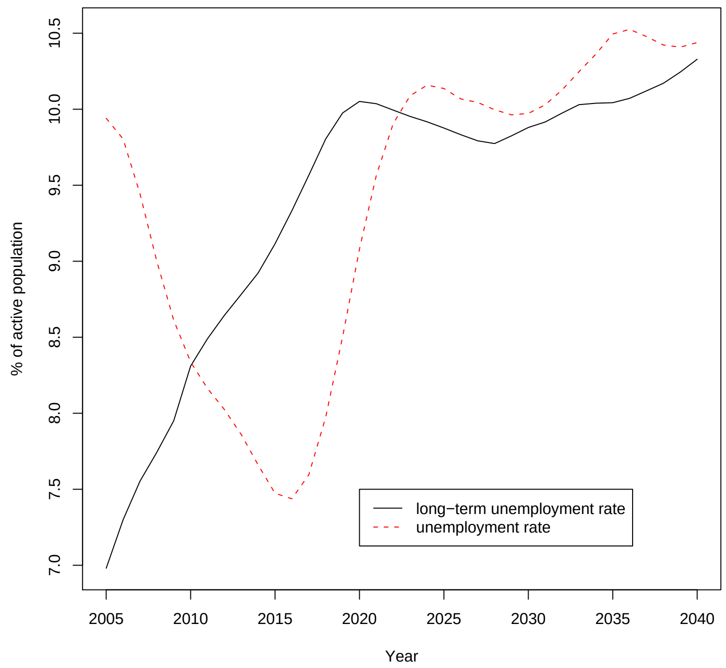
Figure 11: Unemployment rate and its equilibrium value from 2005 and 2009, WS-PS framework



Source: National Accounts (INSEE) from 2000 to 2004, Mésange simulations from 2005.

spread (between foreign and domestic prices) and mostly due to wedge increases. In the next subsection, we analyze these effects more deeply.

Figure 12: Unemployment rate and its equilibrium value from 2005 and 2040, WS-PS framework



Source: Mésange simulations.

4.5 Decomposing the demographic effects: size effects and structure effects

Analytically, ageing can entail two types effects. First, ageing will be characterized by a drop in the active population growth rate and, in levels, by a stabilization followed by a slight decrease in the active population itself. Then, the increasing weight of the eldest in the total population deeply modifies its strcture. Our intention is to try and distinguish between these two phenomena and their consequences on the labor market situation.

4.5.1 From the ageing scenario to the non-ageing scenario

In the previous section, we analyzed a scenario based on projections displaying the consequences of ageing on the economy. To analyze these effects, we build a counterfactual in which the population is not ageing, and another one in which ageing has size-effects on labor supply but no structure-effects, i.e. no impact of the worker/pensioner ratio. More formally, we will call:

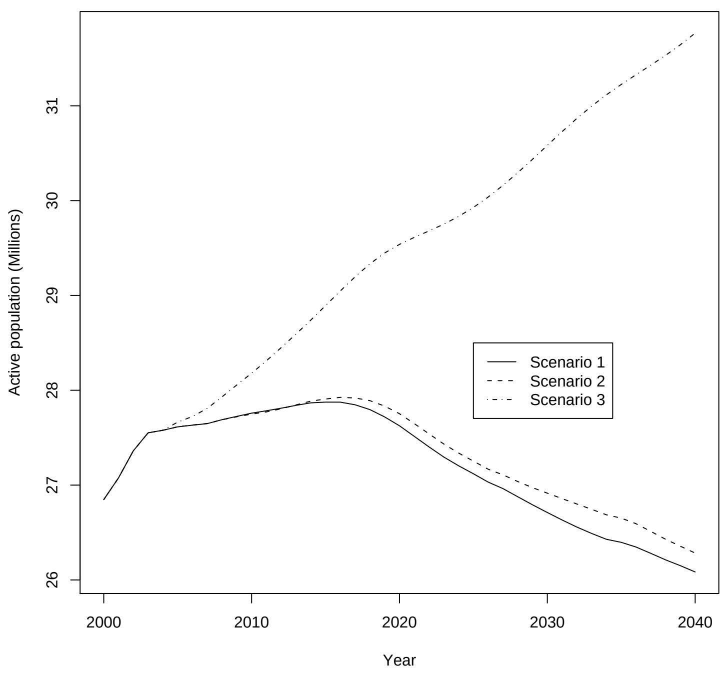
- Scenario 1: the "ageing" scenario. This one corresponds to the simulation we already analyzed and that is based on INSEE demographic projections. In these projections, ageing has both size-effects and structure-effects.

- Scenario 2: the “less active but less inactive” scenario. In this scenario, the active population is fixed at the same levels as in the scenario 1. However, the age structure is fixed at its Scenario 3 level. In particular, the ratio between workers and pensioners is much lower than in Scenario 1. This counterfactual is purely analytical: it represents what would happen in an economy with a decreasing active population but without the retirees’ pensions burden.

- Scenario 3: the “non-ageing” scenario. In this scenario, there is no trend break in the active population: it keeps on increasing at a yearly 0.4% growth rate. Moreover, age structure is fixed at its 2004 level.

Activity rates are the same in the three scenarios. In scenarios 2 and 3, total population is recomputed to take the hypotheses made in terms of active population and age structure into account. Active population in each of the three scenarios is showed in figure 13.

Figure 13: Active population in the three scenarios



Source: Mésange simulations.

With these three scenarios, we are now able to analyze the size-effects (comparing scenario 2 to scenario 3) and the structure effects (comparing scenario 1 to scenario 2).

4.5.2 Back to an analytical exercise: a permanent shock on the active population level

To keep the behavior of our model in mind, we display the results of a simulation implementing a 1% upward shock on the active population (Allard-Prigent et al., 2002)[26]. The shock is permanent and unique. In the short run, the population shock brings about more unemployment, as activity and factors demand is unchanged. A higher unemployment, in turn, exerts a downward pressure on labor cost and prices. The decrease in labor cost has a direct effect on unemployment. Lower prices boost exports and the aggregate demand, which has an indirect but favorable effect on unemployment. In the long run, the increase in active population is neutral on unemployment and inflation. However, GDP benefits from residual effects on trade.

Table 3: The impact of a permanent 1% shock on the active population level

Differences to the benchmark	1 y.	2 y.	5 y.	long-term
GDP	0.16	0.14	0.29	1.11
Household Consumption	0.04	0.02	-0.12	0.53
Total Investments	0.32	0.26	0.35	0.99
Exportations	0.06	0.18	0.82	1.95
Importations	-0.13	0.08	0.03	-0.47
Consumption deflator	-0.31	-0.37	-1.75	-4.57
VA deflator	-0.21	-0.50	-2.06	-4.81
Employment	22	52	88	209
Unemployment rate	0.79	0.68	0.55	0.09
Real Disposable Income	0.02	-0.10	-0.35	0.53
Saving rate	-0.02	-0.10	-0.20	0.00
Trade balance	0.02	-0.03	0.04	0.44
Govt. Net Lending	-0.07	-0.01	0.06	0.46

Source: Allard-Prigent et al. (2002).

Remark: These figures are differences to the benchmark scenario, in levels, in pct. points.

4.5.3 Age-structure effects

In this subsection, we compare scenarios 1 and 2. Both have the same active population: the crucial difference lies into how numerous are the retirees. Scenario 2 is just a replica of scenario 1 in which older workers do not fall into retirement but "disappear" from the model, so that the age structure from 2005 on reproduces the 2004 age structure. Results from the comparison can be found in tables 4 and 5.

In the short run (2005-2009), a total population effect dominates in the economy. As a matter of fact, with the same active population and fewer inactives, the total population is less numerous in scenario 2. The economy is less dynamic (see GDP growth, unemployment,

[26]The version of Mésange used for this exercise is not exactly the same as ours. Some of the equations have been re-estimated in the meanwhile and no budgetary constraint was imposed at that time. Still, this version of the model has a WS curve. Therefore the mechanisms are similar, so that it is interesting to examine these results.

household consumption in table 4) as there is less people consuming.

More unemployment makes the weight of unemployment allowances heavier for the government. Nonetheless, with fewer retirees, pensions are drastically lower in scenario 2. The latter effect largely offsets the first one, leading to a higher public surplus in scenario 2.

Table 4: Comparison between scenarios 1 and 2 in the short-run

	GDP (a)	VA deflator (a)	Consumption deflator (a)	Unemployment rate (b)
2005	0.00	0.00	0.00	0.00
2006	-0.01	0.00	0.00	0.01
2007	-0.08	0.00	0.00	0.02
2008	-0.14	-0.02	-0.01	0.06
2009	-0.13	-0.10	-0.07	0.13

	Employment (a)	Active pop. (a)	Public surplus (c)	Debt (c)
2005	0.00	0.00	0.00	0.00
2006	0.00	0.01	0.03	-0.01
2007	-0.01	0.00	0.15	-0.05
2008	-0.06	-0.01	0.28	-0.18
2009	-0.09	-0.01	0.31	-0.35

	CSG rate (b)	Unempl. allowances (c)	Retirement allowances (c)	Household consumption (a)
2005	0.00	0.00	0.00	0.00
2006	0.00	0.00	-0.04	-0.01
2007	0.00	0.00	-0.16	-0.10
2008	0.00	0.01	-0.30	-0.20
2009	-0.26	0.03	-0.48	-0.23

Source: Mésange simulations.

Remarks: The results are expressed in terms of differences between scenario 2 and scenario 1.

(a): yearly growth rates (difference in pct. points)

(b): rate (difference in pct. points)

(c): GDP ratio (difference in pct. points)

In the long run, GDP growth potential is mainly lead by our hypotheses about labor productivity, active population growth rate and equilibrium unemployment. The first two factors are equal in scenario 1 and 2. Only equilibrium unemployment is likely to differ. We know that, in our WS-PS framework, equilibrium unemployment depends on the fiscal wedge, the consumption-VA deflators spread and the real cost of capital.

Table 5 provides a comparison between the scenario 1 and scenario 2 simulations in the 2005-2040 period. As expected, age-structure effects are huge. In 2009, when a threshold on the public deficit is imposed, public finances equilibrium is reached through an increase in the CSG rate. In scenario 1, the burden of retirement pensions creates an always higher public deficit. In the period 2011-2015, the CSG rate in scenario 1 is already 2.1 points higher than in scenario 2. However, as unemployment has quite slow dynamics, the unemployment in scenario 1 is still a little higher in scenario 2. In the long-run, the CSG rate is around

6 points higher in scenario 1 and unemployment is 1.8 points higher in scenario 1 than in scenario 2.

Table 5: Comparison between scenarios 1 and 2 in the medium and long run

	GDP	Unemploy. rate	Active pop.	CSG rate	Household consumption
2005-2010	-0.03	0.07	-0.01	-0.27	-0.08
2011-2015	0.27	-0.25	0.03	-2.11	0.13
2016-2020	0.29	-1.02	0.07	-3.96	0.19
2021-2025	0.07	-1.22	0.01	-4.48	-0.20
2026-2030	0.42	-1.80	0.05	-4.62	0.05
2031-2035	-0.03	-2.38	0.04	-5.42	0.07
2036-2040	-0.02	-1.82	-0.04	-6.00	0.01

Source: Mésange simulations.

Remarks: The results are expressed in terms of differences between scenario 2 and scenario 1.

4.5.4 Size-effects

In this section, we compare scenario 2 and 3. In terms of age structure, scenario 3 can be described as homothetic to scenario 2. Scenario 3 is an extrapolation of the 2004 population, were the age-structure and the active population growth frozen. Therefore, for each period, scenario 3 will diverge a little more from scenario 2. Another way to conceive it is to depart from scenario 2 and to apply repeted shocks both on the active and inactive populations.

Size-effects diffuse slowly in the model but are very regular. Effects on demand and GDP are straightforward: more people demand more, and the economy grows faster. Effects on prices and labor market comply to our remarks in section 4.5.2, as scenario 3 compared to scenario 2 is just a repeted population expansion shock. In the long run, the unemployment rate is slightly higher in scenario 3 than in scenario 2 (the difference reaches about 0.6-0.7 point). The fiscal wedge plays no role here. As the age-structure is the same in the two-scenarios, there is no need for more fiscal revenues (as shows the stability of the CSG rate).

4.5.5 Conclusion on the WS-PS framework in Mésange

When a WS curve is introduced in the macro-econometric model Mésange, demographic changes have favorable effects in the short-run on unemployment, but unfavorable effects on the medium and long-run. In total, long-term unemployment is 1.2 point higher in the ageing scenario than in the non-ageing scenario. The major part of the unpleasant effects (+1.8 point in long-term unemployment) is due to the deformation of the age structure, leading to higher retirement pensions payments and therefore to a higher fiscal wedge. Size-effects play a beneficial role (-0.6 point on the long-term unemployment rate compared to a situation in which population were to grow at the late 90s rate).

Table 6: Comparison of scenarios 2 and 3

	GDP (a)	consumption contribution (a)	investment contribution (a)	exports contribution (a)	
2005	0.06	0.01	0.02	0.00	
2006	0.09	0.04	0.03	0.01	
2007	0.13	0.05	0.04	0.02	
2008	0.18	0.07	0.06	0.03	
2009	0.23	0.08	0.08	0.04	
2010	0.29	0.10	0.10	0.05	
2011-2015	0.40	0.12	0.13	0.08	
2016-2020	0.49	0.16	0.16	0.08	
2021-2025	0.57	0.19	0.16	0.09	
2026-2030	0.69	0.21	0.19	0.11	
2031-2035	0.59	0.19	0.15	0.09	
2036-2040	0.66	0.19	0.17	0.10	

	Consumption deflator (a)	Unempl. rate (b)	Active pop (a)	CSG rate (b)	VA deflator (a)
2005	-0.03	0.09	0.18	0.00	-0.05
2006	-0.09	0.13	0.15	0.00	-0.12
2007	-0.15	0.21	0.25	0.00	-0.20
2008	-0.23	0.28	0.30	0.00	-0.29
2009	-0.32	0.35	0.34	0.00	-0.39
2010	-0.41	0.39	0.34	-0.06	-0.49
2011-2015	-0.59	0.40	0.39	-0.06	-0.68
2016-2020	-0.62	0.42	0.55	-0.12	-0.72
2021-2025	-0.76	0.65	0.63	-0.02	-0.87
2026-2030	-0.91	0.64	0.68	-0.02	-1.02
2031-2035	-0.82	0.67	0.61	-0.02	-0.91
2036-2040	-0.95	0.66	0.62	-0.02	-1.03

Source: Mésange simulations.

Remarks: Results are to be read as the difference of outcome between scenario 3 and scenario 2.

(a): yearly growth rate (difference in pct. points)

(b): rate (difference in pct. points)

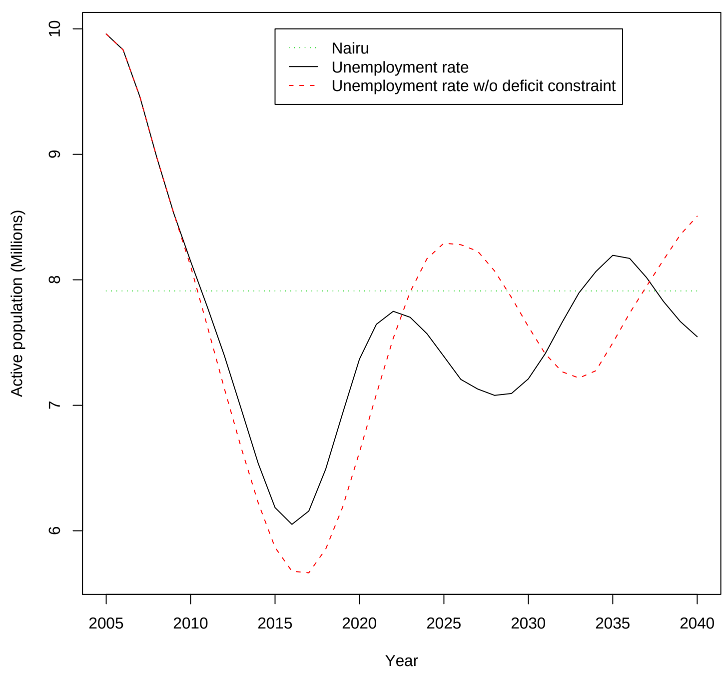
4.6 Projections using the Phillips framework

In this subsection, we change the specification of the wage equation. We use a Phillips curve without any error-correction term [27]. Under this specification, wage growth depends on the unemployment rate, consumption prices, and the spread between consumption and production prices. We have already mentionned the differences between the WS-PS and the Phillips frameworks. In our study, the main one is the fact that the fiscal wedge is not a determinant of the equilibrium unemployment in the Phillips framework.

The fact that taxes no longer affect unemployment directly does not imply they have no effect at all. As taxes increase, aggregate demand is affected, which later brings about more unemployment. To analyze how this effect acts, we build a counterfactual in which public deficit is no longer constrained (i.e. the deficit threshold is pushed to infinity).

Until 2008, the two simulations are strictly equal, as the 1.5% threshold is not binding. The unemployment path is mainly decreasing, as the initial unemployment rate is over its equilibrium level. From 2009 on, tax rates are increased to maintain the deficit at the threshold: the simulations start to diverge. In 2010, demand effects are observed: the wedge increase induces a drop in household income. Domestic demand is affected this very year. However, employment is not adjusted to the lower global supply until the following year.

Figure 14: Projection with a Phillips curve: unemployment rate and its equilibrium level from 2005 to 2015



Source: Mésange simulations.

[27]For more details, see D.

Table 7: Impact of the financing constraint on projections using the model with a Phillips curve

	GDP (a)	Domestic demand (a)	Income (a)	Employ. (a)	CSG rate (b)
2005-2008	0.00	0.00	0.00	0.00	0.00
2009	-0.01	-0.02	-0.11	0.00	0.12
2010	-0.24	-0.34	-0.64	-0.04	0.73
2011	-0.23	-0.35	-0.26	-0.14	0.86
2012	-0.08	-0.13	-0.23	-0.14	0.98

	unemploy. (b)	GDP defl. (a)	real labor cost (a)	Apparent labor productivity full time eq. (a)
2005-2008	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	-0.01
2010	0.04	0.01	-0.02	-0.17
2011	0.16	-0.01	-0.06	-0.02
2012	0.26	-0.18	-0.05	0.15

Source: Mésange simulations.

This table is to be read in differences: outcome “with financing constraint” minus outcome “without financing constraint”

(a): yearly growth rate in pct points - (b): level in pct points

In the long run in a simulation with a Phillips curve and a financing constraint, unemployment converges to its equilibrium level, which is not affected by wedge variations. Therefore, it remains close to its initial level of 7.9%. Compared to the WS-PS simulations, growth potential is higher, thus GDP grows at a higher pace.

Table 8: Long run comparison between the WS-PS and Phillips simulations

	unempl. rate		GDP growth		GDP level (based at 100 in 2000)		CSG rate	
	WS	Phillips	WS	Phillips	WS	Phillips	WS	Phillips
Long term	10.4	7.5	2.0	2.3	231	247	15.8	14.5

Source: Mésange simulations.

Oscillations observed in figure 14 are due to short-term disequilibria. Overall, it seems that WS-PS simulations combine short run “Phillips effects” and structural long run effects due to tax increases.

4.7 Should one specification be preferred to the other?

The long-term impact of demographic changes is crucially dependent on the hypotheses specifying the model. Notably, the major difference between the WS-PS and Phillips frameworks is the explicit dependence of the equilibrium unemployment on the fiscal wedge. The connection between the latter variables is linked to the targets chosen by the agents during wage negotiations. What is the relevant target is still an open question.

The existing literature suggests that the answer to this question can depend on institutional arrangements, more specifically, the organization of wage bargaining. Some empirical work tried to determine which are the best institutions. Daveri and Tabellini (2000) explore OECD data and build three groups of countries, homogenous in their institutions. "Continental European" countries, to which France belongs, are characterized by relatively decentralized negotiations. In "Anglo-Saxon" countries, decentralization is even higher. Finally, "Nordic" countries are those with most centralized negotiations.

In each group, the impact of labor tax variations on unemployment and labor cost is measured. A higher labor tax rate has no significant effect on unemployment in Nordic countries, but a negative and significant effect in Anglo-Saxon and Continental European countries. However, the negative effect is twice as high in Continental European countries as in Anglo-Saxon countries. Labor cost is significantly affected only in Continental European countries. In this group, a labor tax increase is transmitted to the labor cost. In terms of bargaining targets, this means that these workers do not expect that the entire amount of collected taxes will eventually get back to them. Therefore, they negotiate on the after-tax wage rather than on the labor cost. Results by Daveri and Tabellini (2002) follow and confirms those by Tyrvaïnen (1995) and Alesina and Perotti (1997). These results could support the validity of the WS-PS framework for projecting the consequences of demographic changes in a country like France.

The results support the validity of WS-PS framework in projecting the consequences of demographic changes in a country like France. A few remarks, however, are worth making. The first one concerns the criticisms around the previously described econometric approaches with respect to endogeneity and heterogeneity among the various countries. Second, admitting such results does not render Phillips approach irrelevant. Conversely, since we are unable to determine exactly the workers' bargaining targets, we shall accept that reality might be somewhere between WS-PS and Phillips simulations. This underlines the relevance of analyzing impacts according to both approaches.

5 Conclusion

Our work suggests that traditional macroeconomic models can be useful to understand consequences of demographic changes and their underlying mechanisms. The macroeconometric model Mésange captures first-order effects and provides a dynamic view of the way demographic changes will act. As stressed in this study, such changes may exert diverse effects on the labor market, whose strength and timing depend on the departing assumptions.

We draw two main conclusions from our study.

- In the short and medium run (within fifteen years), unemployment is likely to diminish. In practical terms, however, such a decrease remains limited and may be concealed by short term demand-driven features. Anyway, whatever the approach that is adopted, the observed gain due to demography is temporary.

- In the long run, more retirees for fewer workers will generate a fiscally challenging situation in terms of the budgetary deficit, which is likely to be dealt with by raising taxes. Our two approaches diverge when it comes to determine the effects of tax increase on wage bargaining. If we assume that workers negotiate on the labor cost, a

Phillips curve is the adequate way to describe the labor market. In this case, no effect of demography will be observed in the long run. Conversely, a WS-PS framework is relevant if we assume that workers negotiate on their net wage. In the long run, labor taxes weigh on unemployment. Reality could well lie between these two opposite scenarios and our results allow us to infer that the closer workers negotiate to the net wage, the more unemployment will be expected in the long run.

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A The WS Curve

This annex owes to Cahuc and Zylberberg (1999).

The WS curve stands for the negotiations between workers representatives (typically trade unions) and firms. The object of the negotiations may be the wage level or employment[28]. The WS-PS framework restricts itself to the right-to-manage hypothesis[29], in which the firm is allowed to fix the employment level once the wage has been negotiated.

A.1 Nash-bargaining between unions and firms

The negotiations are traditionally described as a Nash-bargaining. Each agent has an objective function for the bargaining, which can be written as the difference between the expected utility in case of success ($V_{i,t}(W_{j,t})$ for the union i, where $W_{j,t}$ is the labor cost in firm j, and $\Pi_{j,t}(W_{j,t})$ for the firm) and the status-quo situation utility (denoted $\bar{V}_{i,t}$ and $\bar{\Pi}_{j,t}$). Parameter γ is the relative bargaining power of the unions. The negotiated wage is then the solution to the program:

$$\underset{W_{j,t}}{Max}(V_{i,t}(W_{j,t}) - \bar{V}_{i,t})^{\gamma}(\Pi_{j,t}(W_{j,t}) - \bar{\Pi}_{j,t}).$$

Re-writing it in logs:

$$\underset{W_{j,t}}{Max}\{\gamma ln(V_{i,t}(W_{j,t}) - \bar{V}_{i,t}) + ln(\Pi_{j,t}(W_{j,t}) - \bar{\Pi}_{j,t}))\} \tag{11}$$

Layard, Nickell and Jackman (1991) consider that, in the firms status quo situation, the operating surplus is zero. It is not so clear if, like in Beffy and L'Angevin (2005), fixed capital stock is taken into account for, or if, like in d'Autume (2001) or in Cahuc and Zylberberg (1999), dynamic elements due to firms investment decisions are introduced. For the unions, status quo will ex-post depend on wage and employment opportunities on the labor market. We assume that firms are small enough to consider macroeconomic variables as given.

The schedule of wage bargaining, hiring then producing, is the following.

1. At the beginning of period t, wage negotiations take place between firms and unions. The unions represent the employees still in the firm at the beginning of t. If negotiations were to fail, these employees would have the opportunity to look for another job immediately (see Step 2).

2. In firms where negotiations went through, the employment level is determined by the firms to maximize their profit. The firms satisfy their labor demand first by rehiring their current employees, then by hiring among the job-seekers pool. This pool consists in workers unemployed during the previous period, workers having lost their jobs at the end of period $t-1$, new-comers on the labor market and eventually workers having quitted their firms after unsuccessful negotiations.

3. Production takes place, workers get paid. During this stage, active population consists only of unemployed and employed workers.

[28]See Layard, Nickell and Jackman (1991) for a model with negotiations dealing with both of them

[29]About the right-to-manage hypothesis, see for example d'Autume (2001), who states that this is not a Pareto-optimal hypothesis.

4. A proportion q of employees quits the firm, before next negotiations take place. Period t ends.

A.2 First-order conditions

To derive first-order conditions from the previous program, we express utilities for the two kinds of agents. The union negotiating with firm j aims at maximizing the utility of the workers whom it represents. Let $L_{j,t-1}$ denote the employment in this firm at date $t-1$. At the beginning of period t, the remaining employment level in firm j is $(1-q)L_{j,t-1}$: the corresponding workers are the insiders that the union represents in the negotiations. *E*x ante, there exists an endogenous probability $S_{i,j,t}$ for a worker employed at the beginning of t to keep his job after labor demand has adjusted. The right-to-manage hypothesis makes it precise that, after the wage is determined by the negotiations, the firm can adjust its workforce to maximize its profit. However, to keep the computations manageable, we will hereafter make the hypothesis that $S_{i,j,t} = 1$[30]. One can justify this hypothesis on the following grounds. First, insiders are usually preferred to newcomers, so no new hire would occur if one insider has to leave. Second, Cahuc and Zylberberg (1999) claim that on a steady-state growth path, employment inside firms keeps on growing, so that no firm has to downsize. Of course, these are *ad hoc* arguments, aiming at stressing that cases in which insiders expect downsizing are not common. Under this hypothesis, the objective of the unions can be written:

$$V_{i,t}(W_{j,t}) = \mathcal{W}_{j,t}$$

where $\mathcal{W}_{j,t}$ is the expected intertemporal utility of an employee in firm j.

The status quo $\bar{V}_{i,t}$ is the intertemporal utility of the worker, if the negotiations were to fail. In this latter case, the worker would join the job-seeker pool, and his utility, independent of j would then be denoted $\mathcal{R}_t$. Finally, the difference between the unions' objective and status quo utility is:

$$V_{i,t}(W_{j,t}) - \bar{V}_{i,t} = \mathcal{W}_{j,t} - \mathcal{R}_t$$

The first-order condition leading to the WS curve is thus written as:

$$\gamma \frac{\mathcal{W}'_{j,t}}{\mathcal{W}_{j,t} - \mathcal{R}_t} + \frac{\partial \Pi_{j,t}(W_{j,t})/\partial W_{j,t}}{\Pi_{j,t}(W_{j,t})} = 0$$

A.3 Unions' status quo and intertemporal expected utilities

We denote a_t the (endogenous) probability for a job-seeker to find a job (this takes place at step 2). If we denote $\mathcal{U}_t$ the expected intertemporal utility of an unemployed worker during period t, $\mathcal{W}_t$ the expected intertemporal utility of an employed worker during period t, a step 2 job-seeker intertemporal utility can be expressed as:

$$\mathcal{R}_t = a_t \mathcal{W}_t + (1-a_t)\mathcal{U}_t$$

Let Z_t denote the unemployment compensation and Cfs the fiscal wedge (supposed identical in all firms) defined as the ratio between the labor cost and the net wage. PC_t is the consumption price and P_t the value-added deflator.

[30] L'Horty and Sobczak (1996) implicitly make this hypothesis.

We derive intertemporal utilities for employed and unemployed workers. A firm j's employee earns a real net wage $\frac{W_{j,t}}{Cfs_t PC_t}$ in period t. During period $t+1$, if he does not quit firm j (that occurs with probability $1-q$), he will remain employed and discount (at a rate β) the expected utility for employees at $t+1$. If he leaves firm j, he will find a new job with probability a_{t+1}. In every other cases, he will be unemployed during period $t+1$.

An unemployed worker at period t receives his compensation, then expects to find a job in period $t+1$ with probability a_{t+1}.

$$\begin{aligned}\mathcal{W}_{j,t} &= \frac{W_{j,t}}{Cfs_t PC_t} + \beta\left[(1-q+qa_{t+1})\mathcal{W}_{t+1} + q(1-a_{t+1})\mathcal{U}_{t+1}\right] \\ \mathcal{U}_t &= \frac{Z_t}{PC_t} + \beta\left[a_{t+1}\mathcal{W}_{t+1} + (1-a_{t+1})\mathcal{U}_{t+1}\right].\end{aligned}$$

Let us note in particular that:

$$\mathcal{W}'_{j,t}(W_{j,t}) = \frac{1}{Cfs_t PC_t}$$

Substracting the two equations, we get:

$$\mathcal{W}_{j,t} - \mathcal{U}_t = \frac{W_{j,t}}{Cfs_t PC_t} - \frac{Z_t}{PC_t} + \beta(1-q)(1-a_{t+1})(\mathcal{W}_{t+1} - \mathcal{U}_{t+1}) \tag{12}$$

A.4 Firms' profits

In the WS-PS literature, firms' profits do not have an univocal definition. When the labor market is perfectly competitive, authors usually mean by profits the operating surplus, which is the capital share of the value-added (Cahuc and Zylberberg, 1999 ; d'Autume, 2001):

$$\Pi^{os}_{j,t} = P_{j,t}Y_{j,t} - W_{j,t}L_{j,t}$$

In some papers based on monopolistic competition frameworks, profit is defined as the profit that the market power allows firms to make and is distinguished from labor and capital revenues (Beffy and L'Angevin, 2005 ; L'Horty and Sobczak, 2001):

$$\Pi^{monop}_{j,t} = P_{j,t}Y_{j,t} - W_{j,t}L_{j,t} - R_{j,t}K_{j,t}$$

Then, reducing this latter equation using factors' remuneration conditions and introducing the competition degree ρ:

$$\Pi^{monop}_{j,t} = (1-\rho)P_{j,t}Y_{j,t}$$

Layard, Nickell et Jackman (1991) also consider a goods market in monopolistic competition but define the profit as the operating surplus (which then contains both the capital revenue and the market power premium). Even if the definition is not univocal, one can remark that applying the envelop theorem leads for both of them to the same condition $\frac{\partial \Pi_{j,t}(W_{j,t})}{\partial W_{j,t}} = -L_{j,t}$.

Multiplying by the labor cost $W_{j,t}$, we see that, in the first order condition of the negotiation, the quantity of interest is precisely the ratio between the labor factor compensation and the profit: $\frac{W_{j,t}L_{j,t}}{\Pi_{j,t}(W_{j,t})}$. Then, there are two types of hypotheses to be made about firms: the definition for profits and the production function (and also the competition degree). Under the hypothesis that the production function is a Cobb-Douglas, this ratio is a constant, whatever the definition is chosen for the profits. This constant depends on competition degree and on the returns-to-scale of the labor factor. If the production function is a CES, the ratio between labor compensations and profits is a function of the wage[31]. In what follows, we choose the definition of the profits given by Layard, Nickell and Jackman (1991). We also assume a Cobb-Douglas production function.

A.5 The WS curve

A.5.1 A relation between wage dynamics and exit rate from unemployment

Remembering that we reached this first-order condition:

$$\gamma \frac{\mathcal{W}'_{j,t}}{\mathcal{W}_{j,t} - \mathcal{R}_t} + \frac{\partial \Pi_{j,t}(W_{j,t})/\partial W_{j,t}}{\Pi_{j,t}(W_{j,t})} = 0$$

as well as the findings of the previous section, we re-express the latter condition as follows:

$$\frac{\gamma}{\mathcal{W}_{j,t} - \mathcal{R}_t} \frac{1}{Cfs_t PC_t} = \frac{L_{j,t}}{\Pi_{j,t}(W_{j,t})}.$$

Multiplying the latter equation by the labor cost $W_{j,t}$, the labor remuneration share in the profit appears in the right hand side. In the Cobb-Douglas case, it is a constant. Denoting $\alpha = \frac{W_{j,t} L_{j,t}}{\Pi_{j,t}(W_{j,t})}$, we obtain:

$$\frac{W_{j,t}}{\mathcal{W}_{j,t} - \mathcal{R}_t} \frac{\gamma}{Cfs_t PC_t} = \alpha$$

We saw that $\mathcal{R}_t = a_t \mathcal{W}_t + (1 - a_t)\mathcal{U}_t$. We then assume symmetry on the labor market: at the equilibrium, labor cost in a firm j is equal to labor cost in a firm k, whatever j and k. Therefore, $\mathcal{W}_{j,t} = \mathcal{W}_t$. *In fine*, we get the following expression:

$$\frac{\gamma}{(1 - a_t)(\mathcal{W}_t - \mathcal{U}_t)} \frac{W_t}{Cfs_t PC_t} = \alpha$$

which can be rewritten:

$$\mathcal{W}_t - \mathcal{U}_t = \frac{\gamma}{\alpha(1 - a_t)} \frac{W_t}{Cfs_t PC_t}$$

Substituting this expression in eq.(12) leads to the following:

$$\beta(1 - q) \frac{W_{t+1}}{Cfs_{t+1} PC_{t+1}} \frac{Cfs_t PC_t}{W_t} = \frac{1}{1 - a_t} - \frac{\alpha}{\gamma}(1 - \frac{Z_t Cfs_t}{W_t}) \tag{13}$$

A.5.2 Flows dynamics and unemployment

We now describe labor market flows. We denote N_t the active population at date t. U_t represent the number of unemployed workers (after step 2 of period t), that is, unsuccessful jobseekers. These jobseekers are composed of unemployed workers from period $t-1$ staying in activity, employees dismissed at $t-1$ ($q(N_{t-1} - U_{t-1})$) but staying in activity, and newcomers ($n_t^e N_{t-1}$). With n_t^e denoting active population entry rate and n_t^x denoting active population exit rate[32], such that:

$$N_t = (1 + n_t^e - n_t^x) N_{t-1},$$

[31] See preceding computations and d'Autume (2001).

[32] Active population entry rate is the ratio between newcomers at a given period and active population at the previous period. Active population exit rate is the ratio between outflows at a given period and active population at the previous period.

The number of unemployed workers at t amounts to:

$$U_t = (1 - a_t)[(1 - n_t^x)(U_{t-1} + q(N_{t-1} - U_{t-1})) + n_t^e N_{t-1}].$$

Normalizing by the active population at $t-1$, and denoting u_t the unemployment rate:

$$(1 + n_t^e - n_t^x)u_t = (1 - a_t)[(1 - n_t^x)(u_{t-1}(1 - q) + q) + n_t^e] \tag{14}$$

This equation allows us to express a_t in eq. (13). Finally, we obtain an equation linking wage and unemployment:

$$\beta(1-q)\frac{Cfs_t}{Cfs_{t+1}}\frac{PC_t}{PC_{t+1}}\frac{W_{t+1}}{W_t} = \frac{(1 - n_t^x)(1 - q)u_{t-1} + n_t^e + q(1 - n_t^x)}{(1 + n_t^e - n_t^x)u_t} - \frac{\alpha}{\gamma}(1 - \frac{Z_t Cfs_t}{W_t}) \tag{15}$$

The latter equation is the WS curve.

We also express from eq. (14) the steady-state unemployment rate, for given and constant a, n^x, n^e and q.

$$\bar{u}(a, n^x, n^e, q) = (1 - a)\frac{(1 - n^x)q + n^e}{1 + n^e - n^x - (1 - a)(1 - q)(1 - n^x)}$$

Differentiating $\bar{u}$ with respect to n^x and n^e allows us to obtain, everything else being equal, the impact of demographic variables on unemployment. We get:

$$\frac{\partial \bar{u}}{\partial n^e} = \frac{a(1 - q)(1 - n^x)(1 - a)}{V^2} \tag{16}$$

$$\frac{\partial \bar{u}}{\partial n^x} = \frac{a(1 - q)n^e(1 - a)}{V^2} \tag{17}$$

with $V = 1 + n_t^e - n_t^x - (1 - a)(1 - q)(1 - n^x)$, the denominator in the expression of $\bar{u}$. Both partial derivatives are positive, so that as n^e or n^x grow, unemployment rises at equilibrium. Quantitative estimates of such elasticities are provided in the text.

A.6 From WS to Phillips

In this section, we show that the latter wage curve could provide structural fundings to the Phillips curve, which is an essentially empirical relation.

A.6.1 The Phillips curve: an empirical relation

The Phillips curve stems from the empirical statement that there is a negative correlation between nominal wage growth and unemployment rate. It conveys the idea that a higher unemployment rate exerts upward pressure on the wages. As there are more unemployed on the labor market, it makes it uneasy to get a higher wage. The Phillips curve is nowadays often showed in his “augmented” form, which includes long-term dependence of nominal wages on prices and productivity. It is also assumed that wage growth is sluggish in the short run. The relation can be written as follows.

$$\Delta w_t = \lambda_0 + \lambda_1 \Delta p_t + (1 - \lambda_1)\Delta p_{t-1} - \lambda_2 u_t + \lambda_3 \Delta a_t$$

Wages, prices and productivity a are written in logs. In the long run, when real wages grow inasmuch as productivity, the unemployment rate reaches its equilibrium value.

$$\bar{u} = \frac{\lambda_0}{\lambda_2} - \frac{1 - \lambda_3}{\lambda_2}\Delta a$$

One can also assume that unemployed can be split into two categories, depending on how long the unemployment spell lasts. In this case, short-spell unemployed are likely to affect more the wage bargaining process than the long-spell ones. To take this effect into account, one can add unemployment rate growth in the Phillips curve.

$$\Delta w_t = \lambda_0 + \lambda_1 \Delta p_t + (1-\lambda_1)\Delta p_{t-1} - \lambda_2 u_t - \lambda_2^{'}(u_t - u_{t-1}) + \lambda_3 \Delta a_t \tag{18}$$

A.6.2 The hypotheses that make it possible to pass from WS to Phillips

We demonstrate in this section that the Phillips curve (18) can be derived from the dynamic wage curve (4). To simplify our demonstration, we simplify flows equations, admitting for now that active population growth rate n is equal to n^e and that $n^x = 0$.

We depart from equation (4). We assume that the fiscal wedge is constant and that unemployment benefits are indexed in nominal terms on wages. We adopt the following notation $\Pi^C_{t+1} = \frac{PC_{t+1}}{PC_t}$, $\Pi^P_{t+1} = \frac{P_{t+1}}{P_t}$ et $\Pi^W_{t+1} = \frac{W_{t+1}}{W_t}$. Then,

$$\beta(1-q)\frac{\Pi^W_{t+1}}{\Pi^C_{t+1}} = \frac{(1-q)u_{t-1} + n + q}{(1+n)u_t} - \frac{\alpha}{\gamma}(1 - BCfs)$$

In the long run we know from the PS curve that there exists a stationary state for prices and wages $(\bar{\Pi}^C, \bar{\Pi}^W)$, which allows us to derive the stationary unemployment rate u^*. Linearizing the latter equation in variables (Π^W_t, Π^C_t, u_t) around the steady state:

$$\beta(1-q)\frac{\bar{\Pi}^W}{\bar{\Pi}^C}\left(\frac{\Pi^W_{t+1} - \bar{\Pi}^W}{\bar{\Pi}^W} - \frac{\Pi^C_{t+1} - \bar{\Pi}^C}{\bar{\Pi}^C}\right) = -\frac{1-q}{1+n}\left(\frac{u_t - u^*}{u^*} - \frac{u_{t-1} - u^*}{u^*}\right) - \frac{n+q}{(1+n)u^*}\frac{u_t - u^*}{u^*}$$

After a log approximation of growth rates:

$$\Delta w_{t+1} = \Delta pc_{t+1} - \frac{1}{\beta(1-q)}\frac{\bar{\Pi}^C}{\bar{\Pi}^W}\frac{n+q}{(1+n)u^*}\frac{u_t - u^*}{u^*} - \frac{1}{\beta(1-q)}\frac{\bar{\Pi}^C}{\bar{\Pi}^W}\frac{1-q}{1+n}\frac{u_t - u_{t-1}}{u^*} + ln\left(\frac{\bar{\Pi}^W}{\bar{\Pi}^C}\right)$$

We then assume short term rigidity for consumption prices, so that both present and lagged VA prices explain present consumption prices:

$$\Delta pc_{t+1} = \lambda \Delta p_{t+1} + (1-\lambda)\Delta p_t$$

In fine, wage bargaining leads to the following equation for wage growth.

$$\begin{aligned} \Delta w_{t+1} &= \lambda \Delta p_{t+1} + (1-\lambda)\Delta p_t \\ &- \frac{1}{\beta(1-q)}\frac{\bar{\Pi}^C}{\bar{\Pi}^W}\frac{n+q}{(1+n)u^*}\frac{u_t - u^*}{u^*} \\ &- \frac{1}{\beta(1-q)}\frac{\bar{\Pi}^C}{\bar{\Pi}^W}\frac{1-q}{1+n}\frac{u_t - u_{t-1}}{u^*} \\ &+ ln\left(\frac{\bar{\Pi}^W}{\bar{\Pi}^C}\right) \end{aligned}$$

It is clear that this latter equation is close to a Phillips curve such as (18), which depends on the unemployment rate both in level and in growth. For this reason, one can regard the Phillips curve as a reduced form of a structural WS wage curve. A drawback of the Phillips approach is that it does not allow any prediction concerning either the impact of certain economic policies, especially tax policies, or the direct influence of demography on the wage formation process and on the unemployment rate. Conversely, some hypotheses used in the WS-PS design are known to be very fragile, and the Phillips approach is a pragmatic and simple way to circumvent that. Except from the structural effects just mentioned, a well-specified WS curve is likely to show the same "Phillips-effect" in the short-run. Choosing between WS or Phillips is, so to say, more a matter of deciding whether structural determinants (taxes, demography) are to be introduced in steady-state value of unemployment rate.

B The Phillips curve calibrated model

B.1 Presentation of the complete model

In a simple IS-LM model, the two main equations are the following. IS derives from the equilibrium of the goods market. Variables involved are value-added Y, consumption C, interest rate r and public spendings G[33]:

$$Y = C(r, Y) + I(r, Y) + G.$$

LM results from the equilibrium of the money market. M is the money supply, P is the price of the unique good of the economy and $L(.,.)$ the money demand function.

$$M = PL(r, Y).$$

Combining these two equations and eliminating the interest rate, we obtain an aggregate demand expression:

$$Y = f(M/P, G).$$

We then assume that public spendings are constant and we log-linearize the previous equation to obtain the following AD equation:

$$y_t = m_t - p_t.$$

We now specify the supply-side of the economy. We assume a constant-return production function which depends of only one factor L. e is labor productivity.

$$y_t = e_t + l_t.$$

N_t being the active population and L_t employment, the unemployment rate is defined as $u_t = 1 - L_t/N_t$. To simplify the computations in our log framework, we use the proxy $u_t = n_t - l_t$.

We then specify the firms price setting behavior, which results from profit maximizing. In a perfectly competitive economy, real wage w/p would equal labor productivity a. Here, we assume monopolistic competition[34], so that a markup μ gets in.

$$p_t = \mu + w_t - e_t.$$

To close the model, we must specify a wage-setting equation, which is the key of the model. We assume that agents observe not only prices but also the labor market situation. Whereas price-setting can be considered to be a firm-only decision, wage-setting results

[33] Except if it is mentioned, we consider real variables.
[34] See Romer (1990).

from interactions between workers and firms. Labor market models essentially differ on the design of wage-setting. Search models put the emphasis on the existence of rigidities on the labor market and on market powers in negotiations. The efficiency wage approach stresses more the principal-agent dimension of the employer-employee relation. Here, we adopt a pragmatic viewpoint: nominal wage evolution depends on prices' evolution, productivity[35] and unemployment. Nominal rigidities are assumed: both current and lagged prices evolutions determine the wage evolution. We thus assume the following log relation:

$$\Delta w_t = \lambda_0 + \lambda_1 \Delta p_t + (1-\lambda_1)\Delta p_{t-1} - \lambda_2 u_t + \lambda_3 \Delta e_t$$

Theoretical *a priori* suggest that the parameters of this equation should comply to some constraints: $\lambda_0 > 0$, $0 < \lambda_1 < 1$, $\lambda_2 > 0$ and $\lambda_3 > 0$.

Combining price-setting and wage-setting equations, we derive the following relation:

$$u_t = \bar{u} - \frac{1-\lambda_1}{\lambda_2}\Delta\Pi_t. \tag{19}$$

where $\Pi_t = \Delta p_t$ stands for inflation and $\bar{u} = \frac{\lambda_0}{\lambda_2} - \frac{1-\lambda_3}{\lambda_2}\Delta e$ is the non-inflating unemployment rate.

Combining the aggregate demand and production function equations, we obtain a second relation between unemployment and inflation.

$$\Pi_t = \bar{\Pi} + \Delta u_t. \tag{20}$$

where $\bar{\Pi} = \Delta m - \Delta n - \Delta e$ is the constant-unemployment inflation rate.

Finally, combining eqs. (19) and (20), we obtain a first-order dynamic system for (Π_t, u_t).

$$\begin{pmatrix} \Pi_t - \bar{\Pi} \\ u_t - \bar{u} \end{pmatrix} = \frac{1-\lambda_1}{\lambda_2 + 1 - \lambda_1} \begin{pmatrix} 1 & -\frac{\lambda_2}{1-\lambda_1} \\ 1 & 1 \end{pmatrix} \begin{pmatrix} \Pi_{t-1} - \bar{\Pi} \\ u_{t-1} - \bar{u} \end{pmatrix}. \tag{21}$$

Eigenvalues for this system are complex.

$$l_1 = \frac{\sqrt{1-\lambda_1}}{\sqrt{\lambda_2+1-\lambda_1}}\left(\frac{\sqrt{1-\lambda_1}}{\sqrt{\lambda_2+1-\lambda_1}} + \frac{\sqrt{\lambda_2}}{\sqrt{\lambda_2+1-\lambda_1}}i\right)$$
$$l_2 = \frac{\sqrt{1-\lambda_1}}{\sqrt{\lambda_2+1-\lambda_1}}\left(\frac{\sqrt{1-\lambda_1}}{\sqrt{\lambda_2+1-\lambda_1}} - \frac{\sqrt{\lambda_2}}{\sqrt{\lambda_2+1-\lambda_1}}i\right)$$

Over the ranges chosen for the parameters, eigenvalues moduluses are negative. Therefore, the system converges to $(0,0)$. Perturbating the system around this steady-state equilibrium, we plot the dynamics in the (Π, u) plan.

B.2 The demographic shock

We consider a one-percent decrease in the active population growth rate. We choose the values of the parameters from Cahuc and Zylberberg (2004)[36]: $\lambda_1 = 0.70$ and $\lambda_2 = 0.51$.

[35] As far as productivity is concerned, we keep in mind a remark by Layard, Nickell and Jackman (1991). Panel studies show no real trend in unemployment series and advocate for the following rule: in a credible model, productivity level should have long-term impacts on unemployment.

[36] In chapter 8, page 484, Cahuc and Zylberberg present an estimation of the very same Phillips equation. We draw our parameters from their estimation.

Different values of the parameters would modify the slope of eq. (7) as well as the amplitude of the oscillations. However, neither the oscillations' frequency nor the long-term impact are modified by a change in these parameters. Figures 7 are 8 display the demographic effects in this model.

C Main hypotheses adopted for simulations with Mésange

Our hypotheses are close to those chosen in Beffy et al. (2003). Data are provided by the INSEE Quarterly Accounts, in Base 1995. Our main hypotheses deal with international environment and monetary policy. We present our hypotheses about exogenous variables in table 9.

Foreign prices evolve at the yearly rate of 2%. As most of international trade is carried out within the EU, we assume projections consistent with ECB objectives. Real interest rates have a long-term target of 2%. Long-term rates have a relative spread of 1.8 point, which is their mean value in the last 20 years.

Table 9: Exogenous variables hypotheses for Mésange simulations

	World Demand to France (a)	Foreign Export prices (a)	Foreign Import prices (a)	Short-term real interest rate (b)	Long-run real interest rate (b)
2003	3,4	-5,3	-3,8	0,5	4,3
2004	7,7	-1,0	-0,2	0,7	2,4
2005	6,3	0,1	0,5	1,0	1,8
2006	4,9	2,0	2,0	1,3	2,5
2010	3,7	2,0	2,0	1,9	3,6
2020	2,2	2,0	2,0	2,0	3,8
2030	1,5	2,0	2,0	2,0	3,8
2040	1,0	2,0	2,0	2,0	3,8

(a): yearly growth rate - (b): level in %

D Wage equations in Mésange

In this section, we provide details about the wage-setting equation used in the Mésange simulations. The other equations are similar to what can be found in Allard-Prigent et al. (2002).

D.1 The WS curve

The WS curve is specified in the following way, omitting constants and time dummies.

$$\begin{aligned} \Delta w^s &= a_1 \Delta w^s_{-1} + a_2 \Delta w^s_{-2} + a_3 \Delta w^s_{-3} \\ &+ b_0 \Delta pc + (1 - a_1 - a_2 - a_3 - b_0) \Delta pc_{-1} + \alpha_{te} \Delta (pc - p) + \alpha_u \Delta u \\ &+ \mu \left(w_{-1} - pc_{-1} + \beta u_{-2} - cfs_{-1} - eff_{-1} \right). \end{aligned} \tag{22}$$

where notations are the following:

- w^s for labor cost (employer labor tax excluded) in the non-agricultural industrial sector. w is the labor cost (employer labor tax included),
- pc is the households' consumption deflator and p the value-added deflator in the non-agricultural industrial sector,
- u the unemployment rate,
- eff the labor efficiency in the non-agricultural industrial sector,
- cfs the fiscal wedge, defined as the ratio between labor cost and net wage (after income tax).

The coefficients are estimated (or set) to the following calibrated values:

- $a_1 = 0.40$, $a_2 = -0.18$, $a_3 = 0.08$ are autoregressive coefficients,
- $b_0 = 0.48$ is the coefficient on consumption prices,
- $\alpha_{te} = -0.24$ is the coefficient on the deflators' spread,
- $\alpha_u = -0.0056$ is the coefficient on unemployment changes,
- $\mu = -0.015$ is the error correction coefficient,
- $\beta = 0.05$ is the long-term labor cost elasticity to unemployment.

To compute a long-term unemployment rate in this framework, we use the error-correction term. At each date, we have:

$$u^*_{WS} = \frac{1}{\beta}\left(\frac{1-0.7}{0.7}(r-p) - cfs - (pc-p)\right) + K_{WS},$$

where :

- r is the interest rate,
- K_{WS} is a constant for the computation of which long-term residuals of price equations are involved.

D.2 The Phillips curve

Using the same notations, the Phillips curve is specified as follows[37]

$$\Delta w = \beta_u u + a_0 \Delta pc + a_1 \Delta pc_{-1} + a_2 \Delta pc_{-2} + \beta_{te} \Delta(p - pc). \tag{23}$$

where coefficients are estimated to the following values:

- $\beta_u = -0.0014$ is the elasticity to unemployment,
- $\beta_{te} = 0.15$ is the coefficient on the deflators' spread,

[37] To estimate this equation, we benefited from remarks by Sterdyniak et al. (1997). After having tested many specifications, we did not include any productivity trend or unemployment hysteresis term in the equation. Moreover, the constraint to sum coefficients a_0, a_1, a_2 to unity was not validated by our tests.

- $a_1 = 0.30$, $a_2 = 0.38$, $a_3 = 0.20$ are the coefficients on current and lagged consumption deflators.

Nairu is a simple notion in simple models. However, in our case, the complexity of the model makes it more difficult to define it. Consumption prices, which are involved in the wage-setting equation, are determined in the long run by the capital cost, the labor cost, and foreign prices. This complexity hinders the definition of an unique PS equation that would allow us to be back to our WS-PS section framework.

However, we may consider equilibrium unemployment as dependent on the equilibrium inflation and productivity growth. We compute a pseudo-equilibrium unemployment that relies on the following hypotheses:

1. the long-term consumption deflator, the long-term value-added deflator and the capital cost are equal,
2. the long-term consumption deflator is proxied by its mean on the fifteen last years of the simulation: $\tilde{\Pi}$.

The long-term unemployment rate in the Phillips case is:

$$u^*_{phil} = \frac{1}{\beta_u}(K_{phil} - \Delta eff - (1 - a_1 - a_2 - a_3)\tilde{\Pi}),$$

where K_{phil} is eq. (23)'s (omitted) constant.

E Mésange simulations with a deficit threshold of 3%

The 1.5% threshold imposed on the fiscal deficit could seem strict regarding the observed past performances in countries of the Monetary Union. The 1.5% threshold has however a structural meaning. It ensures that, under typical economic fluctuations, the deficit will not go under a 3% threshold.

To test the robustness of our results, we simulate the model with another fiscal deficit threshold fixed at 3%. The impact of such a change in terms of public debt accumulation is worth stressing. With a 1.5% threshold, the debt to GDP ratio passes from 63% to 48% between 2005 and 2040 whereas with a 3% threshold it passes from 63% to 76%.

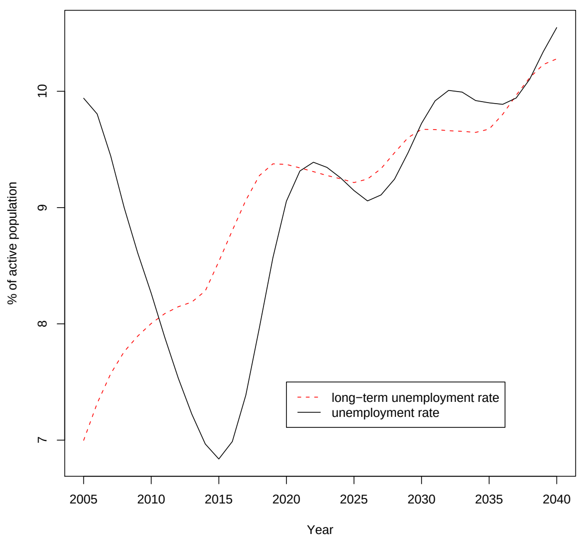
The impact on both the dynamics of the model and the simulation results is not negligible. However, it is more the schedule of the effects that is affected. Figure 15 shows the evolutions of both unemployment and the long-term unemployment in this scenario. Figure 16 shows GDP, domestic demand growths and CSG rate between 2005 and 2040. Figures 17 and 18 compare the paths of CSG rates and unemployment under the 1.5% and the 3% hypotheses. Finally, table 10 gives the long-term values in the 3% scenario and compares it to the 1.5% scenario.

We draw two conclusions from this comparison.

- First, short-term and medium-term dynamics are affected in both scenarios by the strictness of our fiscal rule. Each time the deficit exceeds the threshold, the CSG rate is increased. The increase is enough to prevent the deficit from overcoming the threshold for several years. Each tax increase is associated with a cycle in the economy, as tax has impacts on both the supply-side and the demand-side of the economy. However, the paths of the unemployment rates are close in the two scenarios: decreasing until 2015, increasing afterwards.

- In the long run, table 10 shows that the two scenarios converge. The unemployment rate in the 3% scenario finally catches back the 1.5% unemployment rate, even if it seems lower during the first decades. In a WS-PS framework, a more lenient fiscal rule does not prevent unemployment from increasing. It is, neverless, postponed. Even worse, as the ratio debt over GDP is 30 points higher in the 3%, it is likely that, after 2040, labor market situation will be worse in the 3% scenario.

Figure 15: WS-PS framework and 3% threshold: unemployment and long-term unemployment from 2005 to 2040



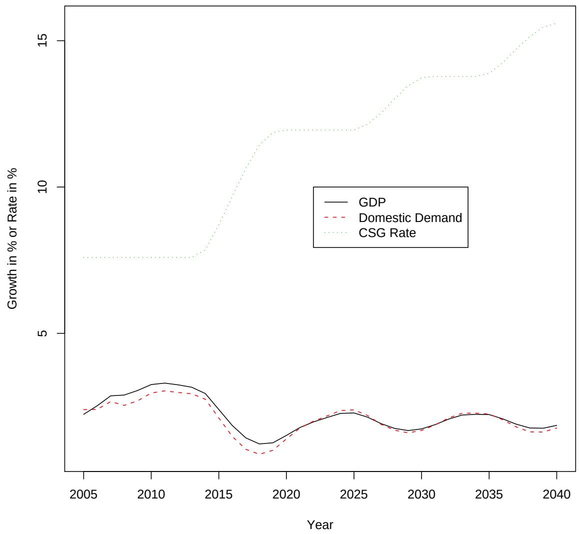
Source : Mésange simulations

Table 10: WS-PS framework: comparison between 1.5% and 3% threshold

	Unemployment rate		GDP growth		GDP level (100 in 2000)		CSG rate	
	1.5%	3%	1.5%	3%	1.5%	3%	1.5%	3%
Long-term	10.7	10.8	1.9	2.0	225	226	16.5	16.1

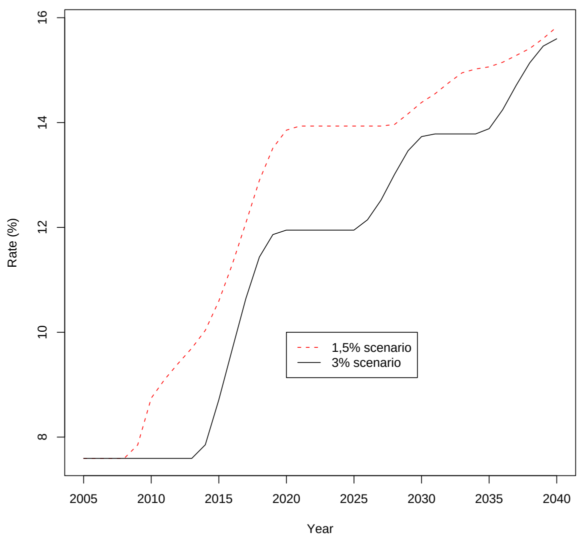
Source : Mésange simulations

Figure 16: WS-PS framework and 3% threshold: GDP, domestic demand and CSG rate between 2005 and 2040



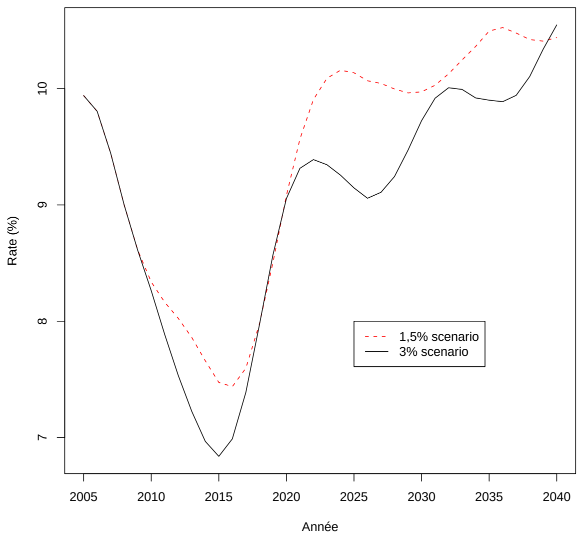
Source : Mésange simulations

Figure 17: WS-PS framework: comparison between 1.5% and 3% threshold for the CSG rate



Source : Mésange simulations

Figure 18: WS-PS framework: comparison between 1.5% and 3% threshold for the unemployment rate



Source : Mésange simulations