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Public jobs creation and Unemployment dynamics*

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Abstract. This paper raises the question of the dynamic effects of public spending in jobs on labor market performance. We use a dynamic matching model and study how public jobs creation affects endogenous workers' decisions to move on the labor market and private-sector firms' job creation and destruction decisions. We obtain that it exerts an attracting effect and a fiscal effect on the labor market that make the unemployment rate and job flows overshoot. As an empirical illustration, we estimate a SVAR model that focuses on the consequences of public job creations on unemployment, wages and job flows dynamics. We confirm our intuition: public employment has a significant ambiguous effect on private wages.

JEL classification: J45, J21

Keywords: Public sector labor market, Unemployment dynamics

Résumé. Ce papier analyse la dynamique transitoire du marché du travail en présence d'emplois publics. Un modèle d'appariement dynamique nous permet d'étudier comment les effets de la création d'emplois publics se propagent dans le temps en présence de deux sources d'éviction: une concurrence entre les secteurs public et privé pour attirer les travailleurs et une pression fiscale qui accroît le coût du travail des entreprises privées. L'effet d'attraction et les externalités fiscales exercées affectent la dynamique du chômage et celle des flux de création et de destruction d'emplois privés. Un modèle vectoriel auto-régressif, appliqué aux données américaines (1972:2-1993:4), illustre empiriquement notre mécanisme théorique. Nos prédictions théoriques sont confirmées: le chômage diminue significativement à court terme suite à la création d'emplois publics et l'emploi public a un effet ambigu significatif sur les salaires privés.

Codes JEL: J45, J21

Mots clés: Emploi public, Dynamique du chômage

1 Introduction

The idea that government intervention acts as a stimulus for economic activity in the short run is popular in traditional Keynesian analysis whereas in the long run, public spending is viewed as an inefficient policy. In this regard, the question of the dynamic effects of public jobs creation on labor market performance is relevant. In the short run, public jobs offset the scarcity of private jobs and reduce unemployment. By offering public infrastructures, the government can exert a positive externality on the productivity of the private sector, increasing labor demand in that sector. However, public jobs creation is also expected to crowd-out private employment, as it increases labor taxes, produces substitutable goods for private ones and exerts wage pressure. This crowding-out effect can be more than complete, leading to an increase in unemployment. Thus, in the long run, public job creation can have no significant effect. In this paper, we propose to study its dynamic effects on unemployment.

Theoretical papers do not have invested the question of the dynamic effects of public jobs creation on labor market performance. Some empirical papers have do it, linking its negative impact to an increase in private wage pressure. Edin and Holmlund (1997) use pooled crossed section and annual time series data for 22 OECD countries over the period 1968-1990. They argue that public sector employment, in the short run, with wages and prices fixed, decreases unemployment, whereas there is no significant long run effect (i.e. in the long run, the crowding-out is complete). Some empirical evidence on dynamic interrelations between aggregate time series on unemployment, real wages and public employment are provided by Malley and Moutos (1996) for Sweden, Malley and Moutos (1998) for Japan, Germany and United-States, Demekas and Kontolemis (2000) for Greece. The crowding-out effect works through a private wage pressure: improvement in employment outlooks increases workers' wage demands, and reduces labor demand. Demekas *et al.* (2000) estimate a vectorial error correction model (VECM) with Greek data (1971:1-1993:4) on public employment, unemployment, private and public real wages. In the long run, the crowding-out is complete and the mean lag (half-life) of the unemployment rate is close to 3 quarters. They use a static job search model where an increase in public wage, or employment, leads through workers' moves on the labor market to a higher increase in private sector wage. The unemployment rate increases as it positively depends on the wage differential between private and public sectors[1]. Malley *et al.* (1996) estimate a VEC model with public employment, private employment and capital stock on Swedish data (1962:3-1990:4). The fall in private employment, due to the increase in public

[1] We believe this result highly depends on some assumptions. Indeed, we expect, as Holmlund (1997), that the crowding-out effect should be more than complete when there is a public wage premium, as the attracting effect of the public sector increases with the relative level of the public wage.

employment, starts after four quarters, with a complete crowding-out effect in five years. In the long run, the crowding-out is more than complete. Malley *et al.* (1998) estimate a vectorial autoregressive model (VAR) with public employment, unemployment and private wages on German data (1960:3-1989:4), on Japan data (1965:4-1994:4) and on US data (1960:3-1996:2). They find that the crowding-out effect of public employment on private employment is complete, i.e. unemployment is not affected by changes in government employment. The mean lag is close to 10 years. However, they argue that this effect doesn't go through a rise in private real wages.

The empirical evidence of a private wage pressure is not clear. Malley *et al.* (1998) use a Choleski decomposition which assumes that unemployment comes before public employment in the causal order. However, they can't give any theoretical or empirical support for this assumption. Demekas *et al.*'s VECM seems not relevant. First, because they use a job search model with exogenous probabilities to move on the labor market. Individuals are perfectly insured such as they have the same utility in and out of the labor market. Second, because the VECM's results (IRF, FEVD) are not discussed. They report a negative correlation between public employment and private wages, which is not consistent with their theoretical model and not informative for the response of private wages to innovations in public employment. They obtain that unemployment is positively correlated with the wage differential but they do not test formally for the positive impact of an increase in the wage differential on unemployment. Malley *et al.* (1996) do not include wages in their VECM. Therefore, we can not conclude on the empirical relevance of private wages as propagation channel of public jobs creation. Malley *et al.* (1998) attribute the fall in private employment to taxes and fixed costs that increase disincentives for private-sector firm and job creation. However, they don't evaluate the relevance of such a propagation channel.

It seems that the wage channel is at best a theoretical possibility for which there is no convincing evidence. The result of a private wage pressure is obtained in bargaining models (Holmlund, 1997, Algan, Cahuc and Zylberberg, 2002) or job search models (Demekas *et al.*, 2000), in which the improvement of employment outlooks increases workers' wage demands. However, fiscal implications of public jobs creation have to be taken into account. If firms can shift all the tax burden onto workers, private wages can decline. If there is no complete shifting, we expect changes in firms' job creation and destruction decisions. Demand studies only find very partial shifting of taxes onto workers (in the form of lower wage rates) and a higher, but not complete, shifting onto labor demand (with time-series data) (Hamermesh, 1993). We believe payroll taxes are a relevant propagation channel of the public crowding-out effect on private labor demand. We propose a theoretical model and a VAR estimation, in which we include private job creation and destruction rates to reflect fiscal distortive effect of public jobs creation and to offset the traditional wage pressure result.

The paper is organized as follows. In Sections 2 and 3, we propose a theoretical mechanism. We use a dynamic matching model. This model permits to study the propagation mechanism of the public shock on the labor market. With endogenous job creation and destruction decisions, the asymmetries that characterize unemployment dynamics are taken into account. Instantaneously, newly created public jobs are filled by the unemployed workers searching for a public job. Thus, in the short run, the unemployment rate decreases and the public sector exerts an attracting effect on private workers. Due to its fiscal implications, public jobs creation affects the private-sector job creation and destruction decisions. The disincentives for private jobs creation that distortive labor taxes generate make the unemployment rate increase. In the long run, the net impact depends on the size of the public wage premium. In Section 4, we empirically invest the question of the dynamic effects of public job creation on the unemployment, private wages, job creation and destruction rates. We use a structural vectorial auto-regressive (SVAR) technique on US data in order to illustrate our model. The data were obtained from the OECD Employment Outlooks, LRD and CPS database. The data cover the period 1972:2-1993:4. We use short-run restrictions (Blanchard, 1989, Davis and Haltiwanger, 1992, Karamé and Mioubi, 1998). We obtain a significant short run fall in the unemployment rate, followed by an overshooting. Labor market flows dynamics are consistent with our matching model. We also obtain that increases in public employment rate are partly due to innovations in unemployment, suggesting a government response to unemployment. Public shock highly affects private wages but the net impact is not clear. Section 5 concludes.

2 A dynamic matching model with public jobs

We consider a dynamic matching model of the labor market with public and private jobs. Our model features three types of agents: private- and public- sectors workers, firms and the government. The size of the labor force is constant and normalized to one. All individuals have the same preferences, live infinite lives and are risk-neutral. There is a common discount rate denoted by r. We consider a framework in which unemployed workers can search either for a public job or for a private job, but not for both types of job at the same time. This assumption is convenient with the fact that, in many OECD countries, the public sector has a specific hiring process, which requires specific knowledge and/or networks. Unemployed workers can move between sectors. They search in the sector in which the return of search is the highest. In equilibrium, there is an arbitrage condition, which implies that the return of search is the same in both sectors. For the sake of simplicity, job to job mobility is not taken into account. There are l_g jobs in the public sector and l_p jobs in the private sector. Accordingly, the number of unemployed workers is: $u = 1 - l_p - l_g$.

2.1 Technologies

In the private sector, each firm has one job. When the job is filled, it produces a numeraire output, using labor. All new jobs are created at maximum productivity[2]. We note px the productivity of a private job where p is a general productivity parameter and x an idiosyncratic one. p is a positive constant parameter. When a shock arrives, the idiosyncratic productivity is drawn from a general distribution $F(x)$, with $0 \leq x \leq eu$. This productivity is independent of initial productivity and irreversible. Idiosyncratic shocks arrive to jobs at Poisson rate q_p. Note $J^p(x)$ the value of a filled job with idiosyncratic productivity x. At some of the idiosyncratic productivities that firms face, production is profitable, but at some others it is not. When a shock arrives, it can be shown that the optimal decision for the firm is to continue production at the new productivity if $J^p(x) \geq 0$ but to destroy the job if $J^p(x) < 0$. As $J^p(x)$ is a monotone continuous increasing function of x, the job destruction rule $J^p(x) < 0$ satisfies the reservation property with respect to the reservation productivity R, defined by $J^p(R) = 0$. By the reservation property, firms destroy all jobs with idiosyncratic productivity $x \leq R$ and continue producing in all jobs with productivity $x > R$[3].

In the public sector, each job produces one unit of public goods, which are consumed by all individuals. Public goods provide $v(l_g)$ utility. This utility is increasing at a decreasing rate in the amount of the public good, i.e. $v'(l_g) > 0$ and $v''(l_g) < 0$. The public-sector employment and wage levels are exogenous. Public jobs are destroyed at rate q_g.

2.2 Matching function

Our model borrows from Mortensen and Pissarides (1994). In the private sector, hiring a worker and searching for a job are costly activities. Private vacant jobs and unemployed workers are brought together in pairs through an imperfect matching process. We assume a matching function that gives the number of jobs formed, at any moment in time, as a function of the number of workers looking for jobs and the number of firms looking for workers. A job can be filled or vacant, but only vacant jobs search for workers. Similarly, a worker can be employed or unemployed, but only unemployed workers search for jobs.

[2] Newly-created jobs are assumed more productive than existing ones, as they benefit from the best technology in the market. We would obtain the same qualitative results with a stochastic matching model.

[3] Using a minimum required idiosyncratic productivity explains why firms shut down rather than make marginal changes that would allow them to continue in existence.

Let u_p denote the number of unemployed workers who look for a private job and v_p the number of vacancies in the private sector. The number of employer-worker contacts per unit of time is given by $m(u_p, v_p)$. The matching function is twice continuously differentiable, increasing and concave in both of its arguments, and linearly homogeneous. Linear homogeneity of the matching function allows to express the per period probability for a private vacant job (unemployed worker) to meet an unemployed worker (a vacant job) as a function of the labor market tightness ratio, $\theta = v_p/u_p$. A vacant job can meet on average $m(u_p, v_p)/v_p = m(\theta)$ unemployed workers per period, with $m'(\cdot) < 0$. Similarly, the rate at which unemployed job seekers can meet private jobs at each date is $\theta m(\theta)$, an increasing function of θ. Since private jobs are destroyed at rate $q_p F(R)$, the evolution of mean private-sector unemployment is given by the difference between the two flows:

$$\dot{u}_p = q_p F(R) l_p - \theta m(\theta) u_p. \tag{1}$$

In the public sector, the government recruits employees at random among the u_g unemployed workers who look for a public job. The evolution of public-sector unemployment is therefore given by:

$$\dot{u}_g = q_g l_g - g u_g. \tag{2}$$

So, the evolution of total unemployment reads:

$$\dot{u} = q_p F(R) l_p + q_g l_g - \theta m(\theta) u_p - g u_g. \tag{3}$$

2.3 Expected asset values

Expected profit from a filled job and from a vacant job

Using the discount rate r, the present-discounted value of expected profit from an occupied job, with productivity in the range $R \leq x \leq eu$, satisfies:

$$rJ^p(x) = px - w_p(x)(1+\tau) + q_p \int_R^{eu} J^p(s) dF(s) + q_p F(R) V^p - q_p J^p(x) + \dot{J}^p(x), \tag{4}$$

where $w_p(x)$ is the wage rate, which is determined by a bargain between the firm and the worker for all $R < x \leq eu$. Wages are taxed at the distortive rate τ. Whenever an idiosyncratic shock arrives, the firm continues producing for a new value $J^p(s)$ if the new idiosyncratic productivity is in the range $R < s \leq eu$, or destroys the job for an expected return V^p otherwise. $\dot{J}^p$ is the expected capital gain from changes in job value during adjustment.

V^p is the present-discounted value of expected profit from a vacant job and it is given by:

$$rV^p = -h + m(\theta) \left[J^p(eu) - V^p \right] + \dot{V}^p,$$

with h the hiring cost. In our simulations, this cost will be made proportional to the mean productivity, as it is assumed that it is more costly to hire more productive workers.

We assume that all profit opportunities from new jobs are exploited in the steady state and out of it, driving rents from vacant jobs to zero $V^p = \dot{V}^p = 0$, which implies:

$$J^p(eu) = \frac{h}{m(\theta)}$$

This condition states that in equilibrium, private-sector labor market tightness is such that the expected profit from a new job is equal to the expected cost of hiring a worker.

Expected utilities of workers

We have neglected labor intensity and search costs. A private- or public-sector worker instantaneously enjoys the utility from his wage rate, $w_p(x)$ or w_g, and from public goods, $v(l_g)$. The unemployed workers enjoy unemployment benefits, z, and public goods, $v(l_g)$[4]. Let $W_e^p(x)$, W_e^g, W_u^p and W_u^g denote, respectively, the expected present values of the lifetime utility for privately employed, publicly employed or unemployed workers.

In the private sector, the returns from working at a job with idiosyncratic productivity $x \epsilon]R, eu]$ satisfy:

$$rW_e^p(x) = w_p(x) + v(l_g) + q_p \int_R^{eu} W_e^p(s)dF(s) + q_p F(R) W_u^p - q_p W_e^p(x) + \dot{W}_e^p(x), \tag{5}$$

$$rW_u^p = z + v(l_g) + \theta m(\theta) \left[W_e^p(eu) - W_u^p \right] + \dot{W}_u^p, \tag{6}$$

$$rW_e^g = w_g + v(l_g) + q_g \left[W_u^g - W_e^g \right] + \dot{W}_e^g,$$

$$rW_u^g = z + v(l_g) + g \left[W_e^g - W_u^g \right] + \dot{W}_u^p. \tag{7}$$

Whenever a shock arrives, the private-sector worker remains employed for new returns $W_e^p(s)$ if the new idiosyncratic productivity is in the range $R < s \leq eu$, or becomes unemployed for an expected return W_u^p otherwise.

[4] Considering exogenous unemployment benefits permit to obtain a partial shifting of the tax burden onto workers. With unemployment benefits index-linked on current private wages, firms would shift all the tax burden onto workers, through lower wages. However, note that the unemployment dynamics would be the same as with exogenous benefits.

2.4 Steady-state equilibrium

In the steady-state, the mean rate of unemployment is constant, $\dot{u} = 0$. Its steady-state value is:

$$u = \frac{q_p F(R)}{\theta m(\theta)} l_p + \frac{q_g}{g} l_g. \tag{8}$$

Therefore, in equilibrium, the mean number of workers who go on unemployment $q_p F(R) l_p + q_g l_g$ is equal to the mean number of workers who get out of unemployment $\theta m(\theta) u_p + g u_g$. In the steady-state, the expected capital gains, during adjustment, from changes in jobs value or in utilities are null, $\dot{J}^p(x) = \dot{W}^p_e(x) = \dot{W}^p_u = \dot{W}^p_u = \dot{W}^p_u = 0$.

Sharing rule

The private wage rate derived from the Nash bargaining solution is the one that maximizes the weighted product of the worker's and the firm's net return from the job match $S(x) = W^p_e(x) - W^p_u + J^p(x) - V^p$. It satisfies $w_p(x) = \arg\max \left(W^p_e(x) - W^p_u\right)^\gamma \left(J^p(x) - V^p\right)^{1-\gamma}$, with $\gamma \in [0,1]$ the relative measure of labor's bargaining strength. The first-order maximization condition gives the sharing rule:

$$W^p_e(x) - W^p_u = \frac{\gamma}{\gamma + (1-\gamma)(1+\tau)} (W^p_e(x) - W^p_u + J^p(x)), \tag{9}$$

where $\gamma/[\gamma + (1-\gamma)(1+\tau)]$ is the worker's share in total surplus, which decreases with a rise in the tax rate.

By substituting $W^p_e(x)$, W^p_u and $J^p(x)$ from (5), (6) and (4) into (9), one gets:

$$w_p(x) = (1-\gamma) z + \frac{\gamma}{1+\tau} (px + h\theta), \tag{10}$$

with $x \epsilon]R, eu]$.

So, the mean expected wage rate of a private employed worker reads:

$$E\left(w_p(x)/x > R\right) = (1-\gamma) z + \frac{\gamma}{1+\tau} (pE\left(x/x > R\right) + h\theta).$$

with $E\left(x/x > R\right) = \left[\left(\frac{q_p F(R)}{q_p} l_p\right) eu + \left(\frac{q_p(1-F(R))}{q_p} l_p\right) \int_R^{eu} x \frac{dF(x)}{1-F(R)}\right] / l_p$ the mean idiosyncratic productivity. We note $\bar{w}_p$ the mean wage rate. This wage is renegociated when a new information arrives.

Private-sector job creation and destruction conditions

Substitution of the wage equation (10) into (4) gives

$$(r + q_p) J^p(x) = (1-\gamma)(px - z(1+\tau)) - \gamma h\theta + q_p \int_R^{eu} J^p(s) dF(s). \tag{11}$$

Evaluating (11) at $x = R$ and subtracting the resulting equation from (11) after noting $J^p(R) = 0$, we get

$$(r + q_p)J^p(x) = (1 - \gamma)p(x - R). \tag{12}$$

Substituting $J^p(x)$ from (12) into the integral expression of (11) gives

$$(r + q_p)J^p(x) = (1 - \gamma)(px - z(1 + \tau)) - \gamma h\theta + \frac{q_p(1 - \gamma)p}{r + q_p} \int_R^{eu} (s - R)dF(s). \tag{13}$$

To derive the condition for private-sector job creation, we evaluate (12) at $x = eu$ and use the zero-profit condition,

$$(1 - \gamma)p\frac{eu - R}{r + q_p} = \frac{h}{m(\theta)}. \tag{14}$$

The expected gain from a new job to the firm must be equal to the expected hiring cost that the firm has to pay. The job creation curve is a downward-sloping curve in the space (θ, R). Indeed, at higher R, the expected life of a job is shorter, so firms create fewer jobs and θ is lower.

To derive the condition for private-sector job destruction, we evaluate (13) at $x = R$ and use the zero-profit condition,

$$R - \frac{z(1 + \tau)}{p} - \frac{\gamma h\theta}{(1 - \gamma)p} + \frac{q_p}{r + q_p} \int_R^{eu} (s - R)dF(s) = 0. \tag{15}$$

The job destruction curve is an upward-sloping curve in the space (θ, R). Indeed, at higher θ, the workers' outside opportunities are better (and wages are higher) and so the reservation productivity R is higher.

Arbitrage condition

The return of search is the same in both sectors, such as the expected utilities of unemployed workers are equal in both sectors. The expected utilities of public- and private-sectors unemployed workers can be rewritten respectively

$$rW_u^g = z + v(l_g) + g\frac{w_g - z}{r + q_g + g},$$

and

$$W_u^p = z + v(l_g) + \frac{\gamma}{1 - \gamma}\frac{h\theta}{1 + \tau}.$$

The arbitrage condition, $rW_u^g = rW_u^p$, gives the equilibrium value of g, the rate at which unemployed job seekers can meet public jobs:

$$g = \frac{\gamma h\theta(r + q_g)}{[w_g - z]\,(1 - \gamma)(1 + \tau) - \gamma h\theta}. \tag{16}$$

Budget constraint

Taxes finance public employment and unemployment benefits. Then, the budget constraint depends on a predetermined variable, the unemployment rate. For the sake of simplicity, we relax this constraint, assuming that there is a perfect capital market[5]. The government can rent into debt at zero cost during adjustment. In the steady state and out-of it, the following budget constraint has to be fulfilled:

$$\int_0^\infty \left[\tau \bar{w}_p l_p(t)\right] e^{-rt} dt = \int_0^\infty \left[w_g l_g + z u(t)\right] e^{-rt} dt. \tag{17}$$

with $x \epsilon]R, eu]$.

The properties of the steady-state are obtained from the simultaneous solution of the equations of the model. The private and public-sector unemployment rates u_p and u_g are given by the respective steady-state conditions (1) and (2) in terms of the private- and public-sector job flows. The private-sector job creation (14) and destruction (15) conditions determine the reservation productivity R and the labor market tightness θ. The probability to move into public employment g is obtained from the arbitrage condition (16). The mean private-sector wage $\bar{w}_p$ is obtained from the sharing rule (10). The budget constraint (17) determines the tax rate[6] τ.

2.5 Out-of steady-state equilibrium

The out-of-steady-state dynamics of unemployment are given by equation (3)[7]. The matching technology does not allow jumps in job formation (firms and workers can't create jobs without delay). The matching process is a backward-looking process that is governed by the difference between the job creation and the job destruction flows, making unemployment a predetermined variable at any moment in time.

We assume that firms can open and close vacancies without delay. This assumption implies that the zero-profit condition for new vacancies holds in and out of steady state $V^p = \dot{V}^p = 0$. Then,

[5] We consider in Appendix 6.2 that the budget constraint has to be fulfilled at each period. In this case, endogenous variables of our model are no more jump variables.

[6] Assuming that R, θ, $\bar{w}_p$ and g are jump variables, we integrate the differential equations (3) and (2) between 0 and t:

$$u(t) = \frac{b}{a} + \left[u_0 + (\theta m(\theta) - g) \int_0^t e^{ax} u_g(x) dx - \frac{b}{a}\right] e^{-at},$$

and

$$u_g(t) = \frac{q_g l_g}{g} + \left[u_{g0} - \frac{q_g l_g}{g}\right] e^{-gt},$$

with $a = q_p F(R) + \theta m(\theta)$, $b = q_p F(R)(1 - l_g) + q_g l_g$, $d = g$, $h = q_g l_g$.

We integrate the budget constraint and substitute $u_g(t)$ into $u(t)$:

$$\int_0^\infty \left[\tau \bar{w}_p (1 - l_g - u(t))\right] e^{-rt} dt = \int_0^\infty \left[w_g l_g + z u(t)\right] e^{-rt} dt,$$

with

$$u(t) = \frac{b}{a}\left(1 - e^{-at}\right) + u_0 e^{-at} + (\theta m(\theta) - g)\frac{q_g l_g}{da}(1 - e^{-at}) + (\theta m(\theta) - g)\left(u_{g0} - \frac{q_g l_g}{g}\right)\frac{1}{a-g}(e^{-bt} - e^{-at}).$$

[7] The analysis of the stability of our solution is reported in Appendix 6.1.

labor market tightness θ is a jump variable. We also assume that firms can destroy unprofitable jobs without delay. This assumption implies that the zero-profit condition satisfied by R holds in and out of steady state $J^p(R) = \dot{J}^p(R) = 0$. So, R is a jump variable and must be on its steady state value at all times. We assume that the sharing rule holds in and out of steady state, consistent with the assumption that the firm and worker can renegotiate any time new information. This assumption also requires that the mean private wage $\bar{w}_p$ is a jump, forward-looking variable. The arbitrage condition is an instantaneous relation. It implies that the return of search is the same in both sectors in and out of steady state, making g a jump variable. With a perfect capital market, θ, R, $\bar{w}_p$ and g are jump variables, with a fixed τ.

2.6 Calibration

The model is calibrated in order to match the US economy, at the end of 90's. The basis period is taken to be 1 quarter. We adopt the following constant returns, Cobb-Douglas matching function $m(u_p, v_p) = Au_p^\eta v_p^{1-\eta}$, with A an efficiency parameter. The elasticity of the matching function η and the bargaining power γ of the employees amount to 0.5. General productivity p is normalized at unity. The distribution of productivity shocks is assumed to be uniform on the support $[\varepsilon l, \varepsilon u]$, that is $F(x) = \frac{x-\varepsilon l}{\varepsilon u-\varepsilon l}$ (Mortensen and Pissarides, 1999). Maximum productivity εu is set to reproduce an unemployment rate u of 4.6% (OECD, 1996-2000). We use the CPS data for 15-64 population on the period 1996-2000. The data report that the mean probability, during one month, to lose his job for a private (public) worker is 1.33% (0.63%). We use these monthly informations to compute quarterly destruction rates. In the same way, the quaterly discount rate r is calibrated on the montly rate of .5%. The search cost h of a firm is set to represent 1/3 of the mean productivity of an employee, to be consistent with survey results reported by Hamermesh (1993). Unemployment benefits are calibrated to reproduce the mean observed replacement ratio (Martin, 1996). The public wage w_g is calibrated to reproduce the mean wage gap between the public and private sectors. The payroll tax rate τ is calibrated such as the public budget constraint is balanced. Our calibration is sum-up in Table 1.

TAB. 1 – Baseline values of parameters

r	el	eu	η	γ	p	A	$q_pF(R)$	q_g	h	z	w_g	τ
.015	0	.54	.5	.5	1	1	.04	.019	$1/3p\bar{x}$	$.12\bar{w}_p$	$1.18\bar{w}_p$	.21

3 Public jobs creation and labor market flows

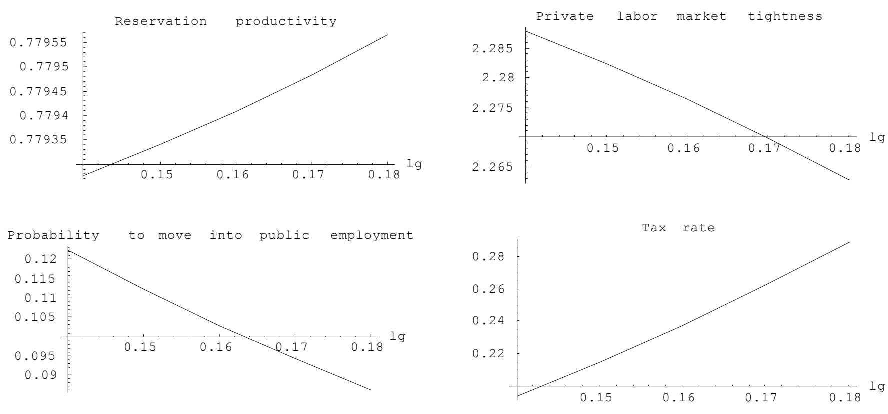
We analyze the effects of public jobs creation on the labor market. Externalities arise as this public policy reinforces the competition between public and private jobs and the fiscal distorsions. A rise in public employment increases the public share of the labor force and decreases the private share. Out-of steady state, unemployment decreases in the short term.

3.1 Steady-state effects of public jobs creation

We study in this section the steady-state effects of a public jobs creation on the unemployment rate. The impact of public employment goes through an "attracting effect", i.e. voluntary workers' flows between sectors, and a "tax effect", which changes private-sector job creation and destruction conditions.

An increase in the public employment rate l_g improves job opportunities of unemployed workers searching for a public job. Their expected utility increase. As unemployed workers search in the sector that gives the best return, these utility gains attract unemployed workers searching for a private job. Voluntary unemployed workers' flows between sectors induce a congestion effect which reduces the probability to move into public employment g. These moves permit to maintain the indifference of unemployed workers to the two sectors. Then, the attracting effect increases the number of unemployed workers searching for a public job u_g and reduces the number of unemployed workers searching for a private job u_p (Graph 2).

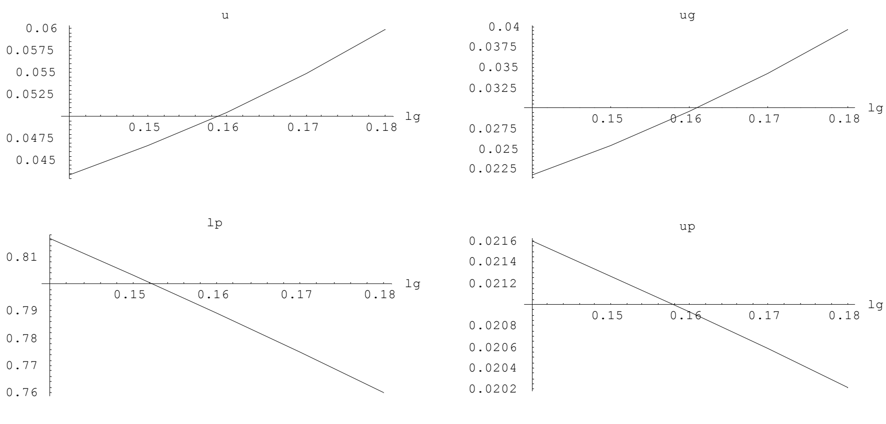
Due to the decrease in the private unemployment rate, with v_p given, the private labor market tightness θ tends to increase. So, the probability $m(\theta)$ that a match occurs between an unemployed worker and a vacant job in the private sector decreases, making the expected cost of hiring a worker higher. Moreover, it increases the private wage pressure as the exit rate from private unemployment $\theta m(\theta)$ increases. Firms open less vacancies such as the labor market tightness θ and the private wage $\bar{w}_p$ remain unchanged. The attracting effect reduces the number of private employed workers l_p (Graph 2).



GRAPH. 1 – The steady-state effects on R, θ, g and τ

Under the budget constraint, the tax rate τ increases in order to finance new public jobs. This increases the private-sector net cost of labor, decreasing the expected return from a job. Firms open less vacancies, making the labor market tightness θ lower. As profitability conditions are changed, the reservation productivity R increases (Graph 1). There are less job creations and more job destructions. The tax effect increase the level of private unemployment u_p and decreases the level of private employment l_p. Moreover, the increase in the tax rate τ and the decrease in the labor market tightness θ reduce the worker's bargaining strength. Firm partially shift the tax burden onto workers: the private wage rate $\bar{w}_p$ and the expected utility of a private unemployed worker decrease. Then, the attracting effect is reinforced: more unemployed workers move from the private sector to the public sector. These additional workers' flows induce a higher public unemployment rate u_g, decreasing the public labor market tightness. The exit rate from public unemployment g falls such as unemployed workers remain indifferent to the two sectors (Graph 1).

Whereas the attracting effect decreases the private unemployment rate u_p through workers' flows between sectors, the tax effect increases it due to the fall in the expected return from a private job. The net effect will depend on the parameter values which affect the probabilities to move on the labor market and the private-sector job creation and destruction conditions. With our calibration, the attracting effect dominates the tax effect, as the private unemployment rate reaches a lower new steady-state value (Graph 2)[8]. The steady-state effects of public jobs creation are to decrease the private-sector labor force $(l_p + u_p)$ and to increase the public-sector labor force $(l_g + u_g)$. There are more unemployed workers u in this economy (Graph 2).



GRAPH. 2 – The steady-state effects on u, u_g, l_p and u_p

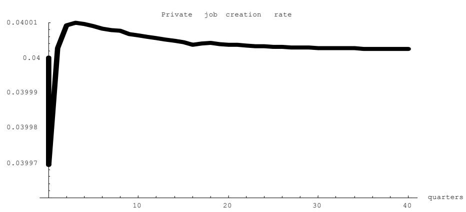
[8]Let us consider an higher replacement rate, which improves the worker's bargaining strength. The expected return of a job is lower and the tax effect induces a higher increase in R. The tax effect dominates theattracting effect, and the private unemployment rate increases.

3.2 Out-of Steady-State Dynamics

We analyze, in this section, the out of steady-state dynamics of the unemployment rate.

Instantaneously

Instantaneously, newly created public jobs are filled by the unemployed workers searching for a public job. Thus, the public-sector unemployment rate u_g instantaneously falls (Graph 4)[9]. The increase in public employment rate is financed through a rise in the tax rate τ_F such as the intertemporal budget constraint remains balanced. This tax rises the private-sector net cost of labor. Therefore, it affects the private-sector job creation and destruction conditions. The reservation productivity R increases and the labor market tightness θ decreases. The job destruction rate $q_p F(R)$ goes up to a higher value, but instantaneously all jobs whose idiosyncratic productivity x is below the new value of R are destroyed. Thus, at the time of the impact, the private job destruction rate jumps to a higher value and then returns to its new steady state value. Given the mass of jobs destroyed, there is instantaneously an over-adjustment of the job destruction rate relatively to its real new steady state value. The private unemployment rate instantaneously rises (Graph 4). The private job creation rate falls (Graph 3), but because private unemployment rate rises with the instantaneous destruction of new unprofitable jobs, it does not fall by the full amount that would have fallen at given u_p[10]. Thus, instantaneously, the private-sector employment rate l_p decreases (Graph 4). The public jobs creation instantaneously decreases the public unemployment rate u_g and the private employment rate l_p and increases the private unemployment rate u_p. The total unemployment rate u instantaneously falls (Graph 4). This fall is lower than the one in public employment rate due to instantaneous private job destructions[11].



GRAPH. 3 – Out-of steady-state dynamic of the private job creation rate

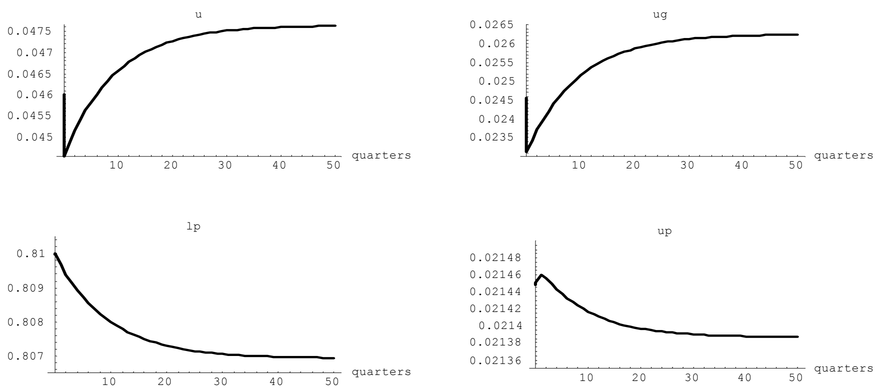
[9] Note that the sign of this result would not be affected assuming endogenous labor market participation. With public goods valuable out of the labor market, even if public jobs creation improves employment outlooks, workers would choose to stay out of the labor force or to leave it.

[10] See Pissarides (2000) for more details.

[11] As stressed by Hamermesh (1993), true dynamic firms' responses take time. These decisions are affected by the structure of the adjustment costs and by how employers forecast the path of shocks. There could be discontinuities in firm's responses to a shock. If public jobs creation changes the cost of setting up a vacancy, it doesn't mean that private firms reduce job creation in a smooth way. There might be some inertia, and only when lost profits from being out of equilibrium are large, job creation behavior is altered. Assuming fixed costs, the dynamic would be roughly the same: the labor demand would jump. Assuming variable costs, the adjustment of employment would be slower.

Labor market dynamics

We simulate the labor market dynamics due to a 1% increase in the public employment rate. The public job creation rate $\frac{gu_g}{l_g}$ decreases whereas the public job destruction rate $\frac{q_g l_g}{l_g}$ does not change. The public-sector unemployment rate u_g has to increase (Graph 4) until the public job creation rate rises up to the level of the public job destruction rate (equation 2). The mean lag of the public unemployment rate is close to 7 quarters[12]. The increase in u_g is obtained through a move of unemployed workers from the private sector to the public sector (Section 3.1). Dynamic adjustment in the private unemployment and employment rates follows the jumps in R and θ: the private unemployment rate u_p increases and the private employment rate l_p decreases. In the very short term, this makes the private job creation rate $\frac{\theta m(\theta) u_p}{l_p}$ increases (Graph 3) whereas the private job destruction rate $\frac{q_p F(R) l_p}{l_p}$ is on its new steady state value. There is an over-adjustment of the job creation rate, before it reaches its new steady state value. This behavior is due to the instantaneous jump in the job destruction rate. A fraction of the private labor force becomes unemployed. The number of workers who wait for a job and the job creation rate increase. Due to voluntary private workers' moves, the private-sector unemployment rate u_p decreases. The private job creation rate $\frac{\theta m(\theta) u_p}{l_p}$ decreases to reach the level of the private job destruction rate (Graph 3). The private employment rate l_p unambiguously decreases (Graph 4). Total unemployment u starts moving according to (3). The new steady-state level of unemployment u is higher than in the initial steady-state equilibrium (Graph 4).



GRAPH. 4 – Out-of steady-state dynamics of the unemployment and employment rates

The mean lag for unemployment's adjustment is close to 7 quarters[13]. With our calibration,

[12] See Appendix 6.3.
[13] See Appendix 6.3.

creation of one public job destroys 2.12 private jobs and increases the number of unemployed workers by 1.12. There are relatively more public-sector unemployed workers (the number rises by 1.17) and less private-sector unemployed workers (the number falls by 0.05) compared to the initial steady-state equilibrium. The size of the crowding-out effect would be the same with a complete shifting of the tax burden onto workers. It depends on the attraction that public sector exerts (relative wages, job security, non wages benefits,...). In our model, public job security and wage premium affect this attraction. Higher public wages and less "risky" jobs will attract more workers into wait unemployment in the public sector, ceteris paribus. And the higher the attraction, the higher the crowding-out effect.

4 A SVAR analysis of the dynamic effects of public jobs creation

We study the dynamic effects of public jobs creation on the unemployment rate, using a SVAR technique. This work consists in estimating the unconstrained reduced form summarizing the joint process of our variables. Then it consists in using a set of just-identifying restrictions to go from the reduced-form innovations to a set of uncorrelated structural innovations. We report the impulse response functions (IRF) of each variable to an innovation in each shock equivalent to a 1% point rise. We analyze the contribution of each structural shock to the variance of the k-quarter ahead forecast error for each endogenous variable.

4.1 Svar specification

Data

The data were obtained from the OECD Employment Outlooks database. The unemployment rate is the ratio of unemployment to the total labor force (Figure 1). The public employment rate is the ratio of general government employment to the labor force. According to the OECD definition (1997), public employment consists of jobs in central and local administrations, in non-profit organizations controlled or financed by public administrations and in military and diplomatic entities (Figure 1). The definition does not include public firms owned or controlled by the government. The private real wage rate corresponds to the ratio of private wages on the GDP deflator (Figure 2).

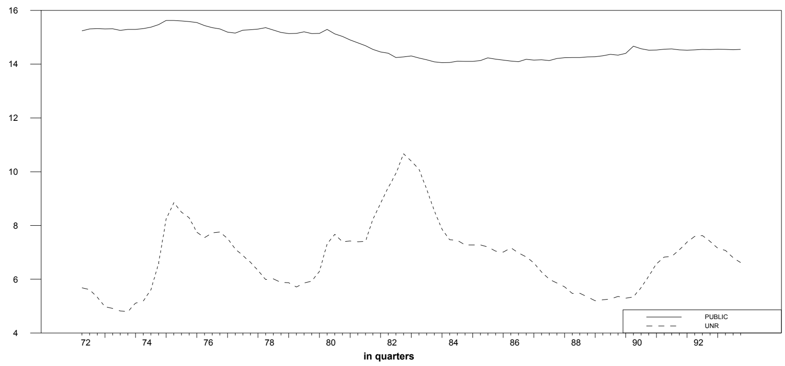


FIG. 1 – Public employment and unemployment rates in United-States from 1972:2 to 1993:4

We use the job creation and destruction rates calculated by Davis and Haltiwanger (1990, 1992) (which combined information from the Longitidunal Research Datafile and the Current Population Survey). They measure workers' inflows and outflows for the US establishments of 5 employees and more in the manufacturing sector[14] (Figure 3). Sample runs from 1972:2 to 1993:4.

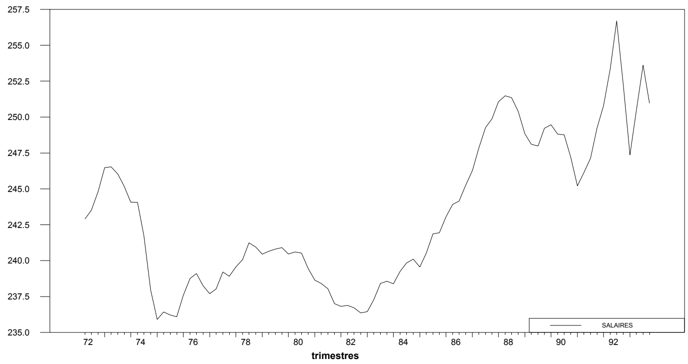


FIG. 2 – Private real wage rate, United-States (1972:2-1993:4). Source: OCDE.

[14]As the manufacturing sector not produces substitutable goods for public ones, we expect that the effect of public employment on private job flows only goes through wages and taxes.

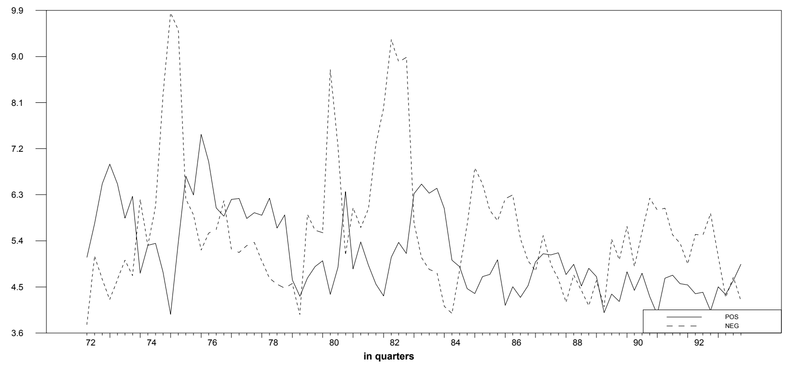


FIG. 3 – Private manufactured job creation and job destruction rates in United States from 1972:2 to 1993:4

Specification

Data are available at a quarterly frequency and are seasonally adjusted. We have introduced in our model dummies for recessions. ADF (and Phillips-Perron) and KPSS unit root tests are performed (Appendix 6.4). They indicate that public employment series *pub* and private real wage rates w are stationary in first difference I(1) whereas unemployment series *cho*, private job creation c and destruction rates d series are I(0). The optimal VAR lag-length is derived from the usual criteria (AIC, BIC, ...), leading to a choice of 2 lags. Estimated residuals satisfy all specification tests and our model satisfies stability tests.

4.2 Structural innovations identification

We estimate the following reduced-form model:

$$A(L)\begin{bmatrix}\Delta pub_t\\ cho_t\\ \Delta w_t\\ c_t\\ d_t\end{bmatrix}=\begin{bmatrix}u_t^{\Delta pub}\\ u_t^{cho}\\ u_t^{\Delta w}\\ u_t^{c}\\ u_t^{d}\end{bmatrix}$$

with *pub* the public employment rate, *cho* the unemployment rate, w the private real wage rate, c the job creation rate and d the private job destruction rate in the manufacturing sector. u_t is the vector of reduced-form innovations. This reduced-form summarizes the sample information about the joint process of our variables. To go from the reduced-form innovations to uncorrelated structural innovations, one needs a set of identifying restrictions. The orthogonalization of reduced-form innovations allows us to disentangle the dynamic effects of each disturbance. We use here short-run restrictions, i.e. we constrain the contemporaneous effects of innovations on our variables.

We assume the existence of five structural disturbances: a public shock ε_t^g, a supply shock ε_t^s, a wage shock ε_t^w, an aggregate demand shock ε_t^a and a reallocation shock ε_t^r.

Orthogonalization of reduced-form innovations

Reduced-form innovations are related to structural innovations by:

$$u_t = D\varepsilon_t \Leftrightarrow \begin{bmatrix} u_t^{\Delta pub} \\ u_t^{cho} \\ u_t^{\Delta w} \\ u_t^{c} \\ u_t^{d} \end{bmatrix} = \begin{bmatrix} d_{11} & d_{12} & d_{13} & d_{14} & d_{15} \\ d_{21} & d_{22} & d_{23} & d_{24} & d_{25} \\ d_{31} & d_{32} & d_{33} & d_{34} & d_{35} \\ d_{41} & d_{42} & d_{43} & d_{44} & d_{45} \\ d_{51} & d_{52} & d_{53} & d_{54} & d_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^s \\ \varepsilon_t^w \\ \varepsilon_t^a \\ \varepsilon_t^r \end{bmatrix} \tag{18}$$

where u_t is the vector of reduced-form innovations, ε_t the vector of white-noise innovations to structural disturbances and D a matrix of full rank. The relation (18) can be expressed in terms of covariance matrices:

$$V\left(\begin{bmatrix} u_t^{\Delta pub} \\ u_t^{cho} \\ u_t^{\Delta w} \\ u_t^{c} \\ u_t^{d} \end{bmatrix}\right) = V\left(\begin{bmatrix} d_{11} & d_{12} & d_{13} & d_{14} & d_{15} \\ d_{21} & d_{22} & d_{23} & d_{24} & d_{25} \\ d_{31} & d_{32} & d_{33} & d_{34} & d_{35} \\ d_{41} & d_{42} & d_{43} & d_{44} & d_{45} \\ d_{51} & d_{52} & d_{53} & d_{54} & d_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^s \\ \varepsilon_t^w \\ \varepsilon_t^a \\ \varepsilon_t^r \end{bmatrix}\right) \Leftrightarrow \Sigma_u = D^{'}\Sigma_\varepsilon D \tag{19}$$

where Σ_u is the covariance matrix of reduced-form innovations and Σ_ε the one of structural innovations. Given the assumption of zero correlation across innovations, the covariance matrix of the structural innovations is diagonal. It includes 5 unknowns. Matrix D includes 25 unknown parameters. The relation (19) contains 30 unknown parameters. As the covariance matrix, Σ_u, contains 15 independent moments (this matrix is symmetrical), we only need 15 just-identifying restrictions. We normalize the diagonal elements of D to unity. We need 10 short-run restrictions on D.

Structural innovations definition

- Innovations in public employment are attributed to public jobs innovations ε_t^g. In our model, a theoretical mechanism is proposed that explain the dynamic effects of public jobs creation. Newly created public jobs are instantaneously filled by unemployed workers: a public employment shock has an instantaneous negative impact on the unemployment rate ($d_{21} < 0$). Due to its fiscal implications, we expect a decrease in private job creation ($d_{41} < 0$) and an increase in job destruction ($d_{51} > 0$). The matching process does not allow jump in job formation whereas job destructions can arise without delay. Empirical studies confirm that job destructions are more volatile than job creations (Davis *et al.*, 1990, 1992). The contemporaneous job creation response to the shock is smaller in magnitude than the contemporaneous destruction response ($d_{41} = -xd_{51}$ with $0 < x < 1$). Private wages ($d_{31} > 0$) can increase if public jobs creation induces a wage pressure de to the attracting effect. But, they can decrease ($d_{31} < 0$) if firms shift the tax burden onto workers. We normalize the public employment response to 1 ($d_{11} = 1$). We constrain the value of the unemployment response $d_{21} = -1$[15]. This assumption allows to disentangle the public shock from an aggregate demand shock. We fix x using the relative elasticities of job creation and job destruction to public employment ($x = 0.2$). We check robustness assuming that d_{21} can take a value on the range $[-1.7, -0.6]$ and x on $[0.2, 0.4]$.

- As in Blanchard (1989), innovations in unemployment are attributed to supply innovations ε_t^s. These innovations reflect changes in productivity. These can induce a change in the composition of the labor force. The job reallocation induced by this shock highly increases job destructions ($d_{52} > 0$). Job creations can decrease or increase, but this response must be lower in magnitude. In order to distinguish this supply shock to aggregate and reallocation shocks, we assume that job creations remain unchanged at the time of the shock ($d_{42} = 0$) (Karamé *et al.*, 1998). Then, the supply shock has a positive impact on the unemployment rate ($d_{22} > 0$). This shock should permit an increase in wages ($d_{32} > 0$) (Blanchard, 1989). We normalize the unemployment response to 1 ($d_{22} = 1$). We constrain the value of job creations response to be null $d_{42} = 0$. We fix d_{32} with the value of the elasticity of real wages to the marginal productivity of labor ($d_{32} = 0.2$) (Blanchard, 1989). We check robustness assuming that d_{42} can take a value on the range $[-1, 1]$ and d_{32} on $[.15, 2.3]$.

- Innovations in real wages are attributed to wage-setting innovations ε_t^w, which can reflect a change in bargaining strength. A wage-setting shock increases real wages ($d_{33} > 0$). We expect that this shock induces a decrease in private job creation ($d_{43} < 0$) and an increase in job destruction ($d_{53} > 0$) with a higher response of job destruction $d_{43} = -yd_{53}$ with $0 < y < 1$. Unemployment jumps if there are instantaneous job creations or destructions. It do not respond to wage-setting innovations ($d_{23} = 0$). We normalize the real wage response to 1 ($d_{33} = 1$). We fix y using the relative elasticities of job creation and job destruction to real wages ($y = 0.2$). We constrain the unemployment response $d_{23} = 0$. We check robustness assuming that y can take a value on $[0.1, 1[$.

- Aggregate disturbances cause creation and destruction to move in opposite directions (Davis *et al.*, 1999). Aggregate demand innovations ε_t^a increase the job creation rate ($d_{44} > 0$) and decreases the job destruction rate ($d_{54} < 0$). Empirical studies conclude that the contemporaneous job destruction response is at least as large as the contemporaneous creation response ($|d_{43}| \geq |d_{33}|$). Then, the unemployment rate instantaneously decreases (we expect $d_{24} < 0$). Wages and prices increase with a demand shock. In the short run, real wages slightly increase (Gamber and Joutz,

[15] Instantaneously, new public jobs are assumed to be filled by unemployed workers, with a constant labor force participation.

1993) or decrease (Blanchard, 1989). As we normalize the job creation response to 1 ($d_{44} = 1$), the job destruction response must be higher than 1 in absolute value. We constrain its value at the opposite of the value of the ratio between the standard errors of destruction and creation series ($d_{54} = -1.55$) (Karamé *et al.*, 1998). We fix d_{34} using the elasticity of real wages to job creations ($d_{34} = 0.07$). Note that using a negative value would have minor effects. We check robustness assuming that d_{54} can take a value on the range $[-4, -1]$.

- Reallocation disturbances cause creation and destruction to move in the same direction (Davis *et al.*, 1999). Reallocation innovations ε_t^r increase job destruction ($d_{55} > 0$) and job creation ($d_{45} \geq 0$). The contemporaneous job creation response to a reallocation innovation is smaller in magnitude than the contemporaneous destruction response ($|d_{55}| \geq |d_{45}|$). As we normalize the job destruction response to 1 ($d_{55} = 1$), the job creation response must be lower or equal to 1 (Karamé *et al.*, 1998). We assume that the contemporaneous response of job creation is the same as the job destruction response ($d_{45} = 1$). Then, a reallocation shock has no impact on the unemployment rate ($d_{25} = 0$). We check robustness assuming that d_{45} can take a value on the range $[0, 1]$.

Matrix D reads:

$$D = \begin{bmatrix} 1 & d_{12} & d_{13} & d_{14} & d_{15} \\ -1.7 & 1 & 0 & d_{24} & 0 \\ d_{31} & 0.2 & 1 & 0.07 & d_{35} \\ -0.2d_{51} & 0 & -0.2d_{53} & 1 & 1 \\ d_{51} & d_{52} & d_{53} & -1.55 & 1 \end{bmatrix}$$

4.3 Results

We report in Appendix 6.5 the impulse response functions of public employment, unemployment, private job creations and destructions rates, i.e. the dynamic response of the level[16] of each of the endogenous variables to innovations in each of the four structural disturbances. Each figure gives both point estimates and one-standard deviation bands obtained by bootstrap simulations.

Impulse Response Functions

- The dynamic effects of a public shock are characterized on the first graph (Graph 8). A one-standard deviation shock leads to a decrease in job creations of 0.05 percent and to an increase in job destructions of 0.254 percent. As new public jobs are created, the shock induces a significative decrease in unemployment of 0.06 percent. Due to instantaneous destructions and to the disincentives to create private jobs, private employment is reduced. This makes the private job creation rate increase of 0.135 percent in the third quarter. Then job creations return to their equilibrium value and the effects are not significantly different from zero after the fourth quarter.

[16] As public employment rate is I(1), we report the accumulated impulse response function of public employment to innovations in each structural disturbance.

Due to these private job creations, unemployment decreases of 0.151 percent in the sixth quarter. Then it reaches its steady state value and there are no significant effect after 2 years. This shock significantly increases public employment growth. So a public shock has a significative negative impact on unemployment in the short run. The mean adjustment time of unemployment to a public shock is 14 quarters (3.5 years). As in our model, firms shift the tax burden onto workers: private real wages decline of 0.626 percent, but not significantly.

- The dynamic effects of a supply shock are characterized on the second graph (Graph 9). A one-standard deviation shock leads to an increase in job destructions 0.290 percent and a constrained null impact on job creations. This makes unemployment increase of 0.135 percent (Blanchard, 1989, Blanchard and Quah, 1989, Gamber *et al.*, 1993). Then job creations increase of 0.183 in the third quarter (this supply impulse can be interpreted as a labor recomposing effect). Job creations return to their equilibrium value and the effects are no more significant after 6 quarters. Public employment growth increases of 0.04, but its response is not significantly different from zero after 2 quarters. Although public employment is in first difference, supply shock makes it return to its steady-state value in the long run. Supply innovations decrease more nominal prices than nominal wages. So, real wages increase but this effect is not significant (Blanchard, 1989).

- The dynamic effects of a wage-setting shock are characterized on the third graph (Graph 10). A one-standard deviation shock leads to a decrease in job creations of 0.041 percent and an increase of job destructions of 0.206 percent in the first quarter. Then, private job creations increase of 0.089 percent in the second quarter, but these responses are not statistically significant. By assumption, unemployment instantaneously do not respond to the wage-setting shock, then it decreases, although not significantly so (Blanchard, 1989). This shock significantly increases real wages of 1.008 percent in the first quarter. A wage-setting makes public employment growth increase, but this effect is not statistically different from zero.

- The dynamic effects of a positive aggregate demand shock are characterized on the fourth graph (Graph 11). A one-standard deviation shock leads to an increase in job creations of 0.264 percent and an higher decrease in job destructions of 0.423 percent. So, it induces a decrease in unemployment of 0.129 percent in the first quarter. Its effects on job flows are not significantly different from zero after the shock (Karamé *et al.*, 1998). In the first year, the aggregate shock leads to a significant fall in unemployment of 0.215 percent. Then unemployment returns to its steady-state value (this increase is not significantly different from zero after 2 years) (Blanchard, 1989, Blanchard *et al.*, 1989, Gamber *et al.*, 1993). Aggregate disturbances make the public employment growth increase of 0.032 percent (this rise is not significant after the first quarter). Aggregate disturbances make real wages increase of 0.018 percent in the first quarter and then decrease, though these effects are statistically insignificant (Blanchard, 1989).

- The dynamic effects of a reallocation shock are characterized on the fifth graph (Graph 12). A one-standard deviation shock leads to an increase in job creations and destructions of 0.284 percent. This shock has no instantaneous effect on unemployment as we've constrained it. The impact on job creations are more persistent: job destructions quickly fall after the shock whereas job creations slightly decrease (Karamé *et al.*, 1998) (the effects on job creations are not significantly different from zero after 6 quarters). This makes unemployment decrease, but without any significant effect. Reallocation disturbances decrease the public employment growth but this effect is not significantly different from zero. Reallocation disturbances tend to decrease real wages but the response is statistically insignificant at all horizons.

Forecast Error Variance Decomposition

We report in Appendix 6.6 the contribution of each source of innovations to the variance of the n-quarter ahead forecast error for each endogenous variable. Table 5 reports variance decompositions for the first difference of public employment rate and for the levels of unemployment, job creation and destruction rates.

- Innovations to aggregate demand, ε_t^a, and innovations to either labor supply or productivity, ε_t^s, account for the most of the variance of unemployment in the short run: one quarter ahead, they account for 43.16 percent and 47.3 percent of the variance of *cho*, respectively (Blanchard, 1989, Blanchard *et al.*, 1989, Gamber *et al.*, 1993, Dolado and Lopez-Salido, 1996). Eight quarters ahead, ε_t^a still accounts for 53.73 percent of the variance of *cho*, whereas this proportion has decreased for ε_t^s (16.14 percent). Innovations to public employment, ε_t^g, account for a growing part of the variance of *cho* (31.19 percent in the long run). In the long run, ε_t^a and ε_t^g jointly explain 83.83 percent of the variance of *cho*. Reallocation innovations ε_t^r not explain the variance of *cho*. This is true by assumption for the one-quarter ahead variance: identification restriction imposes that unemployment doesn't respond to ε_t^r. It is however true at longer horizons: in the long run, they account for 3.33 percent of the variance of *cho*. Wage-setting innovations ε_t^w not explain the variance of *cho*. This is true by assumption for the one-quarter ahead variance: identification restriction imposes that unemployment doesn't respond to ε_t^w. It is however true at longer horizons: in the long run, they account for 1.8 percent of the variance of *cho* (Blanchard, 1989).

- Innovations to aggregate demand, ε_t^a, and reallocation innovations, ε_t^r, account for the most of the variance of private job creations in the short run: one quarter ahead, they account for 45.08

percent and 52.16 percent of the variance of c, respectively (Karamé *et al.*, 1998). By assumption, for the one-quarter ahead variance, supply innovations, ε_t^s, do not explain the variance of c. Eight quarters ahead, ε_t^s accounts for 17.33 percent of the variance of the forecast error. In the long run, ε_t^r account for the most part of the variance: they explain 50 percent (Karamé *et al.*, 1998). Eight quarters ahead, public innovations, ε_t^g, accounts for 9.1 percent of the variance of c. Wage-setting innovations, ε_t^w, explain 5 percent of the variance of c.

- Innovations to aggregate demand, ε_t^a, dominate all other innovations at all horizons: one quarter ahead, they account for 39.69 percent of the variance of private job destructions and ten years ahead, this proportion is 43.39 percent (Karamé *et al.*, 1998). Innovations to public employment, ε_t^g, account for 14 percent of the variance of d at all horizons. So, a change in public job creations changes incentives for private job destructions. Supply innovations, ε_t^s, contribute to 18 percent of the variance of d at all horizons.

- Wage-setting innovations, ε_t^w, account for the most part of the variance of private real wage rate in the short run: one quarter ahead, they account for 70 percent of the variance of w. Eight quarters ahead, public innovations, ε_t^g, account for 30 percent of the variance of the forecast error of w. In the long run, $\varepsilon_t^w$and ε_t^g jointly explain 91 percent of the variance of w. This high contribution of the public shock is convenient with our intuition: public jobs creation affects real wages but the net effect is ambiguous.

- Public innovations, ε_t^g, innovations to aggregate demand, ε_t^a, and reallocation innovations, ε_t^r, jointly account for 93.23 percent of the variance of public employment ten years ahead. One quarter ahead, innovations to either labor supply or productivity, ε_t^s, account for 37.5 percent of the variance of *pub*. This result reinforces our intuition: public job creations decisions partly are due to innovations in labor supply, that make unemployment higher, in the very short term. In long term, these are due to innovations in aggregate demand.

5 Conclusion

We use a dynamic matching model and study how public jobs creation affects workers' decisions to move on the labor market and private-sector firms' job creation and destruction decisions. Instantaneously, newly created public jobs are filled by the unemployed workers searching for a public job. Thus, in the short run, the unemployment rate decreases and the public sector exerts an attracting effect on private workers. Due to its fiscal implications, public jobs creation affects the private-sector job creation and destruction decisions. The disincentives for private jobs creation that distortive labor taxes generate make the unemployment rate increase. In the long run, the net impact depends on the size of the public wage premium. With our calibration, public jobs creation increases unemployment. The mean lag of the unemployment rate is close to 7 quarters. True dynamic firms 'responses take time. Here, we assume that there is no adjustment cost. However, there might be some inertia in private job creation and destruction decisions. Then, the adjustment time of the unemployment rate should be slower.

As an empirical illustration, we estimate a SVAR model that focuses on the consequences of public jobs creation on unemployment dynamics. We use US data on public employment, unemployment, private-sector job creation and destruction rates, obtained from the OECD Employment Outlooks, LRD and CPS database. Sample runs from 1972:2 to 1993:4. We assume the existence of four structural disturbances: a public shock, a supply shock, an aggregate shock and a reallocation shock. We use short-run restrictions in the spirit of Blanchard (1989), Karamé *et al.* (1998) and Davis *el al.* (1999). Our results are consistent with the SVAR literature. We obtain that the unemployment rate significantly decreases in the short-run with a public shock. It is true by assumption for the one-quarter ahead: identification restriction imposes that unemployment negatively responds to the public shock. But it also is true for six quarters-ahead[17]. Then the unemployment rate reaches its steady-state value and there are no significant effect after 2 years. The mean adjustment time of unemployment to a public shock is 3.5 years. This motivates a government response to a change in unemployment. Innovations in public employment account for a significant part of the variance of private job destructions. Job creation dynamics are consistent to those obtained in our theoretical model. Job destructions are more volatile than job creations and they faster reach their steady-state value. In the same way, this is consistent with our matching model. As we expected it, the response of private wages to a public shock is ambiguous. We obtain a non statistically significant effect. This ambiguity comes from conflicting externalities that public jobs creation generates: the attraction effect increases workers' wage demands whereas tax distortions reduce workers' bargaining strength. The high contribution of the public shock to the variance of private wages is consistent with our intuition: public employment affects private wages but this effect is ambiguous. We can conclude that our SVAR model is a good empirical illustration for our theoretical model. Note that the lack of data and the use of a bootstrap simulation of one-standard deviation bands constrain the significativity of the impulse response functions. It would be interesting to replicate this empirical exercise on other countries. However, we do not have data on manufactured private-sector job creations and destructions (for France, we only have

[17] In our model, the assumption of continuous wage renegociation not allows this result. The unemployment rate instantaneously "jumps" with public jobs creation and private jobs destruction. Then it monotically reaches its new steady-state value.

47 observations).

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6 Appendix

6.1 Phase diagram

In Section 2.5, we present the out-of steady-state dynamics of the unemployment rate $u(t)$. We propose here to use a graphical method in order to illustrate the stability of our solution. With jump variables, the two differential equations (3) and (2) of our model read:

$$\begin{cases} \dot{u}(t) = q_p F(R)(1 - l_g - u_g(t)) + q_g l_g - \theta m(\theta)\left(u(t) - u_g(t)\right) - g u_g(t) \\ \dot{u}_g(t) = q_g l_g - g u_g(t) \end{cases}$$

And can be rewritten:

$$\begin{bmatrix} \dot{u}(t) \\ \dot{u}_g(t) \end{bmatrix} = \begin{bmatrix} -\theta m(\theta) & \theta m(\theta) - q_p F(R) - g \\ 0 & -g \end{bmatrix} \begin{bmatrix} u(t) \\ u_g(t) \end{bmatrix} + \begin{bmatrix} q_p F(R)(1 - l_g) + q_g l_g \\ q_g l_g \end{bmatrix}$$

The diagonal matrix of eigenvalues D is given by

$$D = \begin{bmatrix} \dfrac{-2(\theta m(\theta) + g) + \sqrt{2\theta m(\theta) g}}{2} & 0 \\ 0 & \dfrac{-\sqrt{2\theta m(\theta) g}}{2} \end{bmatrix}$$

The negative sign of both eigenvalues confirm that the system is stable (Graph 5).

First case

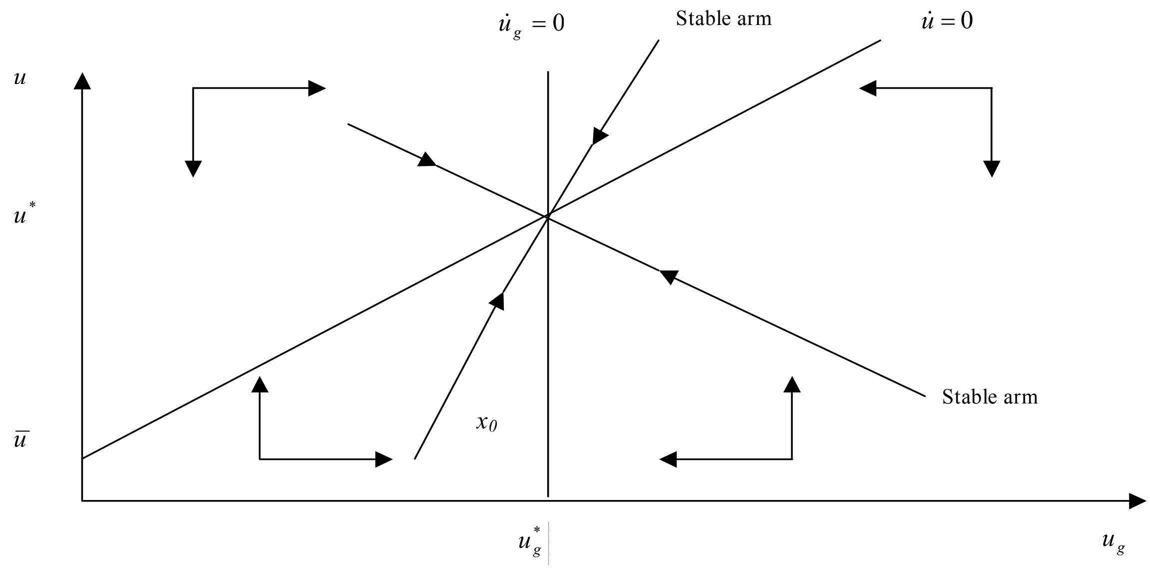
The locus of points for which $\dot{u}$ equals 0 is the upward-sloping line $u_g = \dfrac{\theta m(\theta) u - q_p F(R)(1 - l_g) - q_g l_g}{\theta m(\theta) - q_p F(R) - g}$, under the constraint $\theta m(\theta) - q_p F(R) - g > 0$[18]. The $\dot{u} = 0$ crosses the horizontal axis at point $\bar{u} = \dfrac{q_p F(R)(1 - l_g) + q_g l_g}{\theta m(\theta)}$. If we start at a point on the $\dot{u} = 0$ schedule and increase u a bit, then the right-hand side of the expression for $\dot{u}$ decreases. Hence, $\dot{u}$ becomes negative and u is decreasing in that region. The arrows in this region point south. A symmetric argument implies that the arrows point north for points to the right of the $\dot{u} = 0$ schedule (Graph 5).

The $\dot{u}_g(t) = 0$ locus is given by $u_g^* = \dfrac{q_g l_g}{g}$, a vertical line. The expression for $\dot{u}_g$ implies that if u_g rises, then $\dot{u}_g$ decreases. Hence, to the right of the $\dot{u}_g = 0$ locus, $\dot{u}_g$ is negative, and the arrows point west. The arrows point east for points to the left of the $\dot{u}_g = 0$ schedule (Graph 5).

The steady state is the point at which the two loci cross, a condition that corresponds in this case to

$$\begin{cases} u^* = u_g^* + \dfrac{q_p F(R)(1 - l_g - u_g^*)}{\theta m(\theta)} \\ u_g^* = \dfrac{q_g l_g}{g} \end{cases}$$

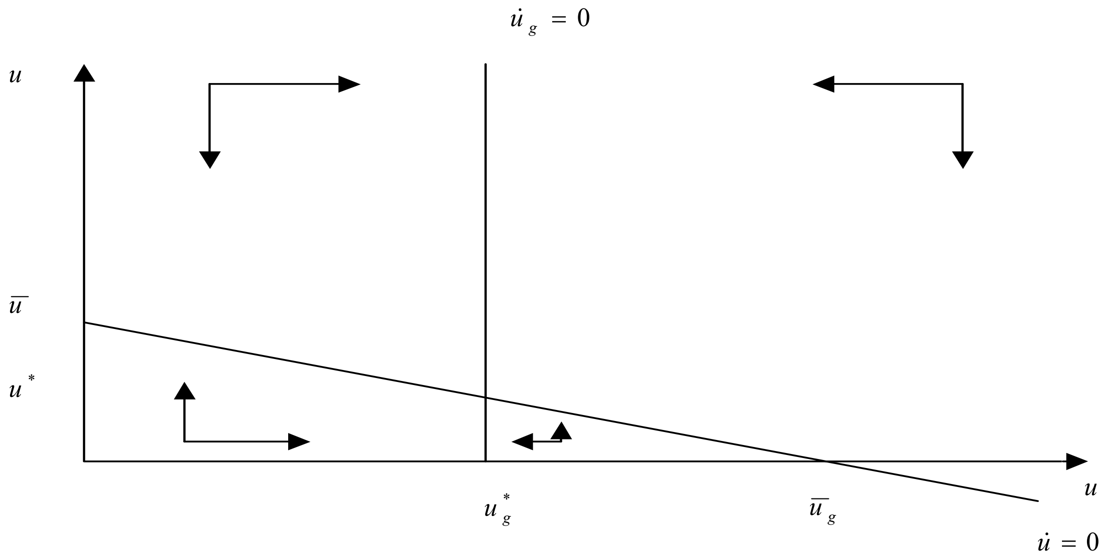
[18] This is the case of our model.



GRAPH. 5 – The phase diagram in the first stable case

Second case

The locus of points for which $\dot{u}$ equals 0 is the downward-sloping line $u_g = \dfrac{\theta m(\theta)u - q_p F(R)(1-l_g) - q_g l_g}{\theta m(\theta) - q_p F(R) - g}$, under the constraint $\theta m(\theta) - q_p F(R) - g < 0$. The $\dot{u} = 0$ schedule crosses the horizontal axis at point $\bar{u} = \dfrac{q_p F(R)(1-l_g) + q_g l_g}{\theta m(\theta)}$ and the vertical axis at point $\bar{u}_g = -\dfrac{q_p F(R)(1-l_g) + q_g l_g}{\theta m(\theta) - q_p F(R) - g}$. As previously, the $\dot{u}_g(t) = 0$ locus is given by $u_g^* = \dfrac{q_g l_g}{g}$, a vertical line. In the case $u_g^* < \bar{u}_g$, the system is stable as for any initial values of u and u_g, the dynamics of the system takes it back to the steady state (Graph 6). In the case $u_g^* > \bar{u}_g$, the two loci do not cross. There is no steady state.



GRAPH. 6 – The phase diagram in the second stable case

6.2 Out-of steady-state dynamics

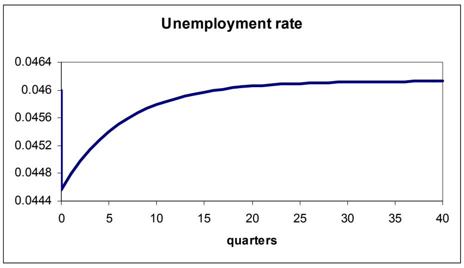
Consider the case of unemployment benefits index-linked on current private wages, such as there is a complete shifting of the tax burden onto workers. In this case, private-sector job creation and destruction decisions remain unchanged. Assume the government can't rent into debt. The budget constraint has to be fulfilled at any moment in time. The out-of steady-state dynamic of unemployment is given by equation (3). The dynamics of τ, w_p and g can be deduced. The zero profit condition on vacant jobs, the sharing rule, the reservation property and the arbitrage condition are instantaneous relations. We allow wages to be renegotiated continually such as the sharing rule holds in rates of change $\dot{S}(x) = \dot{W}_e^p(x) - \dot{W}_u^p + \dot{J}^p(x) - \dot{V}^p$. Therefore, the wage equation (10) holds in and out of the steady-state

$$w_p(x) = \frac{\gamma(px + h\theta)}{1+\tau} \frac{1}{1-(1-\gamma)b} \quad ,$$

with $x\varepsilon]R, eu]$ and b a constant replacement ratio. Out-of steady-state, the expected capital gains from changes in jobs value and in utilities are not null. The exit rate from public-sector unemployment is given by the following arbitrage condition:

$$g\frac{w_g - b\bar{w}_p}{r+q_g+g} + g\frac{\dot{W}_g^e - \dot{W}_g^u}{r+q_g+g} + \dot{W}_g^u = \frac{\gamma h\theta}{(1-\gamma)(1+\tau)} + \dot{W}_p^u.$$

We assume that firms can destroy unprofitable jobs without delay. This assumption implies that the zero-profit condition satisfied by R holds in and out of steady state $J^p(R) = \dot{J}^p(R) = 0$. We also assume that firms can open and close vacancies without delay. This assumption implies that the zero-profit condition for new vacancies holds in and out of steady state $V^p = \dot{V}^p = 0$. We simulate the effect of a 1% public employment increase on the out-of steady-state dynamics of u.



GRAPH. 7 – Out-of steady-state dynamic of unemployment rate

6.3 Mean lags of the unemployment rates

To derive the mean lag of the public unemployment rate u_g, we solve the differential equation (2). We obtain:

$$u_g(t) = u_g^* + (u_{g_0} - u_g^*)e^{-[g]t},$$

with u_g^* the steady-state level of public unemployment, and u_{g_0} the initial level of public unemployment.

The mean lag (half-life) T_g is defined by:

$$u_g^* - u_g(T_g) = (1 - 0.5)(u_g^* - u_{g_0}),$$

that is

$$T_g = \frac{-\ln 0.5}{g}$$

The mean lag of the public unemployment rate negatively depends on the new exit rate from public unemployment g.

To derive the mean lag of the unemployment rate u, we solve the two-differential equation system (3) and (2):

$$\begin{cases} \dot{u}(t) = q_p F(R)[1 - l_g - u_g(t)] + q_g l_g - \theta m(\theta)[u(t) - u_g(t)] - g u_g(t) \\ \dot{u}_g(t) = q_g l_g - g u_g(t) \end{cases}$$

We obtain:

$$\begin{aligned} u(t) &= u^* + (u_0 - u^*)e^{-[q_p F(R)+\theta m(\theta)]t} \\ &+ \frac{1}{g - q_p F(R) - \theta m(\theta)} \left[\theta m(\theta) - g\right] \left(u_{g_0} - u_g^*\right) \left[e^{-[q_p F(R)+\theta m(\theta)]t} - e^{-(g)t}\right], \end{aligned}$$

with u^* and u_g^* the steady-state levels of total and public unemployment, and u_0 and u_{g_0} the initial levels of total and public unemployment, respectively.

The mean lag T is given by:

$$u^* - u(T) = (1 - 0.5)(u^* - u_0).$$

The properties of T_g and T are sum-up in Table 2.

TAB. 2 – Mean lags

	r	q_g	q_p	γ	z
$T_{(g)}$	$-$	$-$	$-$	0	$+$

6.4 Unit root tests

We report unit root tests. In the case of the ADF test, the null hypothesis describes a non-stationnary process (if t-statistic < critical value, the null can be rejected). The null hypothesis describes a stationnary process in the case of the KPSS test (if t-statistic > critical value, the null can be rejected).

TAB.3 – Augmented Dikey-Fuller unit root tests

		ADF					
Séries	Retard optimal	Stat		Stat		Stat	
pub_t	1	-0.94	I(1)	-1.22	I(1)	-0.86	I(1)
cho_t	1	-0.47	I(1)	-3.23	I(0)**	-3.21	I(0)*
w_t	3	0.12	I(1)	-1.45	I(1)	-3.22	I(0)*
c_t	0	-0.53	I(1)	-3.44	I(0)**	-4.7	I(0)***
d_t	1	-0.82	I(1)	-3.75	I(0)***	-3.85	I(0)**

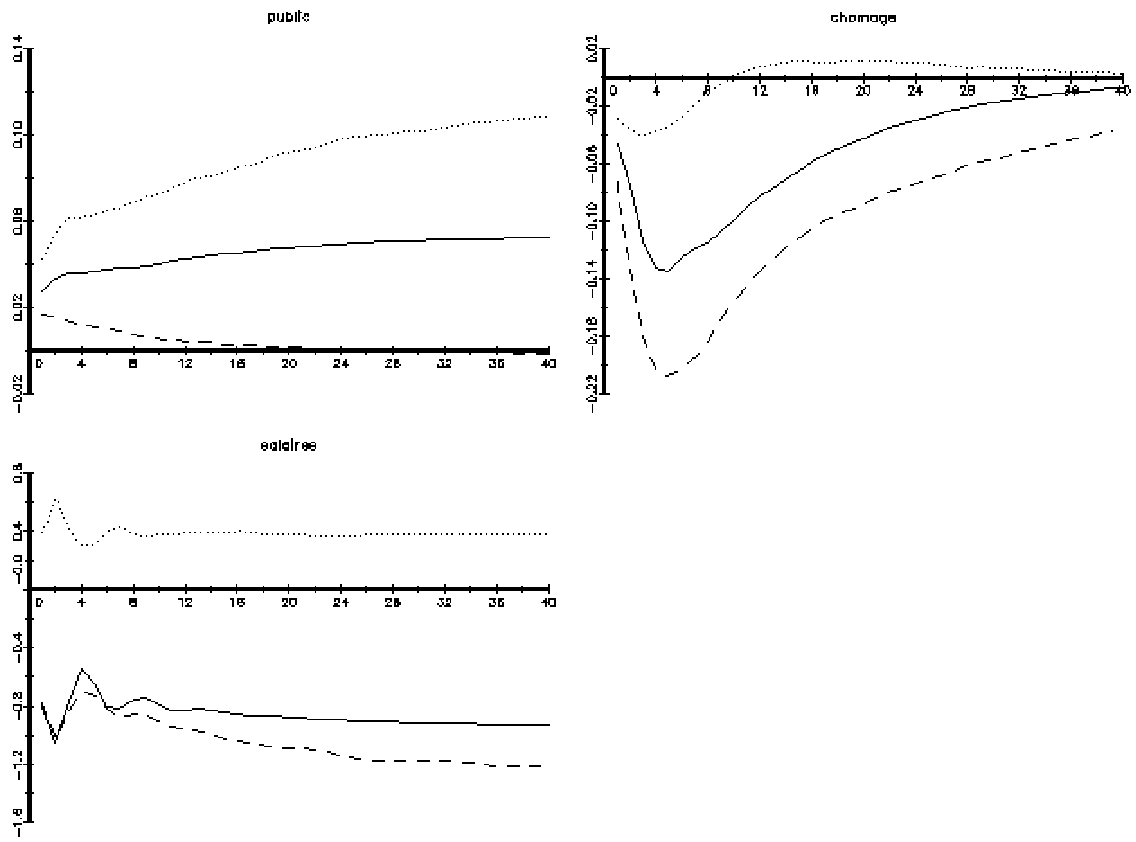
Note: The first stat denotes unit root test statistics based on a regression without constant, the second with a constant, the third with a constant and a trend. * denotes significant at the 10% level, ** at the 5% level, *** at the 1% level.

TAB.4 – KPSS unit root tests

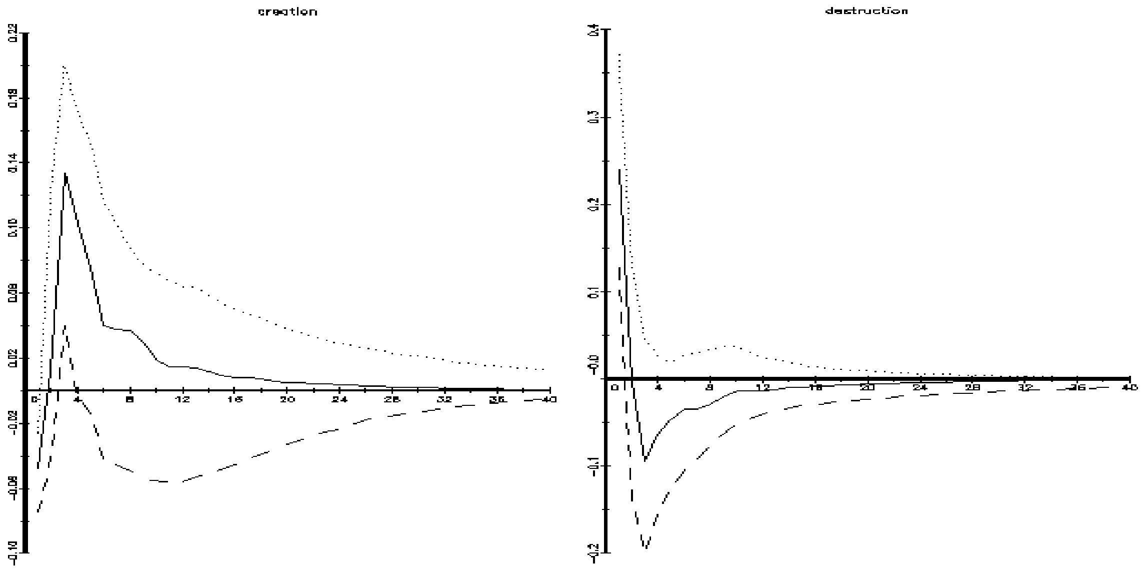
		KPSS			
Séries	Retard optimal	Stat		Stat	
pub_t	1	3.167	I(1)	0.747	I(1)
cho_t	1	0.380	I(0)**	0.386	I(1)
w_t	3	1.284	I(1)	0.363	I(1)
c_t	0	3.48	I(1)	0.08	I(0)***
d_t	1	0.287	I(0)***	0.122	I(0)**

Note: The first stat denotes unit root test statistics based on a regression with a constant, the second with a constant and a trend. * denotes significant at the 10% level, ** at the 5% level, *** at the 1% level.

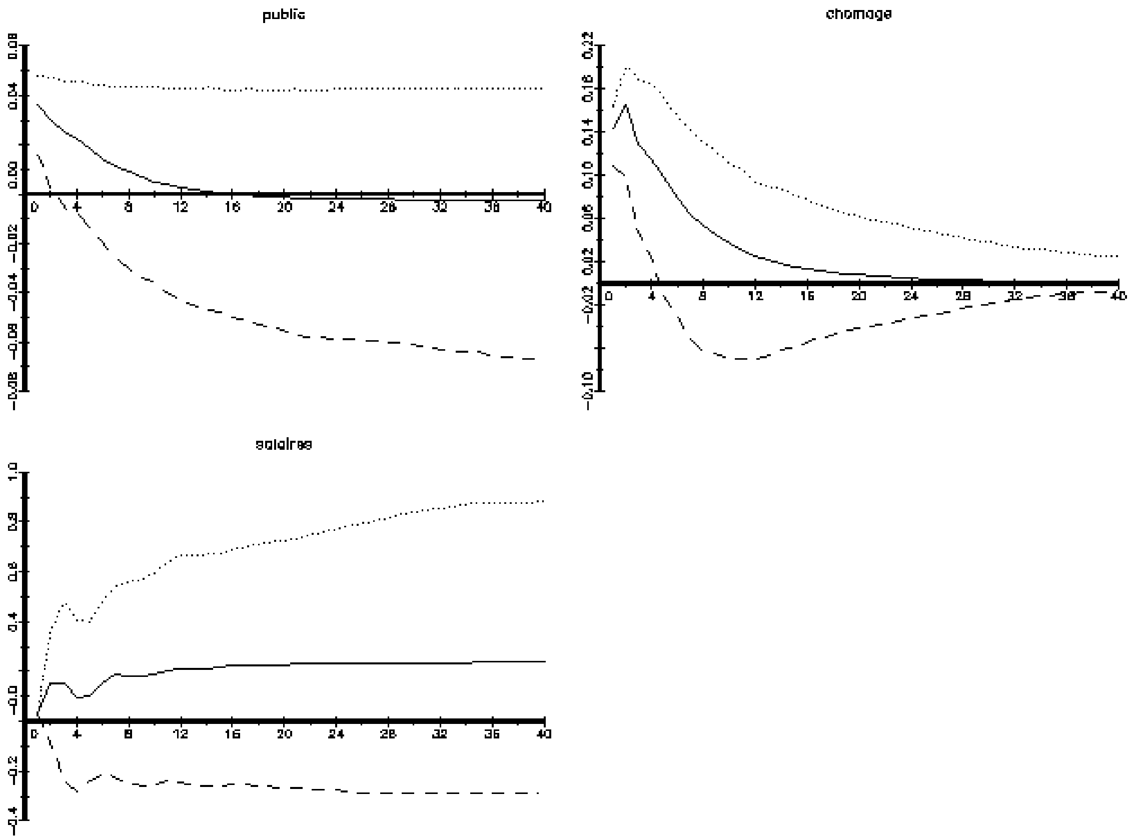
6.5 Impulse Response Functions



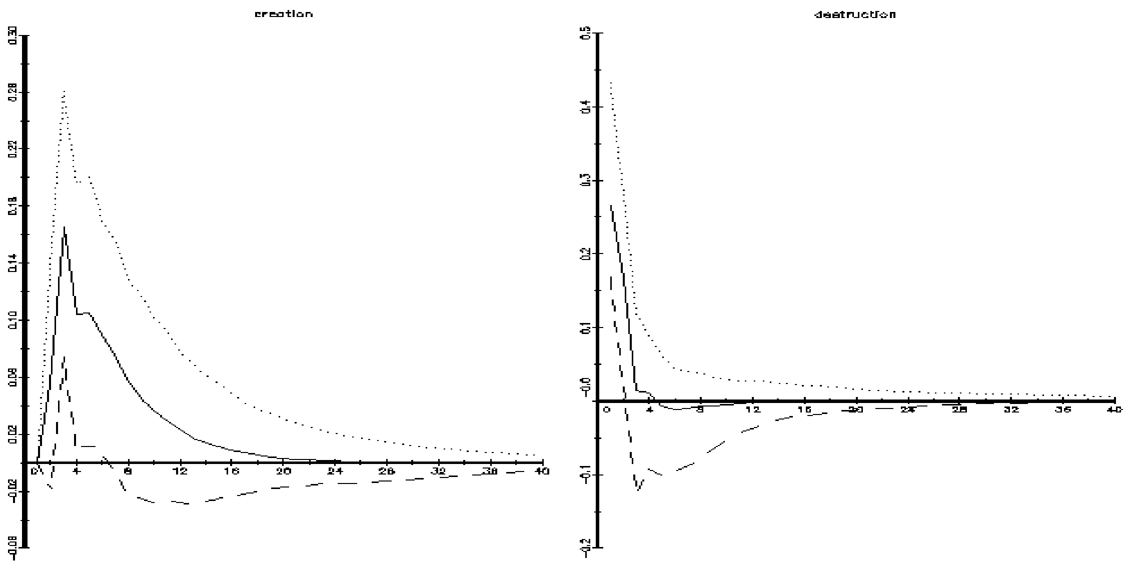
GRAPH. 8a – Responses to a one-standard deviation public shock



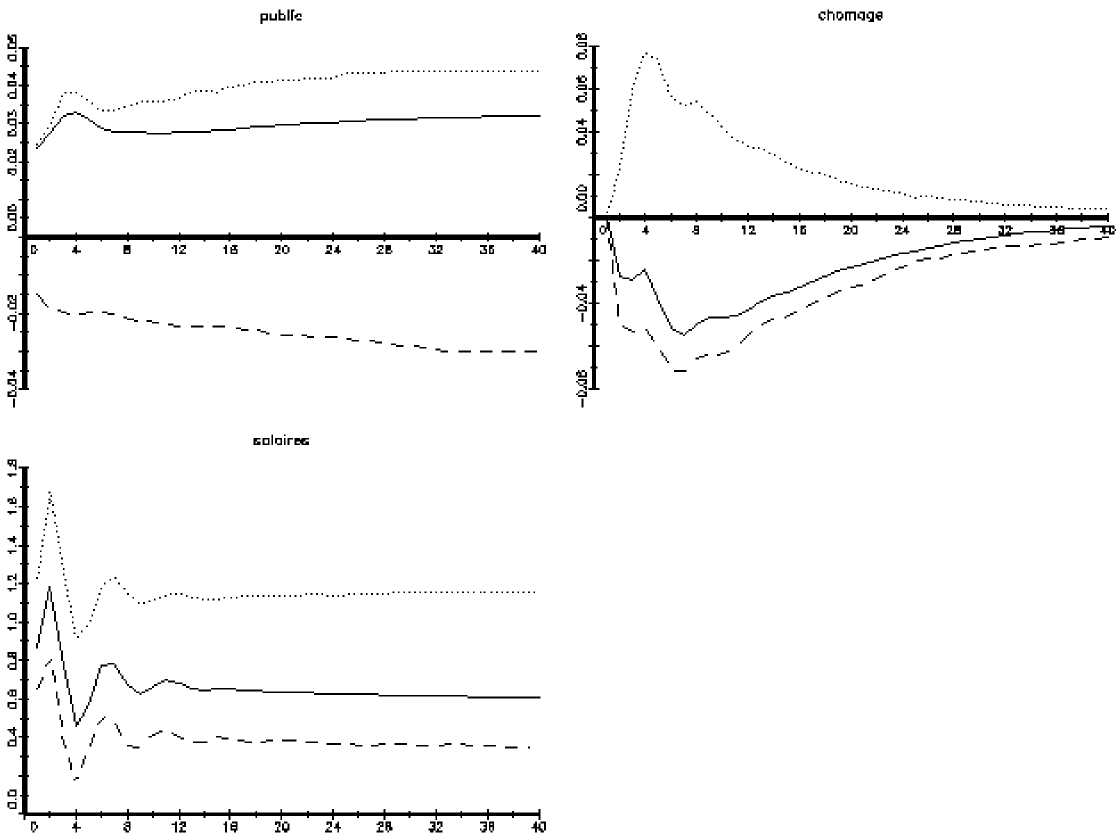
GRAPH. 8b – Responses to a one-standard deviation public shock



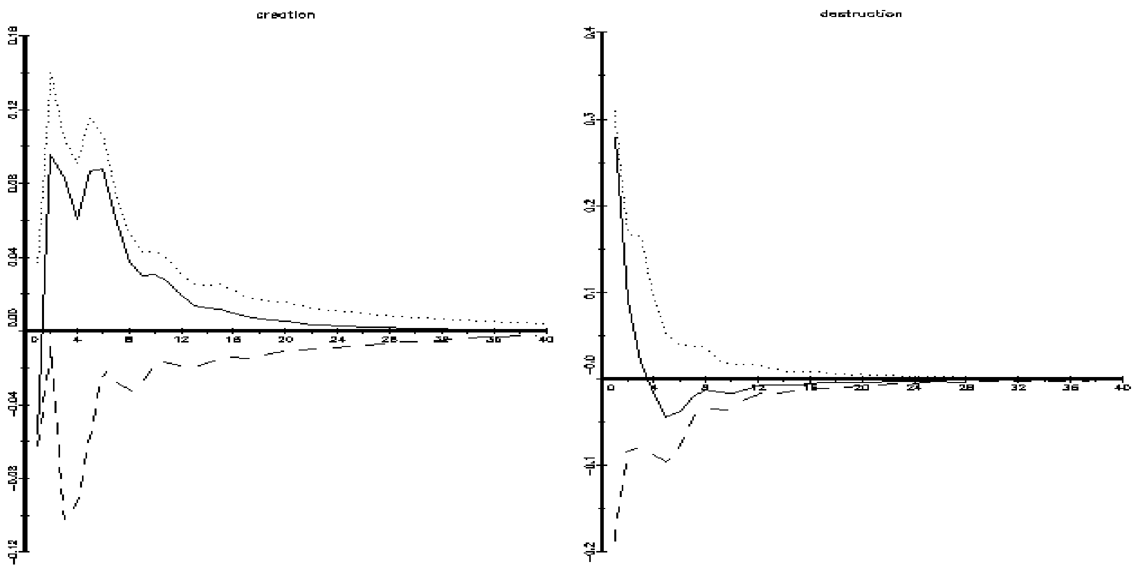
GRAPH. 9a – Responses to a one-standard deviation supply shock



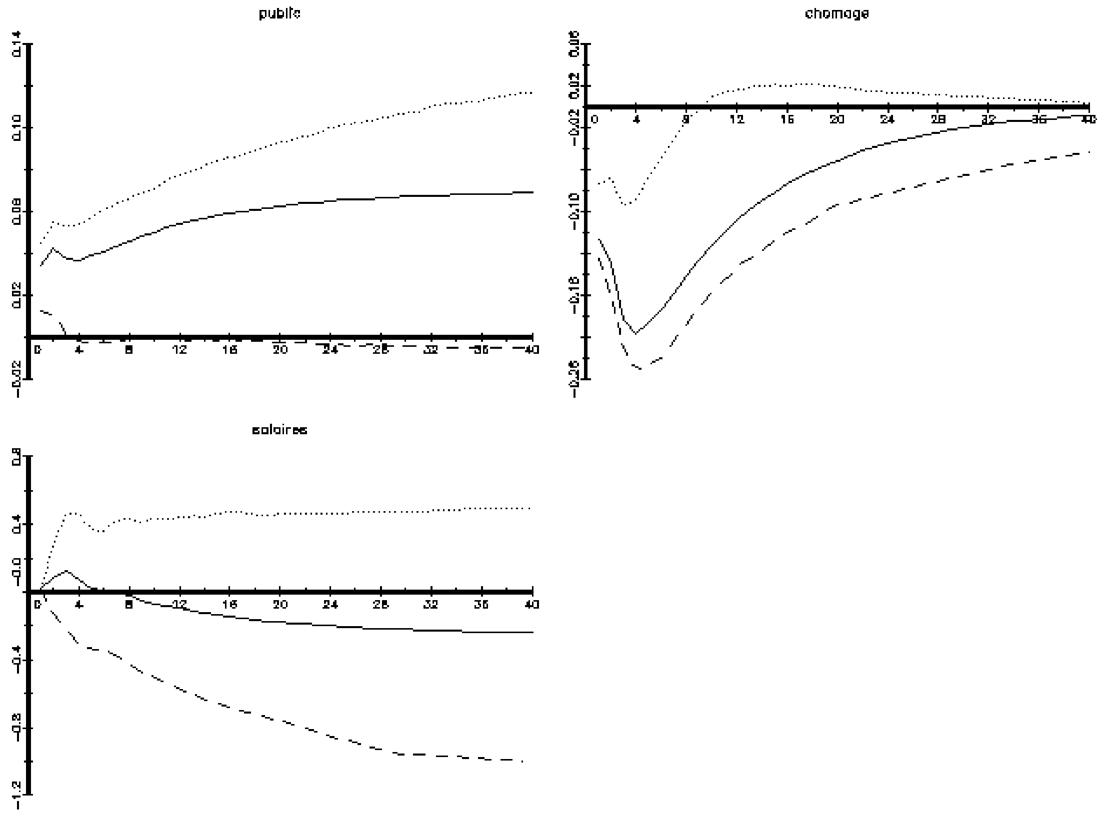
GRAPH. 9b – Responses to a one-standard deviation supply shock



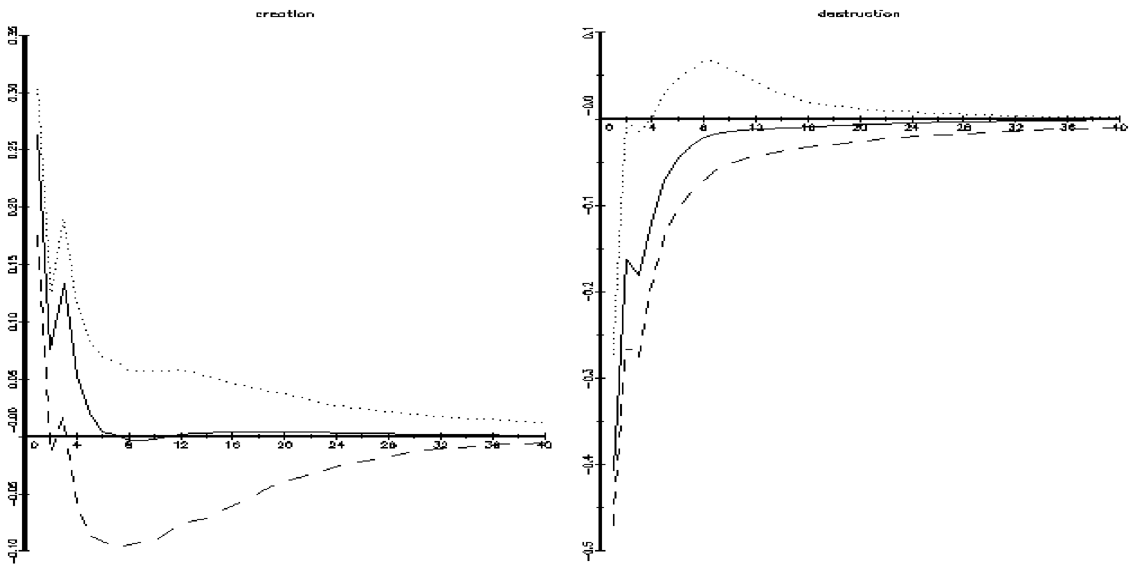
GRAPH. 10a – Responses to a one-standard deviation wage shock



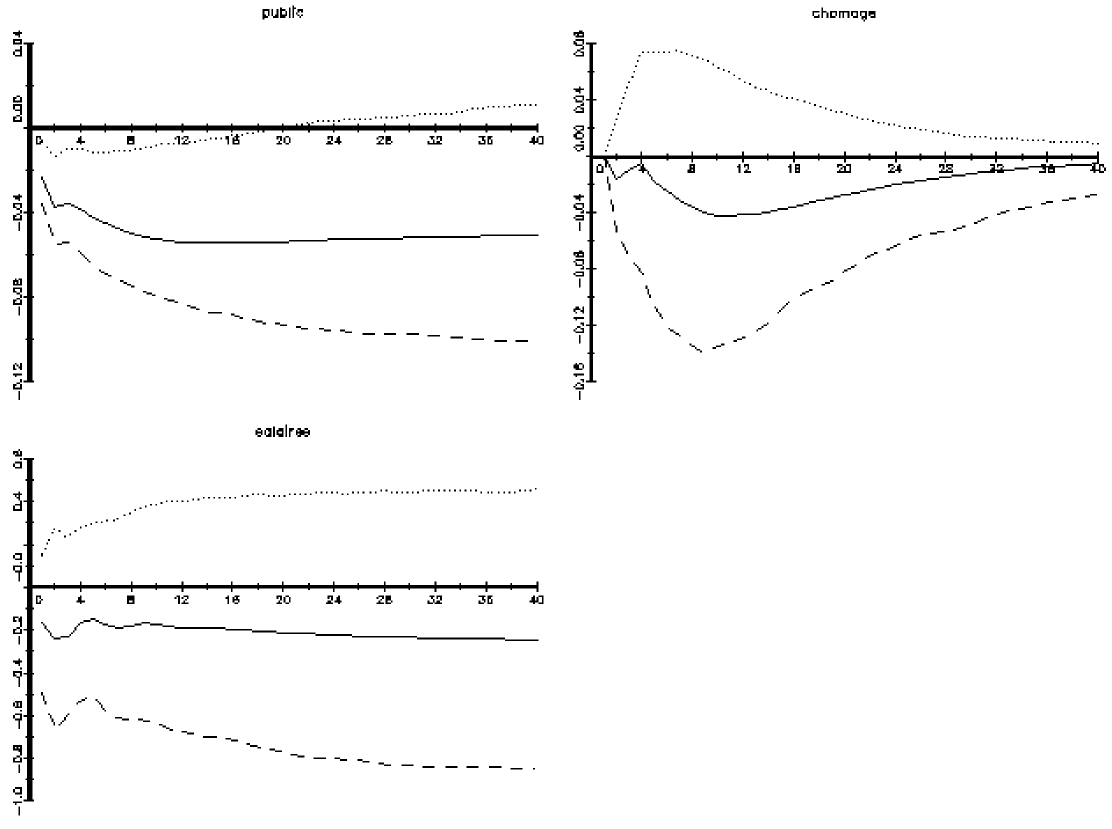
GRAPH. 10b – Responses to a one-standard deviation wage shock



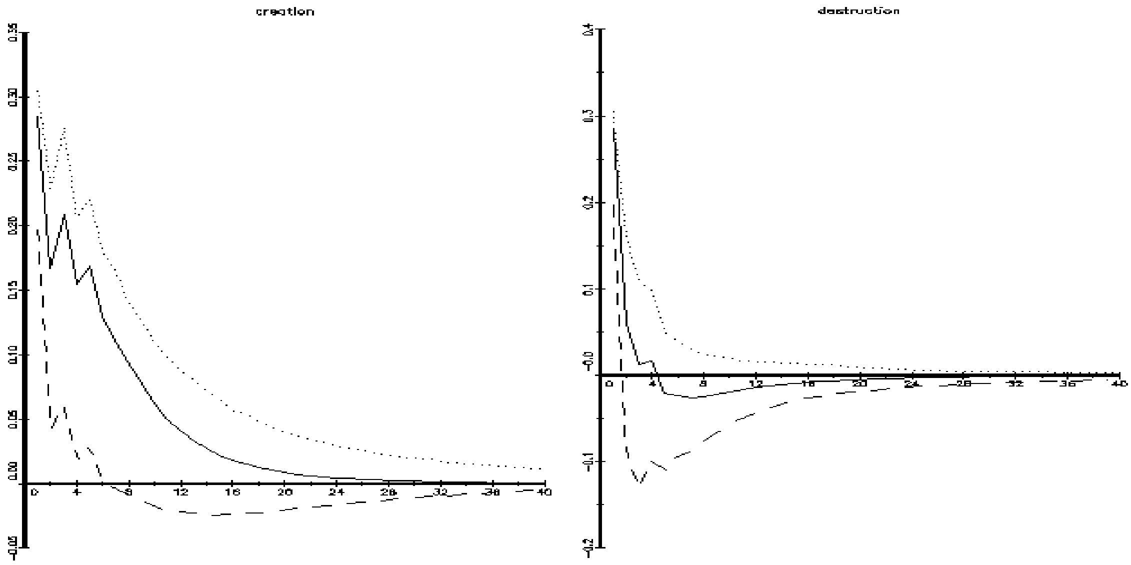
GRAPH. 11a – Responses to a one-standard deviation aggregate demand shock



GRAPH. 11b – Responses to a one-standard deviation aggregate demand shock



GRAPH. 12a – Responses to a one-standard deviation reallocation shock



GRAPH. 12b – Responses to a one-standard deviation reallocation shock

6.6 Forecast Error Variance Decomposition

TAB. 5 – Forecast Error Variance Decomposition

Quarter aheads	ε_t^g impulse	ε_t^s impulse	ε_t^w impulse	ε_t^a impulse	ε_t^r impulse
	Public employment rate				
1	17.38	29.98	12.64	27.55	12.45
8	21.55	8.74	14.31	27.33	28.07
20	21.79	2.75	10.63	33.72	31.10
40	23.18	1.17	9.70	38.32	27.63
	Unemployment rate				
1	5.59	52.71	0.00	41.7	0.00
8	20.63	20.89	2.44	55.3	0.75
20	23.53	15.44	4.05	54.09	2.89
40	23.81	14.85	4.29	53.7	3.35
	Private real wage rate				
1	45.49	0.06	52.51	0.02	1.92
8	47.84	1.54	47.55	0.25	2.81
20	53.15	2.82	40.18	0.92	2.93
40	57.03	3.44	33.77	2.29	3.48
	Private job creation rate				
1	1.47	0.00	1.99	44.31	52.22
8	8.30	14.08	8.76	19.46	49.40
20	8.28	14.36	8.98	18.41	49.97
40	8.30	14.34	8.99	18.41	49.96
	Private job destruction rate				
1	12.66	15.64	17.13	36.61	17.96
8	12.61	16.55	15.03	41.24	14.58
20	12.74	16.4	15.04	41.07	14.75
40	12.76	16.39	15.04	41.07	14.75