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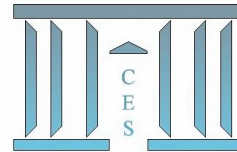


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Credit Constraints and the Persistence of Unemployment

Nicolas DROMEL, Elie KOLAKEZ, Etienne LEHMANN

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Credit Constraints and the Persistence of Unemployment*

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Abstract

In this paper, we argue that credit market imperfections impact not only the level of unemployment, but also its persistence. For this purpose, we first develop a theoretical model based on the equilibrium matching framework of Mortensen and Pissarides (1999) and Pissarides (2000) where we introduce credit constraints. We show these credit constraints not only increase steady-state unemployment, but also slow down the transitional dynamics. We then provide an empirical illustration based on a country panel dataset of 19 OECD countries. Our results suggest that credit market imperfections would significantly increase the persistence of unemployment.

Keywords: Credit markets; labor markets; unemployment; credit constraints; search frictions.

Résumé

Dans ce papier, nous montrons que les imperfections sur marché du crédit impactent non seulement le niveau du chômage, mais aussi sa persistance. En premier lieu, nous développons un modèle théorique d'appariement à la Mortensen et Pissarides (1999) et Pissarides (2000) dans lequel nous introduisons des contraintes de crédit. Nous montrons que ces contraintes accroissent non seulement le chômage d'état stationnaire, mais aussi ralentissent la dynamique transitoire. Nous présentons enfin une illustration empirique basée sur un panel de 19 pays de l'OCDE. Nos résultats suggèrent que les imperfections sur le marché du crédit augmenteraient significativement la persistance du chômage.

Mots-clés: Marché du Crédit; Marché du Travail; Chômage; Contrainte de Crédit; Frictions d'Appariement.

JEL Classification: E24, E44, J08, J64

I Introduction

An important stream of literature has dealt with the incidence of credit market imperfections on the level of unemployment (see e.g. Acemoglu (2001) or Wasmer and Weil (2004)). These papers explain how unemployment may be worsened by frictions outside the labor market, particularly in the credit market. However, the way credit frictions influence the transitional dynamics of unemployment is not obvious. In this paper, we extend the equilibrium matching framework of Mortensen and Pissarides (1999) and Pissarides (2000) by introducing credit constraints. We show that when these constraints are binding, not only the steady-state level of unemployment is increased, but the transitional dynamics also decelerates. We then provide an empirical illustration based on a panel of OECD countries. Our results suggest that credit market imperfections do increase the persistence of unemployment.

We first provide a theoretical argument within a simple matching model. Wages are exogenous and workers lend their money to representative banks. Building new jobs requires capital. Entrepreneurs do not have capital on their own and thereby have to borrow from banks. Absent credit market imperfections, entrepreneurs create jobs until congestion externalities in the recruiting process make job creation no longer profitable. Our departure from the standard matching model lies in the introduction of a credit constraint in the spirit of Matsuyama (2007): Entrepreneurs can only borrow a fraction of pledgeable assets. When the total value of pledgeable assets is too low, job creation is restricted. The steady state in the constrained regime is therefore characterized by higher unemployment. Moreover, as unemployment converges to its steady-state value, the number of jobs changes, affecting the total value of pledgeable assets. Through this channel, the transitional dynamics is slowed down, and unemployment becomes more persistent.

To illustrate this mechanism, we perform an empirical exercise on a panel of 19 OECD countries, during the period 1982-2003. Data were drawn from Bassanini and Duval (2006) for the labor market institutions and Beck, Demirgüç-Kunt and Levine (2006) for financial development variables. We observe that private credit by deposit money banks as a percentage of GDP would be a significant determinant of the unemployment level, in addition to the 1-period lagged value of the unemployment rate and the traditional factors.¹ Without loss of generality, we can arguably think of this private credit variable as inversely related to the stringency of credit constraints. Interestingly, the interaction between private credit and lagged unemployment appears to have a significant negative impact on the level of unemployment. Put differently, the development of private credit would significantly lower unemployment persistence.

¹These variables are: the average unemployment benefit replacement rate, the tax wedge, the employment protection legislation index, the union density index, the degree of co-ordination of wage bargaining, the product market regulations index and the output gap.

Our contribution follows the literature on the macroeconomic consequences of credit market frictions. The seminal papers of Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) explain how credit market frictions amplify business cycle fluctuations through a financial accelerator mechanism. However, they assume away labor market imperfections, and in particular matching unemployment. Acemoglu (2001) investigates how credit constraints can affect the dynamics of unemployment, and argues that credit market imperfections increase the level and persistence of unemployment. In his model, credit frictions induce some individuals that are skilled enough but without sufficient wealth to be workers rather than entrepreneurs. In our model, credit frictions influence more specifically the volume of credit devoted to job creation. Wasmer and Weil (2004) introduce search frictions in both the labor and credit markets. Their focus is on the complementarity between the two frictions, not upon the transitional dynamics. Our empirical exercise is in line with the literature that investigates the empirical determinants of the time patterns of unemployment in OECD countries (see e.g., Blanchard and Wolfers (2000), Nickell, Nunziata and Ochel (2005), Belot and Van Ours (2004), Bassanini and Duval (2006), Bertola, Blau and Kahn (2006)). In a recent paper, Gatti and Vaubourg (2009) try to assess the impact of credit market imperfections on the level of unemployment. We depart from their work by analyzing also the effect of credit development on the persistence of unemployment.

The remainder of this paper proceeds as follows. The theoretical model is exposed in Section II. Section III provides an empirical illustration of the impact of credit frictions on unemployment persistence. Some concluding comments and directions for further research are gathered in section IV.

II The model

Time is continuous and goes forever. The economy consists of three types of risk-neutral agents: workers, entrepreneurs and banks, who all discount future at a common rate $\rho > 0$. Workers can be either employed or unemployed, and lend their savings to banks. Entrepreneurs own jobs that are either vacant or filled. They have no personal capital, so they need banks to finance the creation of new jobs. Competition among banks is perfect.

II.1 Matching technology

There is a unit mass of workers that are either employed or unemployed. Let L be the number of employed workers, so there are $1 - L$ unemployed workers. The total mass of jobs is endogenous. Jobs can be either filled or vacant and require an exogenous amount of k units of goods (capital). L also equals the number of filled jobs. Let V be the (endogenous) number of vacant jobs. The matching function $Q(U, V)$ expresses the flow of hiring per unit of time as the function of the number of unemployed workers and vacancies. We assume that $Q(., .)$ is increasing and concave

with respect to both arguments and that $Q(.,.)$ exhibits constant returns to scale.² We in addition assume that $Q(.,.)$ is continuously differentiable over \mathbb{R}_+^2 . Let $\theta = V/(1 - L)$ denote the tightness on the labor market.

The rate at which a vacancy meets a worker is given by $Q(U, V)/V = Q(1/\theta, 1) \stackrel{\text{def}}{=} q(\theta)$. From the assumptions we made about the matching function, we deduce that $q(\cdot)$ is a decreasing and differentiable function of θ . The rate at which an unemployed worker exits unemployment is $Q(U, V)/U = \theta q(\theta)$. This rate is an increasing and differentiable function of θ . Finally, jobs are dissolved exogenously at rate $\delta > 0$.

The level of employment (the number of filled jobs) evolves according to:

$$\dot{L} = \theta q(\theta) \cdot (1 - L) - \delta \cdot L \quad (1)$$

In steady state, this gives the Beveridge Curve

$$L = \frac{\theta q(\theta)}{\delta + \theta q(\theta)} \quad (2)$$

This curve defines an upward-sloping and convex curve labelled (BC) in the (L, θ) plan (see Figure 1). When the economy is located in the left (resp. in the right) of BC curve, L increases (decreases), so the economy moves rightwards (leftwards).

II.2 Workers

They receive the exogenous wage w when employed and 0 income when unemployed. They enjoy consumption thanks to a linear utility function and they deposit their savings at the banks. Hence savings are infinitely elastic in the interest rate, so banks generate revenue at the workers' discount rate ρ .

II.3 Entrepreneurs

A filled job produces a flow $y > w$ of production. Let r be the (endogenous) interest rate, so the flow of reimbursement equals $r \cdot k$. The value J of a filled job for an entrepreneur verifies the asset equation:

$$\rho \cdot J = y - w - r \cdot k - \delta \cdot J + \dot{J} \quad (3)$$

A vacant job neither yields cost nor gain. It is filled at the Poisson rate $q(\theta)$. The value J^v of a vacancy thus verifies the asset equation:

$$\rho \cdot J^v = q(\theta) (J - J^v) + \dot{J}^v \quad (4)$$

²See Petrongolo and Pissarides (2001)

II.4 Banks

When a bank is in contact with a filled job, it receives a flow $r \cdot k$ of reimbursement. Since the job is dissolved at the Poisson rate $\delta > 0$ and the bank finances itself at rate ρ , the value B for a bank to be in contact with a filled job verifies the asset equation

$$\rho \cdot B = r \cdot k - \delta \cdot B + \dot{B} \quad (5)$$

When a bank is in contact with a vacant job, the latter is unable to pay back its debt until the job becomes filled. Therefore, the value B^v of a bank to be in contact with a vacant job verifies:

$$\rho \cdot B^v = q(\theta)(B - B^v) + \dot{B}^v \quad (6)$$

Perfect competition in the banking sector decreases the lending interest rate r until the zero-profit condition $B^v - k = 0$ in the banking sector is met. This last condition pins down $B^v = k$ and $\dot{B}^v = 0$. Therefore, the interest rate adjusts so that, *at each point in time*:

$$B = k \left(1 + \frac{\rho}{q(\theta)} \right) \quad (7)$$

Summing (3) and (5) gives

$$(\rho + \delta)(J + B) = y - w + \dot{J} + \dot{B}$$

$J + B$ equals the total value of a filled job for the bank and the entrepreneur. It yields a constant profit that equals output y minus wage w and is dissolved at rate δ . This equation featuring forward-looking variables is unstable. Assuming away bubbles implies *at each point in time*:

$$J + B = \frac{y - w}{\rho + \delta} \quad (8)$$

II.5 Job creation

There are two constraints on the job creation.

1. Assume that creating a vacant job induces a once-for-all disutility cost $c \geq 0$. The net gain of creating a job should be nonnegative, so $J^v \geq c$. If this constraint is binding, then $J^v = c$ permanently and $\dot{J}^v = 0$. Using (4) imply that *at each point in time*

$$J = c \left(1 + \frac{\rho}{q(\theta)} \right)$$

This expression combined with with (7) and (8) gives :

$$\frac{y - w}{\rho + \delta} \geq (c + k) \left(1 + \frac{\rho}{q(\theta)} \right) \quad (9)$$

As in Mortensen and Pissarides (1999), this relation defines a tightness level independently of the employment level. Hence in the (L, θ) plan, this curve is horizontal. Below, tightness is lower, so J^v is higher than c and entrepreneurs want to create more vacancies.³

2. Banks require collateral to lend money. More specifically, a fraction $1/\mu$ of the lending is required as collateral. This puts an upper limit on the stock of credit $k(V + L)$. We assume that filled jobs are the only collateralized asset in this economy. Therefore, the credit constraint writes:

$$k(V + L) \leq \mu \cdot L \cdot (J + B)$$

since in case of default by the entrepreneurs, the bank remains the financier of the job (and as such values the job B) but can also resell the job to another entrepreneur (and as such values the job J as well). In the limit case where μ tends to infinity, entrepreneurs do not need collateral to borrow. Using $V = \theta(1 - L)$ and (8), the credit constraint implies *at each point in time*:⁴

$$\theta \leq \left(\frac{\mu y - w}{k \rho + \delta} - 1 \right) \frac{L}{1 - L} \quad (10)$$

Whenever (9) and (10) hold with strict inequality, entrepreneurs find profitable to create additional vacancies and are able to borrow additional credit. The number of vacancies then instantaneously rises, pushing tightness θ upwards. The right-hand side of (9) and the left-hand side of (10) increase. Therefore, entrepreneurs create vacancies until one of the two constraints binds. So, *at each point in time*:

$$\theta = \min \left[q^{-1} \left(\frac{(c + k)(\rho + \delta)}{(y - w) - ((c + k)(\rho + \delta))\rho} \right); \left(\frac{\mu y - w}{k \rho + \delta} - 1 \right) \frac{L}{1 - L} \right] \quad (11)$$

The first term in the right-hand side does not depend upon employment, while the second increases with employment. Therefore, in the (L, θ) map, Equation (11) can be depicted by a curve which is first increasing (corresponding to the constrained regime) and then horizontal (corresponding to the unconstrained regime) (See the curves labeled JC in Figure 1).

If the credit constraint (10) is not binding, Equation (9) holds with equality, which determines θ at each point in time, thereby at the steady state. Then the level of employment converges to its stationary value according to (1). The speed of convergence is given by $\delta + \theta q(\theta)$.

Assume now that the credit constraint (10) is binding. Therefore, one has

$$\theta = \left(\frac{\mu y - w}{k \rho + \delta} - 1 \right) \frac{L}{1 - L} \quad (\text{JC})$$

This defines an upward-sloping and convex relationship in the (L, θ) map, which tends to 0 as L tends to 0 and tends to ∞ when the economy converges to full employment.

³Equation (9) resembles the profitability constraint in Matsuyama (2007).

⁴Equation (10) resembles the borrowing constraint in Matsuyama (2007).

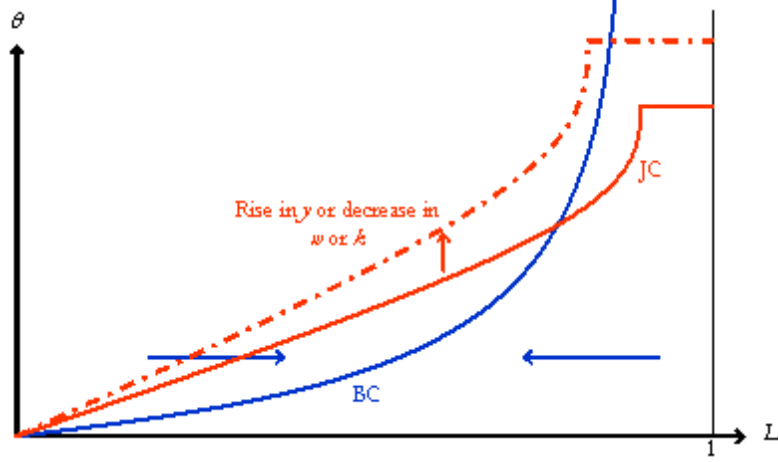


Figure 1: Steady-state stability

At a steady state, using (2) to substitute L in (10) leads to

$$\frac{\delta}{q(\theta)} = \frac{\mu y - w}{k \rho + \delta} - 1 \quad (\text{STS})$$

The left-hand side increases in θ , so a constrained steady state is unique.⁵ Hence, apart from the trivial $L = \theta = 0$ steady state, the JC and BC curves intersect only once in Figure 1, such an intersection defining a steady-state equilibrium. Moreover, when productivity y increases, or when the wage w or the level of capital required to create a job k decrease, or when financial market improves (so that μ increases) tightness increases. Since the JC curve moves upwards as y or μ increases⁶ or w or k decreases, the BC curve has to be steeper than the JC curve to be consistent with the static comparative properties of the steady state, as Figure 1 illustrates. Finally, since the economy lies in the JC curve at any point in time when the credit constraint is binding, the (non-trivial) steady state is stable.

We now examine whether unemployment is more or less persistent when the credit constraint (10) is binding. Since the job creation condition under credit constraint (JC) holds *at each point in time*, plugging (JC) into (1) leads to (see Appendix A):

$$\frac{\partial \dot{L}}{\partial L} = -(\delta + \theta q(\theta)) + (1 - \eta(\theta)) \cdot \frac{\theta q(\theta)}{L}$$

⁵Recall that $q(\cdot)$ is decreasing in θ over \mathbb{R}_*^+ . Let us denote $\underline{q} = \lim_{\theta \rightarrow \infty} q(\theta)$ and $\bar{q} = \lim_{\theta \rightarrow 0} q(\theta)$, with $0 \leq \underline{q} < \bar{q} \leq +\infty$. Existence holds if and only if

$$\frac{\delta}{\bar{q}} < \left(\frac{\mu y - w}{k \rho + \delta} - 1 \right) < \frac{\delta}{\underline{q}}$$

where it is understood that $\delta/\underline{q} = +\infty$ if $\underline{q} = 0$ and $\delta/\bar{q} = 0$ if $\bar{q} = +\infty$.

⁶When financial market improves (higher μ), only the constrained part of the JC curve shifts upwards. Hence the kink moves leftwards and the horizontal part remains at the same height, contrary to what is represented in Figure 1, which corresponds to changes in y , w and k .

where $\eta(\theta) = -\theta q'(\theta)/q(\theta) \in (0, 1)$ denotes the elasticity of the matching function $Q(\cdot, \cdot)$ with respect to the stock of unemployment. In steady state

$$\frac{\partial \dot{L}}{\partial L} = -\eta(\theta) \cdot (\delta + \theta q(\theta))$$

Thus, employment converges at a lower rate to its steady-state value when the economy is credit constrained. To understand why, let us denote by $L^*(\theta) = \theta q(\theta) / (\delta + \theta q(\theta))$ the level of employment which equilibrates labor inflows and outflows. When tightness θ is constant, which is the case in the unconstrained regime, employment converges in an autoregressive fashion towards its stationary target $L^*(\theta)$. Conversely, in the constrained regime, tightness θ increases in L , as a rise in employment increases the stock of collateralized assets. Then, when employment is below (above) the $L^*(\theta)$ target, employment increases (decreases) for the same “flow-rebalancing” reason as in the unconstrained regime. However, this increase (decrease) in turn implies an increase (decrease) of the $L^*(\theta)$ target. As a matter of fact, the convergence towards the steady state is delayed, explaining why employment will converge at a slower pace in the constrained regime.

To fix ideas on how important is the persistence difference between the two regimes from a quantitative viewpoint, let us recall that around the steady state, the speed of convergence is given by $\delta + \theta q(\theta)$ in the unconstrained regime and $\eta(\theta) (\delta + \theta q(\theta))$ in the constrained regime. According to Petrongolo and Pissarides (2001), $\eta(\theta) = 0.5$ is the most plausible value for the elasticity of the matching function. Hence, the speed of convergence towards *the same* steady state (i.e. with the same θ) would be twice smaller under credit constraints. Moreover, since the constrained regime is associated with lower values of tightness, the speed of convergence would be even slower. We are therefore confident that credit constraints have an important quantitative impact on unemployment persistence.

III Empirics

In this section we investigate empirically, on macro-panel data, the impact of the credit market development on the level and persistence of unemployment. The analysis is carried out on 19 OECD countries⁷ over the period 1982-2003. Data were drawn from Bassanini and Duval (2006) for the labor market institutions and Beck, Demirgüç-Kunt and Levine (2006) for financial development variables.⁸

⁷ Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

⁸The definitions and description of the variables are in Appendix.

III.1 Estimated models

To test whether credit market imperfections increase unemployment persistence, we compare the estimates of the following three equations.⁹

$$UR_{i,t} = \alpha \cdot UR_{i,t-1} + \beta \cdot X_{i,t} + \nu_i + \lambda_t + \varepsilon_{i,t} \quad (12a)$$

$$UR_{i,t} = \alpha \cdot UR_{i,t-1} + \beta \cdot X_{i,t} + \gamma \cdot CRE_{i,t} + \nu_i + \lambda_t + \varepsilon_{i,t} \quad (12b)$$

$$UR_{i,t} = \alpha \cdot UR_{i,t-1} + \beta \cdot X_{i,t} + \gamma \cdot CRE_{i,t} + \kappa \cdot (CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR}) + \nu_i + \lambda_t + \varepsilon_{i,t} \quad (12c)$$

where UR_{it} is the aggregate rate of unemployment, $UR_{i,t-1}$ the lagged rate of unemployment, ν_i and λ_t are country- and time-fixed effects. $X_{i,t}$ is a vector of standard unemployment determinants in the literature. It here includes the average unemployment benefit replacement rate (*ARR*), the degree of coordination of wage bargaining (*CORP*), the union membership rates (*UNDENS*), the tax wedge (*TW*), the degree of employment protection legislation (*EPL*), the average degree of stringency of product market regulation (*PMR*), and the OECD measure of output gap (*OGAP*) which particularly aims at controlling for the unemployment effects of aggregate demand fluctuations over the business cycle (see e.g., Bassanini and Duval 2006).

Equation (12a) is our benchmark where unemployment is explained only by its lagged value and other standard determinants in the literature. The coefficient α of the lagged value is our empirical measure of unemployment persistence.

We capture in Equation (12b) the effect of the financial market development on the level of unemployment by introducing an indicator of the stringency of credit constraints: the share of private credit by deposit money banks to GDP (*CRE*). It measures isolated credit issued to the private sector as opposed to credit issued to governments and public enterprises. Furthermore, it concentrates on credit issued by intermediaries other than the central bank. It is a measure of the activity of financial intermediaries in one of its main function: channeling savings to investors. The higher this indicator, the less stringent credit constraints. Credit market frictions may have a steady-state effect on unemployment which is captured by coefficient γ in (12b).

Moreover, we introduce in Equation (12c) an interaction term between credit market imperfection and lagged unemployment. \overline{UR} and \overline{CRE} respectively stand for the means of unemployment rates and of the share of private credit by deposit money banks in GDP over the whole sample. The coefficient κ thus specifically captures how credit market imperfections influence unemployment persistence, while their effect on steady-state unemployment is captured by parameter γ .

⁹The constant term is here implicitly included either in the country-specific effects, or in the time-specific effects.

Since we exploit similar OECD data for labor market institutions, we follow Bassanini and Duval (2006) and use the Generalized Least Square estimation method allowing for heteroscedastic errors. Doing so, we are also consistent with the methodology of Nickell et al. (2005), on a different set of data. Country-fixed effects ν_i capture unobserved heterogeneity between countries, while time-fixed effects λ_t control for world trends and business cycle.

Institutional variables $X_{i,t}$ and $CRE_{i,t}$ are time-varying. Changes in unemployment may cause potential policy reactions that would affect these variables. This could generate simultaneous biases, so that an identification issue arises and we have to rely on an instrumental 2SLS approach. This problem potentially concerns all the variables in the right-hand side of Equations (12). However, since our particular focus is on credit market imperfections, we only instrument $CRE_{i,t}$ (in specifications 12b and 12c) and $(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$ (in specification 12c). For sake of methodological robustness, we provide estimates of Equations (12) both with and without instruments.

III.2 Main results

Results (see Table 1) suggest that:

- Whatever the specification, the estimated coefficient α for the one-period lagged unemployment variable ($UR_{i,t-1}$) is significantly different from zero at the 1% level with the expected positive sign, suggesting a strong persistence of unemployment. This result is very robust and consistent with Nickell et al. (2005), Bassanini and Duval (2006).
- The estimated vector β of parameters associated to standard unemployment determinants in the literature is also quite robust from specifications (12a) through (12c).
 - Regarding labor market institutions, the average unemployment benefit replacement rate (ARR) and the high-corporatism index ($CORP$) would affect the level of unemployment in a significant way (1% level), with the expected signs (respectively positive and negative). A more generous benefit system would tend to increase the level of unemployment, while a higher degree of coordination in wage-setting (e.g. in scandinavian economies) would reduce it. These results are consistent with Nickell et al. (2005) and Bassanini and Duval (2006). Moreover, they seem particularly robust to the introduction of our credit market development variable. The significant positive effect of union density ($UNDENS$) on unemployment does not seem robust to the introduction of financial development variables. In the third specification, the tax wedge (TW) appears as a significant (10% level) factor of unemployment increase, which is in accordance with previous theoretical and empirical research. Employment protection legislation (EPL), whose theoretical effects on

Table 1: Empirical results

Column	Dependent Variable: $UR_{i,t}$				
	Specifications				
	(12a) (1)	(12b) (2) (3)		(12c) (4) (5)	
$UR_{i,t-1}$	0.77*** (36.69)	0.76*** (34.21)	0.72*** (14.85)	0.74*** (32.44)	0.40*** (2.96)
$ARR_{i,t}$	0.02** (2.16)	0.02** (2.07)	0.02 (0.15)	0.02*** (2.66)	0.02 (0.81)
$CORP_{i,t}$	-0.74*** (-3.35)	-0.79*** (-3.53)	-0.73*** (-2.54)	-0.81*** (-3.63)	-0.43 (-0.87)
$UNDENS_{i,t}$	0.02* (1.95)	0.01 (1.28)	-0.03 (-1.40)	0.01 (0.79)	-0.04 (-1.37)
$TW_{i,t}$	0.02* (1.73)	0.02 (1.47)	0.02 (0.75)	0.04*** (2.44)	0.20*** (3.09)
$EPL_{i,t}$	-0.37** (-2.33)	-0.39** (-2.47)	-0.19 (-0.83)	-0.49*** (-2.98)	-2.04*** (-2.77)
$PMR_{i,t}$	0.15* (1.75)	0.12 (1.36)	-0.22 (-0.95)	0.14* (1.65)	0.72** (2.15)
$OGAP_{i,t}$	-0.21*** (-11.27)	-0.22*** (-11.40)	-0.27*** (-6.74)	-0.22*** (-11.70)	-0.26*** (-4.79)
$CRE_{i,t}$		-0.51* (-1.86)	-2.87* (-1.75)	-0.59** (-2.13)	-2.21** (-2.05)
$(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$				-0.08*** (-2.57)	-1.62*** (-3.16)
Instruments	No	No	Yes	No	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes
Davidson and McKinnon exogeneity test					
Statistic			3.81		21.85
p-value			0.05		0.00
Sargan overidentification test					
Statistic			0.258		5.396
p-value			0.61		0.15
Observations	349	349	349	349	349

Estimate coefficients are significant at the 1% level if ***, 5% if **, 10% if *.

Student T-statistics are given in brackets beneath the coefficients.

Nota: \overline{UR} and \overline{CRE} respectively stand for the means of $UR_{i,t-1}$ and $CRE_{i,t}$

Instruments used in column (3): $PMR_{i,t-1}$, $PUBOWN_{i,t-2}$

Instruments used in column (5): $ARR_{i,t-1}$, $PMR_{i,t-1}$, $OGAP_{i,t-2}$, $CRE_{i,t-1}$, $CRE_{i,t-2}$

unemployment are ambiguous (since it can decrease both unemployment entry and exit) appears to lower unemployment.

- The coefficient associated with rigidities in the goods market (PMR) is significantly positive, which is consistent with previous research. Rents and other non-competitive features on the product market would tend to increase unemployment.
- The output gap measure ($OGAP$) would significantly reduce unemployment. This index is computed as the difference between the actual output of an economy and its "full-capacity" production potential, and thus has a negative sign. A negative coefficient associated with $OGAP$ implies that a reduction in the output gap reduces the unemployment level. This result is theoretically consistent, and perfectly in line with Bassanini and Duval (2006).
- The ratio of private credit by deposit money banks to GDP (CRE), which we understand as inversely related to the stringency of credit constraints, would significantly reduce the unemployment level. The estimated coefficient γ is significantly different from zero at the 10% level for specification (12b), and at the 5% level for specification (12c), with the expected negative sign. Interestingly, the introduction of this variable would not change the main findings for specification (12a).
- The ratio of private credit by deposit money banks to GDP would significantly reduce the unemployment persistence (1% level). The estimated coefficient κ is significantly different from zero at the 1% level, with the expected negative sign, which gives a strong support to our theoretical analysis. We are quite confident in the robustness of this effect, since it does not destabilize the results of specifications (12a) and (12b) previously commented.
- We now turn to the possible endogeneity of credit variables $CRE_{i,t}$ and $(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$. Column 3 provides alternative estimates of specification (12b) using 2SLS, instrumenting $CRE_{i,t}$ by $PMR_{i,t-1}$ (first lag of the OECD Product Market Regulation Index) and $PUBOWN_{i,t-2}$ (second lag of the OECD public ownership index, a component of the PMR index measuring the scope of public enterprise, size of public enterprise, special voting rights and control of public enterprise by legislative bodies). Column 5 provides alternative estimates of specification (12c), instrumenting $CRE_{i,t}$ and $(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$ by $ARR_{i,t-1}$, $PMR_{i,t-1}$, $OGAP_{i,t-2}$, $CRE_{i,t-1}$, and $CRE_{i,t-2}$. The results of first-stage within regressions are available in Table 4 and 5, Appendix D.

The 2SLS regressions provide consistent estimates as regards the instrumented credit variables in specifications 2 and 3. Though the coefficients associated with the vector $X_{i,t}$ of

traditionnal unemployment determinants appear to be less significant, they do not seem to contradict the main results of GLS estimations.

Two tests are used to evaluate adjustment quality:

- The Davidson-McKinnon test (1993) is an adaptation to panel data econometrics with fixed effects of the (Durbin-Wu-)Hausman test . It evaluates whether explanatory variables are endogenous. If the associated p-value is equal or lower than $x\%$, we can consider the use of instrumental variables as necessary, with a $x\%$ error risk. The null hypothesis, which states that an OLS fixed-effects model would result in consistent estimates, is rejected at a 5% level in column 3, and at 0% level in column 5, indicating that $CRE_{i,t}$ and $(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$ may be endogenous.

- The Sargan test evaluates regressor exogeneity for a panel data fixed-effects regression estimated via instrumental variables in which the number of instruments exceeds the number of regressors: that is, for an overidentified equation. If the associated p-value is equal or greater than 10%, we can consider that the instruments are valid and not correlated to the error term, with a 10% error risk. According to this criterion, the regressions whose results are gathered in column 3 and 5 would display valid instruments, with a 10% error risk.

These instrumental 2SLS estimations give further support to our quantitative findings.

IV Conclusion

In this paper, we argue that credit market imperfections impact not only the level of unemployment, but also its persistence. For this purpose, we first develop our theoretical argument in a simple model based on the equilibrium matching framework of Mortensen and Pissarides (1999) and Pissarides (2000) where we introduce credit constraints *à la* Matsuyama (2007). We show these credit constraints not only increase steady-state unemployment, but also slow down the transitional dynamics. We then provide an empirical illustration based on a macro-panel dataset of 19 OECD countries. Our results suggest that credit market imperfections would significantly increase the persistence of unemployment.

Some directions for further research naturally follow. First, we want to consider alternative measurements for the stringency of credit constraints. Second, we aim at generalizing the analysis to the case of endogenous job destruction. Third, we plan to investigate how the introduction of another collateralizable asset (aside from labor) would change the analysis. We intend to pursue these projects in the soon future.

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Appendix

A Unemployment Persistence under credit constraints

Deriving (1)

$$\begin{aligned}\frac{\partial \dot{L}}{\partial L} &= -(\delta + \theta q(\theta)) + (1 - L) \cdot \frac{\partial \theta q(\theta)}{\partial \theta} \cdot \frac{\partial \theta}{\partial L} \Big|_{\text{JC}} \\ &= -(\delta + \theta q(\theta)) + (1 - L) \cdot q(\theta) (1 - \eta(\theta)) \cdot \frac{\frac{\mu}{k} \frac{y-w}{\rho+\delta} - 1}{(1 - L)^2} \\ &= -(\delta + \theta q(\theta)) + q(\theta) (1 - \eta(\theta)) \cdot \frac{\frac{\mu}{k} \frac{y-w}{\rho+\delta} - 1}{1 - L} \\ &= -(\delta + \theta q(\theta)) + q(\theta) (1 - \eta(\theta)) \cdot \frac{\theta}{L}\end{aligned}$$

where the second equality follows the derivation of (JC) and the last one stems from (JC).

B Data sources and definitions

Aggregate unemployment rate (UR)

Definition: Unemployed workers in the age group 15-64 as share of the labor force (in %).

Source : Bassanini and Duval 2006.

Average unemployment benefit replacement rate (ARR)

Definition: Average unemployment benefit replacement rate across two income situations (100% and 67% of APW earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (1st year, 2nd and 3rd years, and 4th and 5th years of unemployment).

Source: Bassanini and Duval 2006.

High corporatism (CORP)

Definition: Indicator of the degree of centralisation/co-ordination of the wage bargaining processes, which takes values 1 when wage bargaining is highly centralised or co-ordinated and 0 otherwise.

Source: Bassanini and Duval 2006

Union density (UNDENS)

Definition: Trade union density rate, i.e. the share of workers affiliated to a trade union, in %.

Source: Bassanini and Duval 2006.

Labor tax wedge (TW)

Definition: Tax wedge between the labor cost to the employer and the corresponding net take-home pay of the employee for a single-earner couple with two children earning 100% of APW earnings. The tax wedge expresses the sum of personal income tax and all social security contributions as a percentage of total labor cost.

Source: Bassanini and Duval 2006.

Employment Protection Legislation (EPL)

Definition: OECD summary indicator of the stringency of Employment Protection Legislation.

Source: Bassanini and Duval 2006.

Product Market Regulation (PMR)

Definition: OECD summary indicator of regulatory impediments to product market competition in seven non-manufacturing industries. The data cover regulations and market conditions in seven energy and service industries: gas, electricity, post, telecoms (mobile and fixed services), passenger air transport, railways (passenger and freight services) and road freight.

Source Bassanini and Duval 2006.

Output gap (OGAP)

Definition: OECD measure of the gap between actual and potential output as a percentage of potential output.

Source: Bassanini and Duval 2006.

Private credit by deposit money banks to GDP (CRE)

Definition: *CRE* equals claims on the private sector by deposit money banks divided by GDP. It measures isolate credit issued to the private sector as opposed to credit issued to governments and public enterprises. Furthermore, it concentrates on credit issued by intermediaries other than the central bank. It is a measure of the activity of financial intermediaries in one of its main function: channeling savings to investors.

Source: Beck, Demirgüç-Kunt and Levine 2001.

Public Ownership (PUBOWN)

Definition: *PUBOWN* is a component of the OECD Product Market Regulation Index. It measures the scope of public enterprise, the size of public enterprise, special voting rights and the control of public enterprise by legislative bodies.

Source: Bassanini and Duval 2006.

C Variables description

Table 2: List of variables used in the analysis

<i>UR</i>	: Aggregate unemployment rate
<i>ARR</i>	: Average unemployment benefit replacement rate (%)
<i>CORP</i>	: High corporatism
<i>UNDENS</i>	: Union density (%)
<i>TW</i>	: Labor tax wedge (%)
<i>EPL</i>	: Employment protection legislation
<i>PMR</i>	: Product market regulation
<i>OGAP</i>	: Output gap
<i>CRE</i>	: Private credit by deposit money banks to GDP
<i>PUBOWN</i>	: Public ownership

Table 3: Descriptive statistics of variables used in the analysis

Variable	Mean	Standard deviation	Minimum	Maximum	Number of observations
UR (%)	7.95	4.25	0.45	24.04	349
ARR (%)	29.65	12.95	0.35	64.94	349
CORP	0.51	0.5	0	1	349
UNDENS (%)	38.64	20.84	8.2	83.14	349
TW (%)	28.22	9.19	6.41	45.5	349
EPL	2.00	1.13	0.2	4.19	349
PMR	3.66	1.31	1.05	6	349
OGAP	-0.68	2.34	-10.72	6.30	349
CRE	0.75	0.34	0.18	1.65	349
PUBOWN	3.75	1.44	0.74	6	349

D First-stage fixed-effects (within) regressions

Table 4: Instruments used in Column 3: first-stage regressions

	Dependant Variable: $CRE_{i,t}$
$UR_{i,t-1}$	-0.0194*** (4.54)
$ARR_{i,t}$	-0.0062*** (-3.05)
$CORP_{i,t}$	-0.0505 (-1.30)
$UNDENS_{i,t}$	-0.0077*** (-3.80)
$TW_{i,t}$	-0.0073** (-2.48)
$EPL_{i,t}$	-0.0188 (-0.57)
$PMR_{i,t}$	-0.1436*** (-3.17)
$PMR_{i,t-1}$	0.1140*** (2.36)
$OGAP_{i,t}$	-0.0160*** (-4.02)
$PUBOWN_{i,t-2}$	-0.0909*** (-4.10)
Time dummies	yes
Country dummies	yes
Observations	349

Table 5: Instruments used in Column 5: first-stage regressions

	Dependant Variable:	
	$CRE_{i,t}$	$(CRE_{i,t} - \overline{CRE}) \times (UR_{i,t-1} - \overline{UR})$
$UR_{i,t-1}$	-0.0048*** (-2.55)	-0.2736*** (-7.39)
$ARR_{i,t}$	-0.0059*** (-3.03)	-0.0221 (0.58)
$ARR_{i,t-1}$	0.0047*** (2.70)	-0.0279 (-0.81)
$CORP_{i,t}$	-0.0025 (-0.16)	0.1752 (0.59)
$UNDENS_{i,t}$	-0.0018*** (-2.36)	-0.0285** (-1.95)
$TW_{i,t}$	-0.0012 (-1.08)	0.1140*** (5.08)
$EPL_{i,t}$	-0.0286** (-2.14)	-1.2651*** (-4.81)
$PMR_{i,t}$	-0.0188 (-1.06)	-0.1447 (-0.42)
$PMR_{i,t-1}$	0.0147 (0.83)	0.6637** (0.96)
$OGAP_{i,t}$	-0.0008 (-0.50)	0.0004 (0.01)
$OGAP_{i,t-2}$	0.004 (0.27)	-0.0714** (1.05)
$CRE_{i,t-1}$	1.4120*** (29.77)	-2.5745*** (-2.76)
$CRE_{i,t-2}$	-0.5568*** (-10.75)	1.4859 (1.46)
Time dummies	yes	yes
Country dummies	yes	yes
Observations	349	349