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FINANCING CONSTRAINTS AND FIXED-TERM EMPLOYMENT CONTRACTS*

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This article studies the interactions between financing constraints and the employment decisions of firms when both fixed-term and permanent employment contracts are available. It develops the model of an industry where firms face financing frictions and produce output using both fixed-term and permanent workers. Once calibrated, the model shows that financially constrained firms use fixed-term workers more intensely and make them absorb a larger fraction of the total employment volatility than financially unconstrained firms do. We test and confirm the predictions of the model on a panel data of Italian manufacturing firms with detailed information about financing constraints and the type of workers employed by the firms.

The literature on financing constraints has investigated how financial restrictions may affect firms' decisions. In particular most of the theoretical and empirical literature has analysed fixed capital investment decisions.[1] However, there are very few studies on the effects of financing constraints on the employment policies of firms.[2] The payment of wages and firing costs makes hiring and firing sensitive to the financing frictions that firms face. Moreover the dynamic nature of employment decisions also makes firms sensitive to future expected financing constraints. The aim of this article is to propose and test empirically a new way of identifying the effects of financing constraints on the employment dynamics of firms using the different hiring and firing costs of fixed-term contracts and permanent contracts.

We consider the optimal dynamic employment policy of a firm that faces capital market imperfections and can hire two types of labour: one that is totally flexible (fixed-term contracts) and one that is subject to firing costs (permanent contracts). We assume that both are perfect substitutes but permanent employment is relatively more productive. This implies that a firm without financing constraints would hire permanent workers up to the point where expected firing costs are equal to the productivity gain with respect to temporary workers.

The model shows that financing constraints are an important determinant of employment decisions and that they affect the optimal mix between fixed-term and permanent workers. More precisely, the model predicts two opposite effects of financing frictions on the composition of employment: on the one hand financing

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[1] See Hubbard (1998) for a review of this literature.

[2] Exceptions are Nickell and Nicolitsas (1999), Smolny and Winker (1999), Benito and Hernando (2003) and Rendon (2005).

constraints generate a 'demand for productivity' effect: they increase the value of internally generated earnings, and thus increase the demand of the more productive permanent workers. This effect is stronger for those firms that are currently severely financially constrained but expect to be less so in the future. On the other hand future expected financing constraints generate a 'demand for flexibility' effect: they make firms more vulnerable to liquidity shocks, and increase both the expected volatility of employment and the demand for the more flexible fixed-term workers.

To identify these two effects empirically, we solve the model and calibrate a simulated industry that matches the employment dynamics and the volatility of profits of our data. The simulated industry allows us to have testable implications. It shows that the 'demand for flexibility' effect is the most important one and as a result financing constraints significantly increase the use of fixed-term workers. Moreover the simulations show that financially constrained firms not only hire more fixed-term workers but also use them to absorb a larger part of the total employment volatility, so that their permanent employment becomes relatively less volatile. In other words, we show that the flexibility provided by fixed-term workers is particularly useful for firms facing financing frictions and that this higher use of fixed-term workers interacts with financial frictions and significantly increases the volatility of total employment in an industry.

In the second part of the article we focus on the set of predictions that can be empirically tested:

(1) Financing constraints increase the amount of fixed-term workers relative to permanent workers.
(2) The positive effect of financing constraints on fixed-term employment is asymmetric, because it is much stronger for firms that increase employment than for firms that decrease it.
(3) Financing constraints increase the volatility of all types of employment but should increase the volatility of fixed-term employment relatively more than that of permanent employment.

These predictions are tested on a database of small and medium Italian manufacturing firms with balance sheet data from 1995 to 2000. This data set represents a unique opportunity to verify the joint effect of firing costs, flexible employment contracts and financing imperfections on the labour demand of firms, for several reasons:

(*i*) Italy's labour law establishes a very high level of employment protection.[3] At the same time flexible contracts have been gradually more available to Italian firms in the last 20 years. Therefore our data set is particularly well suited to analysing the effect of the presence of a flexible labour contract in a heavily regulated environment.
(*ii*) The Italian financial system is traditionally underdeveloped. Italian firms, especially small and medium sized ones, face capital market imperfections that are only partially corrected by the availability of bank credit as the main source of external finance.

[3] The OECD 1999 *Employment Outlook* places Italy as the country with the third strictest employment protection legislation among OECD countries in the 1990s.

(*iii*) The data set analysed in this article contains a unique combination of self-reported measures of financing constraints and information on fixed-term and permanent labour contracts.

The results from our empirical analysis confirm the predictions of the model that financially constrained firms use fixed-term contracts more intensively, especially during expansion phases, and have a higher volatility of total employment than financially unconstrained firms. The empirical results also provide some evidence that this increase in volatility is substantially higher for fixed-term contracts than for permanent contracts. Finally, all the results are robust to:

(*i*) the inclusion of additional control variables that take into account possible heterogeneity in the empirical data that is not present in the model;
(*ii*) the use of instrumental variables to correct for the potential endogeneity of the self-reported measure of financing constraints.

1. Related Literature

The findings of this article complement those in the literature on the effect of employment protection on employment dynamics (Bentolila and Bertola, 1990; Bentolila and Saint Paul, 1992; Hopenhayn and Rogerson, 1993). In particular, the issue of fixed-term labour contracts and their interaction with permanent contracts has attracted significant attention in the pre-existing literature.[4] The European countries where both types of contracts coexist, and where several labour reforms have been introduced, constitute interesting natural experiments to test the effects of firing costs and labour market regulations. A significant number of articles have studied the different country cases empirically: Spain (Dolado *et al.*, 2002; Alonso-Borrego *et al.*, 2004), France (Blanchard and Landier, 2002) and Italy (Kugler and Pica, 2004) among many others. All of these articles explore the changes in volatility of employment, the effect of fixed-term contracts on unemployment and the relative use of fixed-term versus permanent contracts. In general they show that, after the introduction of fixed-term contracts, fixed-term workers absorb a higher share of the volatility of output. They also show that overall employment volatility increases but they find ambiguous effects on whether their introduction increases or decreases unemployment. However these articles do not take into account the possible influence of financing constraints. The contribution of this article is to show that not only are financing constraints an important determinant of the decision to hire fixed-term workers in the first place but also that the interactions between financing frictions and firing costs are important for understanding the employment dynamics of firms.

This article is also related to the literature on the effect of financial imperfections on the labour demand of firms. Nickell and Nicolitsas (1999), Smolny and Winker (1999) and Benito and Hernando (2003) explore the relationship between financing constraints and total employment at the empirical level. In general, they find that the presence of financing constrains may deter hiring. The added value of our article

[4] Dolado *et al.* (2002) and Saint Paul (1996) provide a good survey of the relevant theoretical literature on the topic.

comes from exploring the interaction between financing constraints, firing costs and the joint dynamics of fixed-term and permanent employment contracts. That is, in contrast with the previous literature we explicitly model the existence of both types of contracts and show how the presence of financing constraints affects their use. The advantage of our approach is that our calibrated structural model provides several clear and unambiguous predictions about the effect of financing constraints on the trade off between permanent and fixed-term labour contracts. In this sense our article can be considered as a bridge between the two strands of the literature mentioned above.[5]

This article also contributes to the recent literature that investigates new ways of testing for the effect of capital market imperfections at firm level (Almeida and Campello, 2006; Whited, 2006; Hennessy *et al.*, 2007; Hennessy and Whited, 2006; Caggese, 2007 among others). In contrast to these authors, who study the effect of financing frictions on fixed and working capital investment decisions, we focus on the effect on employment decisions. Moreover, while most of the literature does not distinguish between the effects of current and future financing problems, we show that the interactions between financing frictions and employment decisions are also helpful for identifying the effect of future expected financing constraints on the current employment decisions of firms.[6]

2. The Model

2.1. *Setup*

We consider a risk neutral firm that maximises the discounted flow of dividends:

$$V_t(l_t^p, \theta_t, a_t) = \max_{l_{t+1}^p, l_{t+1}^f, b_t} d_t + \frac{1}{R} \mathrm{E}_t\left[V_{t+1}\left(l_{t+1}^p, \theta_{t+1}, a_{t+1}\right)\right], \tag{1}$$

where $V_t(l_t^p, \theta_t, a_t)$ is the discounted value of the firm at time t and d_t are dividends. The gross discount rate is $R = 1 + r$, where r is the market real net interest rate. The state variables that determine the situation of a firm at any given point in time are: the stock of permanent employment contracts l_t^p, the value of the net cash flow (from operations and maybe financial assets) a_t, and the stochastic productivity parameter θ_t, with

$$\theta_t \in \{\theta_1, \ldots, \theta_N\} \text{ and } \infty > \theta_N > \cdots > \theta_1 > 0. \tag{2}$$

We assume that θ_t follows a first order Markow process with transition probabilities $\Gamma(\theta'/\theta)$. The decision variables of the firm are as follows: l_{t+1}^p and l_{t+1}^f are the amount of permanent and fixed-term labour contracts, respectively, which will produce output in period $t+1$. Fixed-term contracts only last one year, while permanent contracts are open ended; b_t is the face value of one period debt borrowed in period t. If negative, it indicates that the firm is a net lender.

[5] Another paper that follows a similar approach is Rendon (2005). The author uses a simulation procedure and compares the effect, on fixed investment and job creation, of relaxing financing constraints as opposed to relaxing labour market rigidities.

[6] One interesting exception is Almeida *et al.* (2004). They study the effect of expected financing constraints on the propensity of firms to retain earnings, while we focus on their effect on the employment decisions of firms.

The firm uses a concave technology in labour input with a degree of returns to scale equal to α:

$$y_t = \theta_t \left(l_t^p + \rho l_t^f \right)^{\alpha}, \tag{3}$$

$$0 < \rho < 1, 0 < \alpha < 1.$$

The parameter ρ represents the relative productivity differential between fixed-term and permanent workers. For simplicity we assume that permanent and fixed-term contracts are perfect substitutes and are paid the same wage, normalised to one. They differ in that permanent workers are more skilled but they can be fired only by paying a fixed cost. Fixed-term workers can be fired without restrictions but are relatively less productive than permanent workers. Appendix 1 shows that this setup is equivalent to a setup where all workers are equally productive ($\rho = 1$), but fixed-term workers are paid a higher wage to compensate for the higher expected probability of losing the job. In other words, the assumption that $\rho < 1$ only implies that the difference in productivity between the two types of contracts is not fully compensated by their wage differential.[7] The timing of the model is as follows:

Time t			Time $t+1$
l_t^p, l_t^f are currently employed. θ_t, y_t are realised.	Debt b_{t-1} repaid. a_t is net wealth and b_t/R is new borrowing.	$d_t, l_{t+1}^p, l_{t+1}^f$ are determined.	

At the beginning of period t the firm has a stock of permanent and fixed-term workers equal to l_t^p and l_t^f, respectively. The firm observes θ_t, realises revenues y_t and repays the debt b_{t-1}. The dynamics of the net assets of the firm can therefore be expressed as

$$a_t = y_t - b_{t-1}. \tag{4}$$

After production the contract of fixed-term workers ends. Conversely, permanent workers leave the firm at the exogenous separation rate δ, so that after producing there are $(1 - \delta) l_t^p$ workers still employed. The firm uses financial wealth plus new borrowing to pay dividends and wages. The budget constraint is the following:

$$d_t + l_{t+1}^p + l_{t+1}^f - F i_t^p S_t = a_t + \frac{b_t}{R}, \tag{5}$$

where b_t/R is the amount borrowed, l_{t+1}^f is the new hiring of fixed-term workers, F is a positive constant that represents the cost of terminating the contract of one permanent worker and i_t^p is the new hiring of permanent workers, $i_t^p = l_{t+1}^p - (1 - \delta) l_t^p$. In order to measure firing costs, we define S_t as an indicator function that is equal to one when i_t^p is negative and is equal to zero otherwise. It follows that $-F i_t^p S_t$ is non-negative and is the total amount of firing costs paid by the firm in period t. If the firm does not pay the firing cost then $S_t = 0$, and i_t^p is constrained to be non-negative. Therefore S_t and i_p must satisfy the following condition:

[7] We take ρ as exogenous and later calibrate it to match the observed use of fixed-term workers. However, in a general equilibrium setup with bargaining, ρ would be an endogenous outcome and the presence of firing costs does not necessarily guarantee that $\rho < 1$ (Ljungqvist, 2002).

$$(1 - S_t)i_t^P \geq 0. \tag{6}$$

Financing imperfections are present in the form of constraints to external financing. The first constraint is the non-negativity of dividends or, in other words, that the firm cannot issue new equity:

$$d_t \geq 0. \tag{7}$$

The second constraint is a borrowing limit $\bar{b}$ on the face value of debt b_t:

$$b_t \leq \bar{b}. \tag{8}$$

This constraint imposes some exogenous credit rationing to the firm.[8] To solve the firm's problem we add the Lagrange multipliers ϕ_t and λ_t to constraints (7) and (8), respectively. Moreover without loss of generality we define $(1 + \phi_t)\mu_t$ as the multiplier of constraint (6). If the firm is firing ($S_t = 1$ and $i_t^p < 0$) or hiring ($S_t = 0$ and $i_t^p > 0$) permanent workers then $\mu_t = 0$. Instead μ_t is positive when $S_t = 0$ and $i_t^p = 0$, indicating that the firm is hoarding the marginal permanent worker. We use (5) to substitute d_t in (1) and we derive the first order conditions of the problem with respect to b_t, l_{t+1}^f and l_{t+1}^p as follows:

$$1 + \phi_t = R\lambda_t + \mathrm{E}_t\left(1 + \phi_{t+1}\right). \tag{9}$$

Equation (9) is the first order condition for b_t. For the following analysis it is useful to solve it forward:

$$\phi_t = R\sum_{j=0}^{\infty}\mathrm{E}_t\left(\lambda_{t+j}\right), \tag{10}$$

where (10) shows that ϕ_t is equal to the sum of the current and future costs of a binding financing constraint. Therefore the shadow cost of one additional unit of external finance is equal to $1 + \phi_t$. As long as $\phi_t > 0$, then the return from investing earnings inside the firm is higher than r, and the firm does not distribute dividends, so that $d_t = 0$. The first order condition for l_{t+1}^f is

$$\frac{1}{R}\mathrm{E}_t\left[\left(1 + \phi_{t+1}\right)\frac{\partial y_{t+1}}{\partial l_{t+1}^f}\right] = 1 + \phi_t, \tag{11}$$

where

$$\frac{\partial y_{t+1}}{\partial l_{t+1}^f} \equiv \rho\alpha\theta_t\left(l_{t+1}^p + \rho l_{t+1}^f\right)^{\alpha-1}. \tag{12}$$

Equation (11) holds with equality when the firm hires a positive amount of fixed-term workers. It shows that the expected marginal return of fixed-term workers must be equal to their opportunity cost. The first order condition for l_{t+1}^p is

[8] The existing theoretical literature has offered various reasons for its existence. See for example Stiglitz and Weiss (1981) or Ausubel (1991).

$$\frac{1}{R}\mathrm{E}_t\left[(1+\phi_{t+1})\frac{\partial y_{t+1}}{\partial l^p_{t+1}}\right] = (1+\phi_t) - (1+\phi_t)\Omega_t + c\mathrm{E}_t\big[(1+\phi_{t+1})\Omega_{t+1}\big], \tag{13}$$

where

$$\frac{\partial y_{t+1}}{\partial l^p_{t+1}} \equiv \alpha\theta_t\left(l^p_{t+1}+\rho l^f_{t+1}\right)^{\alpha-1}; \Omega_t \equiv S_t F + (1-S_t)\mu_t;\ c \equiv \frac{1}{R}(1-\delta). \tag{14}$$

The term Ω_t is positive when the firm decides to fire or to hoard the excess permanent workers. Therefore the term $\mathrm{E}_t[(1+\phi_{t+1})\Omega_{t+1}]$ is the future expected cost of firing or hoarding permanent workers. Finally, we combine (5) and (8) and we define the maximum investment capacity of the firm as follows:

$$d_t + l^p_{t+1} + l^f_{t+1} - Fi^p_t S_t \leq a_t + \frac{\bar{b}}{R}. \tag{15}$$

When the financing constraint is not binding then $\lambda_t = 0$. In this case (10) determines ϕ_t, and (11) and (13) determine l^p_{t+1} and l^f_{t+1}. When the financing constraint is binding then (15) holds with equality and, together with (9), (11) and (13) it determines λ_t, ϕ_t, l^p_{t+1} and l^f_{t+1}.

2.2. *Employment Decisions*

In this Section we analyse the first order conditions of the problem conditional on firing, hoarding and hiring permanent workers. The labour demand of the firm is increasing in the productivity level θ_t, which is a persistent stochastic process. Therefore when θ_t is low, future expected productivity is also low and the amount of permanent workers currently employed in the firm may be inefficiently high, so that the firm may decide to fire or hoard some of them. More formally, let us denote the demand of permanent workers that would be optimal if firing costs were absent in period t but present from period $t+1$ onwards by $\hat{l}^p_{t+1}$. If l^p_t is relatively large and the productivity shock at time t is negative, then the optimal amount of permanent workers is lower than the amount of currently employed workers: $\hat{l}^p_{t+1} < (1-\delta)l^p_t$. Because of the presence of firing costs, the firm can either hoard all workers and choose $l^p_{t+1} = (1-\delta)l^p_t$, or, alternatively fire some of them paying the fixed cost F and hoard some others. In the former case $S_t = 0$ and $\Omega_t = \mu_t > 0$. In the latter case $S_t = 1$, $\mu_t = 0$ and $\Omega_t = F$.

The decision to hoard or to fire the marginal worker depends on the magnitude of μ_t relative to F. μ_t measures the cost of hoarding a marginal worker and is decreasing in the difference between the optimal unconstrained level of permanent workers and the actual level of workers. That is, as $\hat{l}^p_{t+1}$ increases and converges to $(1-\delta)l^p_t$ then μ_t decreases and converges to zero. Therefore, a value of $\hat{l}^p_{t+1}$ exists sufficiently close to $(1-\delta)l^p_t$ such that μ_t is smaller than F and the firm chooses $S_t = 0$ and $l^p_{t+1} = (1-\delta)l^p_t$. The difference $l^p_{t-1} - \hat{l}^p_{t+1}$ can be interpreted as labour hoarding.[9]

[9] This definition of labour hoarding simplifies the exposition but is actually different from the standard definition usually employed in models with firing costs, where it is defined as the difference between employement under firing costs and the fully frictionless employment level (no firing costs ever).

Given the value of l^p_{t-1}, it is possible to solve (11) for l^f_{t+1}. If the resulting l^f_{t+1} is positive, it measures the optimal hiring of fixed-term workers. If it is negative, the optimal hiring of fixed-term workers is zero.

The smaller are θ_t and $\hat{l}^p_{t+1}$, the larger becomes the difference $(1-\delta)l^p_t - \hat{l}^p_{t+1}$ and the cost μ_t of hoarding the marginal worker. When at the margin $\mu_t > F$, it becomes optimal to fire the marginal fixed-term worker, so that in equilibrium μ_t is bounded above by the value of F. In this case $S_t = 1$ and $\hat{l}^p_{t+1} < l^p_{t+1} < (1-\delta)l^p_t$. The difference $(1-\delta)l^p_t - l^p_{t+1}$ is the amount of fired workers, while the difference $l^p_{t+1} - \hat{l}^p_{t+1}$ is the amount of hoarded workers. In this case $l^f_{t+1} = 0$, because it is always optimal to fire fixed-term workers first.

We now consider the case in which the productivity shock is positive and the firm increases employment, so that $\hat{l}^p_{t+1} \geq (1-\delta)l^p_t$. In this case $S_t = \mu_t = \Omega_t = 0$. When hiring, the firm has also to decide on the optimal mix between permanent and fixed-term workers. This decision depends on a trade off. Permanent workers are more productive but also costly to fire. Therefore a firm prefers to hire permanent workers if it expects that the probability of firing them in the future is low. The key factor in this decision is the value of the term $\mathrm{E}_t(\Omega_{t+1})$, the expected cost of firing and hoarding permanent workers in the future. The discussion above makes it clear that $\mathrm{E}_t(\Omega_{t+1})$ increases in l^p_{t+1}, as formalised in the following Proposition:

PROPOSITION 1. *Conditional on θ_t and a_t, $E_t(\Omega_{t+1})$ is a continuous and weakly increasing function of l^p_{t+1}:*

$$E_t(\Omega_{t+1} \mid l^p_{t+1} = 0) = 0; \frac{\partial \mathrm{E}_t(\Omega_{t+1})}{\partial l^p_{t+1}} \geq 0.$$

PROOF. See Appendix 2.

For a hiring firm, l^p_{t+1} and l^f_{t+1} are jointly determined by the following two conditions:

$$\mathrm{E}_t\left[(1+\phi_{t+1})\frac{\partial y_{t+1}}{\partial l^f_{t+1}}\right] = R(1+\phi_t) \tag{16}$$

$$\mathrm{E}_t\left[(1+\phi_{t+1})\frac{\partial y_{t+1}}{\partial l^p_{t+1}}\right] - c\mathrm{E}_t\big[(1+\phi_{t+1})\Omega_{t+1}\big] = R(1+\phi_t). \tag{17}$$

Equation (16) is basically (11) rearranged and (17) is derived from (13) evaluated at $\mu_t = 0$ and $S_t = 0$. Equations (16) and (17) determine the optimal mix between fixed-term and permanent workers for a hiring firm. The right-hand side is the same for both equations because, as shown in Appendix 1, the amount of labour can be interpreted as measured in wage units. By comparing (16) and (17) and by using the result that $\partial y_{t+1}/(\partial l^f_{t+1}) = \rho[\partial l^f_{t+1}/(\partial l^f_{t+1})]$, it follows that a firm is indifferent between hiring a permanent worker or a fixed-term worker if:

$$\rho R(1+\phi_t) + \rho c\mathrm{E}_t\big[(1+\phi_{t+1})\Omega_{t+1}\big] = R(1+\phi_t). \tag{18}$$

The term $R(1 + \phi_t)$ on the right-hand side of (18) is the opportunity cost of the wage paid to one additional fixed-term worker. The left-hand side is the opportunity cost of producing the same output using $\rho < 1$ permanent workers instead. Equation (18) implies that the firm pays less today for the output produced by permanent workers because these are more productive but it faces a positive probability of paying more in the future if it hoards or fires them. Equation (18) can be rearranged as follows:

$$[\mathrm{E}_t(\Omega_{t+1}) + B_t] = R\frac{1-\rho}{\rho}A_t \tag{19}$$

where:

$$A_t \equiv \frac{1+\phi_t}{c\mathrm{E}_t\left(1+\phi_{t+1}\right)} \text{ and } B_t \equiv \frac{\mathrm{cov}\left(\phi_{t+1}, \Omega_{t+1}\right)}{\mathrm{E}_t\left(1+\phi_{t+1}\right)}$$

Condition (19) has an intuitive interpretation. The right-hand side is the marginal productivity gain from the hiring of one additional permanent worker instead of one additional fixed-term worker. The left-hand side is the expected marginal firing costs. Therefore a firm that wants to hire one marginal worker will:

$$\begin{aligned} &\text{hire a permanent worker if } [\mathrm{E}_t(\Omega_{t+1}) + B_t] < R\frac{1-\rho}{\rho}A_t \\ &\text{hire a fixed-term worker if } [\mathrm{E}_t(\Omega_{t+1}) + B_t] > R\frac{1-\rho}{\rho}A_t \end{aligned} \tag{20}$$

Proposition 1 and conditions (2) and (20) imply that (13) always holds with equality, and therefore $l_{t+1}^p = 0$ is never optimal, since the firm prefers to hire permanent workers when its employment level is so low that it does not expect to fire them in the future. But as l_{t+1}^p increases, $\mathrm{E}_t(\Omega_{t+1})$ also increases, until it becomes expedient to hire fixed-term workers.

Equation (19) shows that financing constraints have two counteracting effects on the optimal hiring of a firm. The term A_t summarises the effect of a currently binding financing constraint. It increases in $(1 + \phi_t)/[E_t(1 + \phi_{t+1})]$, which is the ratio between the shadow value of money in period t and the expected shadow value of money in period $t + 1$. Therefore the higher is the intensity of current financing constraints relative to future expected financing constraints, the larger are A_t and the value of $\mathrm{E}_t(\Omega_{t+1})$ that satisfies equation (25), and the smaller is the optimal ratio l_{t+1}^f/l_{t+1}^p. We define a firm for which A_t is large relative to B_t as 'Type A'. This may be a small firm that has profitable opportunities and would like to invest and grow but it faces financing constraints and can only invest up to the amount of internal funds available. In other words, this firm is currently financially constrained but it expects to make profits, grow over time and become less financially constrained in the future. The model predicts that such a firm may hire a smaller fraction of fixed-term workers relative to permanent workers with respect to a similar firm that does not face financing frictions.

The term B_t summarises the effect of future expected financing constraints. Its sign depends on the sign of cov $(\phi_{t+1}, \Omega_{t+1})$, the covariance between the expected shadow value of money and the expected costs of firing permanent workers. This covariance is positive when the firm expects that, in case financing conditions will worsen in the future, the expected cost of firing or hoarding permanent workers will also increase. The larger is B_t, the smaller is the value of $\mathrm{E}_t(\Omega_{t+1})$ that satisfies (19), the larger is the ratio l^f_{t+1}/l^p_{t+1}. Therefore we define a firm for which the term B_t is large relative to A_t as 'Type B'. This may be a firm than that is currently generating profits and is not constrained in the amount of debt it borrows, because it has sufficient internal funds to finance current operations but it faces future expected financing problems. The model predicts that this firm may hire a larger fraction of fixed-term workers relative to permanent workers than a similar firm that does not face financing frictions. It is important to notice that a positive correlation between ϕ_{t+1} and Ω_{t+1} may be driven by both persistent productivity shocks and purely transitory liquidity shocks. After a negative productivity shock at time $t+1$, Ω_{t+1} increases because the firm has excess workers, and ϕ_{t+1} may also increase because the firm expects that firing and hoarding workers is costly and it will reduce financial wealth and increase future expected financing constraints. Moreover consider now a pure liquidity shock that does not affect future expected productivity. Such a shock could reduce wealth a_{t+1} and increase ϕ_{t+1} but it is also likely to increase Ω_{t+1}, because in the presence of financing frictions the reduction in wealth may imply that the firm is unable to pay all the wages and is forced to fire some workers.[10]

It is useful to illustrate how the trade off between the two effects is affected by the structural parameters of the model. The term B_t is on average larger for intermediate values of ρ. If ρ is very close to 1 and the fraction of fixed-term workers is large, it is seldom necessary to fire permanent workers. Likewise if ρ is very small then the firm never hires fixed-term workers in the first place. The term B_t is also decreasing in δ, $\bar{b}$, and R. An higher δ increases the turnover of permanent workers and reduces $\mathrm{E}_t(\Omega_{t+1})$. A higher $\bar{b}$ has the same effect, because it reduces the tightness of the borrowing constraint. An increase in R has the same effect of a reduction in ρ. It discourages the usage of fixed-term workers by increasing the opportunity cost of wages and by reducing the net present value of future expected hoarding and firing costs.

2.3. *Predictions*

According to the previous discussion, the interactions between financing constraints, firing costs and the hiring of fixed-term and permanent workers can be used to identify the effect of financing constraints on the dynamics of firms' employment.

We expect the presence of financing frictions to reduce the use of fixed-term workers when most firms are Type *A*, i.e., when financing frictions only affect young and fast growing firms, that are financially constrained today but expect to be less so in the future. Instead we expected financing frictions to increase the use of fixed-term workers when most firms are Type *B*. In this case, even though few firms are severely financially constrained at a certain point in time, all firms may enter cyclical phases of

[10] Note that if F is so large that a financially constrained firm is unable to pay it, then the firm would be forced to go bankrupt and to liquidate its activity even though it may have been more profitable to continue. This possibility would increase the hiring of fixed-term workers for firms that expect to be financially constrained in the future. However, to simplify the dynamic optimisation problem and make the numerical solution feasible, this possibility is ruled out in this article, where we consider a set of parameter for which such 'endogenous forced liquidation' never happens in equilibrium.

high intensity of financing constraints, and therefore they hire fixed-term workers to reduce the costs of future expected financing problems.

In order to estimate which of the two effects dominates empirically, we use the following strategy. First, we calibrate the parameters of the model to match the moments estimated from our sample of Italian firms. We focus on the statistics that are key to determine the two effects above, such as the volatility and growth of employment, the volatility of revenues, the average fraction of fixed-term over permanent workers and the average fraction of constrained firms. Second, we simulate the artificial industry and evaluate the effect of financing constraints on employment dynamics. Third, we use the simulation results to derive several predictions about the employment dynamics of financially constrained versus unconstrained firms, that can be verified with the empirical data.

2.4. *Calibration*

In this Section we solve the model numerically, we simulate the activity of many artificial firms and we derive testable implications about the effects of financing constraints on the employment dynamics of the firms. To allow the simulated industry to match the key features of the empirical data, we introduce two changes in the basic model illustrated in the previous Section. First, we assume that with an exogenous probability $1-\gamma$ the firm's technology becomes useless, the firm is liquidated and the value of the assets is distributed as dividends. We assume that a liquidated firm does not have to pay the firing costs for the permanent workers, so that (1) is modified as follows:

$$V_t\left(l_t^p, \theta_t, a_t\right) = \max_{l_{t+1}^p, l_{t+1}^f, b_t} \gamma d_t + (1-\gamma) a_t + \frac{1}{R} \mathrm{E}_t\left[V_{t+1}\left(l_{t+1}^p, \theta_{t+1}, a_{t+1}\right)\right]. \tag{21}$$

This exogenous exit probability is necessary in order to generate a simulated industry in which a fraction of firms is financially constrained in equilibrium. If $\gamma = 1$ and firms are infinitely lived, then they eventually accumulate enough wealth to become unconstrained and the simulated industry always converges to a stationary distribution of financially unconstrained firms, no matter how tight the borrowing constraint (8) is. Second, we model the idiosyncratic shock θ_t as a combination of a persistent and an i.i.d. shock (in the remainder of the article we include the subscript i to indicate the ith firm):

$$\theta_t = \theta_t^I \theta_{i,t}^P \tag{22}$$

where $\theta_{i,t}^P$ is a persistent shock:

$$\begin{aligned} \ln \theta_{i,t}^P &= \upsilon \ln \theta_{i,t-1}^P + \varepsilon_{i,t}^P \text{ where } 0 < \upsilon < 1 \\ \varepsilon_{i,t}^P &\sim \mathrm{iid}(0, \sigma_P^2) \text{ for all } i \end{aligned} \tag{23}$$

and $\theta_{i,t}^I$ as an i.i.d. shock:

$$\ln \theta_{i,t}^I = \varepsilon_{i,t}^I \tag{24}$$

$$\varepsilon_{i,t}^I \sim \ \mathrm{iid}(0, \sigma_I^2) \text{ for all } i. \tag{25}$$

The persistent shock θ^P is necessary to match the dynamics of employment. The i.i.d. shock θ^I matches the volatility of revenues. Both shocks are important because they allow the simulated firms to have realistic dynamics for both employment and financial wealth. If we only allow for the persistent shock θ^P (by setting $\sigma_I^2 = 0$) then we cannot match the wealth dynamics observed in the data, because simulated firms would have too low volatility in revenues and also would almost never realise negative net income, which instead is realised in 24% of the firm-year observations in the sample.

One possible shortcoming of the model is that we assume the shock θ to be stationary, while the productivity of the firms in our empirical data may be non stationary. However, we argue that this is not likely to be a problem in interpreting the results of the model and the empirical analysis, for at least three reasons. First, the time series dimension of the empirical data is very short, and therefore non-stationarity is not likely to significantly bias the empirical results. Second, in the model the shock $\theta_{i,t}^P$ is stationary but very persistent and the entry-exit of firms generates growth dynamics very similar to the dynamics observed in the data, because all firms are created small, and conditional on surviving they increase in size and become less financially constrained. In fact the simulated industry matches well the average growth rate of employment at the firm level observed in the data. Third, in Appendix 3 we illustrate the implications of assuming a non stationary shock θ in detail and we show that the predictions of the model regarding the optimal ratio between fixed-term and permanent workers are not affected by this change. Moreover the effect on the other predictions of the model is likely to be small and accounted for by the control variables included in the empirical analysis in the next Section.

The parameters are calibrated as follows: $r = 0.03$, corresponding to 3% interest rate; α, the return to scale parameter, is equal to 0.95; ρ matches the average fraction of fixed-term to permanent workers. This fraction is equal to 0 for $\rho = 0$, then it increases in ρ and it becomes infinitely large as ρ goes to 1. The parameters v and σ_P jointly match the average and the standard deviation of the ratio of gross hiring over total employment. For a given persistence parameter v, the volatility of the permanent shock σ_P determines the average change in employment for the firm. Moreover the higher is v, the higher is the standard deviation of the change in employment. σ_I matches the standard deviation of the sales/assets ratio. γ matches the average age of the firms in the sample.

In handling job destruction rates, the empirical data do not allow us to distinguish between layoffs and voluntary separations. Therefore we choose $\delta = 0.022$, which corresponds to an exogenous separation rate of 2.2% permanent workers per year. Conditional on this value, F matches the average job destruction rate, which includes voluntary separations, firing of those on permanent contracts and the expiration of fixed-term contracts. The calibrated value is 10% of the yearly wage.[11] Table 1

[11] This is much lower than average firing cost for a permanent worker who is fired without a justified reason, which is at least equal to 120–150% of the wage (OECD, 2004). However, it is important to notice that no firm would ever fire a worker in the simulated economy for values of F greater than or equal to 10.5%. For the calibrated value of 10% average firing is as low as 0.6%. We believe that such a value is realistic, because in the model firms fire workers after a persistent negative shock, and such shock in reality may sometimes be considered as a justified reason for firing workers because of economic redundancy. In case of justified economic redundancy, the OECD (2004) estimates that firing costs in Italy are equal to 7% of the annual wage for every year of service.

Table 1

Calibration

Parameter values		Empirical restriction	Matched moments Data	Model
r	0.03	Real interest rate	0.03	0.03
α	0.95	Returns to scale	0.95	0.95
ρ	0.985	Average(fixed-term/permanent)	0.038	0.040
δ	0.022	Retirement of permanent workers	0.022	0.022
v	0.92	Average(gross hiring/employment)	0.102	0.084
σ_P	0.032	std(hiring/employment)	0.175	0.183
σ_I	0.22	Std.(sales/assets)	0.283	0.239
$\bar{b}$	0.13*	% of financially constrained observations	16%	14.5%
F	0.10**	Average job destruction rate	0.084	0.078
γ	0.96	Average age	24	25
		Other moments	Data	Model
		Average net profits/sales ratio	0.42%	0.62%
		% of firms with no fixed-term workers	67%	78%

* The value of $\bar{b}$ is measured as a fraction of the average employment cost for one simulated firm. ** The firing cost F is expressed as a fraction of the yearly wage.

summarises the parameters choices and shows that the model matches the empirical moments reasonably well.

2.5. *Simulation Results*

We use the solution of the model to simulate 100,000 firm-year observations. This corresponds to 4,000 firms that on average exist for 25 years. Every newborn firm starts with an endowment w_0 equal to 50% of the average labour cost of firms in the steady state. Initial employment level l_0^p is equal to 0 and initial productivity θ_0 is drawn from a uniform distribution. The assumption on l_0^p implies an artificially high hiring rate in period 0. Therefore the statistics are computed on the simulated data starting from period 1 for each firm. We use the simulated data to sort firms into groups of more financially constrained firms using the average value of the Lagrangian multiplier $\bar{\lambda}_i = \sum_{i=1}^{T_i} \lambda_{i,t}$. Where T_i is the number of years of operation of firm i and $\lambda_{i,t}$ measures the shadow cost of a binding financing constraint for firm i in period t. We use $\bar{\lambda}_i$ as the criterion for identifying financially constrained firms so that the simulated statistics are more comparable to the empirical data analysed in the next Section. In our empirical sample firms are classified as constrained if they answered positively to one or more questions regarding problems in obtaining additional credit. In the model a higher value of $\bar{\lambda}_i$ implies that firm i has been more frequently constrained in its borrowing. Nonetheless using either $\bar{\lambda}_i$ or $\phi_{i,t}$ as the index of intensity of financing constraints produces very similar results. Unless otherwise specified, in Tables 2 to 5 we consider as constrained the 33% of firms with the highest value of $\bar{\lambda}_i$, and the other firms as unconstrained. The average value of $\phi_{i,t}$, the premium in the shadow value of money for the firm, is equal to 9.5% for the constrained firms and 2.0% for the unconstrained firms.

The first two columns in Table 2 illustrate the employment dynamics of the constrained and unconstrained firms. The third column shows the difference across

Table 2

Predictions of the Model

	Constrained	Unconstrained	% diff.	% diff. from a simulated panel of firms*
Fixed-term/Permanent	0.055	0.033	67%	148%
st. dev. employment/employment	0.291	0.250	16%	12%
st. dev. permanent/employment	0.254	0.239	6.4%	2.4%
st. dev. fixed-term/employment	0.092	0.068	36%	36%
st. dev. permanent/permanent	0.266	0.244	8.8%	3.1%
st. dev. fixed-term/fixed-term	0.528	0.391	35%	24%
% of firms with no fixed-term	68%	82%	−17%	−16%
% of firing of permanent workers	0.35%	0.80%		
% of hoarding of permanent workers	12.9%	12.5%		

* These differences refer to a simulated balanced panel of firms. We calculate each statistic for 6 years of data for each firm. This panel is sampled so that the average age of the firms is the same as the average age in the full simulated sample and in the empirical sample. Then we calculate the percentage difference between the cross sectional averages in the statistics for the constrained and the complementary sample. Hoarding is the difference between l_{t+1}^p and the demand for permanent workers that would be optimal if firing costs were absent in period t but present from period $t+1$ onwards.

Table 3

Hiring and Firing: Effect on Fixed-term Employment

	Dependent variable: Fixed-term/Permanent			
	$D_{it} = 1$ for 50% most constrained firms	$D_{it} = 1$ for 33% most constrained firms	$D_{it} = 1$ for 50% most constrained firms	$D_{it} = 1$ for 66% most constrained firms
$hire_{it} \times D_{it}$	0.044	0.044	0.047	0.052
	(0.002)	(0.002)	(0.002)	(0.002)
$fire_{it} \times D_{it}$	0.005	0.006	0.008	0.010
	(0.0009)	(0.0008)	(0.0007)	(0.0008)
$hire_{it}$	0.092	0.086	0.078	0.067
	(0.001)	(0.001)	(0.001)	(0.001)
$fire_{it}$	0.021	0.020	0.018	0.016
	(0.0004)	(0.0004)	(0.0005)	(0.0006)

Standard errors in parenthesis are computed using a bootstrap procedure. The constant term and the coefficient of D_{it} are equal to zero by construction, and are therefore not reported.

Table 4

Effect of the Introduction of Fixed-term Workers

	All firms			Constrained			Unconstrained		
Fixed-term workers available	Yes	No	%Δ	Yes	No	%Δ	Yes	No	%Δ
Average value of ϕ_t	0.045	0.040	12.5	0.096	0.083	15.6	0.020	0.018	11.1
st. dev. employment/employment	0.270	0.257	5.1	0.291	0.277	5.1	0.251	0.240	4.6
st. dev. permanent/employment	0.254	0.257	−1.1	0.255	0.277	−7.9	0.239	0.240	−0.4
% of firing of permanent	0.65	0.92	−29	0.35	0.66	−47	0.80	1.06	−24.5
% of hoarding of permanent	12.57	13.74	−8.5	12.9	15.0	−14	12.5	13.1	−4.6

Hoarding is the difference between l_{t+1}^p and the demand for permanent workers that would be optimal if firing costs were absent in period t but present from period $t+1$, onwards.

Table 5

Elasticity of Employment to an Increase in the Borrowing Limit

	All firms		Constrained		Unconstrained	
Fixed-term workers available	Yes	No	Yes	No	Yes	No
Statistic	Elasticity with respect to $\bar{b}$					
Fraction of financially constrained firms	−0.127	−0.364				
Fixed-term workers/Permanent workers	0.064	n.a.	0.215	n.a.	−0.064	n.a.
st. dev. employment/employment	−0.035	−0.200	−0.111	−0.329	0.028	−0.093
st. dev. permanent workers/employment	−0.033	n.a.	−0.109	n.a.	0.026	n.a.
st. dev. fixed-term workers/fixed-term workers	−0.210	n.a.	−0.328	n.a.	−0.164	n.a.
% of firing of permanent workers	−0.010	0.023	−0.070	0.307	0.015	−0.065
% of hoarding of permanent workers	−0.070	0.092	−0.167	0.035	−0.017	0.125
% of firms with no f.t. workers	0.045	n.a.	0.050	n.a.	0.043	n.a.

Hoarding is the difference between l^p_{t+1} and the demand of permanent workers that would be optimal if firing costs were absent in period t but present from period $t+1$ onwards.

groups. The statistics are computed following the same method used in Table 1, by pooling all the observations in each group. This method is justified by the fact that in the simulations all firms are *ex ante* identical and operate the same technology. Nonetheless in the fourth column we show the percentage difference across groups when the statistics are instead computed on a balanced sample of simulated firms, following a procedure analogous to the procedure used on the empirical data in the next Section. The results show that the qualitative predictions of the model do not depend on the specific method used to compute the statistics.

Moreover, in Table 2 the volatility of the different employment types are scaled using the average employment levels, to control for the effect of size differences across groups of firms. The same scaling will be used later on in the empirical Section. Finally, the coefficient of variation of fixed-term workers is computed conditional on having a positive amount of such workers. This way we distinguish the probability of hiring fixed-term workers from the volatility of fixed-term workers conditional on them being currently used by the firms.

Table 2 shows that constrained firms have a higher volatility in permanent workers than unconstrained firms, even though they are more likely to hoard rather than to fire permanent workers. This is because financing problems force them to change employment in response to liquidity shocks. More importantly, constrained firms hire more fixed-term workers. This is because future expected financing constraints matter in the simulated industry and, as a consequence, fixed-term employment is mostly used by financially fragile firms that are either constrained or will be financially constrained in the future, conditional on a negative shock. Moreover, fixed-term employment is also substantially more volatile for constrained firms. It follows that while permanent employment is only 6.4% more volatile, total employment is 16% more volatile for constrained firms than for the complementary sample of unconstrained firms.[12]

[12] The qualitative results presented in Table 2 are robust to alternative criteria to select constrained firms. See Caggese and Cuñat (2007) for details. Furthermore, the differences in volatilities are relatively small in quantitative terms. This is because the model is calibrated so that in equilibrium the fraction of fixed-term workers is small, as is found in the empirical data. Nonetheless, given the large number of simulated firms, all differences are statistically significant throughout this Section.

Table 3 estimates the average ratio of fixed-term over permanent workers for firms that increase or decrease employment. Expanding firms are identified by the dummy $hire_{it}$, which is equal to 1 if the firm i increases employment from period $t-1$ to period t and is equal to zero otherwise. Contracting firms are identified by the dummy $fire_{it}$, which is equal to 1 if the firm i decreased employment from period $t-1$ to period t and is equal to zero otherwise. Firms in this group reduce employment either by firing or by not replacing voluntary separations of permanent workers. Finally the constant term of this regression represents the excluded group, which is composed of firms that maintain a constant level of employment. These are the firms that have constant productivity and are not constrained ($\phi_{it} = 0$). The solution of the model implies that firms in this situation hire permanent workers only. Therefore the constant term and the coefficient of D_{it} are equal to zero, and are omitted from the Table.

The results in Table 3 show that the difference between financially constrained and unconstrained firms is almost entirely driven by the behaviour of firms that increase employment. For example, among firms that reduce employment, the average ratio *Fixed-term workers/Permanent workers* is 2.6% for the quantile of most constrained firms (the sum of the $fire_{it}$ coefficient and the $D_{it} \times fire_{it}$ coefficient in the first column) and 2.1% for the complementary sample (the coefficient of $fire_{it}$). Conversely among firms that increase employment this ratio is 11.3% and 7% for the quantile of most constrained and the complementary sample, respectively. Therefore financially constrained firms are mainly Type B firms that use fixed-term workers more intensely, especially during expansion phases, because they fear the financial consequences of having to fire or hoard permanent workers in the future.[13]

Tables 2 and 3 show that financially constrained firms hire more fixed-term workers than unconstrained firms, and that their employment is more volatile. It is a well-known result in the employment literature that the presence of fixed-term workers increases the volatility of employment, because it increases the ability of the firm to change employment policy in response to exogenous shocks.[14] In this respect the added value of our model is to show that financing constraints are an important determinant of the decision to hire fixed-term workers in the first place. Furthermore, our model also shows that not only do financially constrained firms hire more fixed-term workers but also their fixed-term employment is much more volatile than the fixed-term employment of the unconstrained firms. In other words, the positive effect of financing constraints on employment volatility is stronger for fixed-term employment than for permanent employment. Tables 4 and 5 show that this happens because financially constrained firms rely more on fixed-term workers and less on permanent workers to absorb exogenous

[13] We find that the B_t effect dominates the A_t effect despite the model probably being biased against such result. In fact adding some realistic assumptions such as slow learning by doing of permanent workers or higher hiring costs for permanent workers would reduce the magnitude of the term A_t because such assumptions would imply a delay the net productivity gain from using permanent workers.

[14] See Bentolila and Saint Paul (1992) for a general theoretical explanation of this effect. See also Garcia-Serrano (1998) and Amuedo-Dorantes and Malo (2005) among others for some empirical evidence.

shocks with respect to what financially unconstrained firms do. More precisely, Tables 4 and 5 compare employment dynamics in two industries. One is the industry with the benchmark parameters. The other is identical to the first, except that it does not allow for the presence of fixed-term workers.[15] Table 4 shows that the presence of fixed-term contracts increases the volatility of employment in the industry by around 5%. Interestingly, the introduction of fixed-term contracts reduces the volatility of permanent employment by 8% for constrained firms, while it does not affect such volatility for the unconstrained firms. This difference is quite striking, given that both groups of firms hire a significant number of fixed-term workers. The introduction of fixed-term workers reduces the volatility of permanent workers because it allows constrained firms to use fixed-term workers to absorb the fluctuations in employment induced by financing frictions. This also explains why average firing costs decrease by almost 50% for constrained firms after the introduction of fixed-term contract, while they decrease by only 20% for unconstrained firms. The consequence is that without fixed-term workers permanent employment is 15% more volatile for more constrained than for unconstrained firms. Conversely with fixed-term workers is only 7% more volatile.

Table 5 compares the elasticity of employment dynamics to a change in the borrowing limit for the industries with and without fixed-term workers.[16] The results show that relaxing the borrowing limit reduces the fraction of constrained firms and the volatility of employment. Importantly, this effect is much stronger in the industry without fixed-term workers. In other words, the presence of fixed-term workers provides additional flexibility for the employment decisions of the firms and reduces the impact of financing frictions on them.

The final result in Table 5 is that an increase in borrowing capacity increases the ratio of fixed-term over permanent workers, as a result of two counteracting effects. On the one hand the increase in borrowing capacity reduces expected financing constraints of more wealthy and less constrained firms, and reduces their fixed-term employment. On the other hand it increases the ability of constrained firms to hire fixed-term workers following a positive productivity shock. The second effect dominates in equilibrium for the parameter values of the benchmark calibration but only for a small change in $\bar{b}$. A further increase in the borrowing capacity of firms would make the first effect eventually dominate and the ratio between fixed-term and permanent workers would then decrease in the borrowing limit.

[15] Because the model is in partial equilibrium, the simulated industry without fixed-term workers does not account for the changes in prices that would occur in general equilibrium. Nonetheless the bias is relatively small because the total number of workers in the industries with and without fixed-term workers is nearly identical, because the introduction of fixed-term workers increase both average job creation and job destruction by similar amounts.

[16] We focus on marginal changes in $\bar{b}$ so that the statistics reported in Table 5 can be interpreted as the estimation of the sensitivity of employment dynamics for marginal changes in the intensity of borrowing constraints. It would be interesting to evaluate the effect of relaxing the constraint even further. However we think that such exercise would make more sense in an general equilibrium environment, where equilibrium prices are endogenous. Instead in the context of the model the larger the change in $\bar{b}$, the less its effect on the simulated economy is representative of what would happen in reality, due to the partial equilibrium nature of our simulation exercise.

3. Empirical Analysis

The results illustrated in the previous Section allow us to formulate the following predictions regarding the empirical relationship between financing frictions and employment dynamics:

(*i*) Financially constrained firms hire a larger fraction of fixed-term workers than financially unconstrained firms.
(*ii*) The higher use of fixed-term workers among constrained firms is almost entirely due to constrained firms hiring more fixed-term workers when they increase employment.
(*iii*) Total employment, permanent employment and especially fixed-term employment are more volatile for more financially constrained firms than for the other firms.

This Section verifies these predictions on the empirical data, and is divided in three parts. Section 3.1 describes the data and variables used; Section 3.2 explores the validity of the financing constraint measure and shows the first stage of the instrumental variables approach used later on; finally Section 3.3 tests the predictions of our theoretical model.

3.1. *Data and Specification*

To test the empirical predictions of the model we use the data set of the Mediocredito Centrale surveys. The data set contains a representative sample of small and medium Italian manufacturing firms. It is an incomplete panel with two main sources of information gathered in two different surveys:

(*i*) Yearly balance sheet data and profit and loss statements from 1989 to 2000
(*ii*) Qualitative information from four surveys conducted in 1992, 1995, 1998 and 2001.

Each survey reports information about the activity of the firms in the three previous years.

The availability of detailed information about the firms' accounts, the composition of employment and qualitative answers in the surveys makes this data set very useful for studying how the perceptions and expectations of firms affect their decisions.[17] Each survey is conducted on a representative sample of the population of small and medium manufacturing firms (smaller than 500 employees) and refers to three consecutive years of data. After the third year two-thirds of the sample is replaced and the new sample is then kept for the three following years.

For the analysis of this article we restrict our sample to the last six years of the data set (1995–2000), because detailed information about all the different types of employment is only available in the 1998 and 2001 surveys. We also restrict ourselves to firms with 10 or more workers, because firms below such a threshold are subject to a much less

[17] Examples of papers that use the Mediocredito Centrale survey in this spirit are Basile *et al.* (2003) and Piga (2002).

stringent labour protection law. We also drop firms that were subject to a merger or an acquisition and firms that split due to spin-offs or divestitures. That leaves us with 6,540 firms and 18,783 firm-year observations for which we have valid information about the use of fixed-term and permanent contracts.[18, 19]

The calibration of the model predicts a differential use of fixed-term and permanent contracts depending on whether firms are financially constrained or not. To test these predictions we run different regressions in which the dependent variables are: the ratio of fixed-term workers over permanent workers, *Fixed-term/Permanent*$_{it}$ and the ratio of fixed-term workers over total employment, *Fixed-term/Total*$_{it}$. To test the predictions with respect to the volatility of total employment, we use the coefficient of variation of total employment, *cvemployment*$_{it}$, measured as the standard deviation of total employment calculated over a three-year window that coincides with each survey and divided by the mean of total employment in that same period. Therefore *cvemployment*$_{it}$ varies both across firms and for each firm across surveys, taking two different values for the 1995 to 1997 period and the 1998 to 2000 period. In the regressions where this variable is used, standard errors are clustered by firm and three-year period. Finally, to test the predictions on the volatility of each type of contract we use the coefficients of variation of the number of fixed-term contracts, *cvfixedterm*$_i$ and of permanent contracts, *cvpermanent*, using all available periods per firm. We also use as dependent variables the standard deviation of both types of contracts on a three-year window rescaled by average total employment on that same window, *sdfixedterm*$_{it}$/ *meanemployment*$_{it}$ and *sdpermanent*$_{it}$/ *meanemployment*$_{it}$.

Our independent variables of interest are related to the financing constraints that the firm faces. To construct our main measure of financing constraints we consider the questions in the Surveys where each firm is asked:

(*i*) Whether it had a loan application turned down recently.
(*ii*) Whether it desires more credit at the market interest rate.
(*iii*) Whether it would be willing to pay a higher interest rate than the market rate in order to obtain credit.

We use this information to construct our main measure of financing constraints, *constrained*$_{it}$, which takes value 1 for period t if firm i declares having any of the problems (*i*) to (*iii*) and takes value zero otherwise. According to this measure 16% of the firms declared being financially constrained.[20] The cross-sectional standard deviation of the self declared$_{it}$ variable is 0.36 and its time series standard deviation is 0.096.

[18] 80% of the firms appear in the sample for 3 consecutive years and 15% for 6 consecutive years, the rest have different numbers of observations because the firms were created during the sample period or because some firm-year observations are dropped due to outlier cutting or missing values in the dependent or independent variables.

[19] The introduction of more favourable conditions for the employment of fixed-term workers appears to have been fairly gradual in Italy. The fraction of temporary employment was around 5% in the 1985 to 1990 period, and then it increased to 7.5% in 1995 and then to around 10% in 2000 (Source: OECD *Employment Outlook*, 2002, chapter 3). This leaves us with a relatively stationary level of fixed-term contracts. Moreover the estimation that verifies the predictions of the model always includes time dummies that control for the possible influence of trends in the dependent variable.

[20] We drop 55 firm-observations from the sample that have no responses to any of the questions. They represent less than 0.3% of the total observations. The distribution of non-respondents to each question is as follows: question (*i*) 8%, question (*ii*) 0.4% and question (*iii*) 15%.

Given that firm size is a major determinant of financing constraints, with smaller firms facing more problems when it comes to getting additional funding, we also use the size of the firm as an alternative measure of financing constraints. For that we construct a dummy variable, $small_{it}$, that takes the value one if assets are smaller than 5,700 million lira and zero otherwise.[21] This threshold splits the sample roughly into two equal parts.

We include a number of control variables in all the regressions to account for possible heterogeneities between firms that are not present in the theoretical model. The first control variable is *fixed* $capital_{it}$, which is constructed as fixed assets of the firm divided by the number of employees and controls for the fact that the model abstracts from the different intensities of labour versus fixed capital. The second control variable, $lsdsales_{it}$, is the log standard deviation of the sales of the firm calculated over a three year window that coincides with each survey wave and corrects for the heterogeneity of the productivity shock across firms. Finally, we include *growth* $assets_{it}$, which is the annual growth rate of assets calculated year by year. Appendix 3 shows that this variable controls for the effect of possible non-stationarities. We also include year and sector (defined as 2 digit ATECO91 classification) dummies in all the regressions. The qualitative results of the regressions are robust to the exclusion of the set of control variables; see Caggese and Cuñat (2007).

To summarise this Section: a generic specification of the regressions in this empirical part can be written as:

$$y_{it} = \gamma\ Financing\ Constraints_{it} + \boldsymbol{\beta} \mathbf{X}_{it} + d_s + d_t + \varepsilon_{it}$$

For the dependent variable y_{it} we consider the use of fixed-term contracts and the volatility of the different type of employment contracts. Among the explanatory variables *Financing* $Constraints_{it}$ is either the $small_{it}$ variable or the $constrained_{it}$ measure that is occasionally instrumented, as explained in the next Section. d_s and d_t are year and sector dummies and $\boldsymbol{\beta}\mathbf{X}_{it}$ is a vector of controls composed by *fixed* $capital_{it}$, *log standard deviation of* $sales_{it}$ and *growth* $assets_{it}$. Table 6 shows the summary statistics for these variables. Some of the variables calculated as ratios are subject to the presence of extreme values whenever they are not bounded by construction and the denominator is abnormally small. For this reason, we drop the observations corresponding to the top 1% of each of these variables (top and bottom 1% when the variable is not constrained to be positive) when calculating the statistics of Table 6 and whenever they are used in a regression.

The Table shows that the ratio of fixed-term workers to permanent workers is 3.7% for all firms and 4.6% for firms that declare they are constrained. It also shows that constrained firms are smaller and have a higher volatility of total employment and of permanent employment than unconstrained firms, while the volatility of fixed-term workers is similar in the two groups of firms. This unconditional evidence is broadly consistent with the predictions of the model, except for the fact that fixed-term workers seem to be equally volatile across firms. However, it does not provide a formal test of the effect of financing frictions on employment decisions. In the following Sections we first provide evidence that the measure of financing constraints is related to effective financing restrictions faced by firms. We then formally test the predictions of the model with respect to the effect of financing constraints on the use of fixed-term employment contracts.

[21] 5,700 million lira corresponded to $2.94 m according to December 1999 exchange rates.

Table 6
Summary Statistics

	All firms			$Constrained_{it} = 1$		
Variable	Mean	Median	Std Dev	Mean	Median	Std Dev
$Fixed\text{-}term/permanent_{it}$	0.037	0	0.101	0.046	0.000	0.107
$cv(employment)_{it}$	0.051	0.033	0.061	0.065	0.045	0.097
$cv(fixed\text{-}term)_i$	0.669	0.446	0.683	0.655	0.433	0.680
$cv(permanent)_i$	0.065	0.042	0.089	0.077	0.053	0.103
$Constrained_{it}$	0.16	0.00	0.36	1	1	0
$Fixed\ capital_{it}$	0.611	0.371	0.95	0.610	0.372	0.80
$log\ standard\ deviation\ of\ sales_{it}$	0.11	0.08	0.12	0.133	0.099	0.181
$Leverage_{it}$	0.388	0.416	0.257	0.394	0.433	0.274
$Assets_{it}$	9.23	9.03	1.34	8.98	8.84	1.17
$Growth\ assets_{it}$	0.094	0.063	0.210	0.102	0.065	0.215

The variables are defined as follows: *fixed-term/permanent* is fixed-term employment divided by permanent employment; *cv*() refers to the coefficient of variation of the relevant variable defined as its standard deviation over a three year period divided by its mean over the same period; *constrained* is a dummy variable that takes value 1 if the firm declares it is constrained and zero otherwise; *fixed capital* is fixed assets of the firm in billion lira divided by the number of employees; *log standard deviation of sales* is the log standard deviation of the sales of the firm; *leverage* is total debt divided by total assets; *Non zero fixed-term* is a dummy variable that takes value one if the firm uses some fixed-term workers and zero otherwise; *growth assets* is the yearly growth rate of assets; *return on assets* is profit before interest and taxes divided by total assets.

3.2. *Validation of the Financing Constraints Measure*

In this Section we show how the $constrained_{it}$ measure of financing constraints relates to other indirect measures of financing frictions. The reason for this analysis is twofold. In the first place, it assesses the validity of the self declared variable as a reliable measure of financing constraints. In the second place it validates the subsequent use of some of the indirect measures of financing frictions as instrumental variables that correct for potential measurement errors in $constrained_{it}$.[22] For this purpose we run a regression in which the dependent variable is the financing constraints variable ($constrained_{it}$) and the independent variables are as follows: the first variable is the coverage ratio of interest payments, $coverage_{it}$, calculated according to the following formula: $coverage_{it} = (\pi_{i,t} - i_{i,t})/(\pi_{i,t} + i_{i,t})$ where $\pi_{i,t}$ is profits before interest and taxes and $i_{i,t}$ is interest paid on debt. The variable takes the value zero whenever the ratio is negative. The second variable is the net liquid assets of the firm, $liquid\ assets_{it}$, measured as bank deposits and cash divided by total assets. The relationship of this measure with the existence of financing constraints is controversial. In general, firms with more liquid assets are less likely to be financially constrained; however it is also known that firms occasionally hoard liquidity when they expect future negative liquidity shocks that could be correlated with financing constraints.[23] We take an agnostic view and investigate its linear effect on the total sample. The next variable used is a measure of financial development at a regional level, $findev_i$.

[22] It is important to remark here that the qualitative data about self declared financing constraints and the quantitative balance sheet data come from different surveys, so measurement errors are less likely to be correlated between surveys.
[23] See for example Almeida and Campello (2006).

This variable is calculated in Guiso *et al.* (2004) and it measures the likelihood that a consumer bank loan is denied in different Italian regions. The measured is 'inverted' and normalised, so that a value of zero indicates the highest probability of denial and that the maximum possible value is 0.56. We also include a number of variables that capture the reputation of the firm and the possible existence of relationship lending. These are a dummy variable that reflects whether the main office of the main lending bank of the firm is located in the same region as the headquarters of the firm, $main\ region_i$; the natural logarithm of the number of banks that the firm uses, $number\ of\ banks_{it}$; the log of the age (in years) of the firm, age_{it}; the log of the length (in years) of the relationship with the main bank of the firm, $age\ relation_{it}$, and the share of loans that the main bank has, $share\ main_{it}$.[24]

We also add three control variables, the logarithm of firm assets $assets_{it}$, leverage measured as total debt over total assets, $leverage_{it}$, and the change in stocks and work in progress, $stock_{it}$. These variables should jointly capture the size and level of activity of the firm. Finally, we include as additional control variables the same ones that we use in Section 3.3 ($fixed\ capital_{it}$, $lsdsales_{it}$ and $growth\ assets_{it}$) and sector specific year dummies to saturate the intercept of the regression at a sector-year level.[25]

The results can be seen in the first column of Table 7. Firms with higher coverage ratio, higher net liquid assets, more financial development in their region and those with headquarters in the same region as the headquarters of their main bank are less likely to be financially constrained. The results on these variables are sizeable and highly significant. In particular, the variables $findev_i$ and $main\ region_i$ have an important negative impact on the likelihood of being financially constrained. We believe that it is reasonable to assume that they affect employment decisions only through their effect on financing constraints and, therefore, we use them in the next Section as instruments to correct for potential answering biases in the $constrained_{it}$ variable. The coefficients of the variables relative to reputation and relationship banking are also significant and take values that are consistent with some of the ideas in the relationship banking literature: a higher number of banks makes a firm more likely to be constrained. On the contrary, firms with a longer bank relationship are also less likely to be constrained. Total leverage is negatively correlated with financing constraints, indicating that firms with less financing constraints in equilibrium do borrow more. Larger firms are also less financially constrained. This is a well-known result and, for this reason, we use the size of the firm as an alternative measure of financing constraints. The growth rate of assets yields insignificant results and the accumulation of stocks, that often indicates a negative sales shock, is related to more financing constraints.

The model makes predictions about how employment decisions are related to the perceived financing constraints of firms. In this sense, the $constrained_{it}$ variable seems ideal as a proxy for $\bar{\lambda}_i$, the average intensity of financing constraints for firm i in the simulated industry.

[24] These last four variables are reported in the 1998 and 2001 qualitative surveys and their value only changes every three years.

[25] By construction, the variables *coverage* and *leverage* are highly correlated. However the correlation is far from perfect (correlation of −0.24), as firms can have high or low leverage while experiencing a high or a low flow of profits. For this reason, including the leverage variable as an additional control improves the fit of the regression without incurring in multicolineality problems.

Table 7

Financing Constraints Variable

	Dependent variable: $constrained_{it}$	
	1 Validate variable	2 First stage IV
Financial development of region$_i$	−0.0038***	−0.004***
	(0.00032)	(0.00028)
HQ of bank and firm in same region$_i$	−0.038***	−0.033***
	(0.0081)	(0.0073)
$coverage_{it}$	−0.078***	
	(0.0070)	
liquid assets$_{it}$	−0.193***	
	(0.027)	
number of banks$_{it}$	0.027***	
	(0.0075)	
age_{it}	0.000090	
	(0.0056)	
age relation$_{it}$	−0.012***	
	(0.0045)	
share main$_{it}$	0.00047***	
	(0.00016)	
$leverage_{it}$	−0.172***	
	(0.030)	
$assets_{it}$	−0.039***	
	(0.0051)	
$stock_{it}$	0.065	
	(0.082)	
fixed capital$_{it}$	−0.000094*	−0.000015
	(0.000048)	(0.000038)
log standard deviation of sales$_{it}$	0.011**	−0.0097***
	(0.0043)	(0.0025)
growth in total assets	0.075***	0.035**
	(0.020)	(0.017)
Observations	8,594	107,05
R-squared	0.08	0.037
R-squared of omitted instruments		0.020
F-test of joint significance omitted instruments		110***

Standard errors in parenthesis. * Significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is *constrained* that takes value 1 if the firm declares it is constrained, zero otherwise. Independent variables are: *fixed capital* – fixed assets of the firm divided by the number of employees; *log standard deviation of sales* – log standard deviation of the sales of the firm; *growth assets* – annual growth rate of assets; *coverage* – profits minus interest paid on debt over profits plus interest rate paid; *liquid assets* – bank deposits and cash over total assets; *findev* – regional financial development; *logarithm of firm assets; grow sales* – dummy if sales grew over the last year; *leverage* – total debt over total assets; *stock* – change in stocks and work in progress; *number of banks* – number of banks that the firm uses; *age* – the log of the age (in years) of the firm; *age relation* – the log of the length (in years) of the relationship with the main bank; *share main* share of loans of the main bank; *assets* – (these last four variables only change every three years), year and sector dummies included in all the regressions.

Two types of measurement error could potentially affect our regressions: first, firms could have an incentive to overstate or understate their financing constraints. Second, the $constrained_{it}$ measure could be correlated with the productivity shocks that the firm faces. The predictions of the model are robust to such correlation. However, in the model the intensity of financing constraints is determined by the shadow value of investing additional funds in the firm. Conversely, in reality, distressed and poor performing firms may declare to be constrained simply because the banks judge them to be too risky and refuse them additional lending, even in the absence of profitable investment opportunities. We control for the potential bias induced by misreporting and distressed firms by using an instrumental variables approach where we restrict ourselves to the cross-sectional instruments *main region*$_i$ and *findev*$_i$.[26] These instruments have the advantage that they are likely to be uncorrelated with any firm specific shock or misreporting. Furthermore, all the results presented below are robust to the exclusion of the worst performing firms from the sample.[27]

The second column of Table 7 is the first stage of the instrumental variable regressions used in Section 3.3, where the excluded instruments are *main region*$_i$ and *findev*$_i$. The R-squared of the excluded instruments is 2.0% which is relatively high considering that the total R-squared of the first-stage regression is 3.7%. The F-test of the joint significance of the omitted variables yields a value of 110.

Once we have established the validity of our main measure of financing constraints, we proceed, in the next Section, to test the main predictions of the model.

3.3. *Results*

The first prediction of the model, that financially constrained firms hire a larger proportion of fixed-term employment with respect to permanent employment, is tested in Table 8. The ratio of fixed-term workers to permanent workers and to total employment is regressed with respect to the different measures of financing constraints, namely: a dummy variable that takes value one if the firm is small (column 1), the *constrained*$_{it}$ measure that captures the financing constraints that firms declare in the survey (column 2) and the *constrained*$_{it}$ measure instrumented using *main region*$_i$ and *findev*$_i$ as instruments (column 3), Panel (*a*) in Table 8 uses *Fixed-term/Permanent*$_{it}$ as the dependent variable, that is, the ratio of fixed-term workers over permanent ones. This variable is more directly comparable with the predictions of the model but it includes some extreme observations from a small number of firms reporting a very small number of permanent workers. These observations (1% of the total) are eliminated as outliers. Conversely panel B uses *Fixed-term/Total*$_{it}$, which is the ratio of fixed-term workers to total employment, and it includes also the observations that have been eliminated above. All the regressions include as control variables the log volatility of sales, the amount of capital per worker, the yearly change in the assets of the firm, year and sector dummies.

The results in Panel (*a*) in Table 8 show that the difference in the ratio of fixed-term over permanent workers between small and large firms is 0.014. The results also point in the same direction when using the *constrained*$_{it}$ measure and the instrumented version of it, with a difference in the ratio between constrained and unconstrained firms equal to 0.045. This effect is statistically significant in all the regressions and also

[26] Papers such as Kaplan and Zingales (1997) and Fazzari *et al.* (1988) use objective balance sheet measures to construct indices as measures of financing constraints. In this respect the IV regressions used here can be seen as similar to their approach, using a financing constraints index that is a weighted measure of *main region*$_i$ and *findev*$_i$ with the weights that produce the best possible match with the *self declared*$_{it}$ measure in an OLS regression.

[27] See Caggese and Cuñat (2007).

Table 8

Financing Constraints and Relative Use of Fixed-term Contracts (a) Dependent Variable: Fixed-term/Permanent$_{it}$, (b) Dependent Variable: Fixed-term/Total$_{it}$

	1	2	3
(a)			
Small$_{it}$	0.014***		
	(0.0023)		
constrained$_{it}$		0.0042*	0.045**
		(0.0025)	(0.018)
fixed capital$_{it}$	−0.0048	−0.015	−0.01601
	(0.010)	(0.010)	(0.010)
log standard deviation of sales$_{it}$	0.0030***	0.0009	0.0014**
	(0.00076)	(0.00067)	(0.00070)
growth assets$_{it}$	0.016***	0.014***	0.013***
	(0.0044)	(0.0044)	(0.0045)
R-squared	0.10	0.10	0.07
IV	No	No	Yes
(b)			
small$_{it}$	0.0094***		
	(0.0025)		
constrained$_{it}$		0.00064	0.144***
		(0.0027)	(0.022)
fixed capital$_{it}$	−0.028**	−0.035***	−0.040***
	(0.011)	(0.01098)	(0.01227)
log standard deviation of sales$_{it}$	0.0031***	0.0017**	0.0032***
	(0.00082)	(0.00072)	(0.00084)
growth assets$_{it}$	0.012**	0.011**	0.0062
	(0.0047)	(0.0048)	(0.0054)
R-squared	0.12	0.12	0.03
IV	No	No	Yes

Standard errors in parenthesis. * Significant at 10%; ** significant at 5%; *** significant at 1%. Dependent variable is the ratio of fixed-term workers to permanent workers in panel (*a*) and the ratio of fixed-term workers to total workers in panel (*b*). The dummy small takes the value one if assets are smaller than 5,700 million lira and zero otherwise. *Constrained* takes value 1 if the firm declares it is constrained and zero otherwise. The other independent variables and instruments are as described in Tables 6 and 7. Year and sector dummies included in all the regressions. Number of observations is 1,075 in Panel (*a*) and 10,953 in Panel (*b*).

economically sizeable, given that the average use of fixed-term contracts in the sample is also around 4%. The results in Panel (*b*) in Table 8 are broadly consistent with the ones in Panel (*a*), except that the coefficient of the *constrained$_{it}$* measure is only statistically significant in the instrumented regressions. Overall, these results strongly support the main prediction of the model, that fixed-term workers should be hired more often by firms that are subject to financing constraints. The model predicts that this happens because constrained firms use fixed-term contracts as a buffer that protects them against the cost of firing or hoarding permanent workers in the future, conditional on a negative shock. The model also predicts that financially constrained firms should have a significantly higher volatility of total employment. This prediction is tested in Table 9. The dependent variable is the coefficient of variation of total employment, calculated on the three year windows that coincide with the periods covered by each survey. The independent variables follow the same pattern as in Table 8.

Table 9

Financing Constraints and Employment Volatility

	Dependent variable:cv $Employment_{it}$		
	1	2	3
$small_{it}$	0.013***		
	(0.0015)		
$constrained_{it}$		0.018***	0.049***
		(0.0016)	(0.011)
$fixed\ capital_{it}$	0.0075	−0.00235	−0.00310
	(0.0066)	(0.0065)	(0.0066)
$log\ standard\ deviation\ of\ sales_{it}$	0.0064***	0.0047***	0.0050***
	(0.00050)	(0.00043)	(0.00046)
$growth\ assets_{it}$	0.022***	0.020***	0.019***
	(0.0029)	(0.0029)	(0.0029)
Observations	10,705	10,705	10,705
R-squared	0.03	0.03	0.02
IV	No	No	Yes

Standard errors in parenthesis. * Significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is the coefficient of variation of total employment calculated over the three year window of each survey. The dummy small takes the value one if assets are smaller than 5,700 million lira and zero otherwise. Self declared takes the value 1 if the firm declares to be constrained and zero otherwise. The other independent variables and instruments are as described in Tables 6 and 7. Year and sector dummies included in all the regressions. Standard errors clustered at the firm-survey level.

The results show that smaller firms (column 1) and the ones that declare themselves as constrained (columns 2 and 3) have higher volatility in total employment. The effect is highly significant both in statistical terms and in terms of economic impact. The volatility of total employment increases between 0.013 and 0.05 for financially constrained firms with respect to the unconstrained ones. This is a large difference, given that the average coefficient of variation of total employment for all firms is 5.7%.[28] This higher volatility of total employment for constrained firms is partly a direct consequence of a higher use of fixed-term workers, because the unconditional coefficient of variation of fixed-term workers is a full order of magnitude higher than the coefficient of variation of permanent workers (see Table 6). In other words, a higher use of fixed-term contracts among constrained firms would mechanically imply a higher volatility of employment even if constrained and unconstrained firms were identical in terms of the volatility of each type of employment. However, the model also predicts a higher individual volatility of each type of contract among constrained firms. To explore further this issue, in Table 10 we disentangle the effect of financing constraints on the volatility of each of the different types of employment. Columns 1 and 2 correspond to the dummy variable that distinguishes small firms, columns 3 and 4 to the $constrained_{it}$ measure, and columns 5 and 6 to the instrumented $constrained_{it}$. Odd (even) columns have as dependent variable the coefficient of variation of fixed-term (permanent) employment. In Panel (*a*) the dependent variable is the coefficient of

[28] The identification in Tables 8 and 9 relies both on cross-sectional and time series variation, given that we use sector dummies but not firm specific fixed effects. Auxiliary regressions with standard firm fixed-effects and between groups estimators at a firm level show that, in fact, an important part of the effect is due to cross sectional variation.

Table 10

Differential Effect on Employment Volatilites

	Fixed-term 1	Fixed-term 2	Fixed-term 3	Permanent 4	Permanent 5	Permanent 6
Dependent variable	Instrumental variables					
(a) Coefficients of variation						
$small_{it}$	0.076			0.017***		
	(0.048)			(0.0057)		
$constrained_{it}$		0.018	−0.024		0.020***	−0.010
		(0.043)	(0.37)		(0.0051)	(0.044)
fixed $capital_{it}$	−0.19	−0.27	−0.26	−0.024	−0.047	−0.040
	(0.29)	(0.291)	(0.300)	(0.035)	(0.034)	(0.036)
log standard deviation of $sales_{it}$	−0.017	−0.028**	−0.028**	0.009***	0.006***	0.006***
	(0.014)	(0.012)	(0.014)	(0.0017)	(0.0015)	(0.0016)
growth $assets_{it}$	−0.23*	−0.23*	−0.221	0.047***	0.045***	0.051***
	(0.12)	(0.12)	(0.146)	(0.015)	(0.015)	(0.018)
R-squared	0.12	0.12	0.11	0.06	0.06	0.04
IV	No	No	Yes	No	No	Yes
(b) Standard deviations normalised by total employment						
$small_{it}$	0.0024***			0.0156***		
	(0.0009)			(0.0026)		
$constrained_{it}$		0.0024*	0.0290***		0.0193***	0.0426*
		(0.0012)	(0.0113)		(0.0037)	(0.0246)
(% diff. vs mean)	(27.9%)	(27.3%)	(331%)	(26.9%)	(33.4%)	(73.8%)
fixed $capital_{it}$	−0.00022	−0.0033	−0.0031	0.0106	−0.0013	−0.0022
	(0.0035)	(0.0030)	(0.0037)	(0.0121)	(0.0097)	(0.0095)
log standard deviation of $sales_{it}$	0.001**	0.0006	0.0009**	0.009***	0.006***	0.007***
	(0.0004)	(0.0004)	(0.0004)	(0.0010)	(0.0009)	(0.0009)
growth $assets_{it}$	0.0038**	0.0035**	0.0025*	0.025***	0.023***	0.022***
	(0.0017)	(0.0017)	(0.0017)	(0.0047)	(0.0047)	(0.0047)
R-squared	0.02	0.02	0.03	0.04	0.04	0.03
IV	No	No	Yes	No	No	Yes

Standard errors in parenthesis. * Significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variables in panel (*a*) are the coefficient of variation of fixed-term and permanent employment, the regression is a between groups specification. The dependent variables in panel (*b*) are the standard deviation of fixed-term and permanent employment, over average total employment both calculated over the three year window of each survey. Standard errors in panel (*b*) are clustered at the firm, survey level. The dummy *small* takes the value one if assets are smaller than 5,700 million lira and zero otherwise. *Constrained* takes the value 1 if the firm declares it is constrained and zero otherwise. The other independent variables are: *fixed capital* – fixed assets of the firm in billion lira divided by the number of employees; *lsdsales* – log standard deviation of the sales of the firm; *growth assets* – annual growth rate of assets. Year and sector dummies are included in all the regressions. In the IV regressions the *self* $declared_{it}$ variable is instrumented with $findev_i$, which is a measure of financial development at the regional level, and with *main* $region_{it}$, which is a dummy variable that reflects whether the main office of the main lending bank of the firm is located in the same region as the headquarters of the firm. Number of observations is 1,675 in Panel (*a*) and 10,830 in Panel (*b*).

variation, which is not defined for firms that have no workers of a particular type throughout the calculation period, and it is also poorly defined when there is only one period with non-zero fixed-term workers.[29] To minimise the frequency of these firms, the coefficient of variation is calculated over the whole period for each firm. Therefore,

[29] For firms with all observations equal to zero, the coefficient of variation is not defined. For firms with two observations equal to zero and a positive one have a coefficient of variation of 1.73 regardless of the value of their only positive observation. This is a quite high value and could be artificially driving the results if we used a three year window.

these are cross-sectional measures and for this reason we perform between groups estimation. To avoid the difference in results being driven by a different sample in each regression, we restrict each sample to firms that have a valid observation in both the coefficient of variation of fixed-term employment and permanent employment.'

In Panel (*b*) the dependent variable is the standard deviation of each type of contract divided by the average total employment. This measure of volatility also us allows to include firms with no fixed-term workers in many periods, so it is calculated for 3 year windows, as for the coefficient of variation of total employment in Table 9.

The results in Panel (*a*) in Table 10 show that smaller firms and those that declare they are financially constrained have higher volatility in permanent employment than the complementary sample, while they do not show a significant difference in the volatility of fixed-term workers.

The results in Panel (*b*) consistently show that both types of contract are more volatile among constrained firms. Moreover the instrumented regression shows that the increase in relative terms is much larger for fixed-term workers, as predicted by the model. Overall, the results in Table 10 provide some supporting evidence of the prediction of the model that the higher volatility of total employment for constrained firms is driven by a higher volatility for both types of workers, and especially for fixed-term employment.

The model also predicts that most of the difference in the hiring behaviour of constrained versus unconstrained firms is driven by the behaviour of hiring firms (see Table 3). To test this prediction, we introduce dummy variables in Table 11 that split the sample between firms that have hired additional workers over the last year ($hire_{it}$), firms that have reduced their amount of workers from the previous year ($fire_{it}$) and firms that keep the same amount of total employment as in the previous year ($neutral_{it}$). We then interact these dummy variables with the $constrained_{it}$ variable to see the different effect of financing constraints in each situation. In this regression the control variable $growth\ assets_{it}$ is also interacted with the three employment dummies, because we want to distinguish the behaviour driven by changes in employment from the behaviour driven by changes in the total assets of the firm.

Columns 1 and 2 consider the ratio of fixed-term to permanent workers. Columns 3 and 4 consider the ratio of fixed-term over total employment. Odd columns show the regressions using $constrained_{it}$ as the explanatory variable, while even columns show the regressions where $constrained_{it}$ is instrumented. The instruments are also interacted with the dummy variables $hire_{it}$, $fire_{it}$, $neutral_{it}$ to give more flexibility to the first stage of the regression.

The results confirm the prediction that most of the effect of constrained firms using a higher amount of fixed-term workers is the result of these firms using them more when they are hiring new workers. Constrained and hiring firms have a significantly higher level of fixed-term workers than unconstrained and hiring firms in three out of four specifications (coefficient of $hire_{i,t} \times constrained_{it}$). Conversely, in general we do not find a significant difference in the use of fixed-term workers between non hiring constrained and non-hiring unconstrained firms.

With respect to the coefficients of the variables that do not interact with financing constraints, the coefficient of $hire_{it}$ is positive and statistically significant in two out of four regressions, while the coefficient $neutral_{it}$ is not statistically significant ($fire_{it}$ is the

Table 11

Effect When Increasing or Reducing Total Employment

	Fixed-term/Permanent$_{it}$		Fixed-term/Total$_{it}$	
Dependent Variable	1	2	3	4
hire × *constrained*$_{it}$	0.011**	0.114***	0.0057	0.233***
	(0.0043)	(0.035)	(0.0047)	(0.043)
fire × *constrained*$_{it}$	−0.0016	−0.011	−0.0041	0.036
	(0.0057)	(0.053)	(0.0063)	(0.063)
neutral × *constrained*$_{it}$	0.0013	−0.0012	0.0022	0.105***
	(0.0048)	(0.031)	(0.005)	(0.038)
hire	0.010***	−0.006	0.0061*	−0.019
	(0.0030)	(0.011)	(0.0034)	(0.0127)
neutral	0.00087	0.00043	−0.0022	−0.0094
	(0.0032)	(0.011)	(0.0036)	(0.013)
fixed capital$_{it}$	−0.016	−0.017	−0.035***	−0.037**
	(0.012)	(0.012)	(0.013)	(0.015)
log standard deviation of sales$_{it}$	0.270	0.00077	0.0013	0.0029***
	(0.00075)	(0.00086)	(0.00083)	(0.0010)
hire × *growth assets*$_{it}$	0.0120	0.0062	0.012	−0.0016
	(0.0075)	(0.0079)	(0.0082)	(0.0097)
fire × *growth assets*$_{it}$	−0.018*	−0.018	−0.018	−0.018
	(0.011)	(0.011)	(0.012)	(0.013)
neutral × *growth assets*$_{it}$	0.017*	0.017*	0.0082	0.0018
	(0.0090)	(0.0094)	(0.010)	(0.012)
Observations	8,611	8,611	8,806	8,806
R-squared	0.21	0.19	0.22	0.18
IV	No	Yes	No	Yes

Standard errors in parenthesis. * Significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is the ratio of fixed-term workers to permanent workers in columns 1 and 2 and the ratio of fixed-term workers to total workers in columns 3 and 4. The dummy *small* takes the value one if assets are smaller than 5,700 million lira and zero otherwise. *Constrained* takes the value 1 if the firm declares to be constrained and zero otherwise. The other independent variables and instruments are as described in Tables 6 and 7. Year and sector dummies are included in all the regressions.

omitted category). The relevant prediction of the model is the fact that the coefficient of $hire_{it}$ should be positive and significant, because the less constrained firms also use fixed-term workers mainly during expansion periods.

The overall picture from the empirical results shows that financially constrained firms use a higher fraction of fixed-term contracts and have a higher volatility of total employment. The higher volatility of total employment is partly due to the unconditional higher volatility of fixed-term workers, but also to the fact that conditional on being financially constrained, both fixed-term and permanent contracts seem to be more volatile. Finally, most of the difference in the use of fixed-term workers by constrained and unconstrained firms is explained by the firms that increase employment. These results confirm the predictions of the calibrated model.

4. Conclusions

We develop a model to study the firing and hiring decisions of firms in the presence of financing constraints and dual labour markets in which both fixed-term contracts and permanent contracts coexist. We calibrate the model using a representative sample of

Italian firms and we simulate an artificial industry with many heterogeneous firms. We first use the simulations to derive robust predictions about the relationship between financing constraints and employment decisions of firms. We show that financial market imperfections increase expected firing costs, thus making permanent contracts implicitly more expensive and therefore encourage the hiring of fixed-term workers in expansion phases. We then analyse the effect on the simulated industry of relaxing the borrowing constraints and of introducing fixed-term workers in an industry where only permanent workers are available. We show that financially constrained firms not only hire more fixed-term workers but also use them to absorb a larger part of total employment volatility. The consequence is that the introduction of fixed-term contracts makes permanent contracts of financially constrained firms less volatile than before.

We then test the main predictions of the model on our sample of Italian manufacturing firms. We consider several different measures of financing constraints:

(*i*) the size of firm;
(*ii*) a 'self-declared' measure of financing constraints that is constructed using direct qualitative information;
(*iii*) an instrumented version of this measure.

The estimation results confirm the predictions of the model. In particular, financially constrained firms have a larger proportion of fixed-term contracts and a higher volatility of total employment. Both fixed-term and permanent contracts are more volatile among constrained firms.

Our results shed some light on the role of fixed-term contracts in absorbing productivity shocks in the presence of financing constraints. The firing costs associated with permanent contracts make them less likely to absorb employment fluctuations due to productivity shocks. We show that the presence of financing constraints emphasises this effect, not only by increasing the usage of fixed-term workers but also by making fixed-term contracts more volatile.

The article is also a step forward in understanding how financing constraints affect the real activity of firms. Previous literature has mainly focused on the effect of financing constraints on fixed capital investment. We focus instead on the employment decision of firms. Importantly, we show that the interactions between financing frictions and employment decisions allow us to distinguish between the effect of current and future expected financing problems. The theoretical and empirical results of the article confirm that, while a small fraction of firms is currently financially constrained at any point in time, future expected financing constraints matter for a much larger fraction of firms and are an important factor in determining employment decisions.

The policy implications of our results are interesting. The introduction of fixed-term contracts helps firms to reduce their exposure to financing constraints and makes total employment of financially constrained firms more volatile but permanent employment less volatile. Policies that relax financing constraints that firms face will have a positive impact on the stability of total employment and in particular on fixed-term contracts. Therefore policies that aim to reduce the financing constraints faced by firms would not only decrease job instability in general, but would also help to close the gap in terms of job instability between fixed-term and permanent contracts.

Appendix 1

In this Section we show that the normalisation of wages of both fixed-term and permanent workers to one is without loss of generality and simply indicates that the amount of labour force of each type is measured in the model in monetary units.

Consider a more general model in which labour is measured in worked hours and the hourly wages for fixed-term and for permanent workers are w^f and w^p, respectively. Both wages are assumed to be constant over time.

Let $l_t'^p$ and $l_t'^f$ denote the number of total hours worked by permanent and fixed-term workers, respectively. The production function in which labour is measured in hours can be expressed as:

$$y_t = \theta'_t \left(l_t'^p + \rho' l_t'^f \right)^\alpha \text{ with } 0 < \rho' < 1;\ 0 < \alpha < 1,$$

where ρ' measures the difference in productivity per hour worked of each type of contract and θ'_t the productivity level per hour of permanent labour worked. The parameter α is identical to the one in (3). The budget constraint of the firm can be written as:

$$d_t + w^p l_{t+1}'^p + w^f l_{t+1}'^f - Fi_t^p S_t = a_t + \frac{b_t}{R}. \tag{26}$$

We introduce the following changes of variables: $l_t^p = w^p l_t'^p$ and $l_t^f = w^f l_t'^f$, which indicate that labour is now measured in total monetary units paid and not in worked hours. The new budget constraint is therefore identical to the one in (5). The production function becomes:

$$y_t = \theta'_t \left(\frac{l_t^p}{w^p} + \rho' \frac{l_t^f}{w^f} \right)^\alpha \text{ or equivalently } y_t = \frac{\theta'_t}{w^{p\alpha}} \left(l_t^p + \rho' \frac{w^p}{w^f} l_t^f \right)^\alpha. \tag{27}$$

Now we can introduce two further changes of variable $\theta_t = \theta'_t / w^{p\alpha}$ and $\rho = \rho' w^p / w^f$ to reach expression (3), in which the productivity parameter θ_t is re-scaled to reflect productivity per unit of pay of a permanent worker and ρ reflects the productivity differential between fixed-term and permanent workers net of their wage differential. Recall that the model requires that $\rho = \rho' w^p / w^f$ is smaller than one. There are several combinations of wages and productivity that can achieve this result. For example fixed-term and permanent workers could be equally productive per hour, but fixed-term workers may require a wage differential to compensate for a higher job instability. Another possibility would be that fixed-term workers are paid less than permanent workers due to labour market frictions and they are less productive per hour worked, with the productivity differential being larger than the wage differential. This second possibility is the most likely one in the Italian case, given that the unconditional wage ratio w^p / w^f is 1.35 according to the OECD.[30]

Appendix 2

In this Section we illustrate a proof of Proposition 1. Using the definition of Ω_t in (14), we define $E_t(\Omega_{t+1})$ as follows:

$$E_t(\Omega_{t+1}) = E_t\left[\left(F - \mu_{t+1} \right) S_{t+1} \right] + E_t\left(\mu_{t+1} \right).$$

Conditional on a_t and l_{t+1}^p, the realisation of the shock θ_{t+1} determines a_{t+1} and the policy functions $\mu_{t+1}(\theta_{t+1} \mid a_t, l_{t+1}^p)$, $S_{t+1}(\theta_{t+1} \mid a_t, l_{t+1}^p)$ and $l_{t+2}^p(\theta_{t+1} \mid a_t, l_{t+1}^p)$. Therefore the value of $E_t(\Omega_{t+1})$ can be defined as follows:

$$E_t(\Omega_{t+1}) = \sum_{j=1}^{N} \Gamma(\theta_{t+1}/\theta_t) \left\{ \left[F - \mu_{t+1}\left(\theta_{t+1} | a_t, l_{t+1}^p \right) \right] S_{t+1}\left(\theta_{t+1} | a_t, l_{t+1}^p \right) + \mu_{t+1}\left(\theta_{t+1} | a_t, l_{t+1}^p \right) \right\}. \tag{28}$$

[30] To our knowledge there is no paper that calculates this wage differential conditional on observables.

Using the definition of θ_t in (2), we define θ_A as the minimum value of θ_{t+1} such that the firm hires more permanent workers and θ_B as the minimum value of θ_{t+1} such that the firm does not fire permanent workers. It follows that $A \geq B$. Assuming that $A > B > 1$, (28) can be defined as follows:

$$\mathrm{E}_t(\Omega_{t+1}) = F\sum_{j=1}^{B-1}\Gamma(\theta_{t+1}/\theta_t) + \sum_{j=B}^{A-1}\Gamma(\theta_{t+1}/\theta_t)\mu_{t+1}\left(\theta_{t+1} \mid a_t, l_{t+1}^p\right). \tag{29}$$

We can use (29) to interpret the effect of l_{t+1}^p on $\mathrm{E}_t(\Omega_{t+1})$. We define $\hat{l}_{t+2}^p(\theta_{t+1}|a_t)$ as the optimal number of permanent workers in period $t+1$ if the firing costs do not apply in that period only. The assumptions about the production function imply that $\hat{l}_{t+2}^p$ is increasing in θ_{t+1}, and that $\hat{l}_{t+2}^p(\theta_1|a_t) > 0$. Suppose now that $l_{t+1}^p = 0$. In this case $A = B = 1$ and $\mathrm{E}_t(\Omega_{t+1}) = 0$. As l_{t+1}^p increases, eventually $(1-\delta)l_{t+1}^p$ becomes larger than $\hat{l}_{t+2}^p(\theta_1|a_t)$ and A becomes larger than 1. This implies that $\mathrm{E}_t(\Omega_{t+1})$ becomes positive and equal to $\sum_{j=1}^{A}\Gamma(\theta_{t+1}/\theta_t)\mu_{t+1}(\theta_{t+1}|a_t, l_{t+1}^p)$. As l_{t+1}^p further increases, there are four possibilities:

(*i*) A and B do not change. In this case $\mathrm{E}_t(\Omega_{t+1})$ increases because $\sum_{j=1}^{A}\Gamma(\theta_{t+1}/\theta_t)\mu_{t+1}(\theta_{t+1}|a_t, l_{t+1}^p)$ increases in l_{t+1}^p, due to the fact that μ_{t+1} increases.
(*ii*) A increases, B does not change. In this case $\mathrm{E}_t(\Omega_{t+1})$ increases. The effect described in (*i*) is still at work. In addition now μ_{t+1} is positive for a wider range of values of θ.
(*iii*) B increases, A does not change. In this case $\mathrm{E}_t(\Omega_{t+1})$ increases. The effect described in (*i*) is still at work. In addition, now, for some values of θ, the firm fires the workers. Conditional on these outcomes $\mathrm{E}_t(\Omega_{t+1})$ increases by F rather than by $\mu_{t+1}(\theta_{t+1} \mid a_t, l_{t+1}^p)$. Since F is the upper bound to μ, this increases $\mathrm{E}_t(\Omega_{t+1})$.
(*iv*) Both A and B increase. In this case the effects described in (*i*), (*ii*) and (*iii*) are contemporaneously at work, and $\mathrm{E}_t(\Omega_{t+1})$ increases.

This proves Proposition 1.

Appendix 3

In this Section we briefly describe a version of the model with a non-stationary productivity shock. First, we rewrite the production function as follows:

$$\begin{gathered} y_t = \bar{\theta}_t^{1-\alpha}(l_t^p + \rho l_t^f)^\alpha \\ 0 < \rho < 1;\ 0 < \alpha < 1 \end{gathered} \tag{30}$$

where:

$$\bar{\theta}_t \equiv \theta_t^{\frac{1}{1-\alpha}}. \tag{31}$$

Then we assume that the productivity shock θ_t is non-stationary:

$$\log\theta_t = \log\theta_{t-1} + \log\varepsilon_t. \tag{32}$$

Where ε_t is a stationary and possibly persistent stochastic process. It follows that also $\bar{\theta}_t$ is a non stationary stochastic process:

$$\log\bar{\theta}_t = \log\bar{\theta}_t + \frac{1}{1-\alpha}\log\varepsilon_t. \tag{33}$$

Therefore:

$$\frac{\bar{\theta}_t}{\bar{\theta}_{t-1}} = \varepsilon_t^{\frac{1}{1-\alpha}}. \tag{34}$$

By dividing both sides of (30) by $\bar{\theta}_{t-1}$, we obtain a stationary transformation of the production function:

$$\hat{y}_t = \varepsilon_t(\hat{l}_t^p + \rho \hat{l}_t^f)^\alpha, \\ \hat{y}_t \equiv \frac{y_t}{\bar{\theta}_{t-1}};\ \hat{l}_t^p \equiv \frac{l_t^p}{\bar{\theta}_{t-1}};\ \hat{l}_t^f \equiv \frac{\hat{l}_t^f}{\bar{\theta}_{t-1}}. \tag{35}$$

Therefore the firm's problem can be reformulated in terms of stationary variables:

$$V_t(\hat{l}_t^p, \varepsilon_t, \hat{a}_t) = \max_{\{\hat{l}_{t+1}^p, \hat{l}_{t+1}^f, \hat{b}_t\}} \hat{d}_t + \frac{1}{R} \mathrm{E}_t[V_{t+1}(\hat{l}_{t+1}^p, \varepsilon_{t+1}, \hat{a}_{t+1})]. \tag{36}$$

This transformed problem can be solved in the same way as the original problem, and yields similar predictions. Importantly, the key prediction of the model hold true for both the original and the transformed variables. For instance, the optimal ratio between the transformed variables predicted by the model, $\hat{l}_t^f/\hat{l}_t^p$, is by construction also equal to the optimal ratio between the original variables, l_t^f/l_t^p.

Moreover also the predictions about the volatility of employment for constrained and unconstrained firms are likely to be robust to the presence of a non-stationary shock. As an illustration, consider the following approximation of the average value of $\hat{l}_t^f$:

$$\bar{\hat{l}}_t^f = \sum_{t=1}^{T} \frac{l_t^f}{T} \left(\frac{1}{\bar{\theta}_{t-1}}\right) \approx (1/\bar{\bar{\theta}}) \sum_{t=1}^{T} \frac{l_t^f}{T}, \tag{37}$$

where $\bar{\hat{l}}_t^f$ is the average value of $\hat{l}_t^f$ for a generic firm, and $\bar{\bar{\theta}}$ is the average value of $\bar{\theta}_t$ during the sample period. Under this approximation, it follows that the coefficient of variation of $\hat{l}_t^f$ is the same as the coefficient of variation of the original variable l_t^f. This approximation is reasonable for our empirical data, because the sample period is very short. Nonetheless it is the less accurate the more θ_t grows or shrinks during the sample period for a firm. In order to control for this problem, in the empirical section we include the growth of assets of the firms as a regressor in the estimations of the coefficients of variation, and we show that the main results are robust to the inclusion of this variable.

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