

Dual Labor Markets and Firm Productivity

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Research Question and Key Facts

Literature and Contribution

Model

Simulation results

Conclusions and remarks

Research question

What is the effect of the use of temporary employment on firm productivity?

Model prediction

The relationship between the share of temporary contract and the labor productivity at the firm level has an inverted-U shape, 30% optimal share.

Mechanism

- Labor productivity is increasing in worker effort
- Exerting effort is costly but it increases the probability to be confirmed with a permanent contract.
- Workers compete over permanent contracts (**tournament effect**)
- firm trade-off

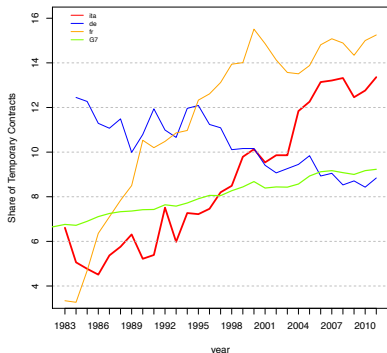
Why Dual Labor Markets?

- Within Europe labor market institutions are heterogeneous
- but most reforms have been “two-tier reforms” affecting a subset of the population also at the s.s.
- contribute to create a **dual labor market**

coexistence of 2 main types of contracts:

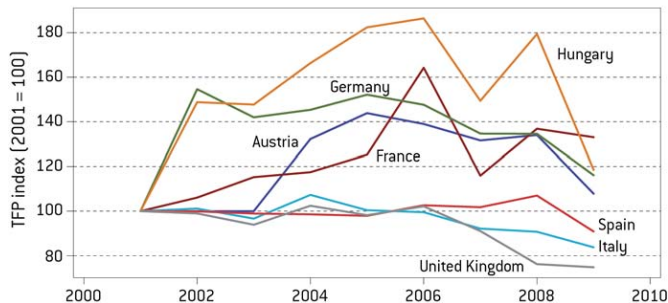
- **permanent contracts**: protected with high firing costs;
- **temporary contracts**: fixed duration, with low or no firing costs, could be renewed when seniority reaches a certain threshold.

Evidence 1: Increase in the share of temporary contracts



- In the last 20 years the use of temporary contracts has sharply increased particularly in some OECD countries (Italy, Spain)

Evidence 2: decrease in firm productivity



Source: Bruegel based on EFIGE and Amadeus datasets.

- from the end of the Nineteens some European countries, like Italy, experienced a decrease in productivity

Contribution of the paper

- I implement an ABM where workers and firms interact in the LM,
- the effect on productivity of temporary contracts is driven by effort choices that evolve over time.

The ABM approach allows to account for behavioural aspects that arise under dual labor markets and cannot be easily handle with technique in the mean-stream literature.

In the presence of temporary contracts there is competition among workers on the level of effort (**tournament effect**).

- The outcome of workers' decisions depends on what other workers of the same firm decide
- Workers interact with an environment that is also changing, as agents learn an optimal behaviour

ABM and labor markets

...simulations, complexity systems, neural networks and artificial agent simulated societies can be used to study labor market systems. Freeman (JEDC, 1998)

- replicate stylized facts (e.g. wage distribution, the Beveridge curve, etc.).
- analyse the effects of specific policies (e.g. training policies, epl, unemployment benefits etc..)

Review on ABM and labor markets: Richiardi, Neugart (2012)

- EURACE, Deissenberg et al. (2008): macro model to replicate the behaviour of a real economy and track time series.
- Neugart(2008): ABM studies distributional effects of a gvmt training policy, $u \searrow$, competition \nearrow

Model description

- 1 factor: labor, variable factor
- 1 sector: firms produce one homogeneous good
- Rationality: workers and firms are risk neutral
- Contracts: dual labor markets
 - **Temporary:** at the end of the period the contract terminates and the worker is either confirmed with a permanent contract or it separates from the firm
 - **Permanent:** the worker is matched with the firm period by period (unless job destruction shock occurs)

Production

- Employed worker i supplies one unit of labor with a level of effort e_i
- Production in a firm j is a function of:

(-) the share of workers employed with a temporary contract T_j over total employment N_j

(+) the total amount of effort supplied by the employees

$$Y_j = \left(1 - \frac{T_j}{1 + N_j}\right) \cdot A \cdot \left(\sum_{i=1}^{N_j} e_i\right)^\alpha, \quad \alpha \in (0, 1) \quad (1)$$

- tfp decreases with the share of temporary contracts, “negative externality”

Mechanism

- For workers supplying effort is costly, the **cost of supplying effort** $\phi(e_i)$ such that $\phi'(e_i), \phi''(e_i) > 0$
- In each firm j all workers are paid the same wage equal to a share of average labor productivity at the firm level

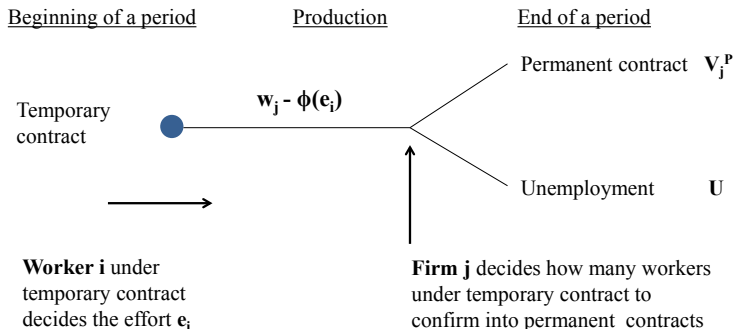
$$w_j = \mu \frac{Y_j}{N_j} \quad , \quad \mu \in (0, 1)$$

At the end of the period,

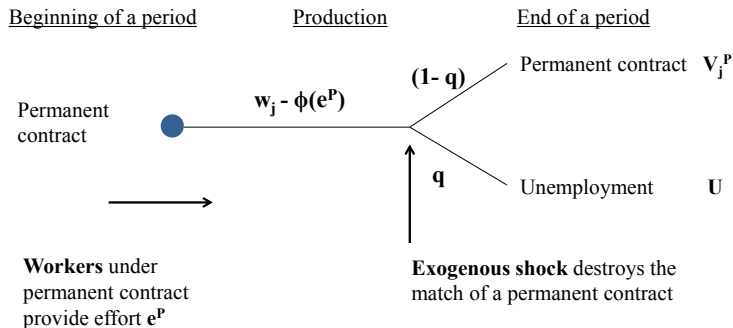
- every firm j decides how many workers with temporary contracts are confirmed with a permanent contract from the next period on $C_j \in (0, T_j]$

The **cost of converting a temporary contract** into a permanent one is l_j .

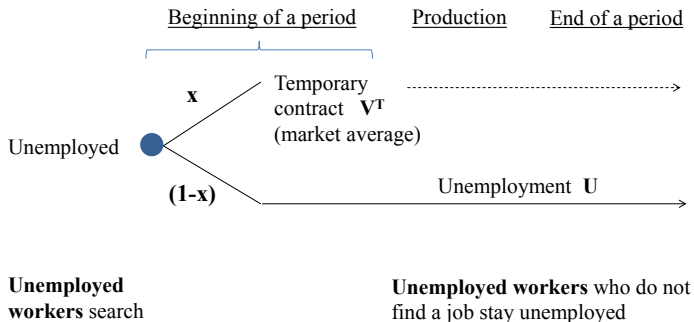
Worker with temporary contract



Worker with permanent contract



Unemployed worker



Firms and the conversion decision

Firms employ N_j workers and they can convert a maximum of $C < N_j$ temporary contracts into permanent contracts.

- Firms observe worker effort during the production process
- Each firm j makes a decision on the number of workers with temporary contracts to confirm with a permanent contract C_j
- C_j is a random draw from a discrete uniform distribution on the support of natural numbers $[1, 2, \dots, \min \{C, T_j\}]$
- Before the period ends every firm ranks the employees with a temporary contract per decreasing level of effort. The top C_j temporary workers are confirmed

Payoff of a worker with temporary contract

- Workers under temporary contracts choose the level of effort from a fixed grid of values (each value is a strategy k)
- Value of the investment firm j makes when it confirms a worker with a permanent contract is $I_j = V_j^P - U$
- Payoff of a temporary worker i who plays strategy k at time t :

$$\Pi_{i,k}(t) = w_j(t) - \phi(e_i(t)) + c_{i,j}(t) I_j + U \quad (2)$$

where $c_{i,j}(t)$ is the indicator function for worker i who is confirmed as a permanent by firm j at the end of time t

Reinforcement learning

Erev and Roth (1995)

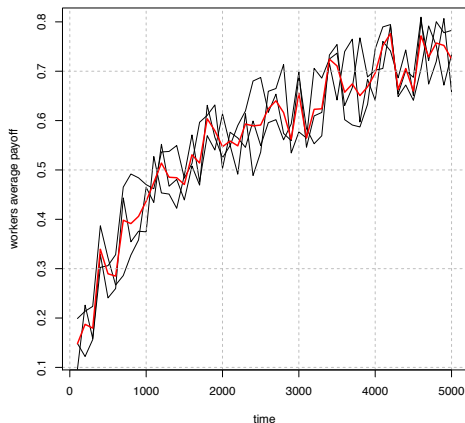
- Workers decide the the level of effort as a random draw from a distribution (the prior is a discrete uniform)
- After a fixed number of T periods, workers sum the payoff gained with each strategy k (*propensity*)

$$q_{i,k}(T+1) = q_{i,k}(T) + \frac{1}{T} \sum_{t \in T} \{\Pi_{i,k}(t)\} \quad (3)$$

The probability that a worker i plays a strategy k for a given period t that belongs to the block $T+1$ is:

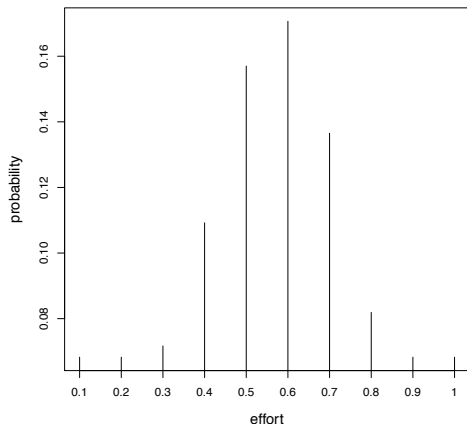
$$p_{i,k}(T+1) = \frac{p_{i,k}(T) + q_{i,k}(T+1)}{\sum_k \{p_{i,k}(T) + q_{i,k}(T+1)\}} \quad (4)$$

Workers' payoff over time



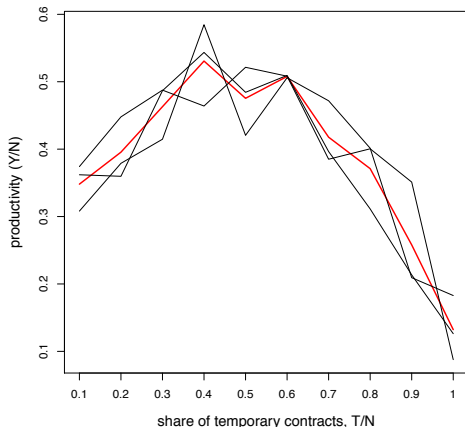
- Three different simulations and their average, workers play 5000 times and update 50 times (every 100 days)
- workers optimize their strategies, payoff \uparrow

Workers' optimal effort distribution



- optimal distribution of effort in a simulation, each probability is the average on all workers
- workers should exert effort 0.6 with greater probability → this probability gave on average greater profits

Inverse U-shape, optimal share T/N



- inverted-U shaped
- given incentives on workers and their effort exerted there is an “optimal” share of temporary contracts

Conclusions and remarks

1. For very low values of T/N workers do not have the incentive to exert high effort (-)
2. A *tournament effect* kicks in and has a positive effect on firm productivity; workers compete for promotion \rightarrow incentive to increase effort \rightarrow effort enters positively in the production function \rightarrow productivity increases. (+)
3. the increase in T/N has a negative effect on total factor productivity since, example, temporary workers are less experienced and take time to adapt to the production environment. (-)
4. The combination of mechanisms \rightarrow inverse U-shape

Conclusions and remarks

- I implement an agent based model to study the complex interaction of workers and firms in a dual labor market with permanent and temporary workers.
- I study the effect of the use of temporary contracts on workers' incentives and consequently on firms and their productivity.
- The main result is that the share of temporary contract has a concave and inverse U-shaped effect on firm productivity.

Financial barriers and sources of funding for innovation in Colombia

- The author researches the characteristics of firms suffering financial barriers for innovation, and which are the barriers faced by firms using cash flow, business group funding, bank leverage, equity, public and cooperation funding for their innovation projects.
- data from the Colombias National Innovation survey 2007-2008 were used
- The results confirms that small firms suffer higher financial restrictions, and it is shown that companies that performed product innovation use a greater diversity of funding sources and suffer from higher financial barriers.

Financial barriers and sources of funding for innovation in Colombia

- Only firms with innovation activities developed in the period 2007-2008 were selected; 2.907 firms. is this a biased sample? did the others did not want or did not get funding? are the selected ones “better” than the others in some dimensions?
- The survey is related to manufacturing industry. what about services? should we expect similar results? which is the market structure in Colombia?
- dependent variables of probit ii) existence of external barriers iii) financial barriers? explain better difference?
- high/med technology industry has a negative relationship with financial barriers, less likely to have barriers. comment on this? should expect opposite?

What do I get with ABM?

Firm productivity depends on the aggregation of individual decisions of effort supply.

These decisions are not independent.

- Workers with temporary contracts compete as in a tournament. The payoff of a single worker depends on the decision of all other employees of the same firm.

The interaction of a worker with the environment in which she takes the decision is complex.

- Because of the reinforcement learning procedure, the environment itself changes as workers understand how they should behave.

Parameters

Parameter	Description	Value
γ	Sensitivity of effort cost $\in (0, 1)$	0.75
ι	Relative gain of a permanent contract ≥ 1	1.50
c	Temp. contracts converted into perm. (average)	20%
q	Destruction probability of a perm. contract	$\frac{1}{20}$
e^P	Effort under a permanent contract	0.5

Table : Description and value of the key parameters used for the simulations.

- We observe 100 firms, that employ 20 workers each, over 2000 periods
- The maximum number of workers to be converted C is chosen such that on average the rate of conversion is $c = 20\%$
- The length of a learning block is 100 periods

Algorithm: initialization

- 0.1 Each worker i is randomly assigned to at most one firm j under a temporary contract.
- 0.2 Employed workers with temporary contracts draw a value of effort from a discrete uniform distribution over the interval $[0.1, 0.2, \dots, 1]$.
- 0.3 Production takes place. Firms record output and productivity. Workers record wage and cost of effort.
- 0.4 After production and before the end of the period firms decide C_j over the interval $[1, 2, \dots, \min \{ T_j, C \}]$.
- 0.5 The top C_j workers per level of effort start the next period matched with the same firm and under a permanent contract. The remaining workers terminate the temporary contract and separate from the firm.
- 0.6 Firms update the share of temporary contracts for the upcoming period.

Algorithm: sequence of steps

- 1.1 Exogenous destruction shock hits workers under permanent contracts.
- 1.2 Non allocated workers match with vacant jobs randomly. Workers reallocate across firms and in and out of unemployment.
- 1.3 Workers under a permanent contract supply effort e^P , unemployed workers supply zero effort. New employees start under a temporary contract.
- 1.4 Workers with temporary contract draw the level of effort from the posterior distribution over the interval $[0.1, 0.2, \dots, 1]$.
- 1.5 Production, contract conversion, worker tournament and match update repeat as in steps [0.3]-[0.6].
- 1.6 Workers under temporary contracts associate the payoff to the strategy k they played in the period. Every 100 periods the propensity $q_{i,k}(T + 1)$ is updated and the posterior probability $p_{i,k}(T + 1)$ is computed for all k strategies.

Reinforcement learning

Erev and Roth (1995)

- Workers decide the the level of effort as a random draw from a distribution (the prior is a discrete uniform)
- At the end of each period t the worker records the strategy she played k and the payoff she gained $\Pi_{i,k}(t)$
- After a fixed number of T periods, the worker sums the payoff she gained in each strategy k (*propensity*)

$$q_{i,k}(T+1) = q_{i,k}(T) + \frac{1}{T} \sum_{t \in T} \{s_{i,k}(t) \Pi_{i,k}(t)\} \quad (5)$$

where $s_{i,k}(t)$ is the indicator function for the agent i who plays strategy k at time t

Reinforcement learning

The probability that a worker i plays a strategy k for a given period t that belongs to the block $T + 1$ is:

$$p_{i,k}(T + 1) = \frac{p_{i,k}(T) + q_{i,k}(T + 1)}{\sum_k \{p_{i,k}(T) + q_{i,k}(T + 1)\}} \quad (6)$$

Workers learn only when they are working in a firm under a temporary contract

- Workers with a permanent contract supply effort e^P
- Unemployed workers supply zero effort

Empirical Literature

Most of the empirical literature finds that temporary contracts have a negative effect on firm productivity.

- Does Dual Employment Protection affect TFP: Evidence from Spanish manufacturing firms (Dolado et al., 2012)
- Two-tier reforms of employment protection: a honeymoon effect? Boeri, Garibaldi (EJ, 2007)
- Temporary contracts and employment effort, Engellandt, Riphahn (LE, 2005)

Wage setting

At every period a fixed number of workers is unemployed

- Within each firm j all workers are paid the same wage
- Wage is set equal to a share of average labor productivity at the firm level

$$w_j = \mu \frac{Y_j}{N_j} \quad , \quad \mu \in (0, 1) \quad (7)$$

Wage setting

Table 6 Two-tier vs. complete reforms in Europe (1980-2007).

Reform area	Two-tier	Complete	Total per row	Of which two-tier
EPL	103	96	199	52%
UB	116	137	253	46%
AP	155	87	242	64%
ECI	74	50	124	60%
ER	49	16	65	75%

AP: activation programs, ECI: employment conditional incentives,
ER early retirement plans

Reinforcement Learning

- Heuristic optimization algorithm introduced by Erev, Roth (1995)
- Agents periodically update their behaviour giving to each action a “reinforcement” proportional to the payoff that the player received with that action
- more an action is successful, grater is the probability that this action is re-played

Evidence 1: temporary employment in Italy

- In Italy, the sharp increase in the share of temporary contracts is due to a number of reforms that increased the possibility of using this type of agreements; see Cappellari, Dell’Aringa, Leonari, (2011).
- 1997 *pacchetto treu* legalized temporary work agencies and regulated collaboration contracts
- law 368/2001: eased restrictions on the use of fixed term contracts, introduced a single general requirement: fixed term contract could be implemented “for reasons of a technical, organizational, production or replacement nature”
- law 30/2003: number of changes in national legislation and reformed apprenticeship, eased even more use of temporary contracts