Evaluating Labor Market Reforms: A General Equilibrium Approach*

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Abstract

Job security provisions, particularly those regarding workers' layoffs, are commonly invoked to explain the high and persistent European unemployment rates. This belief has led several countries to undertake reforms in the last two decades aimed at reducing firing costs. However, the reduction has typically been applied only to fixed-term contracts, while firing costs for tenured contracts have not been altered. Despite the widespread use of such contracts, there is a lack of quantitative analysis of their impact over the aggregate economy. To fill this gap, we build a general equilibrium model with heterogeneous agents in a firing-cost economy. We calibrate our model to Spanish data using in part parameters estimated with a dynamic partial equilibrium model and a panel of firm-level observations. Spain is a particularly interesting case since its labor regulations are among the most protective in the OECD and its unemployment rates among the highest. We find that the introduction of temporary contracts have small and negative effects on aggregate output and employment. These findings suggest that reforms other than relaxing firing restrictions are needed to reduce European unemployment.

Key words: Fixed-term contracts, Firing costs, General equilibrium, Heterogeneous agents.

JEL classifications: E24, C68, J30.

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1 Introduction

The consequences of job security provisions on employment, output and welfare constitute an issue of great concern for both economists and policymakers. Labor market rigidities, particularly those regarding workers' layoffs, are commonly blamed as a major cause of the high European unemployment rates (see OECD (1994a) for an example of this view). Following this belief and hastened by the worsening of the unemployment rates during the eighties, several European countries undertook institutional reforms aimed to increase labor market flexibility.

A common feature of these reforms was the elimination of most restrictions in the use of non-causal fixed-term or temporary contracts, which are characterized by much lower firing costs than those for the existing workers, with permanent or indefinite-term contracts. Since their introduction, fixed-term contracts have accounted for most new hirings in all sectors and occupations (OECD 1993). Spain, with the highest unemployment rate among the OECD countries, appears as a paradigmatic case. After the 1984 reform which allowed the widespread use of non-causal fixed-term contracts, Spain has become the European country with the highest share of temporary employment (around 33 percent in 2000), with temporary contracts representing above 98 percent of hires in the period right after the reform, 1986-1992 (Bentolila and Saint-Paul, 1992).

Until now, there has been a sparse literature evaluating the global outcome of these partial labor market reforms. While their impact on flows (both job creation and job destruction have increased) and on the variability of aggregate employment (also increased) seems unambiguous, the sign of the effect of the reforms on unemployment levels and welfare is less clear. The reason is well known and borrows from the literature on layoff cost. Although the existence of firing costs will reduce the level of hirings after a positive shock, firings after a negative shock will also be lower. Even more importantly, the literature on layoff cost has shown how existing quantitative results depend crucially on the different modelling choices (see Ljunqvist (2001) for a thorough discussion).

This paper is intended as a step in addressing the evaluation of labor market reforms. In particular, it is interested in quantitatively studying the effects of temporary contracts using the tools of standard neoclassical theory. In order to analyze this problem we will develop a general equilibrium model with heterogeneous households, firms and incomplete markets. In our economy, households will offer labor and consume subject to a set of allowed labor contracts and a bound on net asset positions, while firms will maximize profits. The existence of firing costs transforms the firms' problem into a non-trivial

intertemporal one. We will calibrate our model for the Spanish economy. A particular feature of our calibration procedure is that some of the parameters used are estimated using a dynamic partial equilibrium model with a panel of firm-level Spanish data. Then we will measure the impact of the introduction of fixed-term contracts in a firing-cost economy on employment, labor turnover, productivity and welfare.

Our main finding is that eliminating temporary contracts will slightly *reduce* unemployment. In our model unemployment depends on the flows of job creation/destruction. Since temporary contracts reduce the adjustment cost induced by severance payments, they increase these flows, and consequently unemployment. The positive effect of temporary contracts through higher labor supply induced by higher productivity is of second order. Our results suggest that, as a recipe to reduce high unemployment rates, temporary contracts are a failure.

This paper is not, however, the first to asses the effects of temporary contracts. A number of previous studies have concentrated on the effects of fixed-term contracts on the dynamics of the labor market using a partial equilibrium perspective. The models feature that fixed-term contracts increase the number of hirings and firings in the economy while the effects on aggregate employment remain ambiguous. Some examples are the labor demand models by Aguirregabiria and Alonso-Borrego (1999), Bentolila and Saint-Paul (1992) and Goux *et al.* (2001); the model of job creation and destruction by Cabrales and Hopenhayn (1997); or the matching models by Blanchard and Landier (2001), Cahuc and Postel-Vinay (2000) and Wasmer (1999).

A second line of research is mostly empirical and addresses several more specific issues. The transition from fixed-term to permanent contracts has been analyzed by Booth et al. (2001) for the U.K., Güell and Petrongolo (2000) for Spain, and Holmlund and Storrie (2001) for Sweden. Nagypal (2001) studies the interaction between match-specific learning and the liberalization of fixed-term contracts. The effects on unemployment duration of introducing fixed-term contracts has been studied by Boeri (1999) and Güell (2000). Regarding the effects of fixed-term contracts on wages, Bentolila and Dolado (1994) and Saint-Paul (1996) show that an increased dualism in the labor market may imply a higher wage pressure if the unions protect the interests of permanent workers in the wage bargaining. Jimeno and Toharia (1993) and de la Rica and Felgueroso (2000) document how employers tend to underclassify workers with temporary contracts to pay them a lower wage than to an equivalent permanent worker.

Finally, to the best of our knowledge, there are only two other attempts to analyze

these issues in a general equilibrium framework. Güell (2001) looks at the effect of fixed-term contracts on unemployment using an efficiency wage model in which the firm's choice of contracts and the renewal rate of fixed-term contracts into permanent ones are endogenous. She shows that the relationship between firing costs and fixed-term contracts is not straightforward and that fixed-term contracts may not increase employment even in a world where firing costs would reduce employment. Veracierto (2000) studies the short-run effects of introducing labor market flexibility in an severance payments economy. He also finds that fixed-term contracts may increase the unemployment rate.

The rest of the paper is organized as follows. In section 2 overviews how labor contract regulations in Europe have evolved since the 80's and some stylized facts associated with this evolution. Section 3 presents our model and its equilibrium is derived in section 4. Calibration is discussed in section 5 and the results in section 6. Section 7 concludes. An appendix provides some details about the computation.

2 Some Stylized Facts

The regulation of work contracts differs widely among European countries (see European Commission, 1996b and 1997b). For this reason, we need to define carefully what we understand as permanent and temporary workers. Permanent workers are those with indefinite duration contracts, and temporary workers are those with a fixed-term contract. The maximum length of the latter contracts is usually limited to be between two and three years. Also the application of temporary contracts has been ruled by the principle of causality, i.e., aimed at jobs that are occasional or seasonal, jobs for absent post, apprenticeships, and jobs for carrying out a specific task or service predetermined in time. Another important difference between temporary and permanent contracts is the amount of severance payments and the degree of dismissal protection on each of them. Although regulations vary across countries, a general feature of temporary contracts is that both severance payments and dismissal protection are low.

The adverse economic conditions in the mid-80's, together with the complaints of entrepreneurs about the rigidity of contract regulations, led several European countries to partially reform their labor markets. One of the main reforms relaxed the restrictions on the use of temporary contracts, in particular eliminating many restrictions on non-causal fixed-term contracts. Among the countries in the European Union, seven had no limitations on the use of temporary contracts, and another five liberalized their use over the eighties. For instance France substantially deregulated temporary contracts in 1986,

relaxing the limitations on the purpose of these contracts and increasing their maximum length (previously between 6 to 12 months) up to 24 months. A counter-reform in 1990 reduced again the legal purpose of these contracts, the maximum duration fell to 18 months, and severance payments equivalent to 5 percent of gross salary were imposed. Germany moved in 1985 from a very restrictive casuistic to a widespread allowance of temporary contracts for any new hiring and former apprentices. Also the maximum duration was extended from six months to up to two years. In Italy, fixed-term contracts were limited to seasonal and training jobs before 1987. Since then, temporary contracts are allowed through collective agreements and prior official authorization. Nowadays only Finland, Greece, and Sweden keep high restrictions on temporary contracts (see OECD (1994a) and European Commission (1996b and 1997b)).

Table 1
Share of temporary employment in total employment

	1985	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*
*EU-15**	9.0	10.2	10.4	10.9	10.6	11.0	11.5	11.8
Belgium	6.9	5.3	5.1	4.9	5.1	5.1	5.3	5.9
Denmark	12.3	10.8	11.9	11.0	10.7	12.0	12.1	11.2
*Germany**	10.0	10.5	10.1	10.5	10.3	10.3	10.4	11.1
Greece	21.1	16.5	14.7	10.2	10.4	10.3	10.2	11.0
Spain	15.6	29.8	32.2	33.5	32.2	33.7	35.0	33.6
France	4.7	10.5	10.2	10.5	10.9	11.0	12.3	12.6
Ireland	7.3	8.5	8.3	8.7	9.4	9.5	10.2	9.2
Italy	4.8	5.2	5.4	7.5	6.0	7.3	7.2	7.5
Luxembourg	4.7	3.4	3.3	2.9	3.0	2.9	..	2.6
Netherlands	7.5	7.6	7.7	9.7	10.0	10.9	10.9	12.0
Austria	..	..	..	..	..	..	6.0	8.0
Portugal	14.4	18.3	16.4	11.0	9.8	9.4	10.0	10.6
Finland	10.5	11.5	12.0	13.1	12.7	12.9	16.5	17.3
Sweden	11.9	10.0	9.8	10.5	11.5	11.5	12.5	11.8
UK	7.0	5.2	5.3	5.5	5.9	6.5	7.0	7.1

Source: European Commission. Employment in Europe

*Since 1991, data on Germany and EU-15 include the new German Länder

The extent of these reforms can be appreciated in Table 1, where we present the evolution in the temporality rate (share of temporary employment in total employment) in the countries of the European Union. A remarkable fact is the jump experienced by this variable in France, Portugal and Spain, which had deregulated the use of temporary contracts in the mid-eighties.

The case of Spain, where around 33 percent of employees have a fixed-term contract, is specially important. Labor market regulations before 1984 were among the most protective in the industrialized world. That year, many of the previous restrictions on temporary contracts were removed, leading to an unlimited use of these contracts, even beyond the original intent of the reform. Temporary contracts could be cancelled at termination with a low severance payment (12 days per year of tenure)[1] and their extinction could not be appealed to labor courts. The maximum length of temporary contracts was set to three years. Thereafter, the firms should decide whether to offer the worker a permanent contract or to dismiss him. The reform did not introduce any change in the regulations of permanent contracts. In 1992, the minimum length of a non causal temporary contract was set to one year, and in 1994 some restrictions on the use of non causal temporary contracts, related to the age and conditions of the employee, were established. In 1997 severance payments for permanent employees were reduced in order to promote the use of permanent contracts as a hiring instrument[2]. Regulation of temporary contracts is currently a controversial issue, and trade unions are claiming for new legal limitations.

Three basic facts have emerged from these reforms across Europe. First, the introduction of temporary contracts does not correlate with a reduction of unemployment. Second, the entry and exit flows have substantially increased after their introduction. Finally, the elasticity of employment with respect to real GDP has increased as well.

To illustrate the first assertion, in Table 2 we report the correlation between the temporality rate and the unemployment rate using data for the EU countries from 1990 to 1996. We have estimated such correlation controlling for country-specific effects and with time dummies to control for aggregate shocks. In the first column we report the results for the EU-15 countries, and in the second we have excluded the three countries that were last to join the EU (Austria, Finland and Sweden). Whereas the correlation coefficient using the full sample is positive (although marginally significant), the coefficient with the restricted EU-12 sample turns out negative, although very small and clearly nonsignificant. There are three reasons why we think that we should concentrate on the EU-12 results. First, there are issue of data homogeneity, since these three countries joined the EU in 1995. As an extreme case, Austria only reports observations for the

[1]Mandatory severance payments for permanent workers were 20 days of salary per year of tenure (up to 1 year wages) if the dismissal is considered 'fair', and 45 days (up to 42 months wages) if it is considered 'unfair'. The burden of the proof for a fair dismissal must be assumed by the firm in a labor court, courts than tend to rule in favor of workers.

[2]Severance payments for fair dismissals of permanent workers were maintained at 20 days of salary per year of tenure, but those for unfair dismissals were lowered up to 33 days of salary.

last two years. Second, Finland and Sweden have two of the most restrictive legislations on temporary contracts (see OECD, 1994a). Finally, these very same countries suffered from a severe recession in the nineties, and in both cases their unemployment rates were multiplied by a factor of five in six years. Our evidence agrees with the findings in Bertola (1990), who showed no straight forward relationship between low employment on average and job security provisions for the major OECD countries.

Table 2
Within-group regression of the share of temporary employment over the unemployment rate

	EU-15	EU-12
Coefficient	0.182	−0.008
	(0.103)	(0.165)
p-value	0.08	0.96
F test	61.2	67.7
p-value	0.00	0.00

The F-test is a statistic for the null hypothesis of no country effects.

Concerning the effects of temporary contracts on job flows, OECD data show the negative relation between job turnover and different indices of employment protection, including those related with the regulation of permanent and temporary contracts. When the index is built considering only the effects of temporary contracts, the correlations are significantly stronger. They are also robust when correlations are computed for establishments of different size. Note that this finding is not at odd with the similarity in the amounts of job creation and job destruction across Europe and North American (Bertola and Rogerson (1997)). Similar job turnover rates are compatible with the very different rates at which workers enter and leave unemployment. Temporary contracts may have increased entry and exit rates, keeping constant the job turnover rate.

OECD data also show how the types of contract that a person unemployed in the previous period has in the present one have changed after the reforms (see Table 3). Countries that have implemented thorough temporary contracts reforms (i.e., France and Spain) show after them a dramatic decrease in the percentage of previously unemployed people who get a permanent contract. Countries that opted for mild reforms only show modest reductions in that percentage (i.e. Germany and Italy), whereas in those countries in which these contracts were already deregulated that percentage is almost constant (U.K., Denmark or Netherlands).

Table 3
Probability of getting a permanent (P) or a temporary (T) contract conditional on entering from unemployment

	1983		1989		1994	
	P	T	P	T	P	T
Denmark	57.6	42.4	59.6	40.4	54.8	45.2
Germany	68.5	31.5	66.1	33.9	62.1	37.9
Spain	39.0	61.0	22.7	77.3	9.8	90.2
France	81.5	18.5	57.3	42.7	45.1	54.9
Italy	65.3	34.7	..	..	61.2	38.8
Netherlands	59.4	40.6	56.1	43.9	61.9	38.1
United Kingdom	76.6	23.4	83.9	16.1	77.6	22.4

Source: OECD Employment Outlook (1996)

Regarding the third fact, available empirical evidence (see Bertola (1990) and Bentolila and Dolado (1994) among others) document how temporary contracts increase labor demand in booms and decrease it in slumps, relative to the situation in which only permanent contracts are allowed.

3 The Model

To formally explore the impact of temporary contracts in the economy we build a dynamic general equilibrium model with heterogeneous households, firms subject to idiosyncratic shocks and incomplete markets. Our model is in the tradition of Hopenhayn and Rogerson (1993) and Álvarez and Veracierto (2001) among others.

We briefly motivate the different elements in the model. First, since this is the phenomenon we want to explore, we will have two different types of labor contracts, fixed-duration and permanent. Second, we will have heterogeneous households that can only save in a one-period uncontingent bond. Previous contributions have focused on models with complete markets (see Álvarez and Veracierto (2001) for an exception). However the existence of full insurance (including employment lotteries) obscures the potential role of employment protection as a substitute for complete markets. Since empirically unemployment spells seem to be associated with welfare reductions, we believe that our framework, where most financial markets are closed, delivers a more accurate estimate of the impact of labor market regulations. Also households will make nontrivial decisions of labor supply at the extensive margin. In this way the productivity consequences of different labor institutions will affect entry and exit decisions on the labor market.

Third we will have a distribution of firms subject to idiosyncratic shocks. This feature provides us with a margin where firms must decide the composition of their labor input between permanent and temporary workers as the optimal intertemporal response to the idiosyncratic shocks. In this way we capture the stylized fact of the large volume of job creation and destruction at the level of individual firm and study how this firm dynamics and productivity are affected by the change in the labor market regulation.

Fourth, we will introduce a very simple form of labor market friction that provides an additional, empirically grounded, motivation for job security provisions and generates positive unemployment. Households need to search for a period before finding a new job. This simple friction summarizes the matching problems of the labor market. It is a natural reduced form of a more complicated framework that, to simplify the analysis, we do not deal with directly. We feel, however, that we do not lose a lot with the shortcut.

Finally, we will use a general equilibrium approach. We need to keep track of the aggregate effects because of two reasons. First, to be able to fully evaluate the impact of such policy. Introducing fixed-term contracts will have nontrivial implications on the aggregate distribution of workers, capital accumulation and labor supply decisions that can be missed by a partial equilibrium analysis. Second general equilibrium and the fact that we can calibrate the model for the Spanish economy allows us to use it as a measurement tool to quantitatively asses the impact of counterfactual policies.

It is important to note that we abstract from several important features of the data. First, for computational reasons[3], we exclude the study of the effects of fixed duration contracts on the business cycle. Intuition suggest that aggregate fluctuations can be magnified if firms have an additional margin to response to common shocks. Second we do not explore the effects of the temporary contracts on the wage bargaining process. It has been argued that the presence of fixed duration workers increases the bargaining power of permanent workers since the firm will prefer to fire them first if a bad shock hits. However, in a dynamic framework, the presence of fixed duration contracts will shift the average composition of employment and it may reduce the bargaining power of workers. Finally we omit the political-economic consideration that explain why these contracts appeared in Europe during the 80's and 90's. Exploring all these issues deserve future research.

[3]Our model has heterogeneous distributions of firms and households with numerous binding corner constraints. It is not known how to deal efficiently with the computational problem of solving such a model with aggregate uncertainty.

3.1 Household's Problem

There is a continuum of infinitely-lived households of measure one that supply labor services and consume. All labor contracts establish an exogenously fixed duration ν of the working day. Households are endowed with one unit of time, such that $\nu \in (0,1)$[4]. In this way the number of employees at a particular firm is well defined. Each household owns a constant share τ of all firms in the economy. A way to rationalize this is to think of the economy as a huge investment fund whose participations are equally distributed among all agents.

The household i solves the following problem:

$$\max_{\{c_t, l_t\}} E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t^i, 1 - l_t^i\right) \tag{1}$$

subject to

$$\begin{aligned} a_{t+1}^i + c_t^i &\leq (1 + r_t)\, a_t^i + w_t^i l_t^i + \theta^F w_t^i J_t + \tau \Pi_t \\ l_t^i &\in \{0, \nu\} \ , \forall t \qquad (2) \\ a_t^i &\geq -A \ , \forall t \qquad (3) \end{aligned}$$

where $u(\cdot,\cdot) : R_+ \times \{1, 1-\nu\} \to R$ is a C^2 utility function with the usual properties (increasing in both arguments, strictly concave, and $\lim_{c \to 0} u'_c = \infty$), c_t^i is consumption and $(1 - l_t^i)$ stands for leisure. Note that as explained above l_t^i is constrained to be either 0 or ν. In the calibration of the model we will pick a separable parametric form for the utility function consistent with a balanced growth path and with the observation that the unemployed agents consume less than the employed ones.

Moreover, E_0 is the expectation operator at time 0, β is the discount factor, where $0 \leq \beta \leq 1$, and a_t^i is the level of an uncontingent bond at the beginning of the period, which must be always higher than some value $-A$, where $A \geq 0$. In the context of this model, since labor supply is endogenous, $A = 0$ is the natural debt limit in the sense of Aiyagari (1994). There are two additional terms in the budget constraint, $\theta^F w_t^i$, the severance payment to the worker if it was a permanent worker that gets fired in the period (event $J_t = 1$, otherwise $J_t = 0$) expressed in wage terms, and $\tau \Pi_t$, that represents the participation share, τ, on aggregate profits, Π_t. Finally, r_t and w_t^i are the interest rate for assets and the wage received by the household.

[4]This parameter corresponds to the duration of a full-time contract. In this paper, we only concentrate on full-time contracts, which can be fixed-term contracts or permanent contracts. Interestingly enough, in most European countries in which fixed-term contracts have been introduced, the share of part-time contracts is generally small (see OECD, 1994a). Reasons such as non convexities due to commuting time or other coordination problems may explain this observation.

3.2 Firm's Problem

There is a continuum of firms of measure one. Each firm has access to a technology represented by a production function $f(\cdot,\cdot,\cdot) : R_+ \times R_+ \times \Omega \to R_+$, such that the output y_t is given by:

$$y_t = f(k_t, N_t, \varepsilon_t) \tag{4}$$

where the function $f(\cdot,\cdot)$ is increasing in all arguments and concave in N_t and k_t. We also assume that usual inada conditions apply. Note that we do not necessarily impose constant returns to scale in the production function. We will discuss the issue in more detail in the calibration.

The variable k_t is the capital rented by the firm. The variable N_t is an index of efficiency units of labor, defined as

$$N_t = n_t + \lambda m_t \tag{5}$$

This index is a weighted sum of the measure n_t of permanent contracts and the measure m_t of temporary contracts. The weighting parameter $\lambda < 1$, accounts for the lower productivity of those temporary workers. This lower productivity could be due to factors such as lower firm-specific human capital related to shorter contract duration or learning.

The random variable ε_t with support Ω follows a first order Markov process $F(s, s')$ and we can think of it as an idiosyncratic productivity shock or the reduce form of some other (i.e. demand) shock. To assure that an appropriate law of large numbers hold we do not require independence of shocks across firms[5].

Output produced by the firm cab be consumed, used (as described below) for searching and hiring purposes or invested in physical capital, that depreciates at a rate δ each period.

3.3 Labor Contracts and Firms Profits

We will now describe the two types of labor contracts that we allow in this economy. First we will have the permanent contract. Under this contract, firms pay a wage for each working period and a fixed payment to the worker in the case of dismissal. Two points deserve some elaboration. First, we depart from the tradition in the literature (see

[5]Note that we depart from Hopenhayn and Rogerson (1993) and Álvarez and Veracierto (2001) in that we do not model entry and exit of firms. Since in our calibration the expected present value profit of a new firm is nearly zero, we closed down that margin to simplify the description of the model. Picking an appropriate initial distribution of entry cost will make our model equivalent to one with entry and exit of firms.

for instance Hopenhayn and Rogerson (1993)) since we treat firing cost as a payment to the worker and not as a tax to be redistributed in lump-sum fashion. With complete markets the tax choice simplifies the analysis without further consequences. However in our framework it is important to think of the indemnity as a direct payment to the households since it will affect its labor and saving decisions as well as welfare. Also since we have incomplete markets, we break down the argument of Lazear (1990) that, if markets are complete, severance payments are neutral. Second we do not condition the indemnification on seniority as in most European countries. If we did so, we will have a state space too large for practical computation. The final characteristic of the contract households commit themselves to not to quit voluntarily. In that sense, this contract insures both parts: firms against unexpected shortages of labor, and households against arbitrary dismissals[6].

The second type of contract is the fixed-term one. Under this contract, firms will pay a wage for one working period and may offer a permanent contract at the beginning of the next. Households commit themselves to come back next period to the firm and accept a permanent contract if they are offered one[7].

The rental price of labor for permanent and temporary workers is given by w_t^j, where $j = n, m$, respectively. Firms also face hiring and firing costs for permanent and temporary contracts which are represented by θ_j^H and θ_j^F. Assume that $\theta_m^F = 0$ and that $\theta_n^F > 0$, while $\theta_m^H < \theta_n^H$. This first assumption represents the very nature of temporary contracts, a negligible dismissal cost, and the second captures the idea of the severance payment to the worker. The hiring cost takes account of some kind of fixed cost related with writing a new contract or having a screening device. In addition, the cost of hiring can be assumed to be greater for the case of permanent workers because of the longer-term consequences of those hirings. The two most clear examples are tougher screening processes and the required on-the-job training investment. Regarding the first example, it seems clear that

[6]We abstract from voluntary quits. Data suggest that most of them are related to the transfer from one firm to another (keeping a permanent contract) or with life cycle issues such as retirement or maternity. Both reasons are absent in our model. First, human capital is homogeneous and therefore transfers among firms will not increase marginal productivity conditional on the idiosyncratic shock. Second, our agents are infinitely lived.

[7]Again we abstract from the fact that some temporary contracts can be renewed (for instance, in Spain, up to three years) and from the principle that workers are not forced to accept a promotion to permanent. We think that little content is lost. The posibility of renewals of temporary workers are equivalent to changes in the period definition. With respect to the acceptance of a promotion, in our model, the wage in another firm is not going to be higher, and the only difference among firms is the actual realization of the shock (and hence the probabilities of not being fired in the next period). Since the worker is being promoted, in equilibrium that means that the firm has experienced a good productivity shock and that the expected utility flow from that contract is higher than the outside option.

the presence of dismissal costs creates an incentive for the firm to be more careful when deciding hirings. In relation with our second example, even if some on-the-job training is simply learning-by-doing, much of it takes place either in formal or informal training programs. All those programs are a conscious choice on the part of the employer and are costly. These costs are both explicit, as expenditures on training material, or implicit, as the commitment of time by trainers or supervisors to the teaching process.

A special case is the promotion of temporary to permanent workers when their contracts expire. In this case, the firm does not have to pay the hiring cost again, as the screening process has been already done. As a consequence, the firm will always give temporary workers the priority to be hired as permanents (empirically nearly all the firms do so). Only if the firm needs more permanent workers than the amount of temporary it had in the previous period, it will hire them from the market. Then, the flow of permanent contracts, d_t, will be given by:

$$d_t = n_t - n_{t-1} \tag{6}$$

With this description of the labor contracts and of the firm problem we can write the firm's profit function in a period as:

$$\pi\left(\varepsilon_t, n_{t-1}, m_{t-1}\right) = \left\{ \begin{array}{c} f\left(k_t, N_t, \varepsilon_t\right) - \left(r_t + \delta\right) k_t - w_t^n n_t - w_t^m m_t - \theta_m^H m_t \\ - \theta_n^H \max\left\{d_t - m_{t-1}, 0\right\} - \theta_n^F \max\left\{-d_t, 0\right\} \end{array} \right\}$$

and the intertemporal problem as:

$$\max_{\{n_t, m_t, k_t\}} E_0 \sum_{t=0}^{\infty} \beta \frac{1}{(1+r)^t} \pi\left(\varepsilon_t, n_{t-1}, m_{t-1}\right) \tag{7}$$

3.4 Timing

Since a clear grasp of timing in this model is important to understand its behavior, we will spend a few lines in describing it carefully.

3.4.1 Households

At the end of period $t-1$, the household is either unemployed, employed under a temporary contract that expires in that period, or employed under a permanent contract. At the beginning of period t, the household observes all the information about the economy: the wages, the states of the firm where she works, and the distributions of agents.

If the household is a permanent worker in period t, she has to go to the firm to work, and either stays as a permanent worker, or is fired. If she is not fired, at the end of period

t she stays as a permanent worker. If the household is fired, she becomes unemployed at the end of period t and, in period $t+1$, she may go to the employment office. Note that the household cannot quit because of the type of contract she has signed with her firm.

If the household is a temporary worker that finishes her contract in period $t-1$, at the beginning of period t she has to go to the firm. Once there, either she is promoted to permanent worker or is not renewed. In the second case, at the end period t she is unemployed and in period $t+1$ she may go to the employment office. Remember there is no possibility of a renewal as temporary worker.

If the household is unemployed at the end of period $t-1$, she has two options at the beginning of period t:

a) she goes to the employment office and finds a new job (as permanent or temporary) right away. The assignment of employment offers is done with the help of a random device. Recall that she cannot refuse the offer she receives, regardless of the state of the firm that is posting that vacancy.

b) she does not go to the employment office in period t and ends the period as an unemployed.

This simple timing convection incorporates our modelling of a search friction in the job market: it takes a period to find a new job. We can think of this timing as a reduced form of a matching function that implies a period of wait for workers to find a new job. Given our calibration below, where we set a period equal to a year, we will match closely the average wait for a new job in the Spanish economy (around 13 months). Note that we do not incorporate a feedback mechanism from the level of unemployment and the presence of temporary contracts into the market friction. The reason is that the empirically literature has obtained mixed results with respect to the impact of this mechanism. Boeri (1999) concludes that higher worker's turnover implies a decrease of unemployment duration and therefore reduces long-term unemployment. Güell (2000) shows that whereas fixed-term contracts reduce the share of long term unemployment, they can increase the duration dependence of unemployment and be ambiguous with respect to the unconditional length of the unemployment spell.

3.4.2 Firms

At the end of period $t-1$, firms know the number of permanent and temporary workers they have. At the beginning of period t, firms observe wages, distributions and their own idiosyncratic shock, and decide about their new hirings or firings.

If the number of desired permanent workers is equal to the number of permanent workers in the previous period, there are no hirings or firings. If the number of desired permanent workers is larger than the number of permanent workers in the previous period, they promote to permanent those workers that were under fixed-term contracts in the previous period and, if there is not enough of them, firms go to the employment office to hire new workers. Finally, if the number of desired permanent workers is smaller than the number of permanent workers in the previous period, firms fire the number of workers corresponding to such difference. In all cases, if there are more workers to be promoted or to be fired, they are randomly chosen. Regarding temporary workers, at the beginning of each period, if firms need a positive amount of temporary workers, they go to the employment office and hire as many workers as they need.

Finally, along the period, firms produce, and at the end of each period, they pay wages and distribute profits.

4 Equilibrium

We will use the recursive competitive equilibrium concept. For the household i (we drop the superscript when no confusion occurs), we define a quasi-indicator function I_t equal to 0 if the household is unemployed, (-1) if it has a fixed-term contract, and 1 if it has a permanent contract. The function is always evaluated at the end of period $t-1$. The state variables for the employed household in this economy is given by the vector $(a_t, \varepsilon_t, n_{t-1}, m_{t-1}, I_t; P_t)$ where P_t is the joint distribution of firms and households in the economy. For the rest of the paper we will concentrate only in the case where the economy is an stationary equilibrium where P is not indexed by time. Note that households are indexed by the states of the firm in which they are employed at the beginning of the period since these states are relevant to compute the probability of transition from employment into unemployment (permanent) or from temporary into permanent or unemployment[8]. For an unemployed household the states are just given by $(a_t, I_t; P)$ where $I_t = -1$. For convenience, we define also separate measures for households η and firms μ, i.e. $P = (\eta, \mu)$.

The optimality equation for the employed household's problem that stays employed can be written as:

$$V^e(a_t, \varepsilon_t, n_{t-1}, m_{t-1}, I_t; P) = \max_{\{c_t, a_{t+1}\}} \left\{ u(c_t, 1-\nu) + \beta \int V^e(a_{t+1}, \varepsilon_{t+1}, n_t, m_t, I_{t+1}; P)\, dF \right\}$$

[8]It would be equivalent to use as state variables n_t and m_t since, conditional on a_t, they are a deterministic function of n_{t-1} and m_{t-1}.

subject to:

$$\begin{aligned} a_{t+1} + c_t &\leq (1 + r_t) a_t + w_t^n \delta + \tau \Pi_t, \text{ if } I_{t+1} = 1 \\ a_{t+1} + c_t &\leq (1 + r_t) a_t + w_t^m \delta + \tau \Pi_t, \text{ if } I_{t+1} = -1 \\ a_t &\geq -A \ , \forall t \end{aligned}$$

the problem for the household fired in this period is:

$$V^{eu}(a_t, I_t; P) = \max_{\{c_t, a_{t+1}\}} \{u(c_t, 1) + \beta V^u(a_{t+1}, I_{t+1}; P)\} \tag{8}$$

subject to:

$$\begin{aligned} a_{t+1} + c_t &\leq (1 + r_t) a_t + \theta^F w_t^i + \tau \Pi_t, \text{ if } I_{t+1} = 0 \\ a_t &\geq -A \ , \forall t \end{aligned}$$

and the problem for the household that begins the period as an unemployed is:

$$V^u(a_t, I_t; P) = \max_{\{c_t, a_{t+1}\}} \left\{ u(c_t, 1) + \beta V^u(a_{t+1}, I_{t+1}; P), \int V^e(a_t, \varepsilon_t, n_{t-1}, m_{t-1}, I_t; P) \, dP \right\} \tag{9}$$

subject to

$$\begin{aligned} a_{t+1} + c_t &\leq (1 + r_t) a_t + w_t^n \delta + \tau \Pi_t, \text{ if } I_{t+1} = 1 \\ a_{t+1} + c_t &\leq (1 + r_t) a_t + w_t^m \delta + \tau \Pi_t, \text{ if } I_{t+1} = -1 \\ a_{t+1} + c_t &\leq (1 + r_t) a_t + \tau \Pi_t, \text{ if } I_{t+1} = 0 \\ a_t &\geq -A \ , \forall t \end{aligned}$$

Note that following our description of the household problem, the unemployed agent can choose between entering or not the labor force, and if it does, then the value function is integrated with respect to the distribution of firms and households that determines the probability of which firm and under which contract the households will find employment.

In an equivalent way, the vector of state variables for the firm is $(\varepsilon_t, n_{t-1}, m_{t-1}; P)$. The optimality equation for the firm's problem becomes then:

$$W(\varepsilon_t, n_{t-1}, m_{t-1}; P) = \max_{\{m_t, n_t, k_t\}} \left\{ \pi(\varepsilon_t, n_{t-1}, m_{t-1}) + \frac{1}{(1 + r)} \int W(\varepsilon_{t+1}, n_t, m_t; P) \, dF \right\} \tag{10}$$

where the profit function is defined as in section 3.

Our concept of equilibrium will keep track of the fact that individual states of households must be consistent with the states of the firms, i.e. there will be as many households employed in firms with certain characteristics as the labor hired by firms with those states.

Now we are ready to define an equilibrium for our economy. A *recursive stationary competitive equilibrium* for this economy consists of value functions $V^e(\cdot), V^{eu}(\cdot), V^u(\cdot)$ and a set of associated decision rules $c(\cdot)$, $a(\cdot)$, $l(\cdot)$, for the household, and a value function $W(\cdot)$, and a set of decision rules $y(\cdot), k(\cdot), m(\cdot)$, $n(\cdot)$, for the firm, factor price functions $w^n(\eta(\cdot), \mu(\cdot))$, $w^m(\eta_t(\cdot), \mu(\cdot))$, $r(\eta(\cdot), \mu(\cdot))$, and aggregate laws of motion for the distribution of agents in the economy $\eta = h(\eta(\cdot), \mu(\cdot))$ and $\mu = q(\eta(\cdot), \mu(\cdot))$, such that these functions satisfy:

- the household's problem;
- the firm's problem;
- the consistency of individual and aggregate decisions,

$$\begin{aligned} \eta(S_o) &= h(\eta(\cdot), \mu(\cdot))(S) = \int_{S_o} \left\{ \int_S \eta(\cdot)\, d\eta \right\} d\eta \\ \mu(R_o) &= q(\eta(\cdot), \mu(\cdot))(R) = \int_{R_o} \left\{ \int_R \mu(\cdot)\, d\mu \right\} d\mu \end{aligned} \tag{11}$$

  for all $S_o, S \in \sigma(\Upsilon)$ and $R_o, R \in \sigma(\Gamma)$ where $\sigma(\cdot)$ is the appropriate borel algebra.

- the aggregate resource constraints.

We must note that, generically, this economy will present multiplicity of equilibria. In particular there will be equilibria where the relative wage of permanent workers is so high that all contracts are temporary. Also we will have equilibria of the opposite case, where the relative wage of permanent is so low that no temporary workers are hired. We do not think any of these two types equilibria are interesting. More problematic is however the possibility of several equilibria in the range of relative wages where both types of contracts are observed. Such different equilibria may have very different predictions about observables and welfare. Unfortunately we have not been able to prove uniqueness of this type of equilibria. Heuristically, and despite some effort, we failed to find different equilibria that the ones reported below.

5 Calibration

The benchmark economy is calibrated to reproduce some basic characteristics of the Spanish economy during the 1985-2000 period.

Some parameters for the firm and the hiring/firing cost parameters have been taken from Aguirregabiria and Alonso-Borrego (1999), who posit and estimate a dynamic programming model in a partial equilibrium framework. They use an unbalanced panel of

2,356 Spanish manufacturing companies between 1982 and 1993, taken from the database of the Bank of Spain Central Balance Sheets Office. The database contains annual information at the firm level about the number of employees by type of contract (permanent and fixed-term), the total wage bill, and other complementary information. Since, as it is usual with firm-level data, there is no information on employment flows, all the estimates are based on net employment changes.[9] Evidence from the firm-level data clearly reflects the existence of fairly large adjustment costs for permanent workers. It is worth noticing that the job turnover rates are very high for temporary employees, but very small for permanent ones. When the information on severance payments was exploited, it could be observed that under the definitions of firings and quits, half of the destruction of permanent jobs during 1986-1990 was due to voluntary quits. This fact implies that most firms have preferred to wait until redundant workers decide voluntarily to leave the firm rather than incur in costly dismissals.

An important issue which affects the estimation of the model is the wage differential between temporary and permanent workers. This concern appears because it is expected that firms with higher proportions of temporary employees tend to pay lower wages, so that ignoring this fact could introduce serious biases in the estimates. Since wages by type of contract are not observed at the firm level, the use of industry level information is needed. From the industry level data, it is observed that the relative wage has remained fairly constant over the estimation period.

The estimates were obtained by means of a two-stage approach. In the first stage, the technological parameters are estimated using a first-differences GMM estimator. In the estimation, an AR(1) process for technological idiosyncratic shocks was assumed in order to allow for shock persistence. In order to get more precise estimates, they exploit the marginal condition for temporary workers and estimate the relative productivity of temporary workers using within-firms nonlinear least squares. In the second stage, the dynamic discrete decision for the sign of adjustment in permanent employment is exploited. The problem generates a Markov discrete choice model, whose log-likelihood resembles the one for an standard ordered probit, except for the fact that the thresholds depend on the firm's expected marginal value function. The estimation method is a partial maximum likelihood estimator, due to Aguirregabiria and Mira (2001), which consists of an algorithm that exploits a sequence of pseudo maximum likelihood estimators based on approximations to the marginal value function.

[9]Nevertheless, the information on voluntary quits was exploited in order to distinguish between negative employment changes due to voluntary quits and those due to costly dismissals.

The procedure also delivers values for the technological coefficients of a Cobb-Douglas production function under the alternative assumptions of constant returns to scale or unconstrained estimates. Since the data strongly support the presence of constant returns to scale we picked that specification. Note however that since input prices are not equal to the marginal productivities in the period (hiring workers have an effect of the value function of the firm), in equilibrium we may have profits. Computationally they are however nearly zero.

The results from this estimation and the other calibration parameters are reported in Table 4. In the top panel, we report the technological parameters. The most remarkable feature is that the relative productivity of temporary workers λ is very close to the relative wage between temporary and permanent workers. The autoregressive process for shocks implies a relatively high degree of persistence (0.691). Computationally the technology process is approximated by a five states Markov Chain.

Table 4
Benchmark Economy Parameterization

Technology parameters		
Relative productivity of temporary workers	λ	0.795
Technological coefficient of labor	α_L	0.682
Technological coefficient of capital	α_K	0.272
Depreciation	δ	0.11
Productivity Shocks Persistence	ρ	0.691
Productivity Shocks S.D.	σ	0.196
Preference Parameters		
Discount Factor	β	0.96
Leisure preference	φ	0.3
Policy Parameters		
Firing costs	$\phi^F = \frac{\theta^F}{w^n}$	0.511
Promotion costs	$\phi^P = \frac{\theta^P}{w^n}$	0.098
Hiring costs	$\phi^H = \frac{\theta^H}{w^m}$	0.159

Finally, the chosen hiring and firing parameters take account of voluntary quits and costs' heterogeneity between firms[10]. The main results indicate unit firing costs that amount to 51 percent of the gross annual wage of a permanent worker, as well as unit promotion costs and hiring costs about 10 and 16 percent of the gross annual wages

[10]In order to allow for additional unobservable labor costs for permanent workers, the authors introduced a wage idiosyncratic cost, which was assumed to be *iid* with mean μ_ε and variance σ_ε^2. Ignoring this additional labor cost would induce biased estimators if $\mu_\varepsilon \neq 0$.

of permanent and temporary workers, respectively. When voluntary quits of permanent workers were ignored, results were remarkably different, with firing costs about 33 percent of the gross annual wage. The estimated values are similar to the values found for other European countries as in Abowd and Kramarz (2001) and Kramarz and Michaud (2002) for France.

The other parameters were chosen as follows. The depreciation rate δ was chosen to match the capital/output ratio of the Spanish economy and the discount factor was chosen to generate an interest rate of 4 percent in equilibrium. As a utility function a log-log parametrization was assumed with leisure parameter φ of 0.3, a common choice in the literature.

6 Quantitative Results

Here we discuss the effects of temporary labor contracts in the economy. Table 5 presents some of the main results of the benchmark economy.

Table 5
Benchmark Economy, Aggregate Quantities

Output	0.54
Capital/Output Ratio	1.81
Aggregate Firing/Hiring Cost	0.02
Average Labor Productivity	1.60

The capital/output ratio is close to the ratio of nonresidential capital/output ratio in the Spanish economy, that fluctuated around 1.7 during the nineties. The aggregate firing/hiring cost are around 1 percent with respect to the capital/output ratio and the average labor productivity is around 1.6. The main characteristics of the job market are presented in table 6.

Table 6
Benchmark Economy, Job Market

Employment Rate	88.20%
Unemployment Rate	11.79%
Permanents	91.64%
Temporaries	8.36%
Job Creation/Destruction Rate	19.06%
Prob. of finding a permanent job	30.43%
Prob. of promotion	68.03%

The model is able to generate an unemployment rate (11.79 percent) close to the levels of unemployment is Spain around 2000-2001. The distribution of permanent/temporary workers is however, far away from the observed rates (20 percent in the manufacturing industry where our data for the calibration comes from versus 8 percent). A possible explanation for this difference is that we use a model without aggregate uncertainty. The presence of a common aggregate technology shock may increase substantially the use of temporary workers, specially if it induces firms in the lower tail for the idiosyncratic shock to hire temporary to increase production as an answer to the aggregate shock.

We can provide some intuition about the results. Firms use temporary workers in this model to increase production during those periods in which they enjoy good productivity shocks because of two reasons. First, as the grow in size, they prefer to increase first through temporary workers, that have a lower hiring cost and help as an hedge against a reversion to lower productivity levels. In fact as firms keep enjoying high productivity shocks they move towards a mix with higher proportion of permanents. However, even in this case, they keep a percentage of fixed-term contracts for self-insurance purposes. In the same way, households accumulate bonds for self-insurance and they increase their holdings when they are temporary since they will face, with certain probability, an unemployment spell next period. With respect to labor supply, those households that have been for a long period employed in the same firm and get suddenly fired, will not supply labor for a while as they desaccumulate part of their asset position and enjoy leisure time.

The job creation and destruction rate in the model is 19.06 percent (compare with [to be completed]). The probability of moving from unemployment to a temporary contract is substantially higher than the observed one (30 percent versus around 9 percent). However in the observed data we see quite a bit of rolling-over of temporary contracts, including firing and recalling from the same firm (to avoid exceeding the total amount of temporary work allow in the law) that are absent in the model. In our benchmark economy slightly less than 47 percent of new permanent jobs are filled with new hirings, while the remaining 53 percent are filled with internal promotions from temporary to permanents. Finally, note that the ratio of the wage of permanent workers to the wage of temporary workers is 1.20.

We will present now results from several experiments where we change the economy parameters and compare the results with our benchmark economy.

6.1 Experiment 1: Eliminating Temporary Contracts

The first experiment we will perform is to eliminate temporary contracts in the economy[11]. Again, we present results for aggregate quantities (Table 7) and the job market (Table 8).

Table 7 Experiment 1, Aggregate Quantities	
Output	0.53
Capital/Output Ratio	1.80
Aggregate Firing/Hiring Cost	0.02
Average Labor Productivity	1.62

Only minor changes can be observed in aggregate quantities. Output falls by about 0.5 percent due to the lower ability of firms to reallocate labor services in the absence of temporary contracts. Although part of the losses in production are made up by a higher average labor productivity (due to the higher productivity of permanent workers that now make up hundred percent of the employees), there seem to be no evidence to back up the allegations that the lower quality of temporary contracts may reduce the production of the economy. Also, hiring and firing costs rise a 3 percent, reducing the total amount of output available for consumption. The Capital/Output ratio of the economy falls by less than 1 percent, while the interest rate increases nine basic points.

Table 8 Experiment 1, Job Market	
Employment Rate	89.13%
Unemployment Rate	10.87%
Permanents	100.00%
Temporaries	NA
Job Creation/Destruction Rate	12.20%
Prob. of finding a permanent job	100.00%
Prob. of promotion	NA

Table 8 reveals more interesting results though. In particular we see that the unemployment rate is lower without temporary contracts by nearly a 1 percent. The reason for that outcome is simple, and comes from the figures on job creation and destruction.

[11]We could have also calibrated our benchmark economy to match an economy without temporary contracts and then introduce them. However, that will imply matching data either from the sixties and early seventies, when the Spanish economy presented a very different structure, or from the early eighties when the effects of the oil shocks where very acute.

While in our benchmark economy this destruction rate is 19 percent, in the second economy it falls to 12 percent, due to the higher marginal cost of firing workers. Since the unemployment rate in our model has a frictional character, higher inflows and outflows from the job market translate into a higher unemployment rate in equilibrium. The effect on labor productivity of temporary contracts increases wages of permanent workers by 1 percent, not a trivial amount but clearly insufficient to induce more than a second order effect in labor supply.

This results may explain why it has been difficult to find a negative correlation between job market flexibility and unemployment rates (Nickell (1997)): higher flexibility in the job market is good for productivity and total output but it has an ambiguous effect in aggregate employment when it is considered in general equilibrium.

Is this result robust to our modelling choices? We think so. One possible criticism is that we do not allow workers to reduce the waiting period of one year before they find a new job. It may be the case that the higher level of job creation will induce workers to search with more intensity and reduce the friction in the labor market. We believe that this criticism is wrong. First theoretically it may be the case that workers actually search for a longer period when there are more job offers if they know they can always revert easily to a temporary job. In fact the empirical evidence suggest that this is a possible interpretation of what has happened in the labor markets during the last decade and a half. Second Álvarez and Veracierto (2001) modelled the search margin in a slightly different to ours and their results indicate that this margin has a second order importance.

6.2 Experiment 2: Reducing Firing Cost

Other possible experiment is to think about the effects of reducing the firing cost. Hopenhayn and Rogerson (1993) show that in their model, a tax on job destruction equal to one year's wages reduces employment by roughly 2.5 percent and the cost in terms of consumption of this same tax is greater than 2 percent. Diaz-Moreno and Galdón-Sánchez (1999) apply and calibrate that model economy to Spanish data finding that a reduction of the dismissal tax from the equivalent of one year of wages to zero would increase employment by 8.13 percent and productivity by 2.28 percent. Different results are found by Álvarez and Veracierto (2001) that document large and positive effects on employment and welfare of severance payments.

Our model shows results similar, although not as extreme, as Álvarez and Veracierto (2001)[to be completed]

6.3 Experiment 3: Subsidizing the Conversion of Fixed-Term Contracts into Permanent Contracts

A final third experiment is aimed at evaluating the effects of a public subsidy to convert fixed-term contracts into permanent ones. This experiment is motivated by the introduction of such a subsidy in Spain after 1997[to be completed].

7 Conclusion

What are the quantitative effects of temporary contracts in the economy? Our exercise suggest that they tend to slightly increase unemployment levels and reduce welfare. Armed with a cheap instrument to raise or lower output over time, firm increase job flows. Since the labor market does not clear right away, these higher flows generate higher unemployment levels. The counterbalancing effect of higher productivity allowed by the quicker adaptation to idiosyncratic shocks is not strong enough to turn the result around. The intuition is simple and it is just another example of second-best reasoning: in a world where markets are characterized by frictions (as our search friction of one period) introducing flexibility at the margin does not need to deliver an improvement in welfare.

Two main questions remain open for future research. First introducing aggregate uncertainty. The interaction between labor market flexibility at the margin and incomplete markets may be an interesting channel to study. Some evidence suggest that the European economies have a higher elasticity of employment levels to output after introducing temporary contracts. What can theory say about that? and what are the welfare effects? Second, why did European countries introduce these partial reforms instead of reducing severance payment all across the market? Exploring this channel may have deliver important clues about the general political economy of labor markets regulation in Europe and cast further light on the way we got the high and persistent unemployment rates we suffer today.

8 Appendix

This appendix describes an algorithm to compute the stationary equilibrium of our benchmark economy. This procedure is interesting because it assures that we have two different measure, one for firms and one for households and that both of them are consistent with each other. To the best of our knowledge this procedure is an innovation in the literature. Adapting it to the different experiments is straightforward.

The basic structure of the algorithm is as follows:

1. Guess some equilibrium prices w^n, w^m, r. It is usually a good initial point to look for a ratio of permanent/temporary wages close to, but below, the ratio of productivities

2. Given prices, solve the problem of the firm.

3. Find the stationary distribution of firms implied by the problem of the firm.

4. Get the transition probabilities from the households in the job market and in the firms consistent with the stationary distribution of firms.

5. Given these transition probabilities and the vector of prices, solve the household's problem.

6. Find the stationary distribution of households implied by the problem of the household and the transition probabilities found in step (4). Note that using these model-consistent probabilities will assure that the stationary distribution of households will only assign mass to those points that have a positive mass of firms and ensures that we only need to clear the aggregate markets and not set by set.

7. Use the stationary distributions of firms and households to check for market clearing.

8. Update prices in step (1) and continue until all three markets clear.

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