The Emersion Effect: an analysis on labor tax evasion in Italy

Edoardo Di Porto
Department of Economics and Law,'Sapienza", University of Rome and
EQUIPPE USTL/Lille

Leandro Elia
Econometrics and Applied Statistics Unit, IPSC
European Commission-Joint Research Centre

Cristina Tealdi
IMT-Lucca

Very preliminary draft

Abstract

We analyze how different policy interventions may incentive emersion from undeclared work. We use Italian data over the period 1998-2003 to investigate whether the 2003 Italian labor market reform was able to reach the objective to reduce the share of shadow economy. We develop a search and matching model, á la Mortensen, on the basis of our empirical investigation to determine the right mix of policy interventions which maybe effective in generating an emersion effect. Our preliminary findings show that differentiated forms of taxations and enforcement might create a good combination of incentives to achieve a significant reduction in undeclared work.

1 Introduction

Despite tax evasion being a topic extensively studied in economic literature, it is still debated which instruments might be effective to achieve deterrence. Increasing the probability of being caught by a tax enforcement agency or augmenting the fines for this non compliant behaviors are commonly considered the two most important interventions against evasion. In both cases, however, there is contrasting evidence on the effect of these instruments on tax compliance (Garrido and Mittone [19], Alm et al.[3], Diporto [13]). The problem is even more complicated when we move from simple deterrence to emersion.

Emersion from tax evasion is defined, in the case of labor tax evasion, in Di Porto e Elia [14], as the transition of a working employee from the undeclared to the declared sector. More generally, we can define emersion in relation to the evasion of any tax, such as V.A.T.,

income tax, property tax, as the report of an undeclared quantity (i.e. dollars, rents, hours worked) to the tax authorities. As noticed by Di Porto e Elia [14], emersion can be *pure* when the exact undeclared quantity is reported, or *partial*, when in the process of emersion a part of the undeclared quantity gets "lost". In this case we observe a contraction in the total undeclared quantity but we do not observe a corresponding quantity declared to the tax authorities.

It is worth notice that deterrence and emersion are related concepts but they are not synonyms. To better understand the difference between the two, think about a context in which the tax authority can commit to its audit strategy and can inspect with probability 1 all the non compliant tax payers. In this case, the optimal equilibrium audit scheme includes full deterrence; therefore, everybody is compliant and there is no emersion. Hence, we can conclude that emersion starts when deterrence fails. As noted by Boeri e Garibaldi [5] and Schneider [25], in recent years undeclared work has flourished. This might suggest the presence of some degrees of tolerance towards evasion, or it might emphasize the fact that deterrence is a difficult task to implement.

The objective of this paper is to demonstrate that a right mix of interventions could generate some kind of emersion, in the context of labor tax evasion. In several countries, (e.g., Italy, France, Germany), employers are responsible for paying a fraction of the social security contributions for their workers[1]. Evading these payments is the same as declaring only some of the hours worked. Undeclared work plays a major role in several developing and developed countries. In a recent study, Jutting et al.[20] show that out of a global working population of 3 billion workers, nearly two-thirds (1.8 billion) are undeclared or informal. Schneider [25] estimates that in the European area the number of persons working in the unofficial economy doubled from 1978 to 1998. According to a report of the Pew Hispanic Center, the number of illegal immigrants living in the United States was 11.9 million in 2008, of which 8.3 million were part of the U.S. labor force (Cohn and Passel [9]). According to the Canadian Encyclopedia, the police and immigration personnel estimated the number of illegal immigrants in Canada to range between 50,000 and 200,000. Similar percentages are reported for BRIC (Brazil, Russia, India and China) and Eastern European countries.

Which are the instruments that can be used to incentive the emersion of at least part of these workers? This paper tries to provide an answer by studying the 2003 Italian labor market reform, which introduced new types of short term contracts, as an instrument for emersion.

Short-term employment contracts have been deployed rapidly across the rigid EU economies since the early 1990s. Featuring short (fixed) duration, lower costs, and more straightforward hiring procedures, they are designed to be an agile instrument to increase labor market flexibility and, in turn, to reduce unemployment. In Italy, there are two additional reasons which motivated the implementation of these reforms. First, short-term contracts might have helped increase labor force participation, which is particularly low among women. Second, they might have contributed significantly to reduce the share of undeclared work, and therefore labor tax evasion, which is estimated to account for 17% of the Italian GDP. In

[1] In Italy this fraction amounts to two third of the total contribution.

order to target the last objective, the Italian Government approved a number of reforms, which introduced several types of short-term contracts to target specific situations, in which undeclared work might have prevailed. As of today, in Italy the workers unions count up to 46 different types of employment contracts. Moreover, the Italian share of short-term employment jumped from 5% in 1990 to approximately 13% in 2010. The objective of this paper is, firstly, to test empirically whether these reforms have been successful in reducing the share of undeclared work (through the emersion channel). By estimating several econometric specifications based on microeconomic Italian data, we investigate whether and how the undeclared work has changed after the reform has been implemented. This is to test the validity of short term contracts as an instrument to create emersion. Then, we use these empirical findings as the basis to develop a search and matching model. This is intended to explain workers and firms behaviors when different types of contracts are available and when firms may decide whether to hire workers legally or illegally. Latu sensu, the availability of several types of contracts plays the same role as increasing the opportunity to pay taxes, introducing new form of taxations for similar kind of services. Therefore, a distortion in the tax payer's behavior after the policy intervention is expected. We design a search model in the spirit of Diamond [10] and Mortensen and Pissarides [22] and calibrate it to evaluate potential interventions to generate emersion. In the model we account for workers' heterogeneity, social security contributions, and differentiated contracts. In addition, we distinguish between formal and informal jobs and we endogenize the decision of the firms to hire in the formal or informal sector when they open a vacancy. The motivation relies on our objective to explain the differences in job creation rates in the declared and undeclared sector. We assume that firms post generic vacancies and when they are ready to hire the worker, they decide whether to hire it legally or illegally. In addition, they decide whether to hire it on a short-term basis or permanently. If a worker is hired legally, the firm has to pay social security contributions to the tax authority. If the worker is hired illegally, the firm does not pay social security contributions, but might be caught by the tax enforcement authority and be subject to the payment of a penalty fee. The type of contract and the sector (declared or undeclared) are chosen by the firm according to several parameters, such as the quality of the match, the social security fees, the probability to be caught, if acting illegally. In the model, we also allow for transitions from the declared to the undeclared sector and viceversa. The calibration of the model allows us to draw conclusions regarding the rationale behind the firms' decisions and to evaluate the effects of several policy interventions.

Our findings provide evidence in favor of multiple combined interventions to create emersion: the optimal policy includes a mix of deterrent policies and differentiated opportunities to pay taxes (i.e., introducing new contracts in the labor market). From the empirical analysis, we conclude that the 2003 reforms "alone" was not effective in reducing the share of undeclared work. Therefore, short-term contracts per se are not an efficient instrument to reduce undeclared work. When we calibrate the model according to the Italian regulations and institutions, we test the effects of several policy interventions, such as the increase of the monitor rate of the informal sector, the increase of the penalty fee, the reduction of the social security fees. We conclude that emersion is possible just with a well designed mix of

policies that work at different levels.

1.1 Literature review

There are several strands of literature related to this paper.

First of all, this study is linked to the extensive empirical literature on short-term employment contracts and their impact on European labor markets. Studies such as Berton [4], Tealdi [28] and Guell [16] investigate the way short-term contracts have changed the pattern dynamics across states and contracts. Specifically, their objective is to identify the role of short-term contracts as screening device or as an instrument for firms to reduce costs. Their results show that both in Italy and in Spain short-term contracts are used for both purposes. In addition, Pfeifer [23] shows that in Germany short-term contracts are utilized by firms to adjust the workforce according to business cycle fluctuations. A parallel strand of the literature studies the effects of short-term contracts on labor market aggregates, such as employment and unemployment rates. In this context, findings are not always aligned. Berton [4] investigates whether short-term contracts have been effective in reducing the high rate of long-term unemployment in Italy. His results provide a negative answer. Regarding the effect of short-term contracts on employment, Giannelli [15] shows that in Italy short-term contracts did not help increase the length of the first employment spell. In addition, she shows that in general in Italy short-term contracts are associated with higher uncertainty. For the case of Spain, Aguirregabiria and Alonso-Borrego [1] finds that short-term contracts had a positive effect on employment and job turnover. Guell and Petrongolo [16] shows that the rate at which workers leave unemployment is higher after the reforms.This paper complements the existing literature, by testing for the first time whether the introduction of short-term contracts has been effective in reducing the share of undeclared work in Italy.

Second, this paper is related to the literature on black economy, tax evasion and undeclared work. Tax evasion is a problem widely reported since the antiquities. However, it is very difficult to be investigated both from the theoretical and the empirical perspective. Overall, theoretical models based on taxpayer rationality have shown to be unable to describe properly the behavior of agents involved in tax evasion. On the other hand, both game theory and any rational choice approach to the problem of tax compliance, level of penalties and enforcement appears to be insufficient in explaining the degree of concurrence with the tax law. As a consequence, in the last 15 years economists have started investigating the behavioral and experimental aspects of tax evasion, by analyzing the variety of psychological reasons influencing the choice to pay taxes, such as honesty, fear, sense of group membership (Chorvat and Knoll. [8], Alm et al. [3]). On the empirical side, the lack of reliable data on tax evasion has raised concerns on the robustness of the findings. Typically, data on tax evasion are part of administrative audit databases, which often carry a selection problem and not always provide sufficient information to cope with this issue. Some progress in this direction has been achieved during the past few years by using ad hoc surveys (Piketty et al. [24] , Di Nardo et al. [11]) and by relying on individual audit data, where the information provided is detailed enough to allow the adoption of a proper selection model (Di Porto [12] and Di Porto et al. [13]).

Finally, this paper relates to the search model of dynamic labor demand of Mortensen and Pissarides [22]. We extend their framework, by allowing firms to hire workers in different sectors (formal or informal). Moreover, as in Tealdi [28], firms are allowed to offer different types of contracts (permanent or short-term) to the workers and are bound to pay social security fees whenever they hire a worker in the formal sector. Within this literature, this model specifically relates to studies which use the search theory to address the issue of undeclared work (Bouev [7], Kolm and Larsen [21], Fugazza and Jacques [18], Albreacht et al. [2] , Boeri and Garibaldi [5]). The paper which most closely resembles our work is the one by Bosch and Esteban-Pretel [6], in which direct transitions from the formal to the informal sector (and vice versa) are allowed. While they use this set up to analyze the undeclared work phenomenon in developing countries, it serves our purpose to test the effects of the reforms implemented in Italy to increase labor market flexibility.

2 Facts and stats

TBD

3 Empirical Models and Results

This section shows the empirical models performed to test our main hypotheses , namely that law no 30/2003 ("Biagi Law") does not affect the supply of undeclared workers. The "Biagi law" represented the last and more extensive reform applied to the Italian labor market. The reform improved earlier short-term contracts and introduced new contractual forms to better meet the requirements of a changing labour market. One of the major innovation introduced by the reform pertained to the apprenticeship contract. This type of short-term contract has existed for a long time and has also been reformed several times. The lower labor costs associated with it (mostly social security contributions) make it particularly convenient to employers and are intended to compensate firms for the training costs that they incur. Firms are required to give to apprentices time off work to attend training courses provided by local authorities or accredited training institute. Since there are limitations to this formal activity due to lack of public funding and of infrastructures for training courses, most of the training occurs on-the-job. The "Biagi law" liberalized further these contracts. The main change was related to the training, that is, it introduced the option of performing training at the workplace as a substitute for external training. This point made it more difficult to monitor compliance with this obligation by firms. The new rules were not implemented at once, but regional governments, which have exclusive power to legislate over vocational training, had to issue regional regulations. The process was slow such that at the end of 2011 only 15 out of 20 regions are adopted the new regulations. No regions passed any guidelines in 2003 and 2004. Emilia Romagna and Toscana enacted the regulations in 2005, while Friuli, Marche , Sardegna and the autonomous province of Bolzano did it in 2006, and Lazio in 2007. Moreover, It was permitted by national government with the

law no 80/2005 that collective agreements could specify the training content of the new apprenticeship, in absence of regional legislations. Collective agreements took place in the following sectors: Textile, Wood products, Chemicals, Construction, Transportation, Retail Trade Food Products, Telecommunication, Energy, Banking, Metal Manufacturing. We exploit this variation over time and regions (sectors) in a difference-in-differences framework.

We start with analyzing the effect of shifts in temporary jobs regulations on the distribution of hours worked by undeclared and declared workers. We accomplish this by estimating the following equation:

$$\log(U/D)_{r,t} = c + \gamma(D_{Reform})_{r,t} + \beta X_{r,t} + \delta_r + \zeta_t + \epsilon_{r,t} \tag{1}$$

where $\log(U/D)_{r,t}$ is the ratio of undeclared to declared hours in the region r at time t, D_{Reform} is a dummy variable which takes on the value of one for the years and regions affected by the policy, δ_r are regional fixed effects, ζ_t are time fixed effects and $\epsilon_{r,t}$ is an error term. $X_{r,t}$ is a matrix of regional covariates which may help predicting the dependent variable. Table 3 shows the estimates of different version of the equation (1). We use data from 1996 to 2008 provided by SHIW survey of Bank of Italy. Note that since we estimate equation 1 using a region panel data, the policy dummy D_{Reform} considers only part of the variation of the reform, namely that one corresponding to the regions, neglecting the source of variation coming from the industry sectors. The baseline model which controls only for regional and time fixed effects is shown in column 1. Model 2 adds some regional confounding factors, such as the regional share of Construction, Retail Trade, Transport and Real Estate, the average age of the working population, the average education and work experience and the share of women. Model 3 also controls for the unemployment rate and the share of temporary jobs, while columns 4 and 5 uses a shorter time period, 2000-2008 and 2002-2008 respectively. As it is clear from Table 3 the coefficient on the dummy policy variable is not statistically different from zero in all cases. This results are consistent with our hypothesis of no impact of the reform on the ratio of undeclared and declared workers. The effect of the other covariates are mostly not significantly different from zero; this is not surprising because lots of the variance of the dependent variable is captured by the regional and time fixed effects.

In the previous equation the identification of the reform dummy relied on the time and regional difference in the implementation of the new regulations, neglecting the part originating from the industry sector-time differences. We exploit all the variation in the reform dummy by using individual data from SHIW. Pooling the waves from 1998 to 2008, we estimate the following equation for the probability of working in the undeclared labor market:

$$P(\text{Undeclared} = 1|X)_{i,r,t} = c + \gamma(D_{Reform})_{r,t} + \beta X_{i,r,t} + \delta_r + \zeta_t + \epsilon_{i,r,t} \tag{2}$$

where D_{Reform} is our dummy variable identifying the change in policy, δ_r are regional fixed effects, ζ_t are time fixed effects and $X_{i,r,t}$ is a matrix of individual characteristics. We run this equation by using ordinary least squares, so the estimated coefficients are readily interpretable as marginal effects. Table 4 shows the estimated coefficients of different specifications of equation (2). Column 1 is the baseline model, which controls for time and region

fixed effects. Columns 2-7 add a set of individual characteristics, such as work experience and its square, square in age, dummies for educational levels, the interactions between experience and education levels, a dummy for part time job, a dummy for fixed-term contract, a dummy for migrant, and a dummy selecting workers living in urban areas. In addition, we also include industry sectors dummies and occupation dummies. The model in column 3 takes into account region-specific time trend, which may correlate with our policy variable. Since legislations on temporary jobs should potentially affect more heavily those groups of people which experience poor labor market outcomes, we estimate equation 2 focusing on young persons under 24-30 years old and women. The results for this exercise are presented in column 4-5. The estimated coefficients of the policy dummy is still not statistically different from zero in all cases, suggesting that easing the regulations on temporary contracts does not affect at all the chances of getting a job in the undeclared sector.

We also inquired if the reform of apprenticeship contracts affected the hours worked by the undeclared workers. We analyze such issue by estimating the following model:

$$\log h_{i,r,t} = c + \gamma(D_{Reform})_{r,t} + \phi B_{i,r,t} + \varphi(D_{Reform})_{r,t} \times B_{i,r,t} + \beta X_{i,r,t} + \delta_r + \zeta_t + \epsilon_{i,r,t} \quad (3)$$

where $(D_{Reform})_{r,t}$ is our policy dummy, $B_{i,r,t}$ is unity if the workers is undeclared and $X_{i,r,t}$ is a matrix of individual characteristics. The coefficient of interest in equation 3 is φ, which measures the effect of the change in policy on the hours worked by informal workers. The results are presented in Table 5. The models form column 1 to 7 are arranged as in table 4. The first row of table 5 shows the estimated coefficients, φ; it is statistically insignificant in all cases but column 1, the baseline model, in which is positive and slightly significant.

Taken all together, these findings provide encouraging support to the idea that easing restrictions on the use of temporary contracts does not have an impact in reducing the undeclared work phenomenon.

4 A search and matching model

We model the labour market before the reforms, when only permanent contracts are available and employers may hire workers in the formal or in the informal market. We compare it with the labour market post-reforms, when short-term contracts represent an additional option for the firms. Therefore, employers may decide to hire the workers in the formal market by offering them either a permanent or a short-term contract, or in the informal market. One of the innovative features of this approach is the fact that we are able to compare the market before and after the reforms to analyze the impact of short-term contracts. Both models are continuous time search and matching models a la Mortensen and Pissarides. We assume that workers and firms meet in the labour market and from their match a positive surplus is generated. Matches occur randomly and according to a matching function $m(u, v)$ which depends on the total number of unemployed individuals u and the total number of vacancies v. The matching function is increasing in both arguments, concave and homogeneous of degree one. When the firm opens a vacancy, it may meet an unemployed worker according

to a Poisson process with arrival rate $\lambda(\theta)) = m(u,v)/v$, where $\theta = u/v$ is defined as the market tightness. The arrival rate of a job offer for unemployed workers is $\gamma(\theta) = m((u,v)/u$.

Workers are ex ante homogeneous. When the match worker-firm is formed the productivity is revealed. The productivity of the worker has two components: a constant component p, which is the same for all workers and a random component ϵ, which is specific to each match and which is drawn from the random distribution $G : [\underline{\epsilon}, \overline{\epsilon}] \to [0,1]$. Depending on the productivity level the firm decides which contract to offer to the worker.

4.1 The model pre-reforms

Firms can decide to offer a formal (permanent) contract or an informal contract to the unemployed worker they meet. The choice depends on the productivity level of the match. If a formal contract is offered, the firm is required to pay payroll taxes, whose marginal rate is τ, for the entire length of the contract and firing costs F, when the formal employment is terminated. If an informal contract is offered, the firm is not subject to the payroll taxes, however the firm might be caught by Government authorities according to a Poisson process with arrival rate ϕ and might be forced to pay a penalty fee σ. In addition the employment relationship is terminated. In this framework, we allow informal workers to search on the job for better opportunities. Therefore according to a Poisson process with arrival rate $\chi\gamma$, the informal worker may find a new job, terminate the ongoing working relationship and force the firm to open a new vacancy.

After the match worker-firm is formed at arrival rate α a productivity shock may hit the relationship and a new ϵ is drawn from a sector specific distribution $H^j : [\underline{\epsilon}, \overline{\epsilon}] \to [0,1]$, where $j = (F, I)$ (formal, informal). The new productivity levels are i.i.d. across workers and time. The future of the worker-firm relationship depends on the new level of productivity of the match: they might decide to change sector, keep the relationship unchanged or terminate it.

In order to understand the labour market dynamics, we will analyze in detail in the next paragraph the firm's and worker's problems.

4.1.1 The firm's problem

We define V as the value for a firm to open a vacancy and $J^j, j = (F, I)$ as the sector specific value of having a filled position. The value for a firm to open a vacancy is equal to:

$$rV = -c + \lambda \int_{\underline{\epsilon}}^{\overline{\epsilon}} \max[J^F(\epsilon'^I(\epsilon'), V] dG(\epsilon') - \lambda V \tag{4}$$

$$\tag{5}$$

The firm has to pay a cost c for the time the vacancy being open. At rate λ the firm meets an unemployed worker, the productivity level of the match is revealed and the firm decides whether to offer a formal job, an informal job or to keep the vacancy. If the firm decides to

hire the worker legally, the value function for the firm will be:

$$
\begin{aligned}
rJ^F(\epsilon) &= p + \epsilon - (1+\tau)\omega^F(\epsilon) + \alpha^F \int_{\underline{\epsilon}^F}^{\overline{\epsilon}^F} \max[J^F(\epsilon'^I(\epsilon') - F, V - F] dH^F(\epsilon') && (6)\\
&- \alpha^F J^F(\epsilon) && (7)\\
& && (8)
\end{aligned}
$$

The firm will receive a productivity flow equal to $p + \epsilon$ and in exchange will pay the worker a salary equal to $\omega^F(\epsilon)$. In addition, the firm will have to pay payroll taxes, whose marginal rate is equal to τ. A rate α^F a productivity shock may hit the match and a new productivity level ϵ is drawn from the distribution H^F. Together, workers and firms will decide to keep the relation formal, to turn into an informal one or to terminate the contract. In the latter two cases, the firm is required to pay a firing cost F. In case the firm decides to offer an informal contract while hiring a worker, the value function is:

$$
\begin{aligned}
rJ^I(\epsilon) &= p + \epsilon - \omega^I(\epsilon) + \alpha^I \int_{\underline{\epsilon}^I}^{\overline{\epsilon}^I} \max[J^F(\epsilon'^I(\epsilon'), V] dH^I(\epsilon'^I J^I(\epsilon) && (9)\\
&+ \phi(V - J^I(\epsilon)) - \phi\sigma + \eta(V - J^I(\epsilon)) && (10)\\
& && (11)
\end{aligned}
$$

The firm still receives the productivity flow $p + \epsilon$ and will pay to the worker the salary $\omega^I(\epsilon)$, however the firm will not pay payroll taxes. At rate α^I the match will be hit by a productivity shock and as a result the relation may stay unchanged or may be turned into a formal one or may be terminated, according to the new productivity level. In addition, at rate ϕ Government authorities may discover the illegal activity of the firm, terminate the relationship and charge the firm with a penalty fee equal to σ.

4.1.2 The worker's problem

The value function for an unemployed worker is:

$$
\begin{aligned}
rU &= b + \gamma \int_{\underline{\epsilon}}^{\overline{\epsilon}} \max[W^F(\epsilon'^I(\epsilon'), U] dG(\epsilon') - \gamma U && (12)\\
& && (13)
\end{aligned}
$$

The worker receives unemployment benefits b until he is unemployed. At rate γ the worker meets a firm and the productivity level of the match is revealed. The worker may receive a formal offer, an informal offer or no offer and continue to be unemployed. If he receives an offer, this might be formal and informal and the corresponding value functions

are:

$$
\begin{aligned}
rW^F(\epsilon) &= \omega^F(\epsilon) + \alpha^F \int_{\underline{\epsilon}^F}^{\bar{\epsilon}^F} \max[W^F(\epsilon'^I(\epsilon'), U] dH^F(\epsilon') && (14)\\
&- \alpha^F W^F(\epsilon) && (15)\\
rW^I(\epsilon) &= \omega^I(\epsilon) + \alpha^I \int_{\underline{\epsilon}^I}^{\bar{\epsilon}^I} \max[W^F(\epsilon'^I(\epsilon'), U] dH^I(\epsilon'^I W^I(\epsilon) && (16)\\
&+ \phi(U - W^I(\epsilon)) + \chi\gamma \int_{\underline{\epsilon}}^{\bar{\epsilon}} \max[W^F(\epsilon'^I(\epsilon'), U] dG(\epsilon'^I(\epsilon) && (17)\\
& && (18)
\end{aligned}
$$

The formal worker receive a salary $\omega^F(\epsilon)$ and at rate α^F his employment relation may be unchanged or may change by becoming informal or by being terminated, according to the newly drawn productivity level. If the worker is offered an informal job, the worker receives a salary $\omega^I(\epsilon)$ and at rate α^I, his productivity level will change. His employment relation may become informal or terminate or may be unchanged. Moreover, at rate ϕ he may lose his job because the illegal relation has been discovered by the authorities. Finally, informal workers may also look for better jobs while working and find a new position at rate $\chi\gamma$. Since the effort spent in looking for jobs while employed is lower than while unemployed, the probability for employed people to find a job is lower compared to unemployed workers and therefore $\chi < 1$.

4.1.3 Surplus and wage bargaining

The surplus of the match changes according to the type of employment. If the signed contract between firm and worker is formal, the firing cost which the firm has to pay at termination enters in the surplus equation and affects the wage bargaining. Moreover the marginal payroll tax rate is accounted for in the wage negotiations. The Nash bargaining mechanism is used to compute the wage, where $\beta^j, j = (F, I)$ represents the bargaining power of the worker respectively in the formal and informal sector. We believe that the bargaining power of the worker in the informal sector is lower than in the formal sector. For simplicity reasons, we assume that $\frac{\beta^F}{(1-\beta^F)(1+\tau)} = \frac{\beta^I}{(1-\beta^I)}$, which satisfies the above mentioned belief that $\beta^I < \beta^F$. Workers and firms always agree on the decision to terminate the contract, thus there is no room in this model for involuntary unemployment.

$$
\begin{aligned}
S^F(\epsilon) &= J^F(\epsilon) + W^F(\epsilon) - (V - F) - U && (19)\\
\beta^F[J^F(\epsilon) - (V - F)] &= (1 - \beta^F)(1 + \tau)[W^F(\epsilon) - U] && (20)
\end{aligned}
$$

$$
\begin{aligned}
S^I(\epsilon) &= J^I(\epsilon) + W^I(\epsilon) - V - U && (21)\\
\beta^I[J^I(\epsilon) - V] &= (1 - \beta^I)[W^I(\epsilon) - U] && (22)
\end{aligned}
$$

As a result of the Nash bargaining, according to the sector, the following wage equations are derived:

$$\omega^F(\epsilon) = \frac{\beta^F}{(1+\tau)}(p + \epsilon + c\theta + rF) + (1-\beta^F)b \tag{23}$$

$$\omega^I(\epsilon) = \beta^I(p + \epsilon - \phi\sigma + (1-\chi)c\theta) + (1-\beta^I)b \tag{24}$$

4.1.4 Steady State

In order to compute the steady state of the model, we solve five equations in five unknowns. We recognize four productivity thresholds and the market tightness as the parameters which identify the equilibrium. The five equations summarize the job creation and job destruction conditions as well as the free market condition $V = 0$.

When the firm hires an unemployed worker or an informal worker and the productivity level is equal to ϵ_R the firm is indifferent whether to offer a formal or an informal job.

$$J^F(\epsilon_R) = J^I(\epsilon_R) \tag{25}$$

This equation defines the flows of workers from unemployment to formal and informal employment. When the firm transforms a formal job into an informal job the threshold productivity level is equal to ϵ_T. This threshold differs from the one described above, because when transforming a formal job into an informal one the firm is subject to the payment of a firing cost.

$$J^F(\epsilon_T) + F = J^I(\epsilon_T) \tag{26}$$

Therefore, this equation defines the flow of workers from to informal jobs. Finally, the two job destruction conditions from a formal or an informal job are defined by:

$$J^F(\epsilon_F) + F = 0 \tag{27}$$

$$J^I(\epsilon_I) = 0 \tag{28}$$

From equation 26 by plugging in the expression for the wage for formal workers $\omega^F(\epsilon)$ as in 55 we obtain:

$$J^F(\epsilon) + F = \frac{(1-\beta^F)(\epsilon - \epsilon_F)}{r + \alpha^F} \tag{29}$$

From equation 25 by plugging in the expression for the wage for formal workers $\omega^I(\epsilon)$ as in 56 we obtain:

$$J^I(\epsilon) + F = \frac{(1-\beta^I)(\epsilon - \epsilon_I)}{r + \phi + \eta + \alpha^I} \tag{30}$$

The equilibrium of the model is therefore defined by the following set of equations:

$$\frac{1+\tau(1-\beta^F)}{(1+\tau)(1-\beta^F)}\left[\frac{(1-\beta^F)(\epsilon_R-\epsilon_F)}{r+\alpha^F}-F\right]=\frac{(\epsilon_R-\epsilon_I)}{r+\phi+\eta+\alpha^I} \quad (31)$$

$$\left[\frac{(1+\tau(1-\beta^F))(\epsilon_T-\epsilon_F)}{r+\alpha^F}\right]=\frac{(\epsilon_T-\epsilon_I)}{r+\phi+\eta+\alpha^I} \quad (32)$$

$$\epsilon_F=-rF-p+(1+\tau)b+\frac{\beta^F}{(1-\beta^F)}c\theta-$$
$$\alpha^F\left[\int_{\epsilon_{H_F}}^{\epsilon_T}\frac{(1+\tau)}{1+\tau(1-\beta^F)}\frac{(\epsilon'-\epsilon_I)}{(r+\phi+\eta+\alpha^I)}dH^F(\epsilon')+\int_{\epsilon_T}^{\bar{\epsilon}_{H_F}}\frac{(\epsilon'-\epsilon_F)}{(r+\alpha^F)}dH^F(\epsilon')\right] \quad (33)$$

$$\epsilon_I=-p+b+\frac{\beta^I}{(1-\beta^I)}(1-\chi)c\theta+\phi\sigma-$$
$$\alpha^I\left[\int_{\epsilon_{H_I}}^{\epsilon_R}\frac{(\epsilon'-\epsilon_I)}{(r+\phi+\eta+\alpha^I)}dH^I(\epsilon')+\int_{\epsilon_R}^{\bar{\epsilon}_{H_I}}\frac{1+\tau(1-\beta^F)}{(1+\tau)}\left[\frac{(\epsilon'-\epsilon_F)}{(r+\alpha^F)}-\frac{F}{(1-\beta^F)}\right]dH^I(\epsilon')\right] \quad (34)$$

$$\frac{c}{\lambda}=\int_{\underline{\epsilon}^G}^{\epsilon_R}\frac{(1-\beta^I)(\epsilon'-\epsilon_I)}{(r+\phi+\eta+\alpha^I)}dG(\epsilon')+\int_{\epsilon_R}^{\bar{\epsilon}^G}\left[\frac{(1-\beta^F)(\epsilon'-\epsilon_F)}{(r+\alpha^F)}-F\right]dG(\epsilon') \quad (35)$$

By analyzing the equations above we can claim that the equilibrium exist and is unique. Higher θ increases the left hand side of Equation 67 and it lowers both formal and informal surplus, by decreasing the right hand side of equation 67 as both thresholds ϵ^F and ϵ^I depend positively on θ, while ϵ^R does not affect the expected profit from opening a vacancy. Therefore, there is a unique value of θ that satisfies the equation.

We can now retrieve the steady state value of unemployment and formal and informal employment, by looking at the workers flows. Normalizing the labor force to unity, we get:

$$n^I=1-n^F-u \quad (36)$$

$$u=\frac{\alpha^F H^F(\epsilon_F)n^F+\alpha_I H^I(\epsilon_I)n^I+\phi n^I}{\lambda} \quad (37)$$

$$n^F=\frac{[\chi\gamma(1-G(\epsilon_T))+\alpha^I(1-H^I(\epsilon_T))]n^I+\gamma(1-G(\epsilon_R))u}{\alpha^F H^F(\epsilon_F)} \quad (38)$$

4.2 The model post-reforms

We now extend the previous model by including the possibility for the firm to hire workers in the formal sector for a fixed period of time (temporary contracts). Temporary contracts are designed to be more flexible, since at expiration the firm can let the worker go without incurring in any firing cost. Moreover, generally, the marginal rate of the payroll tax associated with temporary contracts is lower compared to permanent contracts. In addition, workers are willing to search for better jobs while employed, so the firm may incur the risk

of losing the worker at rate $\xi\gamma$. Compared to the previous set up, the firm's and worker's problems get slightly more complicated.

4.2.1 The firm's problem

Whenever a firm opens a vacancy it incurs in a cost c as long as the firm meets a worker at rate λ. In this instant the productivity of the match is revealed and the two parities agree on the future of the relationship. If the productivity is very high, the worker is offered a permanent contract. If the productivity is very low, the firm keeps the vacancy opened. In the intermediate situation, the worker may either get a temporary contract or may be hired in the informal market.

$$rV = -c + \lambda \int_{\underline{\epsilon}}^{\bar{\epsilon}} \max[J^P(\epsilon'^T(\epsilon'^I(\epsilon'), V]dG(\epsilon') - \lambda V \tag{39}$$

$$\tag{40}$$

Once the worker is hired permanently, the firm receives a productivity flow equal to $p+\epsilon$ and pays to the worker a salary $\omega^P(\epsilon)$ and to the Government the payroll tax equal to $\tau^P\omega^P(\epsilon)$. At rate α^P the match is hit by a productivity shock and the relation may change according to the new drawn productivity level (Eq **??**). If the worker is hired on a temporary basis, the firm receives a productivity flow equal to $p+\epsilon$ and pays to the worker a salary $\omega^T(\epsilon)$ and to the Government the payroll tax equal to $\tau^T\omega^T(\epsilon)$, where $\tau^T < \tau^P$ since the payroll taxes associated with temporary contracts are lower compared to permanent contracts. At rate α^T the match is hit by a productivity shock and the relation may change according to the new drawn productivity level. In addition at rate δ the worker may find a better job and quit his current position, leaving the firm with an open vacancy (Eq **??**). If the worker is hired in the informal market, the firm receives a productivity flow equal to $p+\epsilon$ and pays to the worker a salary $\omega^I(\epsilon)$. However, the firm pays no payroll taxes to the Government. At rate α^I the match is hit by a productivity shock and the relation may change according to the new drawn productivity level. In addition at rate ϕ the firm may be caught by the Government authorities, subject to the payment of a penalty fee equal to $\phi\sigma$ and forced to open a new vacancy. Finally, at rate η the worker may find a better job and quit his current

position, leaving the firm with an open vacancy (Eq 41).

$$
\begin{aligned}
rJ^P(\epsilon) &= p+\epsilon-(1+\tau^P)\omega^P(\epsilon) \qquad (41)\\
&+ \alpha^P\int_{\underline{\epsilon}^P}^{\bar{\epsilon}^P}\max[J^P(\epsilon'^T(\epsilon'^I(\epsilon')-F,V-F]dH^P(\epsilon'^P J^P(\epsilon)\\
rJ^T(\epsilon) &= p+\epsilon-(1+\tau^T)\omega^T(\epsilon) \qquad (42)\\
&+ \alpha^T\int_{\underline{\epsilon}^T}^{\bar{\epsilon}^T}\max[J^P(\epsilon'^T(\epsilon'^I(\epsilon')-F,V-F]dH^T(\epsilon'^T J^T(\epsilon)\\
&+ \delta(V-J^I(\epsilon))\\
rJ^I(\epsilon) &= p+\epsilon-\omega^I(\epsilon)+\alpha^I\int_{\underline{\epsilon}^I}^{\bar{\epsilon}^I}\max[J^P(\epsilon'^T(\epsilon'^I(\epsilon'),V]dH^I(\epsilon'^I J^I(\epsilon) \qquad (43)\\
&+ \phi(V-J^I(\epsilon))-\phi\sigma+\eta(V-J^I(\epsilon))
\end{aligned}
$$

4.2.2 The worker's problem

When the worker is unemployed he receives unemployment benefits b and meets a firm with an open vacancy at rate γ. If he receives a permanent position, he will get a salary $\omega^P(\epsilon)$ and at rate α^P his productivity level may change as well as his employment status. He might therefore become unemployed, transit to the informal sector or to a temporary position (Eq. 44).

$$
\begin{aligned}
rU &= b+\gamma\int_{\underline{\epsilon}}^{\bar{\epsilon}}\max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'),U]dG(\epsilon')-\gamma U \qquad (44)\\
rW^P(\epsilon) &= \omega^P(\epsilon)+\alpha^P\int_{\underline{\epsilon}^P}^{\bar{\epsilon}^P}\max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'),U]dH^P(\epsilon') \qquad (45)\\
&- \alpha^P W^P(\epsilon)
\end{aligned}
$$

If he is hired on a temporary basis (Eq. **??**), he receives a salary $\omega^T(\epsilon)$, he may get hit by a productivity shock at rate α^T and at rate $\xi\gamma$ he may find a better job. Finally, if he is hired in the informal sector he receives a salary equal to $\omega^I(\epsilon)$ and he may be hit by a productivity shock equal to α^I. In addition at rate ϕ he will lose his job because of the

Government authorities intervention. Finally at rate $\chi\gamma$ he will find a better job (Eq. 46).

$$\begin{aligned} rW^T(\epsilon) &= \omega^T(\epsilon) + \alpha^T \int_{\underline{\epsilon}^T}^{\bar{\epsilon}^T} \max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'), U]dH^T(\epsilon') \\ &- \alpha^T W^T(\epsilon) + \xi\gamma \int_{\underline{\epsilon}}^{\bar{\epsilon}} \max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'), U]dG(\epsilon') \\ &- \xi\gamma W^T(\epsilon) \end{aligned} \tag{46}$$

$$\begin{aligned} rW^I(\epsilon) &= \omega^I(\epsilon) + \alpha^I \int_{\underline{\epsilon}^I}^{\bar{\epsilon}^I} \max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'), U]dH^I(\epsilon'^I W^I(\epsilon) \\ &+ \phi(U - W^I(\epsilon)) + \chi\gamma \int_{\underline{\epsilon}}^{\bar{\epsilon}} \max[W^P(\epsilon'^T(\epsilon'^I(\epsilon'), U]dG(\epsilon') \\ &- \chi\gamma W^I(\epsilon) \end{aligned} \tag{47}$$

4.2.3 Surplus and wage bargaining

The surplus of the match changes according to the sector as well as the type of contract. Therefore, three types of surplus are computed: for permanent contracts, for temporary contracts and for the informal sector. The firing cost F and the payroll taxes τ enter in the bargaining equations and affect the equilibrium wages. To make the problem tractable we assume that $\frac{\beta^P}{(1-\beta^P)(1+\tau^P)} = \frac{\beta^F}{(1-\beta^F)(1+\tau^F)} = \frac{\beta^I}{(1-\beta^I)}$, thus the division of the surplus across jobs is the same.

$$S^P(\epsilon) = J^P(\epsilon) + W^P(\epsilon) - (V - F) - U \tag{48}$$

$$\beta^P[J^P(\epsilon) - (V - F)] = (1 - \beta^P)(1 + \tau^P)[W^P(\epsilon) - U] \tag{49}$$

$$S^T(\epsilon) = J^T(\epsilon) + W^T(\epsilon) - V - U \tag{50}$$

$$\beta^T[J^T(\epsilon) - V)] = (1 - \beta^T)(1 + \tau^T)[W^T(\epsilon) - U] \tag{51}$$

$$S^I(\epsilon) = J^I(\epsilon) + W^I(\epsilon) - V - U \tag{52}$$

$$\beta^I[J^I(\epsilon) - V] = (1 - \beta^I)[W^I(\epsilon) - U] \tag{53}$$

As a result of the Nash bargaining, we can compute the equilibrium wages for the three types of workers:

$$\omega^P(\epsilon) = \frac{\beta^P}{(1 + \tau^P)}(p + \epsilon + c\theta + rF) + (1 - \beta^P)b \tag{54}$$

$$\omega^T(\epsilon) = \frac{\beta^T}{(1+\tau^T)}(p + \epsilon + (1-\xi)c\theta) + (1-\beta^T)b \tag{55}$$

$$\omega^I(\epsilon) = \beta^I(p + \epsilon - \phi\sigma + (1-\chi)c\theta) + (1-\beta^I)b \tag{56}$$

4.2.4 Steady State

The equilibrium steady state is defined by eight equations and eight unknown parameters. The parameters which define the models include eight productivity thresholds and the market tightness. The equations include the job destruction and job creation conditions and the free entry condition $V = 0$.

The threshold ϵ_G defines the level of productivity by which the firm is indifferent whether to offer a permanent or a temporary job. Therefore it defines the job creation condition from unemployment to formal employment (either permanent or temporary). The threshold ϵ_D defines the level of productivity by which the firm is indifferent whether to offer a temporary job in the formal sector or a job in the informal sector. Therefore it defines the job creation condition from unemployment to formal (temporary) and informal employment. Finally the threshold ϵ_B defines the level of productivity below which the firm is firing the worker and opens a new vacancy. Therefore it defines the job destruction condition from temporary employment to unemployment.

$$J^T(\epsilon_G) = J^P(\epsilon_G) \tag{57}$$
$$J^T(\epsilon_D) = J^I(\epsilon_D) \tag{58}$$
$$J^T(\epsilon_B) = 0 \tag{59}$$

The threshold ϵ_A defines the level of productivity by which the firm is indifferent whether to keep the worker as a permanent employee or offer him a temporary job. Therefore it defines the job transition from permanent to temporary employment. The threshold ϵ_S defines the level of productivity by which the firm is indifferent whether to transfer the worker to a temporary job in the formal sector or to a job in the informal sector. Therefore it defines the job transition from permanent to formal (temporary) and informal employment. Finally the threshold ϵ_Q defines the level of productivity below which the firm is firing the worker and opens a new vacancy. Therefore it defines the job destruction condition from permanent employment to unemployment.

$$J^P(\epsilon_A) + F = J^T(\epsilon_A) \tag{60}$$
$$J^P(\epsilon_S) + F = J^I(\epsilon_S) \tag{61}$$
$$J^P(\epsilon_Q) + F = 0 \tag{62}$$

The threshold ϵ_V defines the level of productivity by which the firm is firing the informal worker and opens a new vacancy. Therefore it defines the job destruction condition from informal employment to unemployment.

$$J^I(\epsilon_V) = 0 \tag{63}$$

From equation 60 by plugging in the expression for the wage for formal workers $\omega^P(\epsilon)$ as in 55

$$J^P(\epsilon) + F = \frac{(1-\beta^P)(\epsilon - \epsilon_Q)}{r + \alpha^P} \tag{64}$$

From equation 59 by plugging in the expression for the wage for formal workers $\omega^T(\epsilon)$ as in 56

$$J^T(\epsilon) = \frac{(1-\beta^T)(\epsilon - \epsilon_B)}{r + \delta + \alpha^T} \tag{65}$$

From equation 59 by plugging in the expression for the wage for formal workers $\omega^I(\epsilon)$ as in 56

$$J^I(\epsilon) = \frac{(1-\beta^I)(\epsilon - \epsilon_V)}{r + \phi + \eta + \alpha^I} \tag{66}$$

The steady state equilibrium is therefore defined by the following set of equations:

$$\frac{(1+\tau^P)(1-\beta^P) + \beta^P(1+\tau^T)}{(1+\tau^P)(1-\beta^P)} \left[\frac{(1-\beta^P)(\epsilon_G - \epsilon_Q)}{r + \alpha^P} - F \right] = \frac{(\epsilon_G - \epsilon_B)}{r + \delta + \alpha^T} \tag{67}$$

$$\frac{1+\tau^T(1-\beta^T)}{(1+\tau^T)} \frac{(\epsilon_D - \epsilon_B)}{r + \delta + \alpha^T} = \frac{(\epsilon_D - \epsilon_V)}{r + \phi + \eta + \alpha^I} \tag{68}$$

$$\frac{1+\tau^T(1-\beta^T)}{(1+\tau^T)(1-\beta^T)} \left[\frac{(1-\beta^P)(\epsilon_N - \epsilon_Q)}{r + \alpha^P} - F \right] = \frac{(\epsilon_N - \epsilon_V)}{r + \phi + \eta + \alpha^I} \tag{69}$$

$$\frac{(1+\tau^P)(1-\beta^P) + \beta^P(1+\tau^T)}{(1+\tau^P)} \left[\frac{(\epsilon_A - \epsilon_Q)}{r + \alpha^P} \right] = \frac{(1-\beta^T)(\epsilon_A - \epsilon_Q)}{r + \delta + \alpha^T} \tag{70}$$

$$\frac{1+\tau^P(1-\beta^P)}{(1+\tau^P)} \frac{(\epsilon_S - \epsilon_Q)}{r + \alpha^P} = \frac{(\epsilon_S - \epsilon_V)}{r + \phi + \eta + \alpha^I} \tag{71}$$

$$\epsilon_Q = -rF - p + (1+\tau^P)b + \frac{\beta^P}{(1-\beta^P)}c\theta - \alpha^P\left[\int_{\epsilon^Q}^{\epsilon_S}\frac{(1+\tau^P)}{1+\tau^P(1-\beta^P)}\frac{(\epsilon'-\epsilon_R)}{(r+\phi+\eta+\alpha^I)}\right]dH^P(\epsilon')$$
$$+\alpha^P\left[\int_{\epsilon_S}^{\epsilon_A}\frac{(\epsilon'-\epsilon_B)}{(r+\delta+\alpha^T)}dH^T(\epsilon'^{\bar{\epsilon}_P}_{\epsilon_A}\frac{(1+\tau^T)}{(1+\tau^T)(1-\beta^T)+\beta^T(1+\tau^P)}\frac{(\epsilon'-\epsilon_Q)}{(r+\alpha^P)}dH^P(\epsilon')\right] \quad (72)$$

$$\epsilon_B = -p + (1+\tau^T)b + \frac{\beta^T}{(1-\beta^T)}(1-\xi)c\theta - \alpha^T\left[\int_{\underline{\epsilon}^T}^{\epsilon_D}\frac{(1+\tau^T)}{1+\tau^T(1-\beta^T)}\frac{(\epsilon'-\epsilon_V)}{(r+\phi+\eta+\alpha^I)}\right]dH^P(\epsilon')$$
$$+\alpha^T\left[\int_{\epsilon_D}^{\epsilon_G}\frac{(1+\tau^P)}{(1+\tau^P)(1-\beta^P)+\beta^P(1+\tau^T)}\frac{(\epsilon'-\epsilon_B)}{(r+\delta+\alpha^T)}dH^P(\epsilon'^{\bar{\epsilon}_P}_{\epsilon_G}\frac{(\epsilon'-\epsilon_Q)}{(r+\alpha^P)}dH^P(\epsilon')\right] \quad (73)$$

$$\epsilon_V = -p + b + \frac{\beta^I}{(1-\beta^I)}(1-\chi)c\theta + \phi\sigma - \alpha^I\left[\int_{\epsilon_V}^{\epsilon_D}\frac{(\epsilon'-\epsilon_V)}{(r+\phi+\eta+\alpha^I)}dH^I(\epsilon')\right]$$
$$+\frac{\alpha^I}{(1-\beta^I\tau^T)}\left[\int_{\epsilon_D}^{\epsilon_G}\frac{(\epsilon'-\epsilon_B)}{(r+\delta+\alpha^T)}dH^I(\epsilon'^{\bar{\epsilon}_I}_{\epsilon_G}\left[\frac{(\epsilon'-\epsilon_Q)}{(r+\alpha^P)}-F\right]dH^I(\epsilon')\right] \quad (74)$$

$$\frac{c}{\lambda} = \int_{\underline{\epsilon}}^{\epsilon_D}\frac{(1-\beta^I)(\epsilon'-\epsilon_V)}{(r+\phi+\eta+\alpha^I)}dG(\epsilon') + \int_{\epsilon_D}^{\epsilon_N}\frac{(1-\beta^T)(\epsilon'-\epsilon_B)}{(r+\delta+\alpha^T)}dG(\epsilon'^{\bar{\epsilon}}_{\epsilon_N}\left[\frac{(1-\beta^P)(\epsilon'-\epsilon_Q)}{(r+\alpha^P)}-F\right]dG(\epsilon') \quad (75)$$

4.3 Discussion

TBD

4.4 Calibration and Policy Implication: How to drive emersion

5 Conclusions

We analized how different policy interventions can drive emersion from tax evasion.We have studied in particular the emersion of undeclared labor and we have based our analysis on the Italian labour market 1998-2003. Our empirical investigation suggests that 2003 Italian labor market reform, despite aimed to create the necessary conditions to lead a reduction of shadows activities, it wasn't able to reach its objectives. We develop a searching and matching model on the basis of our emprical results in order to determine the right mix of policy interventions to obtain emersion. Our preliminary findings shows that differentiate the forms of taxations and enforcement should work together to achieve emersion of tax evasion.

References

[1] Aguirregabiria, Victor, Alonso-Borrego, Cesar. "Labor Contracts and Flexibility: Evidence from a Labor Market Reform in Spain",University of Chicago, Department of Economics, 1999.

[2] Albrecht, James, Navarro, Lucas, Vroman, Susan. "The Effects of Labour Market Policies in an Economy with an Informal Sector", *Economic Journal*, 2009, 119(539), pp. 1105-1129, 07.

[3] Alm, James, McClelland, Gary H., Schulze, William D. "Why do people pay taxes?", *Journal of Public Economics*, 1992, 48(1), pp. 21-38.

[4] Berton, Fabio. "The (long) run out of unemployment: are temporary jobs the shortest way?", LABORatorio Revelli Working Paper, 2008.

[5] Boeri, Tito, Garibaldi, Pietro. "Shadow Activity and Unemployment in a Depressed Labour Market", CEPR Discussion Papers No. 3433, 2008.

[6] Bosch, Mariano, Esteban-Pretel, Julen. "Job creation and job destruction in the presence of informal markets", *Journal of Development Economics*, 2011, 98(2), pp.270-286.

[7] Bouev, Maxim. "State Regulations, Job Search and Wage Bargaining: A Study in the Economics of the Informal Sector", William Davidson Institute Working Papers Series 764, William Davidson Institute at the University of Michigan, 2005.

[8] Chorvat, Terrence R., Knoll, Michael S. "The Economic and Policy Implications of Repealing the Corporate Alternative Minimum Tax",Tax Foundation, 2002, 40.

[9] Cohn, Jeffrey and Passel, D'Vera. "A Portrait of Unauthorized Immigrants in the United States", 2009, www.pewhispanic.org.

[10] Diamond, Peter. "Mobility Costs, Frictional Unemployment, and Efficiency", *Journal of Political Economy*, 1981, 89(4), pp.798-812.

[11] DiNardo, John E., Fortin, Nicole M., Lemieux, Thomas. "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach ", *Econometrica*, 1996, 64(5), pp.1001-1044.

[12] Di Porto, Edoardo. "Undeclared Work, Employer Tax Compliance, and Audits ", *Public Finance Review*, 2012, 39(1), pp.75-102.

[13] Di Porto, Edoardo, Persico, Nicola, Sahuguet, Nicolas. "Decentralized Deterrence, with an Application to Labor Tax Auditing ", CEPR Discussion Papers No. 8901, 2012.

[14] Elia, Leandro, Di Porto, Edoardo. "Undeclared Work And Wage Inequality", http://sites.google.com/site/leandroeliaweb/research, 2011.

[15] Giannelli, Gianna C., Jaenichen, Ursula, Villosio, Claudia. "Have labour market reforms at the turn of the millennium changed job durations of the new entrants? A comparative study for Germany and Italy ", LABORatorio Revelli Working Paper, 2009.

[16] Guell, Maya. "Firing Costs, Dismissal Conflicts and Labour Market Outcome", CREI, 2010.

[17] Guell, Maya, Petrongolo, Barbara. "How binding are legal limits? Transitions from temporary to permanent work in Spain", *Labour Economics*, 2007, 14(2), 153-183.

[18] Fugazza, Marco, Jacques, Jean-Franois. "Labor market institutions, taxation and the underground economy", *Journal of Public Economics*, 2011, 88, pp.395418.

[19] Garrido, Nicolas, Mittone, Luigi. "A Description of Experimental Tax Evasion Behavior Using Finite Automata: the case of Chile and Italy", Cognitive and Experimental Economics Laboratory (CEEL) Working Papers No. 809, University of Trento, 2008.

[20] Jutting, Johannes, de Laiglesia, Juan. "Is Informal Normal? Towards More and Better Jobs in Developing Countries", Organization for Economic Co-operation and Development (OECD), 2008.

[21] Kolm, Ann-Sofie, Larsen, Birthe. "Wages, Unemployment, and the Underground Economy", CESIFO Working Paper No. 1086, 2004.

[22] Mortensen, Dale, Pissarides, Christopher. "Job Creation and Job Destruction in the Theory of Unemployment", *Review of Economic Studies*, 1994, 61, pp. 397-415.

[23] Pfeifer, Christian. "Fixed-term Contracts and Employment Adjustment: An Empirical Test of the Core-Periphery Hypothesis Using German Establishment Data", *The Economic Record*, 2009, 85(268), pp. 92-107.

[24] Piketty, Thomas, Saez, Emmanuel, Stantcheva,Stephanie. "Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities", CEPR Discussion Papers No. 8675, 2011.

[25] Schneider, Friedrich. "The Shadow Economy and Shadow Economy Labor Force: What Do We (Not) Know?", IZA Discussion Papers No. 6423, 2012.

[26] Schneider, Friedrich. "The Increase of the Size of the Shadow Economy of 18 OECD Countries: Some Preliminary Explanations", CESifo Working Paper Series No. 306, 2000.

[27] Tealdi, Cristina. "How Do Employment Contract Reforms Affect Welfare? Theory and Evidence", MPRA Paper No. 33573, 2011.

[28] Tealdi, Cristina. "Short-term contracts in Italy: Who is the winner?", Northwestern University Working Paper, 2011.

Table 1: Model parameters

Parameter	Description
r	Interest rate
β^F	Worker's share of surplus in the formal sector
β^I	Worker's share of surplus in the informal sector
$\underline{\epsilon}$	Lower bound of the G distribution
$\overline{\epsilon}^F$	Upper bound of the F distribution
$\overline{\epsilon}^F$	Upper bound of the H distribution
ϕ	Rate at which the informal job is discovered
σ	Penalty fee for irregular work
η	Rate at which informal workers find a better job
α^F	Rate at which a productivity shock hits the match in the formal sector
α^I	Rate at which a productivity shock hits the match in the informal sector
b	Unemployment benefits
p	General productivity level
$\xi\gamma$	Rate at which an informal worker finds a job
γ	Rate at which an unemployed worker finds a job
θ	Market tightness
τ	Payroll tax rate
π	Utility out of the labor force
n^I	Number of informal workers
n^F	Number of formal workers
u	Number of formal workers
F	Firing cost

Table 2: Calibration exogenous parameter values

Parameter	Pre-reforms	Post-reforms
r	0.01	0.01
β^F	0.54	0.54
β^I	0.46	0.46
$\underline{\epsilon}$	2500	2500
$\overline{\epsilon}^G$	1	1
$\overline{\epsilon}^{H_F}$	1	1
$\overline{\epsilon}^{H_I}$	1	1
τ	0.45	0.45
ϕ	0.05	0.05
c	0.01	0.01
ξ	0.4	0.4

Table 3: The estimated impact of temporary jobs reform on the relative supply of undeclared labor.

	(1)	(2)	(3)	2000-08	2002-08
Reform	0.141	-0.0220	-0.0300	-0.118	-0.200
	(0.316)	(0.376)	(0.349)	(0.448)	(0.500)
Construction		-0.0126	-0.0116	0.0103	0.0173
		(0.0351)	(0.0351)	(0.0450)	(0.0542)
Retail Trade		-0.0521**	-0.0523**	-0.0584*	-0.0520
		(0.0175)	(0.0177)	(0.0244)	(0.0374)
Transport		0.125	0.123	0.0679	0.115
		(0.0714)	(0.0736)	(0.0817)	(0.0824)
Real Estate		0.0920*	0.0936*	0.0255	0.0218
		(0.0383)	(0.0375)	(0.0520)	(0.0555)
Age		0.313*	0.301	0.179	0.0853
		(0.141)	(0.144)	(0.211)	(0.267)
Primary Ed.		-0.0115	-0.0118	-0.0132	-0.00719
		(0.0168)	(0.0171)	(0.0280)	(0.0296)
Secondary Ed.		-0.00305	-0.00424	0.0127	0.00227
		(0.0316)	(0.0320)	(0.0600)	(0.0601)
Women		-0.0443	-0.0440	-0.0653	-0.0717
		(0.0241)	(0.0234)	(0.0341)	(0.0364)
Work Experience		-0.366*	-0.353*	-0.441*	-0.392
		(0.154)	(0.163)	(0.210)	(0.221)
Time fixed effects	yes	yes	yes	yes	yes
Unemp.rate - Temp.share	no	no	yes	no	no
N	133	133	133	95	76

Roust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: The estimated impact of temporary jobs reform on the probability of being undeclared.

	(1)	(2)	(3)	Under 24	Under 30	Women	2000-2008
Reform	0.0000738	-0.00415	-0.00632	0.0419	0.00270	-0.00464	-0.00417
	(0.00483)	(0.00461)	(0.00522)	(0.0331)	(0.0177)	(0.00682)	(0.00488)
Region fixed effects	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	yes	yes	yes	yes	yes
Occupation dummies	no	yes	yes	yes	yes	yes	yes
Region $\times$ linear trend	no	no	yes	no	no	no	no
N	43384	42791	42791	3701	9741	17710	30611

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: The estimated impact of temporary jobs reform on hours worked.

	(1)	(2)	(3)	Under 24	Under 30	Women	2000-2008
Reform × Undeclared	1.605*	0.337	0.273	-0.248	0.479	0.301	0.874
	(0.764)	(0.705)	(0.707)	(1.260)	(0.955)	(1.139)	(0.731)
Reform	3.047***	-0.513**	-0.321	0.159	-0.310	-0.810**	-0.263
	(0.200)	(0.171)	(0.184)	(1.015)	(0.464)	(0.249)	(0.180)
Undeclared	-3.493***	-0.505	-0.476	-0.623	-0.217	-0.339	-1.050**
	(0.339)	(0.291)	(0.291)	(0.601)	(0.405)	(0.459)	(0.358)
Region fixed effects	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	yes	yes	yes	yes	yes
Occupation dummies	no	yes	yes	yes	yes	yes	yes
Region × linear trend	no	no	yes	no	no	no	no
N	43332	42749	42749	3695	9734	17698	30604

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$