Labor Market Institutions, Taxation and The Underground Economy

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Abstract

The paper aims at qualifying the links between labor market institutions, taxation, tax monitoring, and underground economic activity.

The proposed model is a continuous time matching model with one commodity produced either overground or underground. Underground economic activity arises because of partial compliance with regulations and tax contributions imposed by the government. Vacancies and workers search are directed at a speci…c labor market. Workers are heterogenous in the subjective cost they face when operating in the irregular sector.

Analytical and numerical investigations suggest that interactions between regular and irregular activities can a¤ect standard results of policy interventions. In that respect, the paper supports the view that policies aiming at increasing individuals bene…ts of participating in the regular sector are more desirable than a deterrence policy.

1 Introduction

Underground economic activity is a feature shared by all OECD countries[1]. However, the debate about accurate estimation procedures and de…nitions is still quite open[2]. The underground sector can include both legal and illegal, and both paid and unpaid activities[3]. In this paper, the underground sector is assumed to cover only legal production. In addition, tax evasion and non compliance with economic legislation are assumed to be the main primary activities involved in it[4]. Henceforth, the underground sector is called the informal or irregular sector interchangeably.

The issue of irregular economic activity has gained a constantly increasing share of attention within public policy communities[5]. Their major concern has been to qualify the underground economy phenomenon in order to determine possible policy interventions able to curb it[6]. The reduction of informal activities is usually motivated by budgetary considerations. However, it is also recognized that the existence of an underground economy is likely to a¤ect economic policies outcomes as it makes o¢cial indicators unreliable[7].

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[1] See Schneider and Enste (2000) for an extensive review of existing estimates.

[2] See for instance the contributions of Tanzi (1999), Thomas (1999) and Feinstein (1999) in a special feature of the Economic Journal.

[3] See for instance Thomas (1992) for a detailed description and an exhaustive listing of currently used de…nitions.

[4] We discuss further in the paper the possibility to relax this assumption in order to include tax avoidance activities like do-it-yourself work and neighbor help.

[5] For instance, since 1990, the European Commssion has funded various studies dealing with the issue. See Barthelemy and alii (1990) and Deloitte & Touche (1997):

[6] See European Commission (1998):

[7] See for instance Schneider (2000) and Schneider and Enste (2000).

This paper develops a theoretical model that allows to assess the in‡uence of various economic institutions upon the size of the irregular sector, while taking interactions between the regular and the irregular sectors into account. The framework also contributes towards the de…nition of policy interventions able to reduce participation in the irregular sector while controlling for aggregate e¢ciency and employment.

Two types of economic institutions are considered in this paper: …scal and labor market institutions.

The link between informality and …scal institutions usually refers to tax evasion. A vast literature on the issue has developed since the seminal paper of Allingman and Sandmo (1972)[8] . The problem, seen from the taxpayer's point of view, has been mostly treated by applying portfolio theory of choice under risk[9]. Other theoretical contributions adopt the view that opportunities for evasion di¤er among occupations[10], and that these di¤erences may a¤ect agent's labor supply decisions[11]. The relation between tax rates and tax evasion appears to rely very much on the assumption made about individuals attitude vis-à-vis risk bearing[12]. Another major attempt of this strand of the literature has been to identify an optimal design of …scal policy in terms of either tax revenues or social welfare. As far as tax proceeds are concerned, theoretical investigations have concentrated on the determination of the most e¤ective policy instrument in containing income underreport. On the one hand, the imposition of relatively high penalty rates (or equivalent tax adjustments) is thought to be more desirable than that of relatively high enforcement e¤ort. The underlying argument is that while the increasing penalties does not entail any resource cost, intensifying audit does[13]. On the other hand, as …scal design a¤ects occupational choices and might generate labor market distortions, analytical outcomes remain unclear[14]. As to social welfare, theoretical prescriptions are found to rely on whether the cost of tax enforcement on evaders is included in the social planner optimization problem or not[15].

Risk aversion has proved to be a powerful theoretical feature to study tax evasion behavior. However, the link between the tax system and the underground economy is somewhat implicit in most of the studies previously quoted. A proper quali…cation of the relationship between the tax system and the underground sector is o¤ered by empirical studies. Almost all studies[16] show that the increase of the tax burden remains one of the main causes for the increase of the irregular sector. Other studies[17] also indicate that increased enforcement (intensi…ed audit) and penalties might reduce the size of the underground economy.

While a considerable amount of theoretical and empirical attention has been directed towards the relation between taxation and tax evasion, very little attention has been devoted to possible interactions between labor market institutions and the underground economy. Using aggregated data, Loayza (1996), for Latin American countries and, Johnson and alii (1997) for a broader sample of countries, …nd a positive relationship between more restrictive labor regulations and the size of the underground sector. However, studies based on disaggregated data draw somewhat contrasting conclusions. For instance, Ahn and de la Rica (1997) use individual data for the Spanish labor market to analyze factors determining whether an individual is susceptible to work in the formal sector, work in the informal sector, or remain unemployed. Their results suggest that the greater the bene…ts attached to the regular sector, the more individuals are likely to search for a job in the regular sector. Then, on the one hand, more "restrictive"

[8] See Andreoni and alii (1998) for an extensive survey.

[9] See Cowell (1990) for a detailed survey of this litterature.

[10] An early example of a two-sector model of tax evasion is that analyzed by Watson (1985):

[11] See, for example, Pestieau and Possen (1992):

[12] For instance, Jung and alii (1994) show that tax rates and tax evasion are positively related to each other only if individuals preferences exhibit increasing relative risk aversion.

[13] See Pyle (1989) for an extensive discussion.

[14] See Slemrod and Yitzhaki (1987) for an early contribution.

[15] As shown in Cowell (1990), the inclusion of tax evaders utility in the social planner objective function may imply that the complete elimination of tax evasion is sub-optimal. In the same spirit, Pestieau and Possen (1991) show that tax evasion and its control could be used by policy makers to introduce variability in the individual's tax treatment.

[16] See Andreoni and alii (1998) for an extensive presentation of some major contributions.

[17] See for instance Cebula (1997):

labor market institutions, like higher minimum wages or …ring restrictions, or, on the other hand, more generous unemployment bene…ts, may serve to attract a larger number job seekers in the regular sector.

Our model is inspired by Saint-Paul (1996) approach of dual labor markets. We assume that some individuals go underground because they are able to fully escape taxation and/or labor regulations imposed by the government. In other words, compliance is only partial.

However, some objective and subjective costs ensue from informality. We take both types of costs into account. Objective costs are assumed to correspond to the probability for informal operators to be caught by the authorities and subsequently …ned[18]. Regarding subjective costs, we assume that individuals face some psychic costs due to their belonging to the underground economy[19]. These psychic costs are interpreted to be an indicator of individuals' tax morale and will henceforth be called "evasion costs". The existence of such costs has been brought to the fore in various experiments run by psychologists[20]. Evasion costs are assumed to be di¤erentiated across individuals.

The model is a model of wage work where production is possible only if a …rm and a worker are able to meet[21]. The process that brings …rms and workers together is not instantaneous. Namely, we make the hypothesis that both labor markets are characterized by search frictions à la Pissarides (2000). Informal labor markets are usually modelized as Walrasian markets. However, there is some evidence supporting the search approach [22]. Individuals willing to operate in the informal sector need speci…c connections, and identifying such connections can be seen as a timing consuming process.

As frictions importance in‡uences transition rates, an additional element is to be taken into consideration by …rms and individuals when deciding whether to enter the regular sector or the irregular one .

The model displays a high parametric dimension that can not be reduced even with the help of empirical indications. Consequently, two types of equilibrium can arise. As each of them is characterized by di¤erent ratios of labor markets tensions, comparative statics yield di¤erent, and even opposite outcomes.

Analytical investigations reveal that more generous unemployment bene…ts stimulate workers participation in the formal sector. However, they may also generate lower aggregate unemployment. Higher wages in the regular sector, for instance due to the introduction of a statutory minimum wage, may also increase workers participation in the formal sector under some circumstances. However, they are likely to generate lower employment levels. Lower tax rates or intensi…ed audit monitoring are found to stimulate workers willingness to search for a job in the formal sector in the …rst place but may lead to higher unemployment rates. Two calibrated versions of the model, that replicate respectively some Italian and Canadian economic features, are used in order to celebrate analytical outcomes as well as to quantify welfare implications. Various quantitative exercises dealing with possible budget balancing procedures are also considered. In general, paying more generous unemployment bene…ts proves to be the most e¢cient policy measure.

The paper is structured as follows. The next section presents the theoretical base-line. In section 3; the impact of policy interventions is assessed. Computational exercises and numerical results are discussed in section 4. Possible policy implications are presented in section 5. Section 6 concludes.

2 The Model

The model is a continuous-time matching model with one non-storable good produced and two sectors. More precisely, we assume that the good can be produced either regularly or irregularly. Thereafter,

[18] Some other objective costs due to informality exist. See Dallago (1990) for an extensive discussion.

[19] A similar assumption is made in Kesselman (1989).

[20] See Schneider and Enste (2000) for a brief survey of the major contributions.

[21] We discuss the relaxation of this assumption in a further section.

[22] Some empiricals facts indicating that searching a job in the informal sector is not frictionless are presented in Thomas (1992; Chap:8).

subscript 1 refers to formal sector variables and subscript 2 to informal sector variables.

The informal sector arises because the government lacks the capability to enforce full compliance with …scal contributions and labor regulations[23]. Taxation is assumed to be raised in order to …nance some level of autonomous public expenditures as well as unemployment insurance.

Each sector has a separate labor market characterized by search frictions. Frictions in the informal labor market are motivated by the fact that operating is made possible only through speci…c connections and the access to the network is time consuming.

We assume that vacancies and workers search are directed to a speci…c labor market. In particular, irregular production occurs when a …rm and a worker both willing to operate in the irregular sector are able to meet. More precisely, on market i (i = 1; 2) the number of matches per unit of time is determined by a matching function $M(V_i; U_i)$ where V_i is the number of vacancies in market i and U_i is the number of unemployed workers in this market. The matching function has the standard properties; it is increasing in both of its arguments, concave, and homogeneous of degree 1.

Moreover, workers and …rms decision to evolve in one or the other sector are assumed to be irreversible. This assumption is supported by Spiro (1993) …ndings for Canada which indicate that individuals once working in the informal sector rarely return to the regular sector even in the long run[24].

In order to establish a clear linkage between the two sectors, a strong form of decreasing returns is adopted. Namely, following Saint-Paul (1996; Chap 9), we assume that the total number of jobs is …xed and is measured by K. As the technology is Leontief, K can also be seen as a measure of the capital stock available in the economy.

With this form of decreasing returns, an e¤ective arbitrage condition between the value of posting a regular vacancy and the value of posting an irregular one is generated.

As regards workers, they are assumed to be heterogenous in their subjective evasion costs, that is, in the subjective cost they attribute to irregular work. Each worker has to decide to search in either of the two sectors, implying an arbitrage condition between the value of searching in the irregular sector and the value of searching in the regular one. Under simplifying assumptions the evasion cost of the pivotal individual, that is the one who is indi¤erent between being over or underground, will indicate the proportion of individuals willing to operate in the informal sector.

In order to make the analysis as clear as possible, the wage prevailing in each sector is assumed to be exogenously given[25].

2.1 The Arbitrage Condition for Vacancies

If the probability of hiring a worker is the same in the two sectors, whether a …rm prefers to produce in the regular rather than the irregular sector depends on the instantaneous net returns it would obtain in the former relative to those it would obtain in the latter.

If the formal sector is more pro…table at time t than the informal one then …rms prefer to post vacancies in the former. An immediate consequence is that the probability of hiring a worker in the informal sector becomes higher as the respective labor market has slackened. As a result the value of posting an informal vacancy has increased and the value of posting a formal one has decreased. In equilibrium, the relative tightness of the two markets is such that the relative value of the two types of vacancies is equal, making …rms indi¤erent between the two.

The probability for a …rm producing in sector i of meeting a worker is given by $\frac{M(V_i;U_i)}{V_i}$ and is denoted henceforth by q_i. J_i^V is the expected pro…t from opening a job vacancy of type i, and J_i^F is the expected

[23] Without partial compliance the irregular sector would not exist and the framework would become the classical one à la Pissarides (2000; Chap: 1):

[24] Appendix E contains the model's solution when some ‡exibility in …rms choice is introduced. It turns out that the results are qualitatively similar to the results obatined in the core model.

[25] A formal treatment of the case of endogenously determined wages is presented in the companion paper Fugazza and Jacques (2001). It is shown that results are qualitatively similar to the case of exogenous wages.

pro…t from recruiting a worker to a job of type i, for i = 1; 2. At equilibrium they satisfy

$$rJ_1^V = q_1 \left[J_1^F - J_1^V \right] \tag{1}$$

$$rJ_2^V = q_2 \left[J_2^F - J_2^V \right] \tag{2}$$

$$rJ_1^F = y - (1 + t_f) w_1 + s \left[J_1^V - J_1^F \right] \tag{3}$$

$$rJ_2^F = \pi \left[1 - \theta_f \right] y + (1 - \pi) y - w_2 + s \left[J_2^V - J_2^F \right] \tag{4}$$

where r is the discount rate, y is the productivity of a match, s is the exogenously given separation rate, w_i is the wage prevailing in sector i , t_f is the payroll tax rate imposed by the government on regular producers, π is the probability of being detected by the authorities and θ_f is the …ne amount imposed on detected …rms. In other words, $\pi\theta_f$ is the e¤ective …ne, that is the expected proportion of output …rms have to renounce to when producing in the irregular sector[26].

Provided that the economy is not in a corner solution, namely that some workers are willing to operate in the informal sector and that not all of them are unemployed, we have seen that, in equilibrium, …rms must be indi¤erent between opening a vacancy in the regular sector and opening a vacancy in the irregular one. Hence

$$J_1^V = J_2^V = J^V \tag{5}$$

and from equations (1) ; (2) ; (3) and (4) we obtain

$$q_2 = \frac{q_1}{\phi - q_1 \frac{(1 - \phi)}{(r + s)}} \tag{6}$$

where, ϕ is the ratio of the instantaneous net returns in the irregular sector over the instantaneous net returns in the regular one. That is

$$\phi = \frac{\left[1 - \pi\theta_f \right] y - w_2}{y - (1 + t_f) w_1} \tag{7}$$

It is now straightforward to verify that the regular sector is more pro…table than the irregular one ($\phi < 1$), then the arrival rate of workers in the irregular sector must exceed the arrival rate in the regular one. The converse is also true.

Equation (6) de…nes a curve VV in the $(q_1; q_2)$ space. VV goes through the origin and is always upward sloping. It is convex and above the 45-degree line[27] for $\phi < 1$. It is concave and lies below the 45-degree line for $\phi > 1$.

The two con…gurations are shown in …gure 1 where the locus labeled VV_A corresponds to the case where $\phi < 1$ (situation A) and the locus labeled VV_B corresponds to the case where $\phi > 1$ (situation B).

[26] We could also interprete $\pi\theta_f$ to be the amount of resources a …rm has to pay in order to protect its activity from tax audition (e.g. bribes or expert accounting services).

[27] For $\phi < 1$, VV has a vertical asymptote at $q_1 = \overline{q}_1 = \frac{\phi(r+s)}{1-\phi}$: For all $q_1 > \overline{q}_1$; $J_1^V > J_2^V$ strictly and all informal workers are unemployed.

2.2 The Arbitrage Condition for Workers

The economy is populated with a continuum of in…nitely-lived risk neutral workers with measure normalized to one. They all derive their utility from the consumption of the good produced in the economy. However, their utility is a¤ected di¤erently across sectors. Let $®_j$ be the indicator of evasion costs (tax morale) for individual j. $®_j$ is assumed to be uniformly distributed over the interval $[0;1]$: We assume that working in the regular sector gives full satisfaction to every agent. These assumptions generate a one-to-one relation between $®_j$ and the proportion of workers willing to operate in the irregular sector.

The probability for a worker of contacting a …rm in sector i is equal to $\frac{M(V_i;U_i)}{U_i}$ and is denoted by p_i thereafter.

Let J_1^U denote the expected returns from job search during unemployment in the regular sector, $J_2^{U;j}$ the expected return for individual j in the irregular sector, J_1^E the expected returns from accepting a position in the regular sector and $J_2^{E;j}$ the expected returns for individual j from accepting a position in the irregular sector. The subscript j is added to the terms related to the informality in order to notify the heterogeneity of individuals in that sector. At steady state,

$$rJ_1^U = (z + b) + p_1 \overset{3}{} J_1^E ¡ J_1^U \overset{´}{} \tag{8}$$

$$rJ_2^{U;j} = z + p_2 \overset{3}{} J_2^{E;j} ¡ J_2^{U;j} \overset{´}{} \tag{9}$$

$$rJ_1^E = (1 ¡ t_w) w_1 + s \overset{3}{} J_1^U ¡ J_1^E \overset{´}{} \tag{10}$$

$$rJ_2^{E;j} = (1 ¡ ®_j) (¼ (1 ¡ \overset{´}{}_w) w_2 + (1 ¡ ¼) w_2) + s \overset{3}{} J_2^{U;j} ¡ J_2^{E;j} \overset{´}{} \tag{11}$$

where z is the return from unemployment common to the two sectors, t_w is the tax rate imposed on regular workers (social contributions) and b represents unemployment bene…ts paid to regular unemployed workers[28]. As mentioned previously, ¼ is the detection probability and $\overset{´}{}_f$ represents the …ne rate. The expected[2]income from underground work is thus given[29] by $(1 ¡ ®_j) (1 ¡ ¼\overset{´}{}_w) w_2$.

From the above system of equations it is possible to identify, always assuming that the economy is not in a corner case, the pivotal individual m , that is, the individual who is indi¤erent between being in the formal sector and being in the informal one, that is,

$$J_1^U = J_2^{U;m} \tag{12}$$

We set $®_m = ®^¤$ thereafter.

Individuals with a dissatisfaction parameter larger than the threshold value $®^¤$ prefer to search in the regular sector while individuals with a smaller dissatisfaction parameter decide to search in the irregular sector.

By using (10) and (11) to substitute respectively for J_1^E and $J_2^{E;j}$ into (8) and (9) and by applying condition (12) we retrieve an expression for the proportion $(1 ¡ ®^¤)$ of workers operating in the formal sector. Namely,

$$(1 ¡ ®^¤) = \frac{1}{p_2 (1 ¡ ¼\overset{´}{}_w) w_2} \overset{\cdot}{} \frac{(r + s + p_2)}{(r + s + p_1)} [(r + s) (z + b) + p_1 (1 ¡ t_w) w_1] ¡ (r + s) z \overset{¸}{} \tag{13}$$

Table 1 contains some comparative statics results.

[28] We assume that individuals in the regular sector qualify for unemployment insurance regardless of past work's experience. This assumption is relaxed in appendix C. As workers participation choice is irreversible, results are not qualitatively altered.

[29] As in the case of irregular …rms, $¼\overset{´}{}_w$ could also be interpreted to be the share of earnings that irregular workers have to pay not to be "o¢cially" detected (e.g. bribes).

	b	z ($p_2 > p_1$)	z ($p_2 < p_1$)	t_w	w_1	w_2	¼; ´ $_w$	p_1; q_2	p_2; q_1
(1 ¡ ®¤)	+	+	¡	¡	+	¡	+	+	¡

Table 1: Partial Equilibrium Comparative Statics

Not surprisingly, the proportion of workers searching in the regular sector is increasing with ¼, ´ $_w$, b, w_1 and, z for ($p_2 > p_1$) and is decreasing with t_w, w_2 and z for ($p_2 < p_1$): It is also increasing with p_1 and decreasing with p_2. We show in the next section that the unemployment rate prevailing in sector i is decreasing in p_i: Then, high regular unemployment rates are expected to be associated with larger irregular labor forces. While higher values of b and w_1 translate into higher expected earnings in the formal sector with respect to expected earnings in the informal one, higher t_w and higher w_2 have the opposite e¤ect.

Theoretical e¤ects are in line with most empirical …ndings.

An increase in the tax and social security contributions burdens (t_w in the paper) is generally found to be positively related to participation in the informal sector[30]. Intensi…ed audit (higher ¼ in the paper) is generally found to reduce the amount of evaded revenue which under some respects can be interpreted to correspond to a reduction in the size of the informal sector[31]. Higher penalties rates are expected to generate the same sort of relationship[32].

The impact of higher levels of b on participation in the formal sector is expected to be positive. This result is validated by Ahn and de la Rica (1997) …ndings. Other empirical works [33] support the view that individuals receiving social payments face strong disincentives to work in the o¢cial economy. In our framework the latter e¤ect can be assessed by varying z, which is not conditional on sectorial participation choice in the same way as social assistance. Participation in the formal sector can either increase or fall depending on the level of p_1 relative to p_2:

Appendix A presents a version of the model where the informal sector also includes do-it-yourself or neighbor help activities. Partial equilibrium properties concerning the wage sectors are found to be maintained.

Appendix B presents a version of the model in which workers are di¤erentiated according to their attitudes towards risk rather than their subjective evasion costs. Again partial equilibrium properties remain qualitatively similar.

2.3 Flows

The number of jobs available is set equal to K: This implies that the currently occupied positions plus the vacant positions in the two sectors must sum up to K :

$$L_1 + L_2 + V_1 + V_2 = K \tag{14}$$

where L_i denotes the labor force employed in sector i: The change in L_i corresponds to hirings minus quits

$$\frac{dL_i}{dt} = ¡ sL_i + M(V_i; U_i) \tag{15}$$

and is equal to zero at steady state.

[30] See for instance Thomas (1992), Tanzi (1999) and Schneider (1986) and (1994).

[31] See, just to quote some of the existing studies, Clotfelters (1983), Dubin and Wilde (1988), Dubin and alii (1990), Beron and alii (1992)and more recently Cebula (1997).

[32] See for instance Pommerehne and Frey (1992).

[33] See Lemieux and alii (1994) for Canada and Lamnek and alii (1999) for Germany.

As the labor force has been normalized to one, in equilibrium we have

$$U_1 = (1 - \alpha) \cdot L_1 \tag{16}$$

and

$$U_2 = \alpha \cdot L_2 \tag{17}$$

where $(1 - \alpha)$ is given by (13).

The objective is to de…ne a curve containing all the combinations $(q_1; q_2)$ corresponding to ‡ow equilibria on the labor markets. For that purpose we re-express every equation in terms of q_1 and q_2:

We have

$$q_i = M\left(1; \frac{U_i}{V_i}\right) \tag{18}$$

which can be reverted as

$$U_i = V_i \cdot \psi(q_i) \tag{19}$$

where $\psi = M(1;.)^{-1}$ is a convex, increasing function[34]. We also have $p_i = \frac{V_i}{U_i} q_i$, which can be rewritten

$$p_i = \frac{q_i}{\psi(q_i)} \tag{20}$$

which is a decreasing and convex function of q_i.

Using (15); (16); (17) and (19) and denoting by u_i and v_i the unemployment and vacancy rates for sector i , that is relative to the labor supply in the respective sector, we obtain

$$u_i = \frac{\psi(q_i)}{\frac{q_i}{s} + \psi(q_i)} \tag{21}$$

$$v_i = \frac{1}{\frac{q_i}{s} + \psi(q_i)} \tag{22}$$

It is easy to check that u_i is increasing and v_i is decreasing with q_i: These results are standard in the search literature[35].

Aggregate unemployment and vacancy rates denoted by u and v are given by

$$u = (1 - \alpha(q_1; q_2))\, u_1 + \alpha(q_1; q_2)\, u_2$$

$$v = (1 - \alpha(q_1; q_2))\, v_1 + \alpha(q_1; q_2)\, v_2$$

Equation (14) can be expressed as

$$(1 - \alpha(q_1; q_2))(v_1 - u_1 + 1) + \alpha(q_1; q_2)(v_2 - u_2 + 1) = K \tag{23}$$

The term $(v_i - u_i + 1)$ represents the number of positions per worker available in sector i. This includes both vacant and occupied positions. Using (21) and (22), (23) becomes

$$(1 - \alpha(q_1; q_2)) \frac{1 + \frac{q_1}{s}}{\frac{q_1}{s} + \psi(q_1)} + \alpha(q_1; q_2) \frac{1 + \frac{q_2}{s}}{\frac{q_2}{s} + \psi(q_2)} = K \tag{24}$$

[34] Appendix A contains an illustration of the ψ function for a standard Cobb-Douglas matching function.

[35] We refer the reader to Pissarides (2000;Chap 1) for an extensive discussion and theoretical quali…cation.

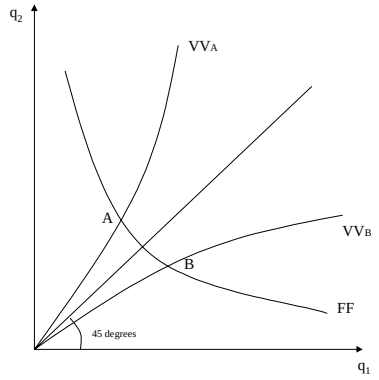

Figure 1: Equilibria

Equation (24) de…nes a curve FF in the $(q_1;q_2)$; which corresponds to ‡ow equilibria on the labor markets.

FF is downward sloping: an increase in q_1 on the one hand reduces job availability rate for workers in sector 1 together with the proportion of workers operating in that sector and on the other hand increases symmetrically the proportion of workers participating in sector 2; in order to o¤set these e¤ects, q_2 has to decrease[36].

Form equation (24) it can be shown that a rise in $(1 ¡ ®^{¤})$ makes the FF locus rotates around its intersection with the 45-degree line. The FF rotation occurs around the intersection point with the 45-degree line because at $q_1 = q_2 = q$; equation (24) becomes $\frac{1+\frac{q}{s}}{\frac{q}{s}+,(q)} = K$, which is independent of the labor force composition. In situation A ($q_2 > q_1$), the number of positions per worker available is larger in the regular sector than in the irregular sector. Then, for the same value of $q_1$and q_2, a rise in $(1 ¡ ®^{¤})$ implies that the number of positions that has to be made available in the regular sector is larger than the number of positions "displaced" from the irregular sector. To keep the equilibrium ‡ow condition satis…ed, more positions have to be displaced from the irregular sector. Namely q_2 must increase for the same value of q_1. In other words, a rise in $(1 ¡ ®^{¤})$ implies that more workers are in the initially less congested sector, that is where the job availability rate is higher. Because no net job creation can occur, further positions have to be freed by the informal sector that is q_2 must increase. The converse holds in situation B. Namely, a rise in $(1 ¡ ®^{¤})$ leads to a lower q_2 for the same value of q_1. Henceforth, we call this ‡ow adjustment process the "relative congestion" e¤ect.

2.4 Equilibria

The two equilibria, noted A and B and corresponding respectively to situation A ($° < 1$) and B ($° > 1$) are represented in …gure 1:

A third possible equilibrium exits and is represented by the intersection point of the FF curve with the 45-degree line. This corresponds to the situation where $° = 1$ and, thus, $q_1 = q_2$. As the latter equilibrium can be seen as rather particular and exceptional, only situations A ($° < 1$) and B ($° > 1$) are considered explicitly in the remaining sections.

[36] Appendix C contains some su¢cient conditions for the curve FF to be downward sloping over some sensible ranges of $q_1$and q_2.

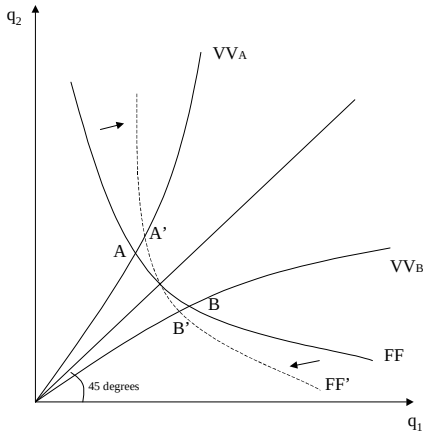

Figure 2: The E¤ects of a Rise in b

3 Labor Market Institutions and Taxation

The scope of this section is twofold. First, we assess the impact of variations in labor market and …scal institutions[37] and determine to what extent taking irregular activity into consideration contrasts "standard" …ndings. Second, we present the e¤ect of policy intervention on the government budget.

3.1 Policy Instruments

Variations in labor market and …scal institutions are expected to a¤ect equilibrium characteristics of the economy mainly through their impact on labor force composition. Discussion on policy implications postponed until next section.

² Unemployment Bene…ts

A change in b a¤ects the FF locus only through its e¤ect on $(1 ¡ ®^{¤})$.

Previous partial equilibrium analysis revealed that a rise in b implies higher participation in the formal sector, that is higher $(1 ¡ ®^{¤})$. As a consequence, the FF locus rotates clockwise around its intersection with the 45-degree line as depicted in …gure 2.

As equilibrium occurs along VV; which corresponds to the …rms non-arbitrage condition, a rise in b leads to a rise in both q_1 and q_2 in situation A. Hence, unemployment increases in both sectors. On the contrary, in situation B; a rise in b leads to lower q_1 and q_2, which implies lower unemployment rates in both sectors.

Note that because of decreasing returns in the matching function, q_2 increases by more than q_1 in situation A and, q_1 falls by less than q_2 in situation B .

In situation A; unemployment increases in both sector because, for increasing values of unemployment bene…ts more workers are directed towards the less congested labor market. Conversely, in situation B more workers are directed towards the more congested labor market where, as a consequence, they will face a higher probability of being hired. This "relative congestion" e¤ect has been identi…ed in the previous section.

[37] Appendix D proposes another policy experiment which consists in subsidizing …rms transition from irregular to regular production. For that purpose, a "‡exible" version of the model is used.

In both situations, the e¤ect on equilibrium ®¤ is not clearly de…ned as q_1 and q_2 move in the same direction. Nevertheless, the respective curvature of VV_A and VV_B allow us to infer that the impact is negative. In this case, aggregate employment can prove to rise in both situations.

² Minimum Wage

The introduction of a minimum wage is …rst interpreted as a rise in w_1 relative to w_2. In that context both VV and FF are a¤ected. As in the case of a rise in b, FF rotates clockwise around its intersection with the 45-degree line. As to the VV curve, the latter shifts downward, as ° increases with w_1.

In situation A; q_1 clearly increases while the impact on q_2 is ambiguous. The rise in q_1 compensates for the loss of pro…tability emerging from higher labor costs in the regular sector. This e¤ect is ampli…ed by higher workers participation in that sector. Lower participation in the irregular sector o¤sets the impact of higher ° implying that q_2 reacts ambiguously. Thus, unemployment in the regular sector increases while nothing can be stated precisely regarding unemployment in the irregular sector.

In situation B; q_2 clearly decreases while the impact on q_1 becomes ambiguous. The adjustment mechanism is similar to the one in situation A. However, the sign ambiguity now falls on q_1 because of symmetric ‡ows adjustment. In this situation, the unemployment rate in the irregular sector falls while the change in the regular unemployment rate is ambiguous.

In both situations, the introduction of a minimum wage in the formal sector could either lead to a smaller or a larger formal sector. The uncertainty appears to be more severe than in the case of the paiement of higher unemployment bene…ts, because of the contrasting e¤ects a higher regular wage has on both sides of the labor market. On the one hand, workers are more eager to search for a regular job as the latter would pay relatively more. On the other hand, …rms …nd irregular production more attractive because of relatively smaller labor costs, then because of arbitrage, q_1 must increase. As higher values of q_1 imply lower workers' participation in the regular sector decreases. Consequently the overall impact on ®¤ is ambiguous.

For the same reasons, the respective impact on formal and informal employment is also ambiguous.

Lemieux and alii (1994) found positive correlation between earnings in the irregular and regular sector, which may indicate that w_1 and w_2 move jointly. In that context previous …ndings are likely to be modi…ed as only the …rms non-arbitrage condition is a¤ected directly by a rise in the regular wage. More precisely, the pro…ts ratio varies according to the sign of

$$(1 + t_f)\left[1 - \frac{\theta'_f}{\theta}\right] - \frac{w_1}{w_2} \tag{25}$$

If (25) is positive then ° increases and the VV curve moves down. The converse is true. Then, regardless of the situation that characterizes the economy, the irregular labor force is expected to increase if ° increases and to decrease if ° decreases. As to unemployment, regular unemployment increases and irregular unemployment falls if ° increases.

² Taxation and Audit

Governmental authorities are usually expected to be able to a¤ect the very size of the informal sector by in‡uencing the arbitrage of …rms through changes in t_f , ¼ and θ'_f and/or the arbitrage of workers through changes in t_w, ¼ and θ'_w:

Lower t_f or higher θ'_f, are expected to have the same qualitative e¤ects. In both cases, the VV locus shifts upward as the regular sector becomes more attractive to …rms. As a result, q_2 increases and q_1 decreases. Equivalently, the probability for a worker to be hired in the informal sector falls while it increases in the formal sector. Hence, the proportion of workers involved in irregular activities is reduced.

Lowering the tax rate applied to workers in the regular sector and/or the …ne level θ'_f have the same qualitative impact than a rise in b. Income from formal employment increases relatively to income form

		b	w_1	# t_f	# t_w	¼
u_1	sit. A	+	+	¡	+	amb
	sit. B	¡	amb	¡	¡	¡
u_2	sit. A	+	amb	+	+	amb
	sit. B	¡	¡	+	¡	¡
(1 ¡ ®¤)	sit. A	amb+	amb	+	amb+	amb
	sit. B	amb+	amb	+	amb+	amb

Table 2: General Equilibrium Comparative Statics

informal employment. Thus, a larger share of workers is willing to search in the formal labor market. In this context, only the FF curve is a¤ected. The latter rotates clock-wise around its intersection with the 45-degree line. As a result both q_1 and q_2 increase in situation A and both of them decrease in situation B. The overall impact on the size of the informal sector can not be properly de…ned.

As to a rise in the detection probability ¼, it a¤ects both the FF and VV curves. The former rotates clock-wise as more workers are induced to search in the formal labor market and the latter shifts upward. In situation A, q_2 increases and q_1 moves ambiguously. In situation B, q_1 falls and q_2 may either increase or decrease. Again, workers participation in the formal sector behaves ambiguously.

3.2 The Underground Sector "Bias"

Previous analytical results, which are summarized in table 2, reveal that the "standard" e¤ects of labor market institutions and payroll taxes on formal unemployment are not only biased but could also be reverted in the presence of an underground sector.

On the one hand, increasing the generosity of unemployment bene…ts the same way as increasing the statutory minimum wage in the regular sector could lead to lower aggregate unemployment. On the other hand, lower tax rates, excluding government budgetary considerations, could generate lower aggregate employment.

We show that these results are essentially due to the combination of labor force composition e¤ects with labor market congestion e¤ects within a speci…c con…guration of …rms production arbitrage.

However, we relax two of the strongest assumptions, namely exogenously determined wages and a constant number of jobs (K), in order to assess how robust our results are in a possibly less restrictive context.

Wage bargaining can be easily introduced in the model. Fugazza and Jacques (2001) assume that the wage rate is the outcome of a Nash bargaining between …rms and workers in the regular sector. There is no wage bargaining in the irregular sector. However, following Lemieux and alii (1994) empirical …ndings, the irregular wage rate is assumed to be positively correlated with its regular counterpart. In that framework, it is shown that results are not dramatically a¤ected qualitatively.

Relaxing the assumption of a constant K and assuming free entry of vacancies in both sectors, like in the canonical search approach, introduces a net job creation e¤ect that o¤sets the congestion e¤ect identi…ed previously. The arbitrage condition of …rms is eventually discarded from the analysis as opening a vacancy in either sector must give zero pro…ts at steady state. This is, in our view, a quite arguable feature as the in‡uence of the demand side of the labor market becomes somewhat of second order. Moreover, the labor force composition e¤ect remains predominant equilibrium e¤ect. As a consequence, we can still …nd situations where "standard" results are mitigated.

An alternative way to reinterpret the model that allows to reconciliate free entry and e¤ective …rms arbitrage consists of considering identical K-position rather than single-position …rms. Firms are free to

enter the economy but have to pay a sunk installation cost. At equilibrium, the value of the …rm, represented by the sum of its vacant and occupied positions in both sectors, must equal the installation cost. This zero pro…t condition also determines the total number of …rms denoted by N. Under the additional assumption that workers belonging to a speci…c sector are unable to discriminate among vacancies neither within nor across …rms, …rms-wide equilibrium conditions re‡ects economy-wide equilibrium conditions. We also retrieve an aggregate ‡ow equilibrium condition that is similar to the one of the paper except for the fact that the total number of available positions ($N \pounds K$) becomes endogenous. As a consequence, the FF curve moves around and along the 45-degree line. Despite this additional movement of the FF curve, results obtained in the paper should not be dramatically modi…ed. For instance a rise in b in situation A increases the total value of a …rm as both q_1 and q_2 both increase because of labor compositional e¤ects. As a consequence the FF curve moves towards the origin. However, the initial impact on q_1 and q_2 is not fully o¤set as equilibrium must occur along the VV_A curve.

3.3 The Impact on Government Budget

In the following we assess the impact of changes in labor and …scal institutions on revenues and expenditures of the government. Budget constraints considerations are discussed in the next section.

Government revenues (R) consist of taxes and …nes proceeds. That is,

$$R = (1 ¡ ®^{¤})(1 ¡ u_1(q_1))[t_f + t_w]w_1 + ®^{¤}(1 ¡ u_2(q_2))¼ \left[´_f y + ´_w w_2 \right]$$

Government expenses include unemployment bene…ts payments, tax evasion detection activity costs ($C(¼)$) and autonomous public expenditures ($\overline{G}$). Namely,

$$G = (1 ¡ ®^{¤})u_1(q_1)b + C(¼) + \overline{G}$$

The introduction of a cost linked to tax evasion detection activity is motivated by the fact that such activity is usually ran by a speci…c tax audit agency. We assume that the agency running costs do not depend on the size of the informal sector but depend positively on the detection probability $¼$. As, for example, in Pestieau and Possen (1991), the cost function $C(¼)$ is such that $C' > 0$ and $C'' > 0$.

Generally speaking the overall impact of a change in a policy parameter on the government budget is the result of a direct e¤ect or equivalently a "ceteris paribus e¤ect" and an indirect e¤ect which includes the e¤ect on labor force participation and the e¤ect on employment. We illustrate this argument by presenting analytical results for a rise in the level of unemployment bene…ts.

The impact of a rise in b on R and G are given respectively by

$$\frac{@R}{@b} = \left[¡ \frac{@u_1(q_1)}{@b}(1 ¡ ®^{¤}) ¡ \frac{@®^{¤}}{@b}(1 ¡ u_1(q_1)) \right][t_f y + t_w w_1] + \left[¡ \frac{@u_2(q_2)}{@b}®^{¤} + \frac{@®^{¤}}{@b}(1 ¡ u_2(q_2)) \right] ¼ \left[´_f y + ´_w w_2 \right]$$

and

$$\frac{@G}{@b} = \left[\frac{@u_1(q_1)}{@b}b + u_1(q_1) \right](1 ¡ ®^{¤}) ¡ \frac{@®^{¤}}{@b}bu_1(q_1)$$

The direct e¤ect simply corresponds to the rise in G due to the increase in the level of the unemployment bene…ts, all other things remaining equal.

The indirect e¤ect a¤ects both R and G as employment levels and labor force participation rates appear in both expressions. In the case of a rise in b, participation in the regular sector is expected to increase in both situation A and B. A rise in the regular labor force, at constant sectorial employment

		b	w_1	t_w	t_f	ϕ
dR	A	$-$	$-$	$-$	amb	amb
	B	$+$	$+$	amb	amb	amb
dG	A	$+$	$+$	$+$	$-$	amb
	B	$-$	$-$	$-$	$-$	amb

Table 3: Government Budget Comparative Statics

levels, implies on the one hand that tax proceeds increase but on the other hand that …ne proceeds decrease. The overall impact on the government budget is positive only if the marginal proceed from taxes is larger than the marginal proceed from penalties. We assume that this is always the case. The reverse may not appear to be a quite plausible assumption as this could lead to "non moral" policy recommendations.

The impact of more generous unemployment bene…ts on employment levels di¤ers depending on the economy's characteristics. In situation A both regular and irregular employment rates are expected to fall while the opposite is expected to occur in situation B. As a consequence, government expenditures are likely to increase in situation A as both unemployment and workers participation in the regular sector increase. As to government revenues, the impact is ambiguous because of the contrasting e¤ect of participation and employment reactions on tax proceeds. All in all, the impact of a rise in b on the government budget constraint remains ambiguous. In situation B, because the unemployment rate in the regular sector falls, a budget surplus is likely to be generated.

Analytical investigations of other policy experiments reveal a large share of ambiguous results which are summarized in table 3.

Budget de…cits (surpluses) are expected to emerge in situation A (B) for changes in the statutory minimum wage. Lower workers tax rates are likely to generate a budget de…cit in situation A but have ambiguous e¤ects in situation B. In all situations, ambiguous e¤ects are obtained when the payroll tax rate is decreased or when …scal fraud detection is intensi…ed.

4 Computational Exercises

In view of the di¢culty of assessing clear equilibrium e¤ects of the various policy instruments under study, we turn to some numerical illustrations of the above model. Computational investigations refer to two speci…c economies (Italy and Canada) whose some equilibrium characteristics are replicated in order to celebrate our theoretical framework within a possibly realistic quantitative framework. Nevertheless, results are treated essentially from a qualitative point of view.

We introduce a measure of aggregate e¢ciency or welfare that can be used as an indicator of the aggregate performance of policy interventions. Together with our theoretical insights, computational outcomes are used to match possible policy interventions with speci…c policy goals. The latter point is discussed extensively in the next section.

We adopt an utilitarian social welfare function, denoted by W, that accounts for all types of economic agents in the economy. Namely,

$$\frac{W}{r} = (1-\theta)(1-u_1)\left[J_1^F + J_1^E\right] + \theta(1-u_2)\left[J_2^F + E\left(J_2^{U,j}\right)\right] + (1-\theta)\left[v_1 J_1^V + u_1 J_1^U\right] + \theta\left[v_2 J_2^V + u_2 E\left(J_2^{E,j}\right)\right]$$

u_1	$\textregistered^{\alpha}$	b	t_w	t_f	$\frac{w_1}{w_2}$	¼
9.7 %	14 %	$0{:}4 \cdot w_1$	0.4	0.08	1.15	0.15

Table 4: The Canadian Economy

u_1	$\textregistered^{\alpha}$	b	t_w	t_f	$\frac{w_1}{w_2}$	¼
12 %	30 %	$0{:}2 \cdot w_1$	0.3	0.5	1.35	0.1

Table 5: The Italian Economy

where $E\left[J_2^{E;j}\right]$ and $E\left[J_2^{U;j}\right]$ the average values of being respectively employed and unemployed in the informal sector. Namely, $E\left[J_2^{E;j}\right] = \int_0^{\textregistered^{\alpha}} J_2^{E;j}(\textregistered_j)\, d\textregistered_j$ and $E\left[J_2^{U;j}\right] = \int_0^{\textregistered^{\alpha}} J_2^{U;j}(\textregistered_j)\, d\textregistered_j$.

In the previous section we assessed the government budget behavior in front of various policy shocks. In the following computational exercises, we impose the additional constraint of a balanced government budget, although we also refer to unconstrained budget responses taking as the benchmark situation a zero de…cit. The government balanced government budget assumption essentially serves the general equilibrium spirit of the model as our framework does not allow for any other type of …nancing sources but proceeds from taxation and tax evaders penalties.

4.1 Calibration

Two situations emerge in our theoretical framework.

In situation A periodic pro…ts of …rms are higher in the regular sector than in the irregular sector while in situation B the reverse is true. Firms in an economy that …ts situation A (A economy) face relatively lower labor costs and/or relatively higher e¤ective …scal fraud …nes with respect to …rms in an economy that corresponds to situation B (B economy).

The A economy is interpreted to be the Canadian economy while the B economy is interpreted to be the Italian economy[38]. We calibrate the model to account for equilibrium characteristics of both economies. Equilibrium features of the Canadian and Italian economies are presented respectively in tables 4, and 5. The reference year is chosen to be 1996 as most of the available empirical estimates of equilibrium features used to calibrate the model, refer to the period 1994-1998.

Regular unemployment rates are retrieved from OECD (1997). Replacement ratios are set according to Martin (1996) average estimates. Tax rates are computed from OECD data on labor costs. The ratio of the regular gross wage over the irregular gross wage is set according to Lemieux and alii (1994) estimates for Canada and according to Brunetta and Ceci (1998) for Italy. Fiscal audit parameters are set arbitrarily. Very few estimates of detection probabilities are available in the literature as underlined in Andreoni and alii (1998) and …nes can not be easily determined as they are likely to depend upon legal court appreciation. Nonetheless, some data related to corruption are available, like for example the Transparancy International Index of Corruption Perception. In 1996 this index was equal to 8.96 for Canada and 3.42 for Italy[39]. In accordance with this indicator, which somewhat re‡ects the e¢ciency of the tax audit agency, the selected e¤ective …ne rates are higher for Canada than for Italy. More precisely, $¼'_f$ and $¼'_w$ are respectively equal to 0.12 and 0.08 for Canada and equal to 0.1 and 0.06 for Italy. Both the detection probability and …ne levels are higher in the Canadian economy calibration.

Other parameters values, which are common to both calibrated versions, are standard. A time period of unit length is interpreted to be one year, the interest rate r is assumed to be 5%, without loss of generality the separation rate s is …xed at 0:1 in both sectors. The matching technology is also assumed

[38] The choice of Italy and Canada as study case economies is motivated by data availability, in particular as concerns relative gross wages.

[39] The index varies form 0 (perceived to be totally corrupt) to 10 (perceived to be totally clean).

to be identical in the two sectors. Again, it might be argued that matching is likely to be less e¢cient in the informal sector. However, no empirical evidence, that illustrates actual di¤erence, exists so far. Then, the matching technology is assumed to be Cobb-Douglas, that is, $M_i = mU_i^a V_i^{1\,i\,a}$; where a is …xed at 0:5 and m = 1 for i = 1; 2. The tax audit cost function is given the simple form $C(¼) = ¼^c$ where c is set equal to 1:1. We choose a relatively low degree of convexity in order to contain the cost e¤ects in exercises where variations in ¼ are considered.

4.2 The Experiments

The following computational experiments aim at de…ning possible policy interventions whose scope would be essentially to reduce labor participation in the informal sector, controlling for unemployment rates and welfare.

The motivation for re‡oating informal activity is usually perceived to be mainly budgetary as tax evasion is one of the main activities in the underground sector. For that purpose, all experiments are in the …rst place ran without imposing budget restrictions to grasp the budget sensitivity to the various policy experiments under consideration[40]. Then, we repeat all experiments imposing a balanced budget constraint. On the one hand, these exercises permit of capturing possible multiplicative e¤ect of policy interventions and on the other hand they permit of establishing an objective "ranking" of the latter. More precisely, previous analytical investigations suggest that labor institutions reforms, like more generous unemployment bene…ts or higher regular wages could stimulate labor participation in the regular sector in the same way as intensi…ed tax audit or lower taxation but possibly with contrasting e¤ects on employment levels. The experiments attempt to throw some light on these theoretical properties.

The …rst experiment consists of increasing the level of unemployment bene…ts. Budget balancing either by varying taxes imposed on …rms or by varying taxes imposed on workers. The second experiment consists of increasing the wage rate in the regular sector. Budget balancing is obtained either by varying …rms taxation or by varying workers taxation. In the third experiment, we increase the detection probability and adjust for taxation to get budgetary equilibrium. In the last experiment, each tax rate is lowered in turn. Budget balancing is obtained by endogenizing the unconstrained tax rate.

4.3 Results

We brie‡y present the main results of our computational experiments. Policy considerations are postpone until next section. For sake of clarity, only a selection of graphical results is reproduced. This selection is presented in appendix F. All results refer to balanced budget exercises where t_w is the endogenous budget instrument.

Generally speaking and as suggested by analytical …ndings, experiments outcomes vary not only quantitatively but also qualitatively across economies.

² Experiment 1: increasing unemployment bene…ts (…gures 4 and 5)

Higher unemployment bene…ts levels generate higher workers participation in the regular sector in both economies. However, they lead to a budget surplus in the Italian economy (situation B) while a budget de…cit emerges in the Canadian economy (situation A). This is explained by the fact that, as expected analytically, regular unemployment increases in the Canadian economy while it falls in the Italian economy. However, we obtain that the overall level of employment increases in both countries.

When imposing the balanced budget constraint, results remain qualitatively the same. Not surprisingly tax rates increase in the Canadian case and fall in the Italian case. Tax rates adjustments amplify the above e¤ects in the latter and dampen them in the former. As to total welfare, it increases in all exercises, in both economies. The upward e¤ect on total welfare is stronger in the Italian than in the

[40] The budget de…cit is zero in the reference equilibria.

Canadian economy. However, …rms surplus always falls in the Italian context, mainly as a consequence of a fall in …rms probability of …lling a regular position. In Canada, it falls only in the case where payroll taxes are adjusted to keep the budget balanced.

² Experiment 2: increasing regular wage (…gures 6 and 7)

Analytical exercises revealed that the impact of a rise in w_1 varies with the assumption made about the degree of correlation between regular and irregular gross wages. Numerical results con…rm these …ndings. Nevertheless we have that in all cases and situations, higher regular wages generate budgetary surpluses.

In the Canadian context (A), a rise in w_1 causes a rise in the size of the regular labor force in all budget constrained experiments. As to budget unconstrained experiments, participation in the regular sector falls in the case of correlated wages. This is due to the observed rise in ° (VV shifts down), which implies a rise of p_2 and a fall in p_1. Total unemployment increases and total welfare falls in all experiments but in the one with endogenous t_w. In the latter, the response is non-monotonic. The turning point corresponds to a change in economic regime inherent to ° values that become larger than one. Nevertheless, workers are always better o¤ while …rms surplus always falls.

In the Italian context (B), contrasting results are also obtained. Workers, participation in the regular sector increases in all experiments when wages are uncorrelated. However, with correlated wages, participation increases only in the case budget adjustments are obtained through workers taxation variations. With uncorrelated wages, total employment falls in the unconstrained budget exercises but increases in the constrained budget ones. With correlated wages, total employment falls in the unconstrained budget experiment as well as in the constrained budget experiment with endogenous t_f. This is due to the fact that labor costs increase substantially in both cases. In the constrained budget experiment with endogenous t_w total unemployment is only slightly a¤ected and shows downward responses for large increases of w_1. Despite the rise in labor costs, the participation e¤ect is strong enough to increase the overall pro…tability of regular jobs.

Generally speaking, workers welfare always increases while …rms surplus always falls. As to total welfare, it increases in the constrained budget exercises with uncorrelated wages and in the constrained budget exercise with correlated wages and endogenous workers taxation.

² Experiment 3: increasing ¼ (…gures 8 and 9)

In both economies a rise in the detection rate increases the participation rate in the formal sector and produces budget de…cits, which indicates that the audit cost e¤ect dominates the …nes revenue e¤ect. However, these impacts are larger in the Canadian economy (A). The overall unemployment rate decreases in the Italian economy (B). In the Canadian case, the response of total unemployment is not monotonic. It …rst falls slightly and then starts increasing. This is essentially a consequence of the composition e¤ect. Increasing labor participation in the formal sector implies that more and more people are directed towards the low-unemployment sector.

Balanced budget experiments reproduce qualitatively the previous results. Not surprisingly, we …nd that tax rates adjustments are larger in the Canadian case than in the Italian case. Moreover, aggregate welfare falls in all experimental situations and so does workers welfare. The downward e¤ect on the latter is obviously more accentuated for t_w adjustments. Regarding …rms surplus, it always falls in the Italian context. In the Canadian context it only falls when t_f is the budget balancing instrument.

² Experiment 4: decreasing tax rates (…gures 10 and 11)

Generally speaking, a cut in …rms taxation or workers taxation induces a rise in the size of the regular labor force. Not surprisingly, the rise in $(1 ¡ ®^{¤})$ is much more pronounced when workers tax rates are lowered.

Unconstrained budget experiments reveal that budget de…cits emerge in all cases.

Constrained budget experiments allow us to identify possible reaction asymmetries. With non-linearities in the economy, lowering t_f and endogenizing t_w is not expected to produce the same outcome as lowering t_w and endogenizing t_f. Moreover, results are also likely to vary across economy types.

In the Italian economy (B) lowering t_w causes stronger upward e¤ects on regular and total employment even though both policy experiments generate identical tendencies. This is also true for total welfare which is found to increase in both con…gurations, even though the impact is more marked for lower t_w: The only di¤erence appears in the e¤ect on workers welfare and …rms surplus. Not surprisingly, lower t_w generate higher welfare for workers and lower surplus for …rms while the opposite is obtained for lower t_f.

In the Canadian economy (A), lower t_f produce qualitative results similar to those in the Italian economy. However, when worker taxation is lowered, we obtain reverted results in many respects. In particular, regular employment falls. Moreover, some non-monotonic responses appear. Total employment and total welfare responses are U-inverted-shaped. The turning points correspond to a change of regime in terms of pro…ts ratio. As t_w falls and t_f increases periodic pro…ts in the informal sector continuously increase with respect to their counterpart in the formal sector.

5 Policy Implications

The …ght against informal activity is a recurrent theme in OECD countries. While the dominant method is to increase deterrence[41] (intensi…ed audit and /or higher …nes), previous analytical and numerical investigations suggest that it is not the most e¢cient in various respects. Besides the size of the irregular labor force, our theoretical framework allows us to take economic indicators, that are highly relevant for de…ning policy orientations (e.g. sectorial and total unemployment rates and e¢ciency measures), into account. Theoretical and numerical investigations also suggest that policy interventions are likely to a¤ect di¤erently, dissimilar economies.

Broadly speaking, unemployment bene…ts prove to be e¢cient tools to curb participation in the irregular sector in the same way as intensi…ed …scal audit or lower tax burdens. Moreover, numerical results also indicate that contrary to any other policy intervention, increasing the generosity of unemployment bene…ts (experiment 1) leads to lower total unemployment rates and higher total welfare levels in all exercises. Indeed, increasing the probability of being caught (experiment 3), on the one hand generates higher total employment rate only in the Italian context but on the other hand always leads to lower total welfare. Lowering workers social contributions (experiment 4) replicates unemployment bene…ts increases e¤ects in the Italian context. However, in the Canadian context, this is the case only for small variations of t_w. Lowering payroll taxes always bene…ts the economy in the Italian context while only regular employment increases in the Canadian context. As to the e¤ects of increasing regular wages through a statutory minimum wage (experiment 2), they vary according to the hypothesis made about the degree of correlation between regular and irregular labor earnings but are never similar to those of experiment 1.

The …ndings of the paper support the view that a positive approach to raise individuals motivation to stay in the regular economy is likely to generate better equilibrium outcomes than the more traditional disincentive approach to decrease individuals motivation to operate in the irregular economy. In other words, policy strategies to curb irregular activities should concentrate on increasing bene…ts of participating in the formal sector rather than increasing costs of participating in the informal sector. Indeed, the adoption of a positive approach can serve other policy objectives like higher levels of total employment and higher levels of aggregate e¢ciency.

In particular, increasing the generosity of unemployment bene…ts appears to be the best alternative

[41] See Frey and Schneider (2000).

to intensi…ed deterrence. Nonetheless, this result relies to a large extent on the assumptions that only formal worker are entitled to these bene…ts and unemployed workers search with constant intensity. This is implicitly equivalent of assuming that unemployment insurance recipients monitoring by unemployment agencies is perfect. Although this may not be a fully realistic assumption, there is evidence of intensi…ed monitoring in most of OECD countries[42]. Nevertheless, our framework o¤ers the possibility to consider the case of totally ine¢cient monitoring. Indeed, this would be equivalent to liken parameter z to parameter b: In that context all workers are entitled to unemployment bene…ts. Previous investigations revealed that higher participation in the regular sector is obtained for higher values of z when p_2 is larger than p_1 (B economy)[43]. Generally speaking, increasing the generosity of the welfare system in countries like Italy can be expected to lead to higher participation in the regular sector and lower unemployment rates. On the contrary, increasing unconditional welfare payments in countries like Canada (A economy) is expected to generate opposite outcomes[44].

6 Conclusions

This paper aims at developing a uni…ed framework in which it is possible to assess the in‡uence of labor market institutions, taxation and tax audit interaction on the underground sector. The innovative feature of our theoretical framework is twofold. First, we consider joint labor supply and demand responses to policy interventions. For that purpose we adopt the search approach to labor markets. Second we are able to account for possible interactions of the o¢cial with the underground economy.

Analytical investigations, corroborated by numerical exercises, reveal that the introduction of an underground sector can lead to "non-standard" policy outcomes. For instance, we …nd that more generous unemployment bene…ts can lead to higher aggregate employment levels, while less stringent taxation imposed on …rms can cause higher aggregate unemployment rates.

Various policy experiments are undertaken in order to identify possible policy orientations. Two major conclusions are drawn. First, increasing individuals' incentives to participate in the formal sector ("incentive approach") is able to reduce informal activity in the same way as increasing the individuals' cost of participating in the irregular sector ("deterrent approach"). Moreover aggregate e¢ciency as measured by social welfare is always higher with the former policy strategy. Second, contrary to the deterrent approach, the incentive approach can serves other policy objectives, like lower unemployment rates.

Our results have been obtained with a fairly simple model. Nonetheless we present various possible extensions of the model in order to test the "robustness" of our framework. We consider the case of do-it-yourself or neighbor help activities. Analytical investigations suggest that the qualitative properties of the core set up are preserved. In particular we …nd a similar relationship between regular and irregular activities. Introducing risk aversion is shown not to modify analytical results concerning workers arbitrage. However, it is somewhat obvious that it could bring interesting insights into welfare investigation. Wages are assumed to be exogenously determined. We point out that introducing some type of endogenous determination rule does not modify qualitatively the paper results.

Further research could consist of relaxing irreversibility in workers choice. This might yield interesting informations and would further enlarge the range of policy interventions.

[42] See for instance Boeri and alii (2000) and the recent reform of the French unemployment insurance system (Plan d'Aide au Retour à l'Emploi).

[43] See table 1.

[44] This result is somewhat in accordance with Lemieux and alii (1994) …ndings which indicate a relatively high particiaption rate in the informal sector among welfare claimants.

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A The FF curve

The FF curve is characterized by the following equation

$$(1 - \theta(q_1;q_2))\left(\frac{1+\frac{q_1}{s}}{\frac{q_1}{s}+\psi(q_1)}\right) + \theta(q_1;q_2)\left(\frac{1+\frac{q_2}{s}}{\frac{q_2}{s}+\psi(q_2)}\right) - K = 0$$

Let

$$A = \frac{1+\frac{q_1}{s}}{\frac{q_1}{s}+\psi(q_1)}$$
$$B = \frac{1+\frac{q_2}{s}}{\frac{q_2}{s}+\psi(q_2)}$$

then, the total derivative of the above equation reads as

$$dq_1\left(\frac{\partial\theta}{\partial q_1}(B-A) + (1-\theta)\frac{\partial A}{\partial q_1}\right) + dq_2\left(\frac{\partial\theta}{\partial q_2}(B-A) + \theta\frac{\partial B}{\partial q_2}\right) = 0$$

and

$$\frac{dq_2}{dq_1} = -\frac{\frac{\partial\theta}{\partial q_1}(B-A) + (1-\theta)\frac{\partial A}{\partial q_1}}{\frac{\partial\theta}{\partial q_2}(B-A) + \theta\frac{\partial B}{\partial q_2}}$$

If $q_2 > q_1$ then $B < A$ (if $q_2 < q_1$ the reverse is true). As the function $f(x) = \frac{1+\frac{x}{s}}{\frac{x}{s}+\psi(x)}$ is decreasing and convex[45], we have that

$$\frac{B-A}{q_2-q_1} \geq \frac{\partial A}{\partial q_1}$$

then

$$(B-A) \geq \frac{\partial A}{\partial q_1}(q_2-q_1)$$

If we multiply both sides by $\frac{\partial\theta}{\partial q_2}$, which is negative, we have that

$$(B-A)\frac{\partial\theta}{\partial q_2} \leq \frac{\partial A}{\partial q_1}(q_2-q_1)\frac{\partial\theta}{\partial q_2}$$

If we make the hypothesis, we call H, that,

$$\frac{\partial A}{\partial q_1}(q_2-q_1)\frac{\partial\theta}{\partial q_2} \leq -\theta\frac{\partial B}{\partial q_2}$$

[45] If the matching function, as assumed in the computational exercise, takes the form of $U^{0.5}V^{0.5}$, then $\psi = x^2$. It is then straightforward to check that $f' = -\frac{1+2xs+x^2}{s(x+sx^2)^2} < 0$ and $f'' = \frac{2+s+7x+3x^2s+2x^3}{s(x+sx^2)^4} > 0$.

then,

$$\frac{@q_2}{@q_1} \cdot 0$$

The H hypothesis is interpreted to be an upper bound condition for the elasticity of ® with respect to q_2, noted $"_{\frac{®}{q_2}}$.That is $"_{\frac{®}{q_2}}$ must satisfy

$$"_{\frac{®}{q_2}} = \frac{@®}{@q_2}\frac{q_2}{®} \, , \, i \, \frac{q_2}{q_2 \, i \, q_1}\frac{\frac{@B}{@q_2}}{\frac{@A}{@q_1}}$$

This is veri…ed around the 45-degree line that is, for q_1 close to q_2: Indeed, in that case the condition reduces to $"_{\frac{®}{q_2}} = \frac{@®}{@q_2}\frac{q_2}{®} \, , \, \frac{1}{\frac{q_1}{q_2} \, i \, 1}$. The right hand side term goes to $(\, i \, 1)$ as q_1 and q_2 get closer and closer.

The intuition behind the condition on $"_{\frac{®}{q_2}}$ is clear. Take the case of a constant ®. Then the FF curve would be unambiguously decreasing as a higher probability of …lling a vacancy with a worker in the formal sector would have to be o¤set by a lower q_2 so that the ‡ows condition remains satis…ed. The fact that in the above case ® depends on q_1 positively does not modify the o¤setting mechanism: if ® increases with q_1 (which is the case as higher q_1 translate into lower p_1), then a rise in q_1 must be compensated for by a relatively larger fall in q_2 as ® and q_1 a¤ect the ‡ows condition in a similar and thus mutually reinforcing manner. However, as ® and q_2 are negatively related, then, if $"_{\frac{®}{q_2}}$ is too high an absolute value, then a rise in q_1 might require a rise in q_2 rather than a fall and make the FF curve positively sloped.

A similar reasoning can be applied to the case in which $q_2 < q_1$; however, the elasticity condition would read as

$$"_{\frac{1 \, i \, ®}{q1}} = \frac{@(1 \, i \, ®)}{@q_1}\frac{q1}{(1 \, i \, ®)} \, , \, \frac{q1}{q_2 \, i \, q_1}\frac{\frac{@A}{@q_1}}{\frac{@B}{@q_2}}$$

B Do-It-Yourself and Neighbor Help

This appendix presents the sketch of an extension of the core theoretical framework of the paper to account for do-it-yourself or neighbor help. Do-it-yourself and neighbor help are part of the informal sector in the sense that they are not o¢cially registered activities. Roughly speaking, these activities refer to unpaid domestic work that does not require any job search. Do-it-yourself and neighbor help do not involve tax evasion but tax avoidance[46]. Henceforth, we call these activities the third sector.

In order to introduce the third sector in our framework, we assume that the utility enjoyed by individuals operating in that sector is decreasing with ®. We consider the plausible case where the third sector is populated by individuals with high evasion costs relative to individuals who operate in the informal wage work sector. We could also interpret ® to be an index of tax avoidance willingness. In that context, for instance, ® = 0 means no willingness to avoid taxation but full willingness to evade it.

We denote by J_3^j individual's j expected value of belonging to the third sector.

We consider a simple form of J_3^j, namely

$$J_3^j = \frac{z + (1 \, i \, ®_j)R}{r}$$

[46] See for instance Thomas (1992, Chap. 2).

where R are the periodic gains retrieved from do-it-yourself, neighbor help activities. This gain may correspond to the market price of these activities when it exists. As no job search is required to be in the third sector, individuals are always active.

Expressions for informal and formal unemployment are given by respectively

$$J_2^{U;j} = \frac{(r+s)z + p_2(1 - \theta_j)(1 - \tau_w)w_2}{r(r+s+p_2)}$$

and

$$J_1^U = \frac{(r+s)(z+b) + p_1(1-t_w)w_1}{r(r+s+p_1)}$$

J_1^U; $J_2^{U;j}$; and J_3^j expressions are graphed in …gure 3 with θ_j on the abscissa. J_1^U does not depend on θ_j and is thus represented by an horizontal line. It is straightforward to check that $J_2^{U;j}$; and J_3^j are both decreasing in θ_j.

We restrict our analysis to the situation in which the three sectors coexist. In order to be in such a situation two conditions must be necessarily satis…ed[47].

In $\theta_j = 1$ we must verify that

$$\frac{(r+s)(z+b) + p_1(1-t_w)w_1}{r(r+s+p_1)} > \frac{z}{r}$$

In $\theta_j = 0$ we must verify that

$$\frac{(r+s)(z+b) + p_1(1-t_w)w_1}{r(r+s+p_1)} < \frac{z+R}{r} < \frac{(r+s)z + p_2(1-\tau_w)w_2}{r(r+s+p_2)}$$

The share of the labor force involved in the formal sector is given by $(1 - \theta_1^{\alpha})$;where θ_1^{α} solves $J_1^U = J_3^j$, that is,

$$\theta_1^{\alpha} = \frac{R(r+s+p_1) - (r+s)b + p_1 z - p_1(1-t_w)w_1}{R(r+s+p_1)}$$

The share of workers involved in the third sector corresponds to $(\theta_1^{\alpha} - \theta_2^{\alpha})$, where θ_2^{α};the size of the irregular salaried labor force, solves $J_2^{U;j} = J_3^j$, that is,

$$\theta_2^{\alpha} = \frac{p_2(1-\tau_w)w_2 - (r+s+p_2)R - p_2 z}{p_2(1-\tau_w)w_2 - (r+s+p_2)R}$$

In that context the equation of the FF curve is:

$$(1 - \theta_1^{\alpha})\frac{1 + \frac{q_1}{s}}{\frac{q_1}{s} + \gamma(q_1)} + \theta_2^{\alpha}\frac{1 + \frac{q_2}{s}}{\frac{q_2}{s} + \gamma(q_2)} = K \qquad (A1)$$

It is easy to check that $(1 - \theta_1^{\alpha}(q_1))\frac{1+\frac{q_1}{s}}{\frac{q_1}{s}+\gamma(q_1)}$ does not vary with q_2 but is negatively related to q_1. $\theta_2^{\alpha}(q_2)\frac{1+\frac{q_2}{s}}{\frac{q_2}{s}+\gamma(q_2)}$ decreases in q_2 and is independent of q_1. Then, for the equilibrium ‡ow to be satis…ed, q_1 and q_2 must vary oppositely which implies that the FF curve is unambiguously downward sloping.

[47] The mathematical analysis above is based :

on the comparaison on the value of each function when $\theta_j = 0$ (i.e.for J_1^U; $J_2^{U;j}$; and J_3^j respectively : $\frac{(r+s)(z+b)+p_1(1-t_w)w_1}{r(r+s+p_1)}$; $\frac{(r+s)z+p_2(1-\tau_w)w_2}{r(r+s+p_2)}$ and $\frac{z+R}{r}$);

and, on the comparaison on the value of each function when $\theta_j = 1$ (i.e.for J_1^U; $J_2^{U;j}$; and J_3^j respectively : $\frac{(r+s)(z+b)+p_1(1-t_w)w_1}{r(r+s+p_1)}$; $\frac{(r+s)z}{r(r+s+p_2)}$ and $\frac{z}{r}$):

Like in the core model, unemployment benefits, the tax rate and the regular wage level directly affect labor participation in the regular sector. On the contrary, audit parameters and informal labor earnings have only an indirect impact. The latter goes through variations in the transition probabilities. These variations can be assessed by looking at the movements of the FF curve.

We illustrate FF movements by considering a rise in b. As b increases the size of the regular sector increases on impact. Hence, the first term in (A1) increases for the same value of q_1 and, q_2 must decrease for the flow condition to be satisfied. Then, the FF curve shifts up without rotating around its intersection with the 45-degree line as in the text. We expect the regular salaried work sector to expand, the irregular salaried work sector to shrink while the third sector size falls when previous necessary conditions hold. This result is in line with the core analysis findings although the impact on sectorial and aggregate unemployment rates may be reverted in situation B.

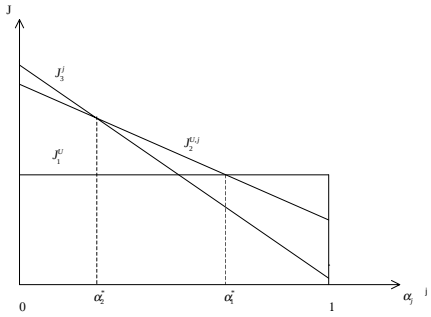

Figure 3: Participation Rates

C Risk Aversion

The appendix offers an alternative approach to the workers decisional arbitrage framework. Namely we assume that they are only differentiated according to their attitudes towards risk. We show that, taking the case of a variation in the unemployment benefits level, comparative statics generate results qualitatively similar to those of the paper.

We follow Pestieau and Possen (1992) by assuming that the individual's function depends only on her disposable income $\hat{A}$. Further, her utility function have an isoelastic form. That is

$$u_j(\hat{A}) = \hat{A}^{1-\beta_j}(1-\beta_j)^{-1}$$

with $\beta_j \geq 0$.

Each individual is characterized by a value of β_j such that $0 \leq \beta_j < 1$ and individuals are assumed to be uniformly distributed on this interval. The parameter β_j is the Arrow-Pratt relative risk aversion measure. Restricting β_j so as not to exceed 1; as we will see below, allows us to retrieve directly the labor force composition.

Let $J_1^{U;j}$ denote the expected returns from job search during unemployment for individual j in the regular sector, $J_2^{U;j}$ the expected return in the irregular sector, $J_1^{E;j}$ the expected returns from accepting a position in the regular sector and $J_2^{E;j}$ the expected returns from accepting a position in the irregular sector. The subscript j is added to all terms in order to notify the heterogeneity of individuals in terms of risk aversion. At steady state,

$$rJ_1^{U;j} = u_j(z + b) + p_1(J_1^{E;j} - J_1^{U;j})$$

$$rJ_2^{U;j} = u_j(z) + p_2(J_2^{E;j} - J_2^{U;j})$$

$$rJ_1^{E;j} = u_j((1 - t_w)w_1) + s(J_1^{U;j} - J_1^{E;j})$$

$$rJ_2^{E;j} = (1 - ¼)u_j(w_2) + ¼u_j((1 - ´)w_2) + s(J_1^{U;j} - J_1^{E;j})$$

Consider the following functions

$$\begin{aligned} A_j^1 &= u_j(z + b) \\ A_j^2 &= u_j(z) \\ B_j^1 &= u_j((1 - t_w)w_1) \\ B_j^2 &= (1 - ¼)u_j(w_2) + ¼u_j((1 - ´)w_2) \end{aligned}$$

All these functions are strictly increasing with $(1 - ®_j)$ as long as earnings are positive.

The equilibrium condition for $(1 - ®_j)$ is obtained for identical J^U across sectors. Thus, this condition reads as an equality between two strictly increasing functions of $(1 - ®_j)$:

$$rJ_2^{U;j} = \frac{(r + s)A_j^2 + p_2B_j^2}{r + s + p_2} = \frac{(r + s)A_j^1 + p_1B_j^1}{r + s + p_1} = rJ_1^{U;j}$$

The individual n characterized by $®_n = 1$; the most risk averse, is in the formal sector as $rJ_1^{U;j} > rJ_2^{U;j}$. The opposite is veri…ed for the individual m characterized by $®_m = 0$:

The curve corresponding to $rJ_2^{U;j}$ intersects with the curve corresponding to $rJ_1^{U;j}$ for some value of $®_j \in [0;1]$ only if the slope of the former is larger than the slope of the latter. This has to be veri…ed if we do not want the economy to be in a corner solution where only one of the two sectors would be producing.

As the consequence function $F(1 - ®_j; b) = rJ_2^{U;j} - rJ_1^{U;j}$ increases with its …rst argument. It is easy to check that it decreases with the level of unemployment bene…ts. Indeed while $rJ_1^{U;j}$ increases with b, $rJ_2^{U;j}$ is independent of b. Thus, using the implicit functions theorem,

$$-\frac{\frac{@F}{@b}}{\frac{@F}{@(1-®_j)}} = \frac{@(1 - ®_j)}{@b} > 0$$

The intuition is straightforward. As individuals are risk-averse, they always try to smooth consumption as much as possible. In the absence of perfect capital markets, unemployment insurance plays a major smoothing role in times of unemployment.

D Irreversibility

The scope of this appendix is twofold. First it aims to de…ne to what extent relaxing some irreversibility in the decision made by …rms a¤ects previous equilibrium conditions. Second, we consider the e¤ects of an alternative policy expected to re‡oat the underground sector. Namely, we consider the paiement of a subsidy to underground …rms choosing to become formal. This type of policy has been introduced recently in Italy under the name of "contratti di riallenamento".

We assume that informal …rms can decide at any point in time to switch to the regular sector by putting a vacancy on any occupied position. Namely, informal workers are replaced with formal workers any time informal …rms …nd it pro…table. Further, we still assume choice irreversibility for …rms that has initially decided to be formal. The possibility to assume fully revertible decisions in both sectors is not treated and is left as a possible future exercise. We focus on situation B as periodic pro…ts in the informal sector are higher relative to periodic pro…ts in the formal sector. This implies that the subsidy, called R , will have an e¤ect only it is above some threshold level. In situation A, subsidizing the underground economy reemerging would prove to be a pointless policy as all informal …rms would be tempted to switch to regularity without any additional incentive.

In order to become formal informal …rms are assumed to have to post a vacancy in the formal sector on each occupied informal position and to get R for each successful match.

Equation (3) remains unchanged while (4) becomes

$$rJ_2^F = \frac{1}{4}\left[1 - \acute{}_f\right] y + (1 - \frac{1}{4}) y - w_2 + s\left[J_2^V - J_2^F\right] + \max\left[0; q_1\left[J_1^F - J_2^F\right] + R\right]$$

The last term of the above equation represents the …rm's value of a …nding a worker in the formal sector. Then a …rm will replace an informal with a formal worker if and only if

$$J_1^F - J_2^F + R > 0$$

After some manipulations we obtain a new arbitrage condition for vacancies

$$q_2 = \frac{q_1}{\circ + q_1 \frac{R}{y - (1+t_f) w_1}}$$

$\frac{R}{y - (1+t_f) w_1}$ represents somewhat an indicator of the compensatory paiement made to informal …rms for their periodic pro…ts loss. The above equation characterizes the "new" VV curve which is ‡atter than and below its counterpart in the rigid regime.

We can deduce from the previous expressions that informal …rms decide to emerge if, and only if,

$$R > \frac{\circ - 1}{r + s}$$

The latter expression has a clear interpretation. The subsidy, to become e¤ective, at least, has to compensate for the present discounted value of loss in pro…ts incurred by informal …rms deciding to become formal.

The arbitrage condition of the pivotal worker is also modi…ed as workers in the informal sector are faced with a higher probability of loosing their job.

The proportion of regular workers is now given by

$$(1 - \textregistered^{\alpha}) = \frac{1}{p_2}\left[\frac{(r + s + p_2 + q_1)}{(r + s + p_1)}\left[\frac{(r + s)(z + b)}{w_2} + p_1 \frac{(1 - t_w) w_1}{(1 - \acute{}_w) w_2}\right] - \frac{(r + s + q_1) z}{w_2}\right]$$

Equation (23) is now

$$(1 - \alpha^{\ddagger}(q_1;q_2))(v_1 - u_1 + 1) + \alpha^{\ddagger}(q_1;q_2)v_2 = K$$

and can be re-written as

$$(1 - \alpha^{\ddagger}(q_1;q_2))\frac{1+\frac{q_1}{s}}{\frac{q_1}{s}+\theta(q_1)} + \alpha^{\ddagger}(q_1;q_2)\frac{1}{\frac{q_2}{s+q_1}+\theta(q_2)} = K$$

The form of the previous equation suggests that FF is downward-sloping for realistic values of $(1 - \alpha^{\ddagger})$.

Brie‡y, we see that the general shape of the equilibrium conditions has changed only slightly. Thus, results derived in the paper are expected to hold, at least qualitatively, in the latter framework.

We now turn the policy instrument presented previously. An increase in R shifts the VV curve downward. The FF curve is not directly a¤ected and will respond only to variations in the vacancies hazard rate. Then, subsidizing reemerging underground …rms may generate non expected results. Indeed, q_1 increases and q_2 decreases with R. Hence, formal unemployment tends to rise and informal unemployment to fall. However, from the above expression for $(1 - \alpha^{\ddagger})$; we have that the e¤ect of a rise in q_1 is unclear, implying that the share of workers willing to operate in the informal sector is ambiguously a¤ected meaning that FF can rotate either direction. It can thus be concluded that the overall e¤ect on employment can not be properly de…ned.

These results indicate that what is interpreted to be a successful policy is in fact a counter-productive one and the rise in emerged …rms could simply be the consequence of a lager number of immersions.

E Unemployment Bene…ts Entitlement

In this appendix, we consider a simple case where unemployed workers in the regular sector lose their entitlement to unemployment bene…ts for some reasons outside the model. Although we only report steady state equations, this extension is compatible with the assumption that initially, no regular worker is entitled to unemployment bene…ts.

Equations characterizing the steady state in the irregular sector are not a¤ected. Steady state equations for the regular sector are modi…ed:

$$\begin{aligned} rJ_1^U &= z + b + p_1(J_1^E - J_1^U) + a(J_1^{U\ddagger} - J_1^U) \\ rJ_1^{U\ddagger} &= z + p_1(J_1^E - J_1^{U\ddagger}) \\ rJ_1^E &= (1 - t_w)w_1 + s(J_1^U - J_1^E) \end{aligned}$$

where a is the exogenous rate at which regular unemployed lose their entitlement to unemployment bene…ts and $rJ_1^{U\ddagger}$ is the ‡ow of value associated with uncompensated unemployment.

We show here that the presence of non-compensated unemployed workers does not modify form a qualitative point of view the impact of policy shocks on $(1 - \alpha^{\ddagger})$. Pivotal worker evasion cost satis…es

$$J_1^{U\ddagger} = J_2^{U;j}$$

As in the core model,

$(1 - \alpha^{\ddagger})$ depends negatively[48] on p_2 and positively[49] on p_1.

$(1 - \alpha^{\ddagger})$ depends positively on b and wage w_1 but negatively on t_w, negatively on w_2, ¼ and $\acute{}_w$.

The FF curve is downward sloping under the conditions stated in appendix A.

[48] Mathematicaly if the derive $J_2^{U;j}$ with respect p_2; the derivative is positive if $z < (1 - \alpha)(1 - ¼\acute{}_w)w_2$ that means that the gain of informal work, even it is detected, is higher than z:

[49] The proof is simply based ob the positivity of $J_1^E - J_1^U$ and $J_1^E - J_1^{U\ddagger}$ (otherwise no one looks for a job). If we derive the

F Experiments Graphical Outcomes

In the following …gures, Reg. Un. reads Regular Unemployment / Inf. Un reads Informal Unemployment / Tot. Un. reads Total Unemployment / Reg. Work. reads Regular Work Force / Tot. Wel. reads Total Welfare / Work. Wel. reads Workers Welfare / Fir. Wel. reads Firms Welfare/ Rep. Rate reads b in the text / Det. Rate reads ¼:

² Experiment1

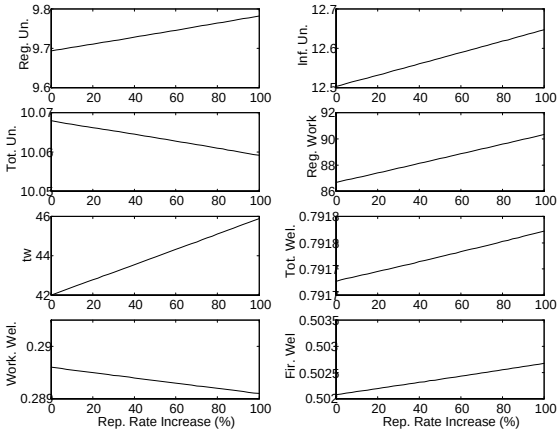

Figure 4: Canada (A)

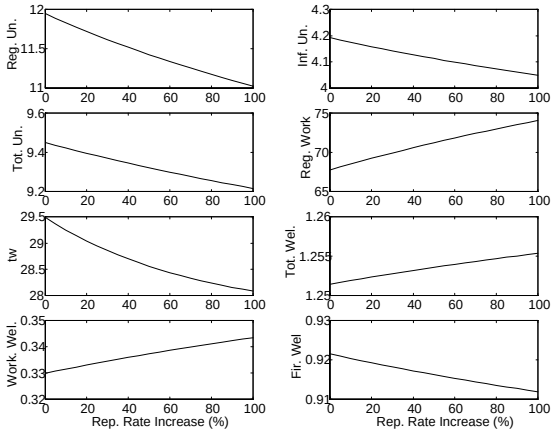

Figure 5: Italy (B)

arbitrage equations with respect to p_1; it is easy to express $\frac{dJ_1^U}{dp_1}$ with parameters and the di¤erences $J_1^E ¡ J_1^U$ and $J_1^E ¡ J_1^{U¤}$: $\frac{dJ_1^U}{dp_1} = \frac{(J_1^E ¡ J_1^U) + \frac{a(J_1^E ¡ J_1^{U¤})}{r+p_1}}{r(r(r+s)+p_1(2r+p_1)+a(r+p_1+s))} > 0$: Hence $\frac{dJ_1^E}{dp_1} = \frac{s}{r+s}\frac{dJ_1^U}{dp_1} > 0$ and at least $\frac{dJ_1^{U¤}}{dp_1} = \frac{p_1}{r+p_1}\frac{dJ_1^E}{dp_1} + \frac{J_1^E ¡ J_1^{U¤}}{r+p_1} > 0$:

2 Experiment 2 (Correlated Wages)

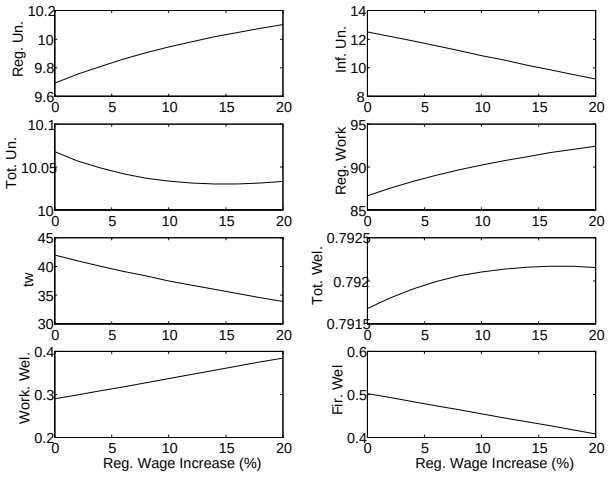

Figure 6: Canada (A)

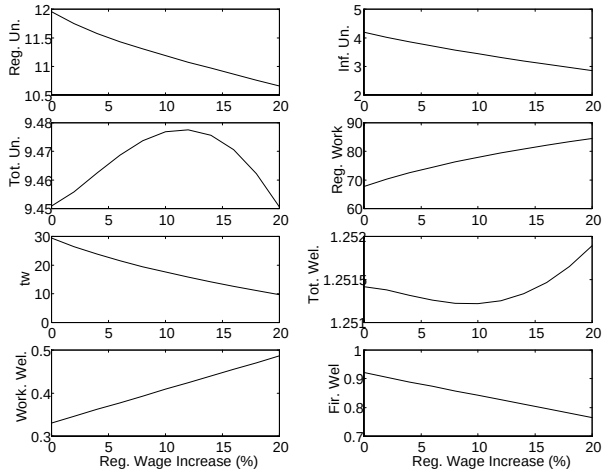

Figure 7: Italy (B)

2 Experiment 3

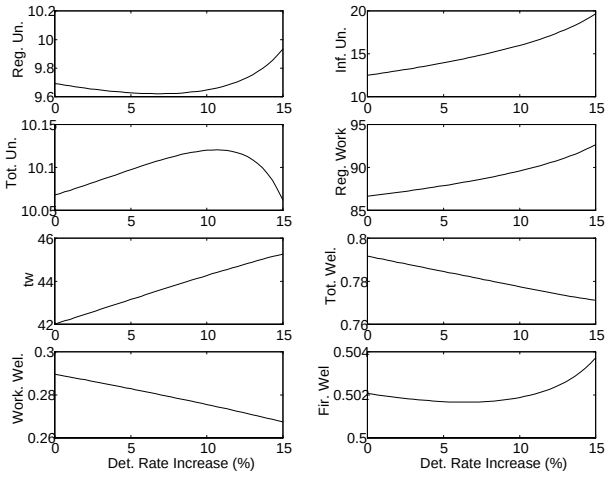

Figure 8: Canada (A)

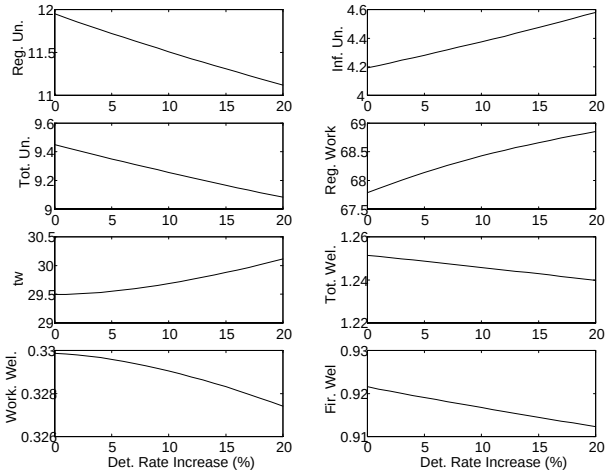

Figure 9: Italy (B)

2 Experiment 4

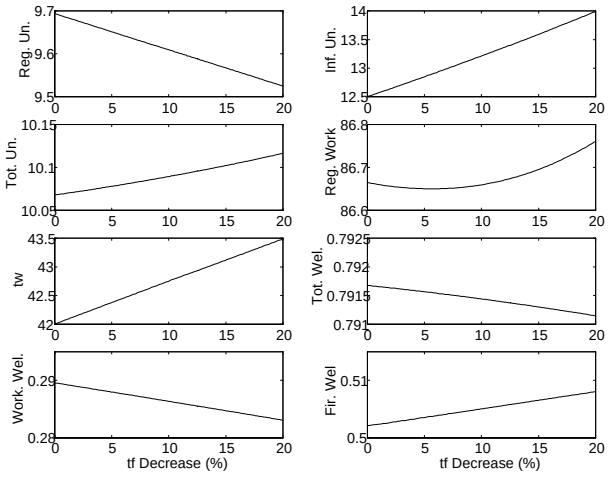

Figure 10: Canada (A)

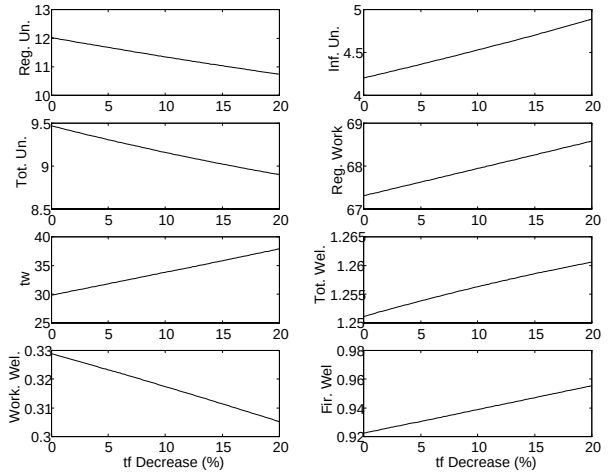

Figure 11: Italy (B)