Audit, tax compliance and undeclared work

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Abstract

This paper analyzes labor tax evasion and the impact of labor inspectorate auditing. The analysis is based on a unique dataset built by linking two important sources of information: a) a dataset of individual artisan firms, b) an individual audit dataset. Our data describe the universe of artisan firms in Piedmont (Italy) in 2000-2005. Using information on firm characteristics and tax evasion, observed directly from the audit exercise, we: a) estimate undeclared work in the artisan sector; and b) evaluate the impact of tax inspections on employer labor tax declarations. Relying on a double hurdle selection model we find that the artisan sector includes around 14% of undeclared workers. We find also that inspections could be counterproductive, decreasing tax revenues and not increasing non compliance.

JEL Classification:
Keywords: Audit, undeclared work, tax compliance, double hurdle, difference in differences.

1. Introduction and literature review

The relation between tax compliance and auditing has been explored in theoretical work in economics since the pioneering work by Allingham, Sandmo (1972). Andreoni et al. (2003) provide an outstanding survey that emphasizes the different impacts of "commitment", and "no commitment" audit strategies on tax compliance behavior.

The main difference between these strategies/models is the assumption of commitment by the tax agency. Some models (in the contract theory tradition) assume that the tax agency can announce and commit to an audit policy, that is known to taxpayers before they file their tax returns. Other models assume that the tax agency cannot commit to an audit policy, and makes decisions after receiving tax returns about which taxpayers to audit. Both assumptions are reasonable, but yield very different predictions about tax evasion and auditing.

Another flourishing branch of the theoretical public finance literature looks at the relation between uncertainty, audit enforcement and compliance behaviors (see, among others Snow-Warren (2005,2008); Alm (1998, 2006WP). With regard on Snow-Warren they notice that uncertainty on audit effectiveness could induce more compliance, and that experience the event of an audit can induce non compliant behavior.

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However, there are few empirical analyses due to the fact that privacy laws and secrecy policies make it difficult to disclose this information. The majority of the empirical work in this field is aimed at understanding the consequence of an audit for income tax evasion and taxpayer compliance (see Erard (1997)' Dubin (1998) for examples).

If we exclude Alm, Blackwell and McGee (2004), which focuses on Gross Receipts Tax in New Mexico, there are few empirical analyses of firm compliance choices. Dabla-Norris, Koeda (2008) and Gatti, Honorati (2008) use firm level data to study the relationship between bank credit and informality in a transition country; while Straub (2005) provides a survey of empirical work on bank credit and informality.

To our knowledge, there are no studies labor tax evasion/compliance (or undeclared work) developed using individual audit data, or on the impacts of audits on labor tax evasion and the effect on firms' labor force declarations[1].

There are several examples of statistical economics analyses that try to estimate the size of undeclared work or the hidden economy. Schneider and Enste (2000) provide an very extensive cross country empirical analysis of the size of the hidden economy. They report estimates for various years, based on four main methods: the Currency Demand method (Tanzi (1983)), the Aggregate Electricity Consumption method (Johnson et al. (1997)), the Household Electricity Consumption method (Lacko' (1999)) and the MIMIC (Loayza (1996) and Giles (1999)).

Our analysis uses individual audit data to estimate the undeclared labor force.

Our study focuses primarily on labor tax evasion (contributive evasion), or evasion of social security tax. Usually this tax is collected by employers, who have the responsibility for saving part of the gross wages for their workers. As we explain, the presence of undeclared workers in a firm is strongly related to labor tax evasion. In order to avoid payment of social security contributions employers are obliged to under declare the real numbers in their labor force, to the social security authorities .

This analysis explores a unique dataset based on labor tax inspections which we use to model undeclared work. We conduct two empirical analyses to understand the relation between auditing and social security tax compliance (and consequently undeclared work).

We explain how we deal with specific econometric problems (i.e. sample selection) related to the data.

Our main findings are that inspections could be counterproductive, decreasing tax revenues and increasing non compliance.

We also discuss some practical and theoretical intuitions to support our empirical evidence.

Since this study is the first to use individual audit data on social security compliance, we believe that further work is needed on this area. Nevertheless, it should make a first contribution to the literature.

2. Our setting

2.1 Environment

To encourage tax compliance in the Italian social security tax system, the Italian Social Security Institute (INPS) conducts audits of firms. The aim of these inspections is to detect evasions and to fine entrepreneurs that try to cheat. In our case cheating means hiding a part of the labor force by non-declaration to the appropriate authority[2] thereby avoiding payment of social-insurance tax.

[1] We explain in detail why labor force declaration and labor tax compliance are related.

[2] We use the definition in OECD (DATE):

Irregular or undeclared work is a job developed without the compliance of fiscal and social security law.

Good and services produced in this activity are legally marketable, therefore are not included goods as weapons or drugs.

Within this definition are the activities of:

1) Permanent work developed without compliance with social security law

INPS is responsible for collecting social security contributions and enforcing payment. Employers in Italy are responsible for paying the social insurance taxes for their employee (acting as "*sostituto di imposta"*). They set the amount of taxes to be paid making monthly declarations of the numbers of their employees to INPS. This tax in Italy is around 40% of the gross wage[3] and an employer found to be underreporting labor numbers is fined to the amount of the underpaid tax plus 33%.

We examine the Piedmont artisan sector. "Artisan" refers to firms registered in the *Albo degli artigiani*. Artisan firms are not regarded as manufacturing firms, which is related to the tradition in the Italian labor market. However, it is common to find services for manufacturing firms, transport services, personnel services and technology (i.e. games and software houses) in this group; which firms can be included as artisan is dependent on their size. According to the production sector (to which they belong) artisan firms cannot exceed a certain number of employees[4].

Generally, Italian artisan firms employ less than four workers, but in the majority case declare only one employee. Artisan firms in most of the Italian region exceed 50% of total firm activity, which applies also to the case of Piedmont.

Undeclared or "black work", in Italy is a substantial problem. Every year the Italian Statistical Institute (ISTAT) estimates the [5] percentage of Italian undeclared employees to provide an aggregate level of full time employed (FTE) irregular workers, per regions, per year for the four main productive sectors (industry, constructions, agriculture, services)[6]. For the years taken in our study 2000-2005, the percentage of undeclared workers estimated by ISTAT is around 17% (of the total amount FTE in the labor market), of which 27% was in the southern Italian regions (i.e. Calabria). The percentage of non-declared in Piedmont is around 5-6%. The ISTAT index is an aggregate indicator that does not allow descriptions for the artisan sector; this applies also to the provincial level.

We propose an indicator that takes account of the artisan sector based on our individual audit dataset.

2.2 Auditing scheme

As Andreoni et al.(2003) note, there are two ways to build an auditing scheme. Audit authorities can decide to publish or not their audit policies.

Theoretical schemes are difficult to apply in practice. Based on knowledge of the procedures applied by an audit authority, it is difficult to ascertain whether an authority subscribes to one or the two schemes. An appropriate test would be to construct in order to answer this question carefully. Di Porto's (2009) 2009 PhD dissertation and Persico, Di Porto, Saughuet (2010 WP), provide for INPS auditing a test that shows INPS authority follows the strategy of non-disclosure (no commitment) of their scheme.

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2) Occasional work by self employed workers responsible for payment of their own tax , students, housewives or retired people

3) Foreign or irregular employees A work developed by a stranger nonresident or irregular

4) Part time work, part of a multiple employment, which is not the main job but, without declaring this situation to the appropriate institutions.

Receiving a wage without paying full social security taxes is tax evasion. The guilt rests on the employee if the obligation to pay the social security tax is his (as in Sweden), but in most countries, it is the employer who is responsible of deducting the tax from the gross wage and paying it to the appropriate authority (as in Italy).

[3] For most workers this tax is 40-42% of the gross wage; for some it is 38%

as "artisans," and only 23% for specific types of workers who are not permanently employed. Our data distinguish among the first two types of workers. Our declared worker are all "artisan", since we are exploring the artisan labor market in Piedmont.

[4] For an extensive survey on Piedmont artisan firms see Di Porto, Giordanengo, Filippi (2009),)(in Italian).

[5] An explanation of this methodology is provided in "L'occupazione non regolare nelle stime di contabilità nazionale"nota metodologica, www.istat.it, cited in OECD (2004) available on line at www.oecd.org

[6] In 2010, ISTAT will publish a more refined index, containing more disaggregated sectors.

INPS audit department (vigilanza ispettiva INPS) keep their targets secret. They choose firms to audit based on maximizing INPS revenues through the fines imposed[7]. Therefore, they select, from the whole universe of firms, those most likely to have underreported their workers.

We can identify two groups of inspections: a) the authority as a strong clue that an underreport it was made, we can call this the "red flag" group audit which happens if the authority receives a declaration directly from a private citizen (i.e. a worker that would have back his social security payments). Or when by mistake (or on purpose) the employer declares the worker but do not pay his social security tax[8] (scopertura contributiva). Our data shows when an inspection is conducted following a red flag ; b) the authority decides to target a particular group of firms, relying on its socio-economic knowledge of the market, which we call "targeted inspections". Sometimes it is the inspector him or herself that audits the particular firm, in this case he or she relies on knowledge of the territory he or she covers. INPS inspectors have certain degree of freedom in his choice; it is normal practice for policing authorities to have discretionary power in their dealings with their customers. INPS inspectors are regarded by the public as Street level bureaucrats Lipsky (1980). Every INPS inspector is assigned to a particular area where he or she develops the audit. Areas are usually by province, or municipality if the province is too big (i.e. Rome, Milan, etc). Our dataset give information about this last kind of inspection, although it does not explain us why a specific firm was targeted.

We use a selection model based on the firm's observed characteristics (location, dimension, etc) and characteristics of the audit, in order to understand which firms are more likely to be audited. This information is fundamental for estimating tax evasion /undeclared work in the artisan firm sector.

3. Data

Our dataset is built by linking two main sources of data: A) an individual audit dataset that contains information on inspection characteristics, information on the firm inspected and information on the result of the inspection: amount of fine, number of undeclared workers found, number of days spent on the inspection. This dataset contains also: Uff(i), dummies that describe which office in the INPS structures decides to develop the audit. The INPS organization is structured as follows. There is a national level, a regional level and a territorial level. At any level a decision could be taken to audit a particular firm. Uff1 define the national level, Uff2 the regional, Uff3 the territorial agency and Uff4 defines when is another Institution that advises INPS to conduct an audit. The dummies Control(i) define the administrative control of the previous audit . Those controls describe the different red flag situations or the targeted inspections: Control1 are administrative controls developed merging different administrative datasets, control2 are targeted inspections, control3 define those audit that are developed after a complaint (a worker wants to be reimbursed for a contribution and calls INPS for an inspection), these have been referred to as whistleblower audits. Control4 are inspections after a bankruptcy trial. Control5 are audits developed after a "scopertura contributiva". The dummies Task(i) define the task force that developed the audit: Task1 is where one INPS inspectors goes to inspect the firm. Task2 is when the INPS and some other administrative inspectors are involved (i.e. health care inspector etc.). Task3 is one when a policeman accompanies with the INPS inspector. This dataset refers to inspections in Piedmont artisan firms in the period 2000-2005 .

B) an individual firm dataset of Piedmont artisan firms, which contains information about all artisan firms active in the period 2000-2005, information on employers (i.e. sex), firm (location, productive sector,

[7] This is what they try to do in principle; we show that other factors could make this objective difficult

[8] This situation happens frequently for a number of reasons, i.e. the employer relies on a large number of firms present in the market and on that forgetting a monthly payment might not be noticed by the authorities (recall that payments are due monthly). It can happen also if an employer under declares in one month his already declared labor force.

number of years of activity, etc.[11]), workers (number declared every year, average yearly labor tax to be paid by the employer for a FTE worker, expressed in euro). These two sources are lined by the identification numbers that occur in both datasets[12] and allows us to link the artisan firms in the firm dataset with the corresponding inspected firm in the audit database. In other words for those firms not inspected we have information only from the firm dataset; for audited firms we have information from both datasets.

Our dataset contains black economy firms, firms that are not registered as firm but that develop a productive activity using undeclared workers[13].

We summarize our main information based on simple summary statistics, which are explained in detail in Appendix 1 which provides tables of summary statistics.

Our dataset consists of a structures panel dataset. Not all firms are active for the whole observation period, which means that the panel is not balanced. The panel is composed of a total of 200,965 firms for the 2000-2005 period.

Roughly 133,000 firms are active each year, 1,5% of which have been inspected by INPS. The average number of workers declared by these firms is 1, they are very small firms and 90% of the firms active every year do not declare more than 4 workers. These dimensions are in line with Italian standards.

The average number of undeclared workers found during an inspection is less than 1[14], while the average value of tax evasion discovered in an inspection is roughly around 1,100 euro. Just 53% of the selected firms are inspected 'successfully' by which we mean resulting in a fine to the employer[15].

For FTE declared workers in the artisan sector the amount of tax annually is 4000 euro on average[16]. Thus, on average, in our observational setting, a worker found working in the black economy has been under declared for less than 3 months[17]. Using the amount of evasion discovered and the average amount of tax to be paid for a FTE legal worker (both available from our dataset), we can calculate the number of months that a worker has worked undeclared. This information can be used to calculate a proxy for irregularity which we call FTEBW (FTE black workers), that is the euro value evaded and discovered by the inspector in a specific firm, divided by the average amount of tax to be paid in one year for a FTE legal worker. This s a continues variable that is 1 if the amount of evasion discovered is equal to the average amount of labor tax to be paid yearly. On average, an artisan firm discovered evading 4,000 euro will have FTEBW≈1. This variable is created since the information provided by number of workers detected as undeclared during an inspection is not reliable indicator for the dimension of the evasion. FTEBW on average is around 1.1 but its 75th percentile is 0.46; this variable is skewed and mostly 0, table 7 provided detailed stats on this variable.

[11] The productive sectors considered are: Mechanical, light manufactures, other manufactures, Construction, Reparation,Transport , Firm services and Personal services. The locations are the Piedmont provinces: Alessandria,Asti,Biella,Cuneo,Novara,Torino,V.C.O.,Vercelli.

[12] Provided by INPS Regione Piemonte and Osservatorio delle attività produttive Regione Piemonte

[13] INPS audit dataset contains information on those firms. When one is detected by an inspector the firms is forcibly recorded as inspected. Therefore we should find it, firstly, in the individual audit dataset. After the inspection a "completely black" firm is then recorded as a firm and, from that period it has to pay labor tax (plus the fines imposed). We find these firms recorded also in the second dataset and their activity will start from the year of the inspection. Very often those firms do not continue production after being discovered. The cases of massive evasion reported in table 4 appendix 1, usually are cases of completely black firm.

[14] This because some inspections do not find irregular workers.

[15] INPS defines successful audits as those audits that reveal every kind of formal irregularity. Formal irregularities are also irregularities such as not recording in the firms records the name of a worker, therefore also silly formal issue, usually not fined (or fined with a risible forfeit). Conversely, our analysis highlights, only those cases directly related to undeclared work. Even including these small formal irregularities the success rate is 65%.

[16] This amount is calculated knowing the average amount of gross salary paid every year per each sector.

[17] As already said, the evasion discovered is proportional to the number of days worked undeclared. This means that evasion of 4000 euro correspond to a 1 years completely undeclared work; 1000 corresponds to 3 months.

4. Undeclared work estimation

Measuring tax evasion is very difficult. Tax evasion by nature is concealed, compliance goes hand in hand with enforcement, and observed compliance is the result of the strategy of the enforcement agencies in response to the tax-payers' behaviors.

In our case we attempt to measure undeclared work relying on individual audit information. This, as explained in section 2.2, are indeed information provided after a strategic selection.

INPS selects firms for audit that are likely to have underreported their real labor force numbers.

Selected data produce biased estimates, if the selection is not treated carefully.

Relying on what we know about the audit schemes and firm and inspection characteristics, we can attempt to estimate undeclared work in a appropriate selection model. Our dataset was built with this aim and includes characteristics of non audited firms. Thus we can observe the full sample of artisan firms, and the sub sample of those believed to be tax evaders, which indicates the results of inspection.

The proposed selection model follows Cragg's (1971) and Blundell-Meghir's (1987) modified Tobit or double hurdle model (DH). In our setting an audit follows a precise procedure.

The audit department selects a sample of firms and the real result of the inspection (the number of irregularities detected) fallout from the inspection. Therefore, there are two selections to be treated, one is "being inspected or not", and the second is "being irregular and how much" (given the fact of being inspected).

Our variable FTEBW, could be used as a dependent variable in the selection model to estimate undeclared work, but is strongly skewed and sometimes zero as shown in table 7. Moreover a linear prediction based on this variable could lead to negative predicted values, which are not consistent with our aims; thus we decided not to use Heckman selection. We transform FTEBW from continuous to count and we choose to model this new variable in a setting that can handle skewness and a great amount of zeros[19].

The idea behind the DH formulation is that a probability model governs a binary outcome of whether a count variables varies as a zero or positive. If positive, the "hurdle is crossed", and the conditional distribution of the positives is governed by a Tobit or similar data model.

The double hurdle setting has a similar log likelihood to a Tobit, as demonstrated by Cragg, but allow us to get rid of the negative prediction problem, which is guaranteed by the Tobit (or truncated zero model in the second stage). Therefore, we need to compute two stages: one for the binary outcome (inspected or not) and one that assumes that a normal distribution truncated at zero governs the errors of our positive outcomes (detected as evaders and fined). With these assumptions we can complete our model using a Tobit (or truncated at zero) regression[20]. DH can be estimated using count or continuous dependent variables in this second stage. This is a perfectly legitimate variation on the limited dependent type model proposed by Tobin and it is a slight variation of Cragg (1971). The second step of a double hurdle can be computed in many different ways, when we use count variable as dependent, Poisson regression or zero truncated negative binomial are common, this is confirmed by Amemiya (1984). Newman et al. (2008) provide a similar model, accounting for a continuous dependent variable in a double hurdle setting.

In the usual double hurdle formulation, a Probit determines the decision to participate in a program (or make an expenditure), while a Tobit determines the level of variation that has a certain outcome variable given the fact of being involved in the program (or level of expenditure). In our model we have a "forced participation" level, being selected as possible evader and, a second level that quantifies the extent of the

[19] Moreover a maximum likelihood (ML) technique such as the one we provide is always more efficient than a Heckit.

[20] Amemya(1984) demonstrates that TOBIT can be approximated by truncated at zero ML, however other transformation are commonly used in double hurdle approach: zero truncated negative binomial, Poisson etc.

evasion. This second level includes only firms identified as probable evaders in the first stage and detected as evading a certain amount of tax[21].

For practical reasons, we implement the model in two stages, which is a legitimate transformation of the original Cragg formulation, and as explained in McDowell (2003), the hurdle model log likelihood can be maximized without loss of information, by maximizing the two components separately. The theory provides no guidance about which explanatory variables to include in the first and second stages of the DH model. However, including the same set of covariates in each hurdle makes it difficult to identify the parameters of the model and so exclusion restrictions must be imposed (Jones, 1992; Yen *et al.*, 1996).

Of course our formulation is not free from limitations, it can be argued, for example, that corruption or bribery behaviors may lead to bias. However, we believe that these kinds of practices are not very diffused in this part of Italy. Data such as we have here would be more biased if based on regions where criminal organizations had great power over the market, which does not seem to apply to Piedmont.

We rely on the DH formulation to take account of other types of measurement error.

The first stage Probit model is developed on the whole sample of firms for 2000-2005. ISP is a dependent variable that takes the value 1 when a firm is inspected. The covariates we use in this stage are DEP number of declared dependent workers, SEX the employer's gender, AGEFIRM number of years of firm activity, the 3 UFF(i) dummies, the 6 Control(i) dummies (that define red flag or targeted inspections), 8 dummies for the productive sectors and 8 dummies for the Piedmont provinces.

The second stage is developed on the sample of firms evading detected by the audit. The dependent variable is disHTE, the covariates are DEP, the dummies for provinces and sectors, the 3 TASK(i) dummies detect the effect of different task forces, SEX the employer's gender and PERIOD the number of days over which the inspection was conducted. Our dependent variable in this second stage is a count variable. It is created starting from our indicator of irregularity FTEBW. Firstly we winsorize FTEBW at the 95 percentiles. Then we discretize this continuous variable recoding in the following way: from value 0 to 0.25 we create class 0, from 0.251 to 0.75 we create class 1, this stands for one half time equivalent (HTE) undeclared worker detected, from 0.751 to 1.25 we create class 2, thus two HTE detected (or a FTE undeclared worker). We continue in this way creating 11 classes of HTE undeclared workers. In fact the 95 percintile of FTEBW is around 5. As we said this second step of DH can be done in many different ways. We choose zero truncated negative binomial estimation (ZTNB). Our purpose is to treat the large amount of zero that affect our dependent variable as well as its skewness. For this reason ZTNB or Poisson (zero truncated poisson) are good choices in DH model. After an appropriate LR test we prefer to use ZTNB, DH formulation imply to test normality of residuals in the two stages, in Appendix 2 we present robustness checks for residuals, LR tests and Wald tests for the specification of the model.

Table 5 shows an extended formulation of the model, usual coefficients and marginal fixed effect for both the regressions are presented.

In the first stage the covariate DEP as a positive effect, therefore probability of being inspected increase with firm dimension. Older firms are less likely to be inspected, AGEFIRM coefficient is indeed negative. Older firms could be seen as the stronger firms in the artisan market, we could say that employers of those firms learned how to stay on the market, usually those firms are less involved with illegal practice (Meldolesi, 2000). INPS doesn't seems to differ really much its choice referring on productive sector, while much more clear is the strategy adopted for the different provinces. According just on the information provided to this first stage, INPS seems to suspect evasion being concentrated on those firms young and big (big respect to the tiny dimension of this artisan sector), no matter which sector they come from. Sex of the employer doesn't seems to be a clue for the inspector. The other dummies used at this stage are qualities of the inspection developed. They are all significant, INPS leaves to its local departments a good amount of

[21] We treat this sample as a truncated sample (at zero), not allowing for zero at this stage is our attempt to solve for observed zeros in our dependent

discretionary. The dummies for Regional and territorial department are both positive and significant. While the great part of the audits derive from whistleblower, targeted and bankruptcy inspections.
The second stage reveals that bigger firms evade more, age is not significant while sectors dummies explain, better than in the previous stage, the extent of the evasion. Respect to the benchmark sector (mechanicals) every other sectors seem to evade less. Long inspections reveal much evasion, in fact period is positive and significant. Audits developed together with other authorities are more profitable.

A better picture could be revealed predicting the average number of undeclared workers in the artisan sector. Tables 6 describes the average percentage of full time equivalent black economy workers disaggregated for different characteristics. The average value of undeclared work in our sector is around 14%[24].

An average of 14% is not in line with ISTAT estimates for this Region. Thus if ISTAT index is a good predictor of the average amount of under declaration presents in the whole Piedmont market, we have to conclude that artisan sector seems to attract the great quantity of hidden economy, as a consequence evasion is mostly concentrated in artisan sector. This picture is in line with a great part of the Italian literature on the field. Meldolesi (2000), observes that the informal connections that characterize artisan production increase the probability of getting to illegal contracts. Artisan sector is composed by a huge amount of little firms and this create a perfect humus in order to conceal non compliant behaviors. The same picture is provide by Di Porto, Giordanengo, Filippi (2009). The province of Torino, which is the biggest and the more industrialized in the Region, has the great percentage of evasion around 17%. Mechanical sector is predict to have the great amount of evasion the double if compared with other sectors, more than 10% of the evasion is present in manufactures and transportations. It should be noted in the particular case of transportation, this results was expected since in Italy there is a pervasive existence of "padroncini" very small transport companies (specialized in domestic removals and transport) with limited vehicle fleets, usually small vans. Take advantage of the fact that these vehicles are always on the move, there is no established "head office" and it is fairly easy to not declare numbers of drivers and thus evade tax.
Our prediction is a very refined picture of the labor market, which allows us to detect undeclared work at province level, ISTAT index cannot provide this disaggregated picture. To our knowledge, no other estimator has been provided that is capable of detecting evasion in the artisan sector.

5. Evaluation

5.1 A simple model

We now provide an evaluation of the impact of an inspection on firm choices. We are interested in how an audit influences the future behavior of the employer. Does behavior change or not? We are interested in whether : a) auditing a firm affects future tax declarations by the employer (this argument is clearly related to the number of workers declared by the employer); b) auditing has an effect on the numbers of black economy workers hired by a firm in the future.

We rely on our dataset to answer these questions, and therefore asses an empirical evaluation based on difference in differences (DiD) analysis.

A first theoretical view of our setting is fundamental in order to form expectations on the possible outcome of our empirical evaluation. As already mentioned, we principally follow the assumption of a no commitment audit, in which the audit authority does not make public its strategic choices before conducting an audit.

[24] Our Double hurdle estimates are based on classes of HTE black workers, from them the passage to FTE is an obvious and simple multiplication. Indeed 2 HTE = 1 FTE. Therefore we predicted the number of HTE in every artisan firm form the DH model and then we transform them into FTE.

To understand the possible effects on employers' compliance we need to investigate a) the probability of being audited and/or the probability of being audited several times in a row; b) the amount of the fine(s) imposed; c) the possibility of avoiding total payment of combined fines.

On the first point, issue Di Porto, Giordanengo, Filippi (2009) develop a simple simulation on the probability of being audited based on the observed audit probability in the period 2000-2005 in the Piedmont artisan sector. They observe that if every year a random 1.5% of firms was inspected (in line with the average percentage of inspected firms), among Piedmont artisan firm after 10 years the probability of being chosen (randomly) at least once time would be around 15%, which means that 85 % of the firms would not be inspected. The same simulation provide an idea of how the situation would change with an enforcement of 5% which would mean that after 10 years the probability would be 40% of the firm population. It is clear that the probability of being inspected plays a fundamental role in firm choice.

In the case of artisan firms, the probability of being chose over time is small[25].It is also interesting to examine the behavior of an employer that has been audited. This was investigated by Snow-Warren (2007), who notes that tax evasion is affected by the taxpayer's perceptions of the audit probability and is influenced by prior audit experience, showing that for a variety of risk preferences (CARA,CRRA and DARA) , Bayesian updating increases present and expected future tax evasion and reduces tax payments, inclusive of expected fines. Therefore, it could be expected that, as a result of being audited, under declaration increase. In the case of artisan firms there are no examples of more than one audit of the same firm in the 5 years observed[26] .

In order to emphasize points b) and c) above, we develop a simple model of a no commitment audit to explain the compliance behavior of an employer and the role played by fines. We would also underline an issue neglected by the theoretical models of the role played by the public credit recovery system and administrative justice. An interesting argument in the context of the Italian labor market, is the inefficiency of the Italian administrative justice. In our case, this inefficiency allows an evader discovered by the INPS to be cheating, to pay just a small proportion of the fine imposed[27],based on evidence from the Italian "Corte dei Conti", which estimates the amount of credit recovery from contributive inspections to be less than 23%. In the following, we provide an interesting and very simple model of tax compliance, similar to that in Snow-Warren (2005). We make some minor modifications to account for what we call the "recovery problem" related to the penalty rate: in Snow-Warren the penalty rate θ is equal to the amount of the fine evaded plus a certain percentage (i.e. 1000 euro of evasion detected becomes 1300 euro of fine, that is equal to a $\theta=1,3$,therefore $\theta>1$). In our example, we use a recovery rate of r, $0\leq r\leq 1$. Therefore the penalty rate becomes a "real penalty rate" of $\Theta=\theta r$. We assume that an employer decides to cheat (or not), based on this real value of the penalty rate. We consider an individual taxpayer with a fixed taxable income W, facing a non random, proportional tax rate t, who chooses an amount of undeclared income x to hide from the tax authority. The taxpayer's income is $W(N)=W(1-t)+tx$ if no audit is conducted. If the taxpayer is audited, a proportion $\alpha\in[0,1]$ of the evaded tax tx is detected. Income is then reduced by the amount of tax evasion detected multiplied by the gross penalty rate $\Theta>1$. Thus, in the event of an audit, the taxpayer's income is $W(A)=W(1-t)+(1-\Theta\alpha)tx$. We assume that audits are random and that the taxpayer knows the probability p of being audited, but is uncertain about α, and hence is uncertain about the effectiveness of tax audits for detecting evasion. The taxpayer is assumed to be strictly risk averse, and expected utility maximizer with the

[25] The simulation cited models inspection as they were developed randomly, therefore the effect of inefficiency seems larger, but at this stage we would just create a reliable scenario for our empirical findings.

[26] Di Porto (2009) finds very weak evidence of re-inspection even on the whole Italian market.

[27] Usually an employer threatened with a penalty takes legal procedures against the INPS based on possible procedural infractions during conduction of the audition. A slow civil justice system as in Italy, implies at least 3 year for a preliminary decision, and another 3 for the final decision. Therefore, at least 6 years is likely to pass before the fine is payable. At the end of this long procedure the employer could ask to pay in 60 installments. In Italy amnesty tax laws are quite frequent (one every 7-8 years) and this allows the employer to pay just a part of the fine imposed.

von Neumann-Morgenstern utility function U(W) . Thus, the taxpayer chooses x subject to the constraints $W \geq x \geq 0$ to maximize the expected utility function:

$(1-p)U(W(N))+p\int U(W(A))dF(\alpha)$ where the cumulative distribution function $F(\alpha)$ represents the taxpayer's uncertainty about α. We assume that the taxpayer's expected return per euro of tax evaded is positive. Since the taxpayer exhibits second-order risk aversion (Segal and Spivak 1990), and the expected return to evasion is positive, the taxpayer's optimal choice of undeclared income $x*$ is positive.

We assume that $x*$ is less than W, and therefore satisfies the first-order condition:

$(1-p)U'(W(N))+p\int U'(W(A))(1-\Theta\alpha)dF(\alpha)=0$.

Since the taxpayer is strictly risk averse, the second-order condition is also satisfied. We now consider the effect on taxpayer compliance of increased uncertainty about the proportion of tax evasion that will be detected if an audit is conducted (audit effectiveness). A mean preserving spread of the distribution $F(\alpha)$ (Rothschild and Stiglitz (1971)) decreases the amount of tax evasion if the integrand in the first-order condition, $U'(W(A))(1-\Theta\alpha)$ is a concave function of α, that is, if $2U'(W(A9)+(1-\Theta\alpha)txU''(W(A))$is negative.

The first term is negative given risk aversion ($U''<0$) , and the second term is non-positive if the taxpayer is downside risk averse ($U'''>0$) and α is no less than $1/\Theta$. Observe that α must exceed $1/\Theta$ for at least some values in support of $F(\alpha)$, otherwise the taxpayer would report no income, which is contrary to our assumption. We conclude that prudence (i.e., risk aversion accompanied by downside risk aversion) is sufficient to imply that tax evasion decreases with greater uncertainty about audit effectiveness, provided the taxpayer believes that the proportion of evaded tax detected by an audit will never be less than $1/\Theta$. This result allows us to use the property $\alpha \geq 1/\Theta$ in order to understand the relation between uncertainty, penalty and compliance. For example, in Italy $\theta=1.33$, considering a tax of recovery r=1, an employer would have to have an uncertainty of around 75% (i.e. , he believes that at least around the 75% of the amount evaded will be detected)of an inspection, for this to be a considerable tax evasion deterrent. As already underlined, in Italy r is considerably less than 1, to be precise, in a computation, the Corte dei Conti shows (for the first time in 2007) that the recovery rate for evaded contributions is around 22.3%. Taking this into consideration , we can fix the uncertainty rate at around 90% and using the previous property, calculate the gross penalty rate Θ, to obtain 5.05. This is the penalty rate that equates with the decision to evade. This means that, even considering a high uncertainty (credible only if the employer believes that inspectors are able to detect 90% of the total evasion) we should increase the penalty rate by around 5 times, to obtain a good deterrent effect against non compliance.

This theoretical result means we should not expect an audit to have a major impact on compliance. In fact, if we assume that employers are prudent (i.e. risk adverse and downside risk adverse) we would suggest that the Italian "real penalty rate" is not enough to achieve compliance.

To summarize, we have no preliminary “rational” clues to believe that audits for labor tax evasion in the case of artisan sector will have a positive influence on compliance behavior. This is the null hypothesis we test.

5.2 The effect of auditing on firms’ declarations

In this section, we estimate two empirical models to explain the impact of an audit on the employer's decision to hire workers. In particular, we want to know what is the effect of an inspection on the propensity to declare workers and/or to hire and not declare workers.

For this reason, we calculate, first DiD fixed effect panel regressions, in which the dependent variable is the difference in the number of declared workers for two consecutive years and the covariates are dummy variables built by multiplying the amount of the fine imposed by a dummy that equals 1 if the firm was audited. In the second analysis, the difference in the estimated number of FTE undeclared worker (for two consecutive years), is regressed as a dependent in a pooled linear regression using the same covariates as before. As we have already mentioned, we are dealing with a unbalanced panel dataset, which creates some problems in choosing the right sample for our models.

First, we have to exclude the possibility that an inspection will lead to closure of the artisan firm's activity; this is the same as the attrition problem for our panel. Artisan firms might have short lives due to the seasonality of their production. The event of an inspection could be non-significant in explaining what happens to the firm's activity; nevertheless, it could induce the employer to close or to modify his declared labor force. Our theoretical view leads us to question whether closing production after an inspection is unlikely. This is because Italian audits are not very powerful in terms of the fines imposed (the recovery system is not efficient and few audits result in high fines). Moreover, following the Snow Warren Bayesian game, it is possible that the event of an audit could increase the number of under declarations.

If we can show that an inspection cannot lead to the end of the firm's activity, we can demonstrate that the event is either not significant or induces a modification in the number of declared workers.

Therefore, finding that an audit is not significant in explaining firm mortality allows us to use just the firms that are always active (during the whole observation period), in order to regress the difference in the number of declared workers on the event of being inspected[28].

Table 8 presents the conditional fixed effects logistic regression, in which the dependent variable is a dichotomous variable PROB_OUT which is 1 if the firm(i) closes its activity in the year t, and 0 otherwise. The covariate is ANYMONEY, which is a dummy variable equal to 1 if the firm(i) was inspected and detected as irregular in the year t. We are interested in the relation between the dependent in the year t and the covariate in the year t-1.

Inspections are not significant to explain firm mortality as shown in table 2, and confirm that audits seem not to have a great impact on firm survival, which we investigated further in the theoretical part.

Based on this evidence, we analyze a sample composed of firms active across the whole period.

We show first (table 9) a panel of fixed effects linear regression where the dependent variable is DF , i.e. the difference in the number of declared workers for year t and year t-1, and the covariates are 3 dummies FINELOW, FINEMED and FINEHIGH. The first is 1 if the firm is inspected in year t and receives a fine of less than 500 euro, the second is 1 if the firm is inspected in year t and the fine is between 500 and 2,236 euro, the third is 1 for fines of more than 2,237 euro (i.e. the 75th percentile of the fine distribution).

Table 9 also presents a pooled linear regression, which uses the differences in the estimated number of black economy workers per firm for two consecutive years as the dependent variable, DFBW, this variable is directly computed form our DH predictions. In both models, we are interested in the relation between the dependent variable at time t and the covariates at time t-1.

In the first case we use a panel regression to formulate our DiD evaluation, here our counterfactual is created from the non inspected firms based on the whole observation, (therefore we take in to account for this first model either inspected firms or non inspected active for the whole period), We formulate the model including and excluding time dummies. The results for all the covariates are significant, and the number of declared workers decreases with the event of an audit. As the fine increases, the negative differential also becomes larger.

For the second model we prefer not to use the panel formulation, because in this case the coefficients may not be so simple to interpret. For the dependent variable we use the estimated value of undeclared work, which, in principle, is a function of the event of being inspected. This could introduce different problems, for example, collinearity. We prefer to formulate a pooled model, allowing for the possibility of having time dummies.

[28] The idea is simply that an inspection could induce 3 different events in the firm's life: a) end of the firm activity; b) no effect; c) modification in the number of workers declared. Therefore, if we find that a) does not apply, we can take just the firms that are always alive and active in order to find b) and c)

Our choice is driven by the idea to complete our analysis, considering the fact that results are extremely interesting even if we recognize that the coefficient found could be difficult to interpret. The coefficients of the covariates go in a interesting direction. Our covariates are not significant therefore an inspection cannot be seen as a sure deterrent against undeclared work. In the second model including time dummies coefficients, remaining not significant, go in the direction suggested by Snow Warren. These results explain the theory that inspections do not forcedly increase compliance, and also in relation to the second point, although the evidence is weaker, it is in line with the Snow Warren Bayesian game.

The implications for policy from the first model are strongly that audits reduce tax revenues (and consequently employment). Moreover, there are no clues that inspections could be a good deterrent for tax evasion.

6. **Conclusions**

We used individual audit micro data in order to understand the behavior of an employer faced with the decision about whether or not to try to evade social insurance tax when there is the threat of an audit. We use the population of Piedmont artisan firms to explain the real impact of an audit policy on a firm's decision.

We built a new dataset to use in a double hurdle selection model to predict the number of undeclared workers in the market. The estimation procedure predicts the number of FTE irregular positions; the estimate is unbiased due to the procedure used, and reveals an average of 14% of undeclared workers. To our knowledge this is the first attempt of predicting labor tax evasion at this refined-level.

We assessed audit policy evaluations to understand the impact of inspection on firms' compliance decisions, and find that: inspections could induce counterproductive reactions. The number of declared workers decrease significantly with the amount of the fine imposed, reducing tax revenue.

Our empirical findings suggest that an employer has a lower expectation of a future audit if he or she has been audited in the past. As a consequence evasion and undeclared workers could be increased by an audit event. In both of our models, the empirical findings are in line with the theory.

The individual contributive audit data used in this analysis, provides an interesting and useful instrument to asses policy evaluation and estimations of undeclared workers. Since this is a novel dataset, we believe that further work could be done in terms of evasion estimations or evaluation. Nevertheless, we think that this study provides some novel and interesting new insights.

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APPENDIX 1

Our panel is composed by 200965 firms. In table 1 we present the number of active firms and the number of inspected firms per year.

Table1: descriptive statistics on firms non audited, audited, undeclared workers detected and declared workers.

Firms	2000	2001	2002	2003	2004	2005
not audited	127,170	128,758	130,318	131,814	132,455	134,572
audited	1,293	1,898	2,338	2,503	2,088	1,705
Total	128,463	130,656	132,656	134,317	134,543	136,277
Workers						
Undeclared						
mean	0.17	0.20	0.19	0.15	0.12	0.08
Sd	3.50	2.78	4.00	1.72	1.71	0.68
Max	309	197	427	156	157	27
Declared						
mean	0.98	0.97	1.06	1.01	1.00	0.95
sd	2.51	2.49	2.60	2.50	2.49	2.96
max	45	52	58	41	56	45

Source: our computation on INPS and Osservatorio artigiani Data

The number of active firms is constantly increasing in 2000-2005. During the same period, the number of inspected firms increases up to 2003 and then decreases from 2003 to 2005 . The percentage of inspected firms is around 1.5% per year. The number of inspections in the artisan sector increases rapidly after 2001 for several reasons which it is difficult to take into consideration in our analysis. After 2001, INPS increased enforcement and recruited more inspectors, although we do not know how many were assigned to Piedmont. During 2002, across the whole of Italy, INPS conducted a number of audits aimed at supporting the imminent approval of an amnesty tax law for nonresident workers - the Bossi/Fini law. However, we have no way of knowing which audits resulted from this action. Certainly, the increased number of inspections is related to the increase in the number of active firms (see TableA1 above. It should be remembered, that INPS strategies derive principally from considerations for the whole Italian labor market, of which artisan firms are a small proportion.

Table 1 also provides descriptive statistics for number of workers "declared" by employers. It is usual in Italy to find a large number of small firms with more than the 90% of Italian firms employing fewer than four (declared) workers. This is also applicable to France, Spain and some areas of Germany. Therefore, the case of artisan employment is a good example for the Italian environment. The average number of declared workers is near to 1 (this is because for this summary statistic, we set the number of declared workers to =0 when the firm owner (employer) is the only worker declared, a situation that is common among Italian firms), only a few firms are larger than 40 employees, which is the generally the upper bound for a firm to be considered artisan. There are cases were artisan firms could have employment of more than 40 if experts are hired for a set period of time. As already noted, it is important to analyze the case of firms that drop out of the sample completely or stop production for a period . Table 2 provides preliminary evidence on this particular problem.

Table 2: percentage of firms inspected (and not inspected) that goes out of our sample between two years

% Firms out	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
non insp	7.22	5.99	7.75	8.65	7.25
insp	8.03	5.39	7.63	10.39	8.23

Source: our computation on INPS and Osservatorio artigiani Data

Table 2 reports the percentage of firms that discontinued activity as artisan companies[29]. In the transition for year t and year t+1. We divide the sample into two groups for this analysis, to better understand the motivation for activity ceasing. Therefore, for every year we observe the group of firm that is inspected, and the group that is not inspected. Comparing the percentage of firms that drop out of these two samples between year t and year t+1, we note that the annual difference in the two samples is always less than 1%. Moreover, in some transitions, the sign of this difference changes (i.e. in 2001-2002 and 2002-2003, non inspected firms appear to be more likely to discontinue their activities).This is a preliminary test to show that mortality and audit seems not to be strictly related.

Table 3: descriptive stats on evasion detected every year, numbers in euro

Evasion	2000	2001	2002	2003	2004	2005
mean	1,147	772	479	879	1,218	1,028
p50	0	0	0	0	0	0
sd	16.313	7.040	4.005	13.099	10.106	10.336
max	1,104,931	318,880	112,550	1,142,447	436,340	475,690

Source: our computation on INPS and Osservatorio artigiani Data

Table 3 presents detected evasion result from an audit, in euro and provides some summary statistics. This is based on taking into consideration every firm in the sample; thus, the large number of zeros is based on the fact that in the majority of cases there was no inspection . We can see that for the inspected firms, the variable "euro evaded" is extremely skewed, the median is around 50 euro and the 75th percentile is around 2237 euro. If we look at average values, we can see that this distribution is specular to the distribution of inspected firms. Therefore, we observe an increasing value of detected evasion during the years in which there are fewer audits. In some years when productivity per inspection increases. INPS asked to its Regional agencies to obtain the same level of euro detected but at the same time, they decreased the budget of every agency. In some parts of Italy such as Piedmont this increased the value per inspection.
Table 4 shows the average annual amount of labor taxes that an employer has to pay for one FTE worker. Comparing these values, with those in Table 3, we observe that the average value of detected evasion is around 1/4 of the value of the tax that has to be paid. This means that, on average, an audit discovers 1 undeclared FTE for 2/3 months. Table 1 (the bottom) supports this providing evidence of the number of undeclared workers detected during an inspection. Here, the average is 0.15, which corresponds to 2 months full time period of black work. Note that the distribution of the maximum shows that, every year, there is at least one "massive" evasion case discovered. These are usually cases of "completely in black" production.

[29] More precisely, a firm may disappear from our sample by becoming too big to be classed as an artisan as well as if it ceases production. In this case production passes from the manufacturing sector to the industrial sector. As there are very few artisan firms that develop industrial scale production in Piedmont, we do not take account of this possibility

There are fewer of these cases these are striking but really out of the normal standard evasion that at least for Piedmont artisan sector seems to be diffused but minor.

Table 4: average amount of labor taxes to be paid for a FTE worker every year on different sectors, numbers in euro

Labor Tax.	2000	2001	2002	2003	2004	2005
Mech.	4,807	5,107	5,387	5,496	5,835	5,806
Light manif.	4,090	4,255	4,377	4,464	4,580	4,604
Ot. manif.	4,467	4,679	4,861	4,977	5,349	5,210
Constr.	4,697	5,159	5,372	5,473	5,735	5,739
Reparation	4,447	4,738	4,906	5,035	5,310	5,246
Transport	5,715	5,925	6,029	6,142	6,400	6,170
Firm's serv.	3,832	4,074	4,194	4,267	4,474	4,349
Pers. serv.	3,145	3,205	3,284	3,404	3,583	3,588

Source: our computation on INPS and Osservatorio artigiani Data

Table 5: Double Hurdle Estimation

Double Hurdle Model

	first stage probit		second stage ZTNB			first stage probit		second stage ZTNB	
	isp	mfx	disHTE	mfx		Isp	mfx	disHTE	mfx
Dep	0.008***	0.000***	0.018***	0.027***	uff2	0.368***	0.001***		
	(0.001)	(0.000)	(0.007)	(0.010)		(0.049)	(0.000)		
Agefirm	-0.002***	-0.000***	-0.005	0.001***	uff3	0.395***	0.001***		
	(0.001)	(0.000)	(0.003)	(0.000)		(0.059)	(0.000)		
Sex	-0.021	-0.000	-0.061	-0.007	uff4	0.409***	0.001***		
	(0.018)	(0.000)	(0.084)	(0.005)		(0.047)	(0.000)		
light manif.	0.028	0.000	-0.176*	-0.092	control2	2.291***	0.141***		
	(0.022)	(0.000)	(0.105)	(0.131)		(0.086)	(0.018)		
ot. manif.	-0.015	-0.000	0.109	-0.248*	control3	2.215***	0.105***		
	(0.027)	(0.000)	(0.128)	(0.140)		(0.058)	(0.008)		
constr.	0.010	0.000	-0.038	0.171	control4	2.226***	0.120***		
	(0.018)	(0.000)	(0.086)	(0.210)		(0.058)	(0.009)		
reparation	0.000	0.000	-0.304*	-0.057	control5	1.805***	0.059***		
	(0.026)	(0.000)	(0.164)	(0.129)		(0.119)	(0.013)		
transport	-0.013	-0.000	-0.058	-0.398**	control6	2.154***	0.109***		
	(0.036)	(0.000)	(0.150)	(0.188)		(0.062)	(0.010)		
firm's serv.	-0.025	-0.000	0.210	-0.084	Period			0.000***	-0.130
	(0.036)	(0.000)	(0.154)	(0.213)				(0.000)	(0.204)
pers. serv.	-0.017	-0.000	-0.331**	0.347	task2			0.587**	0.717***
	(0.028)	(0.000)	(0.158)	(0.281)				(0.236)	(0.236)
Asti	-0.017	-0.000	-0.210*	-0.429**	task3			0.565**	1.068*
	(0.026)	(0.000)	(0.117)	(0.177)				(0.251)	(0.592)
Biella	0.063**	0.000*	0.062	-0.289*	year2001			-0.100	-0.144
	(0.032)	(0.000)	(0.145)	(0.150)				(0.099)	(0.140)
Cuneo	-0.056**	-0.000**	-0.139	0.095	year2002			-0.119	-0.171
	(0.024)	(0.000)	(0.117)	(0.229)				(0.107)	(0.148)
Novara	-0.042	-0.000	-0.246*	-0.197	year2003			-0.221**	-0.309**
	(0.030)	(0.000)	(0.138)	(0.157)				(0.100)	(0.132)
Torino	-0.042**	-0.000**	-0.102	-0.331**	year2004			-0.155	-0.222*
	(0.020)	(0.000)	(0.083)	(0.168)				(0.098)	(0.134)
Verbania	-0.083*	-0.000**	-0.083	-0.151	year2005			-0.087	-0.127
	(0.043)	(0.000)	(0.179)	(0.122)				(0.106)	(0.149)
Vercelli	-0.038	-0.000	-0.090	-0.119	Constant	-3.471***		-0.225	
	(0.034)	(0.000)	(0.148)	(0.248)		(0.037)		(0.285)	
					Observations	784148	784148		

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: our computation on INPS and Osservatorio artigiani Data

Table 6: estimated average number of FTE undeclared workers in the artisan sector

undeclared work estimation					
Year		Province		Sector	
2000	0.16	Alessandria	0.14	Mech.	0.26
2001	0.14	Asti	0.11	Light manif.	0.11
2002	0.14	Biella	0.13	Ot. manif.	0.15
2003	0.13	Cuneo	0.11	Constr.	0.12
2004	0.14	Novara	0.1	Reparation	0.08
2005	0.15	Torino	0.17	Transport	0.12
		Verbania	0.12	Firm's serv.	0.17
		Vercelli	0.12	Pers. serv.	0.09

Source: our computation on INPS and Osservatorio artigiani Data

Table 7: descriptive stats on the variable FTEBW

FTEBW	
mean	1.10
sd	5.28
p50	0.00
p75	0.46
p95	5.01
max	235.24

Source: our computation on INPS and Osservatorio artigiani Data

Table 8: probit estimation on the probability of going out of the sample

Conditional fixed-effects						
PROB_OUT	coeff	St. Err	Z	P-value	Conf	
anymoney(t-1)	-0.014	(0.045)	-0.31	0.755	-0.101	0.074
Number of obs	784148					

Source: our computation on INPS and Osservatorio artigiani Data

Table 9: Difference in differences estimations, first using the difference in the declared number of workers as dependent, 2nd using the difference in the estimated number of FTE undeclared workers

Difference in Differences				
	DF declared		DF estimate BW	
Fine high	-0.495***	-0.426***	-0.001	0.001
	(0.030)	(0.024)	(0.005)	(0.005)
finemed	-0.103***	-0.216***	-0.002	0.001
	(0.039)	(0.033)	(0.006)	(0.006)
finelow	-0.115***	-0.196***	-0.004*	-0.003
	(0.016)	(0.015)	(0.003)	(0.003)
year2000		-0.019***		0.024***
		(0.004)		(0.003)
year2001		0.043***		0.010***
		(0.004)		(0.003)
year2002		-0.046***		0.024***
		(0.004)		(0.003)
year2003		-0.025***		0.001
		(0.005)		(0.003)
year2004		-0.047***		0.000
		(0.004)		(0.000)
Constant	0.013***		0.004***	-0.009***
	(0.001)		(0.001)	(0.002)
Observations	488984	488984	42926	42926
N id	81496	81496		

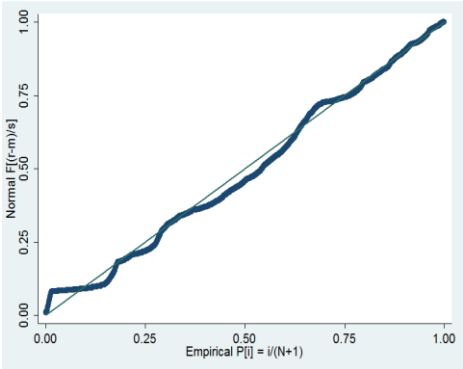
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our computation on INPS and Osservatorio artigiani Data

APPENDIX 2

We develop a number of robustness and specification check for our DH model.
The first check provided is a Likelihood-ratio test, for our first stage DH, Probit we test a restricted model without Uff(i) and Control(i) dummies against an unrestricted that hold the two sets of covariates the result is: LR chi2(8) = 46861.54 (Assumption: restricted nested in unrestricted) and Prob > chi2 = 0.0000 .
The same could be seen with a battery of Wald test for Uff(i) and Control(i) covariates, which lead to chi2(8) =12435.89 and Prob > chi2 = 0.0000 . We also provide a Wald test for the probit with all the covariates in obtaining chi2(25) =12933.32 and Prob > chi2 = 0.0000. All the tests confirm that unrestricted model has to be preferred.
For the second stage ZTNB we provide as well a battery of Wald tests, we start for a model including all the covariates but not Task(i) and years obtaining chi2(17) =112.80 and Prob > chi2 = 0.0000 . Then we include Task(i) obtaining chi2(19) = 118.82 and Prob > chi2= 0.0000. And we finish including also year dummies, chi2(19) = 118.82 and Prob > chi2 = 0.0000. Relying on Wald tests, even in this second stage we prefer this last formulation with all the covariates in.
Another interesting point to test is the normality of the residuals in the two model of the DH. We show that graphically, the two graphs below (graph 1 and 2) shows the quantiles of our residual distribution on the quantiles of a normal distribution. Quantiles of the two distributions almost overlap this conduce to believe the residuals of the two components of the DH are normally distributed (we develop this graph using STATA command "qnorm")

Graph1: probit residuals VS Normal



Graph2: ZTNB residuals VS Normal