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Evidence From A Semi-Parametric Approach

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Abstract

Using individual level data from Turkstat Household Labor Force Survey for 2005-2009 period, we analyze whether there is a wage gap between formal and informal workers with comparable observable characteristics, where the formality of employment is defined with respect to individuals' registry status to compulsory Social Security System. We find that both standard Mincerian regressions and the propensity score matching exercises indicate a sizable formal employment wage premium in Turkey. This contrasts with earlier studies stating that findings on wage gap between formal and informal workers is not robust to estimation methodology. However, we find that the estimation methodology matters for the relative size of formal employment wage premium across demographic groups: While Mincerian regressions give similar estimates for formal-informal wage gap across males and females or old and young workers, the propensity score matching suggest that earning inequality due to differences in formality status is higher among females and young workers.

Keywords: Formal/Informal Employment, Formal Employment Wage Premium, Propensity Score Matching.
JEL classification: C14; J30; J42; J60; O17

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1 Introduction

One of the distinctive characteristics of labor markets in developing countries is the mass number of workers with informal employment contracts. For example, according to OECD (2009), informal employment constitutes to an average of 57 percent of total employment across countries in Latin America while that rises to 70 percent for countries in South and Southeast Asia.[2] As stated by Freeman (2007), the persistence of large informal sectors in developing countries puts a premium on increasing our knowledge of how informal labor markets work, which may also be crucial for designing institutions and policies to deliver social benefits to workers in those markets.

A particular question emerging from the coexistence of workers with formal and informal employment contracts in developing countries is whether the markets for these workers are segmented from each other. Dualistic labor market theory, starting with the seminal work of Lewis (1954), states that labor markets in developing markets may be segmented such that both pecuniary and non-pecuniary benefits received by informal workers can be inferior to those received by formal workers with similar characteristics. According to this view, workers involuntarily choose informal employment because of barriers to find a formal job. In particular, workers who enter the informal market are those who are rationed out of the formal sector due to wages above market-clearing level (Harris and Todaro, 1970 and Stiglitz, 1976). In other words, workers with no access to formal jobs may have limited options, as a result of which they accept jobs with lower wages, worse working conditions and/or without access to social security coverage (see for example, Mazumdar, 1976). As a result, dualistic theory predicts that possible entry barriers to formal jobs may lead to a wage gap between formal and informal workers who have comparable characteristics. Competitive labor market theory, on the other hand, predicts that there are no barriers to entry into formal jobs and workers choose informal employment voluntarily (Amaral and Quintin, 2006).

However, empirical studies on this issue do not provide a clear evidence on which explanation is more relevant for developing countries. Studies by Mazumdar (1981) for Malaysia, Roberts (1989) for Mexico, Pradhan and Van Soest (1995) for Bolivia, Tansel (1999) for Turkey and Gong and Van Soest (2001) for Mexico provide empirical evidence for the existence of segmented labor markets in various developing

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[2]Data in OECD (2009) are based on ILO LABORSTA database and ILO Global Employment Trends Report, 2009.

countries. In contrast, using Colombian data, Magnac (1991) argues that even when one restricts attention to demographic groups who would presumably be more likely to face segmented labor markets, the competitive labor markets hypothesis cannot be rejected. With Panamanian data, Heckman and Hotz (1986) state that empirical results regarding to the existence of the segmented labor markets are sensitive to the specification of wage equation. In particular, they argue that OLS estimates of the standard wage equations would be biased and inconsistent, if the individuals may select sectors on the basis of observed and unobserved characteristics that are related with earnings. In a similar fashion, using Mexican data, Maloney (1999) argues that much of the informal employment is a result of voluntary selection by workers, and the immobility between sectors, which is one of the central predictions of the segmentation hypothesis, cannot be supported by data. In a more recent empirical study, Fiess et al. (2010), analyze data from Argentina, Brazil, Colombia and Mexico. Their empirical findings indicate both countercyclical and procyclical behavior of informal employment, which provide supporting and contrasting evidence with the segmented labor markets hypothesis.

A particular critique on studies utilizing standard wage equations in order to test segmented labor market hypothesis is that they rely on strong parametric assumptions and are potentially vulnerable to misspecification problems. In particular, they assume that formal and informal workers would have the same specification for their earnings functions. Such an approach may be inappropriate especially when the distributions of individual characteristics differ across formal and informal workers.

In this study, we analyze the formal employment wage premium in Turkey both by using standard Mincerian wage regressions and alternatively with semiparametric techniques, which do not require strong parametric assumptions on forms of earning functions and can give sensible estimates for formal-informal worker wage gap even when the distribution of individual characteristics differs across these groups.[3] A particular technique suitable for our analysis is the propensity score matching (PSM) (Rosenbaum and Rubin, 1983, 1984). PSM has a number of advantages over the parametric techniques. For example, PSM does not require a linear functional form

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[3]It is worth noting that the earlier studies by Tansel (1999) and Taymaz (2009) have also analyzed the wage gap between formal and informal workers in Turkey and found that there are significant earning differences between these two groups. However, our study differs from them in terms of employing matching estimators to estimate the wage gap between the formal and informal workers who have similar characteristics measured in terms of probability of being a formal worker conditional on their observed demographic and job-related characteristics.

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for the outcome equation. It also allows for heterogeneity of formal-informal wage gap among comparable workers at different points of the distribution of observed characteristics. Finally, while parametric methods may give biased estimates as they use observations outside the common support of the individual characteristic distributions of formal and informal workers, PSM provides the wage outcomes of formal and informal workers only with comparable observed characteristics (Heckman, Ichimura, Smith and Todd 1998).

PSM has recently been used by Pratap and Quintin (2006) along with standard wage regressions for the analysis of the formal-informal wage gap in Argentina. In their analysis, they find evidence for large and significant formal-informal wage gaps with parametric methods. In contrast, their PSM estimates indicate small and insignificant wage gaps. In other words, formal-informal wage gap for Argentina is not robust to the use of semi-parametric techniques, which have more plausible features than wage regressions for this problem. This result can also be regarded as suggestive evidence that the earlier findings in favor of dual labor markets in developing countries may be an artifact of utilization of inappropriate estimation techniques.

Our main results are as follows: In line with most studies, standard Mincerian wage regressions suggest that formal workers earn more than informal workers in Turkey by around 16-20 percent, conditional on workers' observed individual characteristics. On the other hand, in contrast with earlier studies arguing that the evidence on formal employment wage premium is not robust to the use of semi parametric techniques, we find large and sizeable wage gaps between formal and informal workers in Turkey also with PSM. For example, formal-informal worker wage gaps observed within each year in our sample period varies between 10 percent and 23 percent. Finally, we analyze the formal employment wage premium by gender and age groups. While standard wage regressions show that the wage gap between formal and informal workers is 19.5 percent both for females and males, the PSM estimates for males and females are 14 percent and 22 percent, respectively. For the age groups, we also find a parallel finding in the sense that the parametric techniques conceal the heterogeneity in formal-informal wage gap across age groups, whereas PSM indicates much higher wage inequality among young workers due to differences in formality status.

The rest of the paper is structured as follows. Section 2 briefly introduces the data. In section 3, we present our results on formal-informal wage gap obtained with the standard Mincerian wage regressions. Section 4 presents the propensity score

matching results for formal-informal wage gaps within entire sample as well as within gender and age categories. Section 5 concludes the paper.

2 Data

The dataset used in this study is taken from annual individual data releases of the Turkstat Household Labor Force Survey (THLFS) for the 2005-2009 period.[4] As we are interested in how hourly wages of individuals differ across formal and informal workers, we exclude unpaid family workers, self-employed individuals and individuals stated as employers in the survey from the sample.[5] Also, due to possible measurement problems about earnings, individuals younger than 15 years of age are also excluded from the sample. Finally, following OECD (2009), we focus on workers employment in non-agriculture sector, due to potential difficulties in distinguishing between formal and informal employment in agriculture sector.[6] However, for robustness purposes, we also provide results regarding the whole sample which includes workers in agriculture sector.

A particular information provided by THLFS is whether individuals are registered to the legally mandatory *Sosyal Guvenlik Kurumu* (i.e. Turkish Social Security Institution, SGK hereafter) at their current job. In this study, we categorize workers who are not registered to SGK as informal workers. Statistical definition of informal employment by the International Labour Organization (ILO) includes not only the informal employees working in formal sector enterprises, but also all workers employed in informal sector enterprises and households producing goods exclusively for their own final use.[7] However, McKinsey Global Institute (2003) states that most of the business in Turkey are registered and formal enterprises but they partially report business revenue and employment. Therefore, we use the alternative definition by OECD (2009), which defines informal employment as whether the individual is

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[4]All private households living in the territory of the Republic of Turkey are covered by this annual survey. Residents of schools, dormitories, kindergartens, rest homes for elderly persons, special hospitals, military barracks and recreation quarters for officers are not covered by this survey. For more information, see the Turkstat website which is available at www.turkstat.gov.tr .

[5]Since our study focuses on the wage differences due to formality status, we exclude the non-wage earners, which constitute employers, self-employed individuals and unpaid family workers, when constructing our final sample. While the overall informality ratio is slightly above 40 percent, it is around 27 percent in the sample of wage and salary earners in 2005-2009 period.

[6]See Appendix Table 1 for the sample exclusion rules.

[7]See also Freeman (2010).

covered by the social security system or not. In particular, we categorize a worker as an informal worker if the worker is not registered to SGK at his current job. Our informality definition is also in line with various studies, such as Maloney (2004), Reis et al. (2009), OECD (2009) and Ramos et al. (2010).

Although the THLFS provides individual level data on a wide range of individuals' demographic and job-related characteristics starting from 2002, this study focuses on the post-2005 period, as the absence of data on usual hours worked by individuals in 2002-2004 period makes it impossible to calculate the hourly wages of the individuals. The data on real hourly wages is obtained by dividing monthly nominal after tax cash earnings by total hours worked in the month. It is then deflated by regional price indices into 2008 prices. [8]

3   A Simple Mincerian Approach

Following the large body of existing literature, we first provide results obtained with standard regression analysis. In particular, we estimate the following Mincerian wage regression, which takes into account the possibility that determinants of real hourly wages differ across formal and informal workers:

$$\log W_{irt} = \alpha + \beta F_{irt} + X'_{irt}\gamma + \mu_r + \lambda_t + \nu_{irt} \tag{1}$$

where W_{irt} is the real hourly wage rate of worker i observed in region r at time t. F_{irt} is the formality status of the worker as explained above. F_{irt} takes value 1 if the worker is categorized as formal. X_{irt} represents the set of measured characteristics of worker i, μ_r is the region effect, λ_t is the time effect and ν_{irt} is the error term. Other variables which are used to control for individual heterogeneity are age, gender, marital status, employment location, years of education, enrollment to a school, years of tenure at the firm, firm size, industry of employment, and occupation, permanency of the job, part-time work, other activity to earn income and employment status in the same month of last year.[9] The main parameter of interest in equation (1) is β, where $\beta > 0$ implies that formal workers earn higher than informal workers, after controlling for observed individual characteristics.

The second column of Table 4 shows results with all individuals including agricul-

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[8]Regional prices and unemployment rates are available on Turkstat website.
[9]See Data Appendix for a detailed description of these variables.

ture sector wage workers, for whom the wage difference between formal and informal workers is estimated as 20 percent on average. Alternatively, when we exclude agriculture sector workers from the sample considering the potential problems in measuring wages and informality status in agricultural sector in Turkey, we still find a wage gap around 19.3 percent. In summary, our findings with standard Mincerian regressions indicate that there are sizable hourly wage gap between workers who are registered and unregistered to compulsory social security system in Turkey. It is important to note that these findings are in line with earlier literature. When we consider the regression results by Pratap and Quintin (2006) for Argentina, indicating a formal employment wage premium in 0.23-0.37 range, we can conclude that these estimates are fairly reasonable. On the other hand, we find much smaller estimates for this gap compared to Tansel (1999), who uses Turkstat's 1994 Household Expenditure Survey. In particular, she finds that formal males and females earn 68 percent and 150 percent higher than their informal counterparts. However, it is worth noting that the differences in the time period and the data source between our study and Tansel (1999), as well as the fact that the hourly wages in THLFS is available in post-2005 period, do not allow for us to totally explain the large difference between the estimates in these two studies.

4 Semi-Parametric Methods

4.1 Estimation Strategy

Although the preceding section provides support for the existence of segmented labor markets in Turkey, the major concern about the methodology used is the possible misspecification problem due to disregarding the possible differences across earnings functions of the workers in these categories. For example, possible differences in the distribution of observed characteristics of the formal and informal workers may lead to biases for the estimates in the preceding section. Moreover, as recently been shown by Pratap and Quintin (2006) for Argentina, results on the existence of formal-informal worker wage gaps may depend on the estimation technique.

Considering these potential problems in parametric approaches, we estimate the formal-informal wage gap with Propensity Score Matching. PSM is a two-step estimation procedure where the first step involves predicting the probability of being a formal worker (called "propensity scores") using a probit regression while in the

second step, wages of workers with similar propensity scores are compared with each other. By assessing the wage gap for workers who are very similar to each other in terms of observational characteristics but different with respect to their formality status, PSM provides more reliable results on the wage gap compared to the results obtained with standard wage regressions. In particular, PSM attempts to control for the confounding effects of covariates, which complicates the identification of whether the formal employment wage premium is due to differences in the exposure to the formality status or due to having different observed characteristics across formal and informal workers. The conformance of PSM for this analysis can be seen in Table 2, which shows important differences between formal and informal workers in terms of observed characteristics related to their earnings. For example, there is a considerable difference in terms of education level, job tenure or the ages of formal and informal workers, raising concerns about the suitability of standard wage regressions for the estimation of formal-informal worker wage gap. Another advantage of this approach is that it does not rely on a particular functional form for earnings. Therefore, PSM allows us to get estimates which are not subject to any potential bias due to the possibility of having different specifications in earning functions of formal and informal workers. Finally, PSM is particularly useful when there is potentially a large set of observed characteristics which are correlated with both formality status and wages. That's why, obtaining propensity scores for individuals conditional on their observed characteristics and matching them on the basis of these scores reduce the dimensionality of the matching.

Formally, following LaLonde (1986) and Heckman et al. (1999), we estimate the formal wage gap as the average effect of treatment on the treated (ATT):

$$\beta = E(w^F|X, Formality = 1) - E(w^I|X, Formality = 1) \qquad (2)$$

where X is the observable characteristics as defined above while w^F and w^I are the formal and informal real hourly wage rates, respectively. However, there is an important practical problem for estimating β due to the fact that only one of the wages are observed for each individual. In other words, the unobservability of the counterfactual for a formal worker, i.e. the wage level that would prevail if the individual was working as an informal worker, generates a missing data problem. This impedes estimating the second term on the right hand side of (2).

A particular approach that one can follow to estimate β is to use the matching es-

timator. Following Rosenbaum and Rubin (1983, 1984), the conditional independence that we need to estimate β can be written as:

$$w^F, w^I \perp Formality | X. \tag{3}$$

The conditional independence assumption suggests that the actual wage w^F and the potential wage w^I is randomly assigned and independent of the formality status, conditional on the observed characteristics denoted by X. Then, we can write the estimator as:

$$\beta = E(w^F | X, Formality = 1) - E(w^I | X, Formality = 0). \tag{4}$$

Now, we have two measurable expectations on the right hand side that will allow us to obtain a plausible estimate. In practice, the matching estimator for the wage gap between formal and informal workers, denoted by β^m, can be estimated by:

$$\beta^m = \frac{1}{N} \sum_{i \in F} \left(w_i^F - \sum_{j \in I} \eta_{ij} w_j^I \right) \tag{5}$$

where η_{ij} is the weight of informal worker j for comparison with formal worker i and N is the number of formal workers in the sample.

A particular practical issue that deserves attention is the choice of the weights η_{ij}, which can be regarded as a measure of "similarity" across individuals on the basis of propensity scores. For this, we utilize the most commonly used two approaches, namely the caliper matching and the nearest neighbor matching.[10] In the caliper matching method, an individual i with the propensity score p_i is only matched with an individual j with the propensity score p_j if $|p_i - p_j| < \delta$, where δ is the maximum distance between the propensity scores of two different individuals who are matched with each other. In this respect, δ can be viewed as the parameter governing the tightness of the matches. Therefore, the caliper matching technique involves the use

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[10]See Caliendo and Kopeinig (2005) for a comprehensive discussion on the implementation of PSM and various matching algorithms.

of the following weights:

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\eta_{ij} = \begin{cases} 0 & \text{if } |p_i - p_j| > \delta \\ \\ \dfrac{\frac{1}{|p_i - p_j|}}{\sum_{\{i,j:|p_i - p_j| \leq \delta\}} \frac{1}{|p_i - p_j|}} & \text{otherwise.} \end{cases} \tag{6}
$$

This definition of weights η_{ij} means that an individual is matched with individuals whom propensity scores are close enough, and those matches are weighted disproportionately to their distances to that propensity score of individual. The maximum distance δ is chosen to be 10^{-4} as in Pratap and Quintin (2006), who also uses similar techniques to estimate wage gap between formal and informal workers in Argentina.[11]

In order to check the sensitivity of our results to use of different matching algorithms, we alternatively use the nearest neighbor matching, where wage of each formal worker is compared to that of informal workers with the n closest propensity scores. For the choice of n, we take $n = 1$ for the baseline and check the robustness of our results to use of $n = 2$ and $n = 5$.

However, a particular caveat that deserves attention is that the matching estimator may still fail to deliver an unbiased estimate for the wage premium arising from the differences in formality status of the individuals. This is particularly the case if the formality status is determined not only by observed characteristics X, but also by unobserved differences across individuals. Since such unobserved factors cannot be included in the estimation of the propensity score, conditional independence assumption may be violated, as a result of which PSM may not fully eliminate all biases that would be observed in parametric estimators, such as those based on standard wage equations.

4.2 Empirical Results

4.2.1 Determinants of Formality Status

Before presenting the results concerning the formal-informal worker wage gap, one may be interested in individual characteristics correlated with formality status in

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[11]There is a trade-off in choosing the distance parameter δ. For smaller values, there are more instances where no control observations exist in δ neighborhood. For larger values, less precision in matching is achieved. However, our results are robust when we choose $\delta = 10^{-3}$.

Turkey. For obtaining the propensity scores, we estimate a probit regression, where the dependent variable takes value of 1 for workers registered to the social security system and zero otherwise. The potential determinants of the formality status involves age, gender, job tenure, marital status, size of the firm where individuals are working, education level, occupation and industry of employment.

Table 5 presents the probit marginal effects for determinants of the formality status by each year in our sample. These results are mostly in line with our expectations. In particular, we find that probability of being a formal worker increases monotonically with education level. For example, considering the results for 2005, we observe that an individual without a primary school degree is 11 percent less likely to be a formal employee than a primary school graduate and 20 percent less likely to be formal employee than an individual with at least university diploma. The probability of being a formal employee increases with both job tenure and age, where the difference in the propensities due to an extra year of job tenure and age decreases with the level of job tenure and ages. These results suggest that workers with a more favorable level of job-related characteristics, such as higher education or experience, are more likely to have more favorable employment contracts than workers with lower skill levels, possibly due to having higher bargaining power with a higher skill level. Males are at least 20 percent more likely to be formal workers than females, conditional on other observed characteristics. While the individuals who are concurrently enrolled to an education institution are more likely to be formal employees, the individuals who simultaneously hold more than one job are in general 3-5 percent less likely to be a formal worker. We also find that married individuals are more likely to be formal workers.

An interesting pattern that we observe is the non-monotonic relationship between firm size and formality status of workers. We find that individuals working in small firms, which correspond to those with at most 9 employees in our data, are least likely to be formal workers. In a similar fashion, individuals working in firms with 10-24 employees are less likely to be a formal worker than those working in larger firms. On the other hand, for firms employing at least 25 workers, we cannot conclude that propensity to be a formal worker is monotonically increasing with firm size. For example, results indicate that individuals employed at firms with 50-249 employees are more likely to be formal than individuals working in firms with at least 250

employees.[12]

The non-monotonic structure of the relationship between firm size and formality status in Turkey has some methodological implications as well. A particular way of measuring formality status in the existing literature, such as Mazumdar (1976) and Banerjee (1983), is the use of firm size as a formality proxy, based on the observation that there is a positive relationship in general between formality status and firm size. However, as stated by various studies, such as Rauch (1991), Pratap and Quintin (2006) and Badaoui et al. (2010), empirical support for formality wage premium in studies utilizing firm size as formality measure may be due to factors other than formality status. For example, a higher need for efficiency wages in a larger firm may lead to a wage difference that may essentially be unrelated with formality status. Our results indicate that a monotonic relationship between firm size and the formality status may not always be granted, complementing earlier studies in terms of raising concerns on the use of the firm size as a formality status measure.

Figure 1 and Table 6 document the frequency distributions and histograms of propensity scores of formal and informal workers for each year in our sample period. We observe that distributions are very similar across years. As expected, formal workers have higher propensity scores in general compared to informal workers. An important characteristic that needs to be emphasized is that both distributions have a common support which helps us finding a possible match for almost all treated observations.[13]

4.2.2 The PSM Results on Informal-Formal Wage Gap

Tables 7 shows the PSM estimates for the wage gap between formal and informal workers obtained with caliper matching and nearest neighborhood matching. These results suggest significant wage gaps in each year. In particular, the formal-informal wage gap is more than 20 percent for 2005 and 2009 and around 10-15 percent in the remaining years.

We also provide evidence on how formal employment wage premium changes with respect to different categories of individual characteristics. In these exercises, we first

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[12]In a related manner, Taymaz (2009) finds that the firm size and the formality status of the *firms* in Turkey have a nonmonotonic relationship. In particular, he finds that the informality tendency of the firms in Turkey increases with the firm size (up to 7 employees in manufacturing and 24 employees in services), then decreases.

[13]PSM can only identify the effect of formality for workers in the common support (Heckman, Ichimura, Smith and Todd 1998).

divide the individuals into subgroups and then conduct PSM within these groups. First, we analyze the magnitude of formal-informal worker wage gap by gender groups. The second column in Panel A in Table 8 presents results from standard regression techniques obtained separately for males and females. These results indicate that the formal-informal wage gap within male and female subgroups are significant and 18.8 percent and 19.9 percent, respectively. That is, the wage premium for being a formal worker does not significantly vary by gender types according to Mincerian regressions. However, we find with semi-parametric techniques that formal employment wage premium for males is around 14 percent, whereas that for females is 22 percent. These findings suggest that returns to becoming a formal worker is higher for women than men in Turkey.

In Panel B, we categorize workers into two categories with respect to their age, whether it is below or above the overall sample mean, which is 34.1 years. While the regression results indicate a similar formal employment wage premium for young and old workers, PSM results suggest that the premium is significantly higher among young workers. In particular, while standard Mincerian regressions indicate an hourly wage difference of 19.2 percent and 19.7 percent for the young and old workers, we obtain 26.5 percent and 15.0 percent with PSM, respectively. Results of these two subgroup analysis in panels A and B suggest that standard regressions may lead to misleading results for the relative magnitude of formal employment wage premium within different subcategories.

5   Conclusion

In this paper, we use a rich individual level data from the Turkstat Household Labor Force Survey for 2005-2009 period and a variety of parametric and semi-parametric techniques to analyze the magnitude of the wage gap between formal and informal workers. Our analysis based on standard Mincerian regressions indicate that formal workers earn more than informal workers conditional on individuals' observed individual characteristics. When we use propensity score matching by considering the possibility of misleading results due to different distributional observed characteristics of formal and informal workers, we still find a significant wage gap with magnitudes comparable to the regression results. This contrasts with recent studies for other developing countries, which find no wage gap with semi-parametric tech-

niques, suggesting that empirical evidence for a significant wage gap between formal and informal workers may be an artifact of parametric techniques. These results can be regarded as a support for the existence of dual labor markets in Turkey among formal and informal workers, where individuals with similar observational characteristics face different wages under formal and informal employment contracts in Turkey.

Our estimates also indicate that there are considerable differences in the formal employment wage premium across different groups. For example, while the standard wage regressions indicate a similar returns to formal employment across gender or age categories, PSM indicates that the returns for females and young workers are considerably higher than males or old counterparts. In other words, the estimation approach also matters for the relative magnitudes of the formal employment wage premium across demographic groups.

These results suggest that the formality status, defined in our exercises with respect to registration status to the mandatory Social Security System, is a key aspect of the income inequality in Turkey. The fact that informal workers earn 15-20 percent less than their formal counterparts with comparable observational characteristics suggest that there is a considerable segmentation across labor markets in Turkey. These imply that increasing the compliance with social security system in Turkey may have implications in terms of increasing the access to social safety net as well as reducing the income inequality.

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A   Data Appendix

In this appendix, we provide details about our dataset. First, we present our data coverage and number of observations for different restrictions in Table 1.

Second, we summarize our data with respect to informality for different subgroups. Particularly, Table 2 lists percentages of formal and informal workers for four individual characteristic categorizations and three different sample coverage.

Finally, we give details about individual specific control variables that we use. Following Mincer (1974), we regress our dependent variable on a number of control variables related to individual heterogeneity, which are listed below:

- Age. The survey provides eleven age categories in 5-year intervals.

- Gender. Female=1 and Male=0.

- Marital status. Two dummy variables are constructed for marital status. First, Single=1 for individuals who never been married, and zero otherwise. Second, Married=1 for individuals who are currently married and living together, and zero otherwise.

- Employment location. Urban=1 and Rural=0.

- Education. The variable *educ* is years of completed education, while the variable *enrolled* is a binary variable which takes the value 1 for individuals enrolled to a school, and zero otherwise. Variable *req_att* equals to 1 for individuals who are enrolled in a school that requires regular attendance, 0 otherwise.

- Social security registration: Binary variable which takes the value 1 if the individual is registered in the social security administration, and zero otherwise.

- The individual's years of tenure at the firm. This is calculated as the starting year at the current job subtracted from the survey year.

- Industry classification. This is a set of 9 binary variables categorized according to the NACE Rev.1.1 classification pertaining to the industry. They include agriculture, mining, manufacturing, electricity, construction, transportation, trade and finance, and community, social and personal services.

- Occupational group. This is a set of 9 binary variables categorized according to the ISCO-88 classification. They include legislators, senior officials and managers; professionals; technicians and associate professionals; clerks; service workers and shop and market sales workers; skilled agricultural and fishery workers; craft and related trades workers; plant and machine operators and assemblers; and elementary occupations.

- Permanency of the job. Permanent=1, and Temporary or Seasonal=0.

- Employment type. Full-time=0 and part-time=1.

- Other activity to earn income. Yes=1 and no=0.

- Firm size. This is measured by the number of persons employed in the firm and summarized by 5 binary variables corresponding to the following categories: less than 10 employees, 10-24, 25-49, 50-249, 250-499, and 500 and more.

- Employment status in the same month of last year. Binary variable which takes the value 1 if the individual was working in the same month of last year, and zero otherwise.

Table 1: Number of Observations

Restriction/Selection Rule	Observations
All observations in sample years 2005 to 2009	2,453,265
Civilian wage workers age 15 and over, with positive sampling weight, formality status and non-missing demographics such as: age, tenure, gender, marital status, education etc.	383,280
After excluding:	
Individuals with no wage information	379,512
Sample including individuals in agricultural sector:	
Male	294,169
Female	85,343
Sample excluding individuals in agricultural sector (Main Sample):	
Male	286,034
Female	81,061

Table 2: The Fraction of Formal Workers By Types

	All workers		All but agricultural workers	
	Formal	Informal	Formal	Informal
Gender				
Male	72.89%	27.11%	74.44%	25.56%
Female	72.39%	27.61%	75.97%	24.03%
Age				
Old	75.50%	24.50%	77.94%	22.06%
Young	70.46%	29.54%	72.12%	27.88%
Tenure				
High	85.04%	14.96%	87.06%	12.94%
Low	65.48%	34.52%	67.43%	32.57%
Education				
High	88.58%	11.42%	88.82%	11.18%
Low	58.57%	41.43%	61.45%	38.55%
Location				
Urban	74.80%	25.20%	75.70%	24.30%
Rural	64.38%	35.62%	70.56%	29.44%
Marital Status				
Single	63.18%	36.82%	64.85%	35.15%
Married	76.82%	23.18%	78.89%	21.11%
Divorced or widowed	62.55%	37.45%	66.21%	33.79%
Firm Size				
Less than 10	42.61%	57.39%	45.10%	54.90%
10 to 24	74.61%	25.39%	77.72%	22.28%
25 to 49	85.71%	14.29%	86.56%	13.44%
50 to 249	93.24%	6.76%	93.42%	6.58%
250 to 449	95.96%	4.04%	96.06%	3.94%
500 and more	98.18%	1.82%	98.18%	1.82%

Notes: (1) Young (Old) refers to individuals younger (older) than sample mean value for years of age, which is 34.1. (2) Low (high) tenure refers to individuals with tenure less (more) than the sample mean value, which is 6.94 years. (3) Low (high) education refers to individuals with less than or equal to 8 years of schooling (more than 8 years of schooling).

Table 3: Real Hourly Wages by Formality Status and Types

| | All workers | | | All but agricultural workers | |
	Formal	Informal		Formal	Informal
Gender					
Male	5.05	2.35		5.05	2.40
Female	5.46	2.15		5.46	2.30
Age					
Old	6.04	2.69		6.06	2.83
Young	4.31	2.04		4.32	2.08
Tenure					
High	6.58	2.57		6.60	2.74
Low	4.02	2.24		4.03	2.29
Education					
High	6.40	2.92		6.40	2.94
Low	3.43	2.15		3.43	2.22
Location					
Urban	5.27	2.37		5.27	2.41
Rural	4.51	2.10		4.52	2.45
Marital Status					
Single	4.06	1.85		4.06	1.87
Married	5.47	2.56		5.48	2.67
Divorced or widowed	5.51	2.77		5.53	2.99
Firm Size					
Less than 10	3.50	2.13		3.51	2.18
10 to 24	4.94	2.37		4.95	2.54
25 to 49	5.32	2.78		5.33	2.87
50 to 249	5.54	3.14		5.54	3.18
250 to 449	5.78	3.64		5.79	3.67
500 and more	6.64	5.98		6.64	6.01

Notes: (1) Young (Old) refers to individuals younger (older) than sample mean value for years of age, which is 34.1. (2) Low (high) tenure refers to individuals with tenure less (more) than the sample mean value, which is 6.94 years. (3) Low (high) education refers to individuals with less than or equal to 8 years of schooling (more than 8 years of schooling).

Table 4: The Formal/Informal Wage Gap Estimated with Mincerian Wage Regression

	All workers	All but agricultural workers
Formality	0.201	0.193
	(0.038)***	(0.036)***
Age	0.039	0.041
	(0.002)***	(0.002)***
Age^2	-0.0005	-0.0005
	(0.000)***	(0.000)***
Female	-0.102	-0.096
	(0.011)***	(0.011)***
Single	-0.068	-0.071
	(0.004)***	(0.005)***
Married	0.019	0.017
	(0.006)***	(0.006)***
Urban	0.021	0.018
	(0.010)**	(0.010)*
Enrolled	0.056	0.060
	(0.012)***	(0.013)***
Permanent	0.079	0.071
	(0.019)***	(0.019)***
Part-time	0.406	0.407
	(0.025)***	(0.026)***
More than 1 job	-0.044	-0.050
	(0.008)***	(0.009)***
Employed last year	0.079	0.081
	(0.011)***	(0.010)***
Firm Size (10-24 Emp)	0.164	0.173
	(0.011)***	(0.013)***
Firm Size (25-49 Emp)	0.180	0.182
	(0.014)***	(0.016)***
Firm Size (50-249 Emp)	0.249	0.250
	(0.020)***	(0.021)***
Firm Size (250-499 Emp)	0.313	0.315
	(0.017)***	(0.017)***
Firm Size (Emp>500)	0.390	0.392
	(0.020)***	(0.020)***
Primary school grads	0.029	0.031
	(0.015)**	(0.014)**
Secondary school grads	0.076	0.074
	(0.012)***	(0.010)***
High school grads	0.215	0.217
	(0.015)***	(0.015)***
University grads	0.530	0.532
	(0.018)***	(0.017)***

Table 4: (Continued)

	All workers	All but agricultural workers
Experience	0.019	0.019
	(0.001)***	(0.001)***
Experience^2	-0.0002	-0.0002
	(0.000)***	(0.000)***
Industry		
Agriculture	-0.259	
	(0.026)***	
Mining	0.078	0.080
	(0.064)	(0.064)
Manufacturing	-0.180	-0.176
	(0.030)***	(0.029)***
Energy	0.138	0.139
	(0.025)***	(0.024)***
Construction	-0.013	-0.016
	(0.020)	(0.021)
Trade	-0.195	-0.190
	(0.023)***	(0.023)***
Transportation	-0.059	-0.057
	(0.022)***	(0.022)***
Finance	-0.078	-0.074
	(0.029)***	(0.029)**
Occupation		
Professionals	0.017	0.017
	(0.061)	(0.061)
Technicians	-0.169	-0.169
	(0.062)***	(0.062)***
Clerks	-0.304	-0.304
	(0.063)***	(0.062)***
Service workers	-0.401	-0.400
	(0.056)***	(0.056)***
Skilled agricultural workers	-0.360	-0.400
	(0.063)***	(0.063)***
Craftsmen	-0.329	-0.327
	(0.063)***	(0.064)***
Plant operators	-0.343	-0.342
	(0.060)***	(0.060)***
Elementary occupations	-0.442	-0.436
	(0.069)***	(0.070)***
N	379,512	367,095
R^2	0.602	0.599

Notes: (1) Dependent variable is log real hourly wages. (2) Results are presented for different sample specifications. (3) The numbers in parentheses are robust standard errors clustered for within region and within year correlations and (*), (**) and (***) denote significance at 10%, 5% and 1%, respectively. (4) The variable Formality is equal to 1 if the worker is registered to the social security system and 0 otherwise. A positive and significant coefficient estimate for the variable Formality suggests higher wages for formal workers. (6) Omitted categories for marital status, firm size, education, industry and occupation dummies are divorced or widowed, less than 10, not completed any educational institution, community services, and legislators, respectively.

Table 5: Determinants of Formality Status

	2005	2006	2007	2008	2009
Age	0.036	0.038	0.037	0.030	0.028
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Age^2	-0.001	-0.001	-0.001	-0.0005	-0.0004
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Female	-0.073	-0.073	-0.051	-0.041	-0.039
	(0.006)***	(0.005)***	(0.005)***	(0.004)***	(0.004)***
Single	0.034	0.049	0.019	0.018	0.014
	(0.012)***	(0.011)***	(0.011)*	(0.009)**	(0.009)
Married	0.092	0.105	0.062	0.050	0.039
	(0.014)***	(0.013)***	(0.012)***	(0.010)***	(0.009)***
Urban	-0.011	-0.002	-0.003	-0.009	0.002
	(0.005)**	(0.004)	(0.004)	(0.004)**	(0.004)
Enrolled	0.058	0.041	0.055	0.048	0.034
	(0.008)***	(0.008)***	(0.007)***	(0.005)***	(0.005)***
Permanent	0.311	0.341	0.370	0.328	0.126
	(0.011)***	(0.011)***	(0.011)***	(0.012)***	(0.009)***
Part-time	-0.262	-0.191	-0.206	-0.183	-0.223
	(0.023)***	(0.021)***	(0.020)***	(0.017)***	(0.015)***
More than one job	-0.050	-0.040	-0.041	-0.031	-0.012
	(0.016)***	(0.013)***	(0.014)***	(0.012)***	(0.010)
Employed last year	0.088	0.082	0.076	0.061	0.060
	(0.007)***	(0.006)***	(0.006)***	(0.005)***	(0.005)***
Experience	0.020	0.018	0.015	0.014	0.014
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Experience^2	-0.0005	-0.0004	-0.0004	-0.0003	-0.0003
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Firm Size (10-24 Emp)	0.134	0.121	0.111	0.089	0.090
	(0.003)***	(0.003)***	(0.003)***	(0.002)***	(0.002)***
Firm Size (25-49 Emp)	0.175	0.166	0.154	0.120	0.120
	(0.003)***	(0.003)***	(0.003)***	(0.002)***	(0.002)***
Firm Size (50-249 Emp)	0.268	0.219	0.199	0.161	0.161
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***
Firm Size (250-499 Emp)	0.171	0.173	0.155	0.121	0.118
	(0.003)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Firm Size (Emp>500)	0.183	0.189	0.173	0.134	0.129
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Primary school grads	0.108	0.090	0.096	0.074	0.081
	(0.008)***	(0.008)***	(0.007)***	(0.006)***	(0.006)***
Secondary school grads	0.123	0.111	0.104	0.076	0.086
	(0.006)***	(0.006)***	(0.006)***	(0.005)***	(0.004)***
High school grads	0.192	0.176	0.167	0.131	0.133
	(0.007)***	(0.006)***	(0.006)***	(0.005)***	(0.005)***
University grads	0.204	0.199	0.185	0.147	0.153
	(0.005)***	(0.005)***	(0.005)***	(0.005)***	(0.005)***
Number of Observations	70,487	72,964	73,629	75,078	74,937

Notes: (1) Marginal effects; Estimated with probit to predict the propensity scores used in semi-parametric estimation for wage gaps. (2) Results are presented for the main sample where workers in the agricultural sector are excluded (results are robust when we include them). (3) Other control variables include occupation and industry dummies. (4) Omitted categories for marital status, firm size and education are divorced or widowed, less than 10, and not completed any educational institution, respectively. (5) The numbers in parentheses are robust standard errors clustered for within region correlations and (*), (**) and (***) denote significance at 10%, 5% and 1%, respectively.

Table 6: Histogram of Propensity Scores of Formal and Informal Workers

| | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | |
Propensity Score	F	I	F	I	F	I	F	I	F	I
[0.00, 0.05]	104	2431	126	2412	125	2213	93	1842	69	797
(0.05, 0.10]	162	1616	132	1552	135	1406	140	1122	88	883
(0.10, 0.15]	229	1454	221	1378	179	1234	143	1031	133	894
(0.15, 0.20]	293	1495	264	1282	208	1085	185	1071	184	992
(0.20, 0.25]	331	1319	347	1314	291	1062	234	982	247	954
(0.25, 0.30]	448	1364	455	1327	327	1084	309	869	352	1080
(0.30, 0.35]	502	1281	482	1235	438	1120	337	870	427	1058
(0.35, 0.40]	640	1125	615	1131	497	988	443	862	548	1000
(0.40, 0.45]	754	1082	675	1064	603	973	519	880	582	1024
(0.45, 0.50]	862	917	842	990	795	934	640	815	749	931
(0.50, 0.55]	908	875	941	959	905	900	853	799	981	964
(0.55, 0.60]	1107	825	1072	830	1195	878	987	815	1166	898
(0.60, 0.65]	1214	783	1253	742	1271	819	1236	808	1398	882
(0.65, 0.70]	1497	716	1457	744	1491	770	1459	718	1630	760
(0.70, 0.75]	1706	615	1676	672	1799	658	1673	732	1919	759
(0.75, 0.80]	1911	545	2042	579	2163	654	2125	670	2533	681
(0.80, 0.85]	2488	514	2531	547	2650	562	2851	591	3227	611
(0.85, 0.90]	3317	459	3107	474	3514	540	3800	548	4481	532
(0.90, 0.95]	5774	376	5012	440	5765	455	6276	553	7401	500
(0.95, 1.00]	26077	371	20136	384	21607	395	23345	398	30147	475

Notes: (1) F and I stand for formal and informal workers, respectively.

Table 7: Formal/Informal Wage Gap Estimates by Years and Estimating Methods

|	Caliper	Nearest Neighbor
2005	0.223	0.232
	(0.021)***	(0.032)***
2006	0.147	0.152
	(0.027)***	(0.032)***
2007	0.101	0.095
	(0.026)***	(0.040)**
2008	0.116	0.114
	(0.032)***	(0.049)**
2009	0.215	0.213
	(0.017)***	(0.019)***

Notes: (1) Caliper and nearest neighbor matching estimators of formal wage gap for 26 regions and 5 years are presented in the table. Positive numbers indicate higher wages for formal workers. δ is chosen to be 10^{-4} for caliper matching method while n is chosen to be 1 for nearest neighbor matching method. (2) Results are presented for the main sample where workers in the agricultural sector are excluded (results are robust when we include them). (3) The numbers in parentheses are robust standard errors and (*), (**) and (***) denote significance at 10%, 5% and 1%, respectively. Standard errors are clustered for within region correlations.

Table 8: Comparison of Parametric and Semiparametric Estimates of Formal Employment Wage Premium by Categories

| | Mincerian Wage Regression | Propensity Score Matching | |
		Caliper	Nearest Neighbor
Panel A: Gender			
Male	0.188	0.143	0.143
	(0.032)***	(0.014)***	(0.017)***
Female	0.199	0.224	0.225
	(0.048)***	(0.027)***	(0.032)***
Panel B: Age			
Young	0.192	0.265	0.266
	(0.032)***	(0.018)***	(0.015)***
Old	0.197	0.150	0.148
	(0.037)***	(0.020)***	(0.028)***

Notes: (1) Parametric and semiparametric estimators of formal wage gap by types are presented in the table. Caliper matching and nearest neighbor matching parameters δ and n are chosen to be 10^{-4} and 1, respectively. (2) Results are presented for the main sample where workers in the agricultural sector are excluded (results are robust when we include them). (3) Young (Old) refers to individuals younger (older) than sample mean value for years of age, which is 34.1. (4) The numbers in parentheses are robust standard errors clustered for within region and within year correlations and (*), (**) and (***) denote significance at 10%, 5% and 1%, respectively.
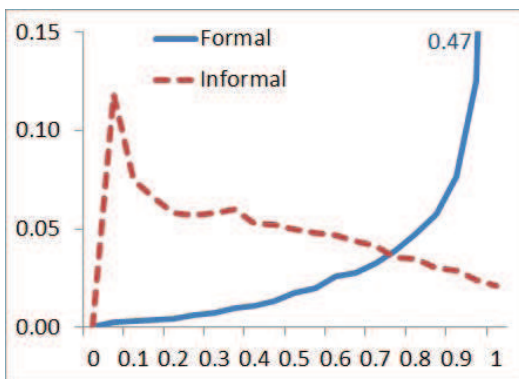
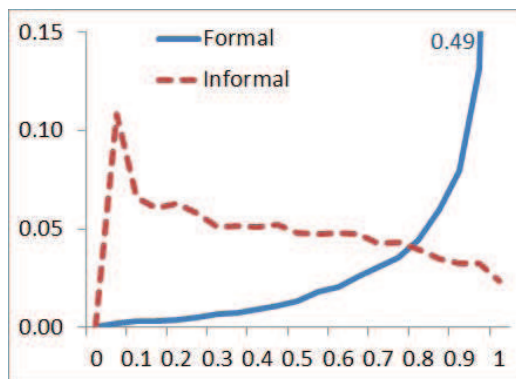Figure 1: Frequency Distribution of Propensity Scores
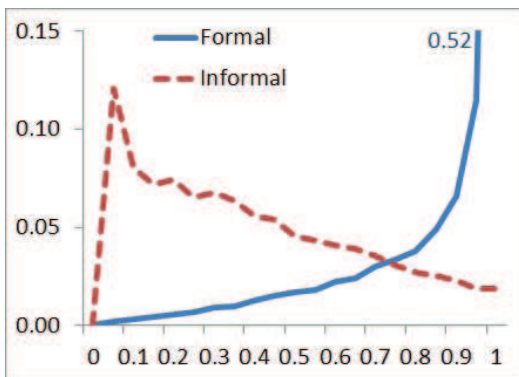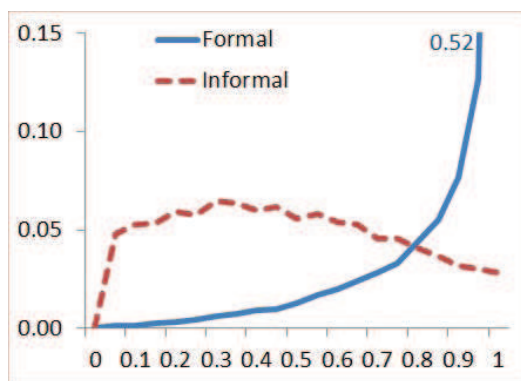

(a) 2005 sample
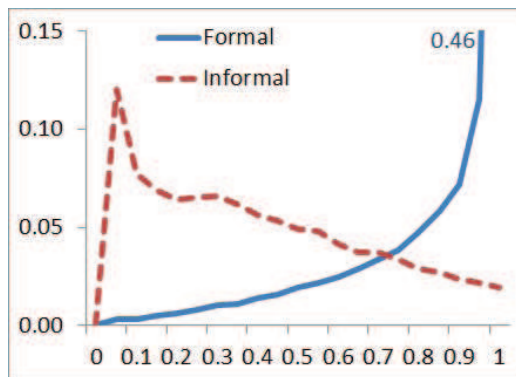
(b) 2006 sample

(c) 2007 sample

(d) 2008 sample

(e) 2009 sample

Notes: Propensity scores (probability of being formal) are in the x-axis while y-axis represents frequencies of formal and informal workers. Estimation results used for constructing these figures are presented in Table 5. Histogram of scores is documented in Table 6.

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