Firm-Size Wage Gaps along the Formal-Informal Divide: Theory and Evidence*

Binnur Balkan †
Central Bank of the Republic of Turkey

Semih Tumen ‡
Central Bank of the Republic of Turkey

March 9, 2014

Abstract

Observationally equivalent workers are paid higher wages in larger firms. This fact is often named as the "firm-size wage gap" and is regarded as a key empirical puzzle. Using micro-level data from Turkey, we document a new stylized fact: the firm-size wage gap is more pronounced for informal (unregistered) jobs than for formal (registered) jobs. To explain this fact, we develop a two-stage wage-posting game with market imperfections and segmented markets, the solution to which produces wages as a function of firm size in a well-defined subgame-perfect equilibrium. The model proposes two explanations. *First*, taxes on formal employment generate a wedge between formal and informal size wage gaps. Thus, government policy can potentially affect the magnitude of the firm-size wage gaps. The *second* explanation features a market-based framework with strategic interactions. Relative to small firms, large firms typically post higher wages for both formal and informal jobs they open. A high-wage formal job attracts a larger pool of applicants than a high-wage informal job. The larger pool of applicants for the formal job, in turn, allows the firm to somewhat lower the initial wage offer, while this second-round effect is negligible for informal jobs. As a result, size differentials are lower in formal jobs than informal jobs. We argue that the observed patterns in the use of social connections in job search and heterogeneity in job preferences can be used to justify the validity of this second mechanism.

JEL codes: C78, J21, J31, L11.

Keywords: Firm size; wage gap; informal job; wage posting; subgame perfection; taxes; social networks.

---

*We thank Daron Acemoglu, Kerem Cosar, Hakan Ercan, seminar participants at the Central Bank of the Republic of Turkey, the participants of the Turkish Economic Association Workshop on Economic Statistics in Ankara, and BETAM/World Bank Labor Market Network Meeting in Istanbul for helpful comments and suggestions. The views expressed here are of our own and do not necessarily reflect those of the Central Bank of the Republic of Turkey. All errors are ours.

†binnur.balkan@tcmb.gov.tr. Research and Monetary Policy Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

‡semih.tumen@tcmb.gov.tr. Research and Monetary Policy Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

1 Introduction

It is well-documented in the literature that larger firms pay higher wages to observationally equivalent workers than smaller firms pay.[1] This fact holds almost invariably across countries and sectors as well as across jobs with different supervisory responsibilities.[2] Several explanations are offered in the literature ranging from unobserved worker heterogeneity [Idson and Feaster (1990)] to unobserved firm productivity [Idson and Oi (1999)] and from the need for better data [Troske (1999)] to firm-level differences in labor turnover due to differences in hiring and human resource management practices [Idson (1996)]. Still, the firm-size wage gap is regarded as one of the key empirical challenges in labor economics and additional research is called for to enhance our understanding of this observed phenomenon.

In this paper, we document a new fact: the firm-size wage gap is higher for informal jobs than formal jobs. We perform our empirical analysis using a nationally-representative micro-level dataset from Turkey, which we believe that is a good laboratory to study this question—since around 25 percent of all jobs are informal based on official figures. "Size" corresponds to the number of workers employed in a particular firm. The data allows us to define firm size in 6 categories, 1 being the smallest and 6 being the largest. After controlling for a comprehensive set of observed covariates, we find that the wage gap between the firms of the largest versus the smallest size (i.e., Size 6 versus Size 1) is 21.5 percent and 31.2 percent for formal and informal jobs, respectively. This means that the average pay differential between the largest and the smallest firm is 10 percent higher in informal jobs than formal jobs. Moreover, this difference increases monotonically—from 0 to 10 percent—as size increases from 1 to 6; that is, when we consider wages as a function of size, our finding means that the slope of this function is steeper for informal jobs than formal jobs. See Figure (2.1) for a clear empirical visualization of this statement.

[1] See Oi and Idson (1999) for a comprehensive review of the early literature. Breakthrough papers in the early literature that deserve attention include Mellow (1982), Brown and Medoff (1989), and Groshen (1991).

[2] For studies documenting firm-size wage gaps at the country level, see, for example, Marcouiller, Ruiz de Castilla, and Woodruff (1997) for El Salvador, Mexico, and Peru, Tan and Batra (1997) for Colombia, Mexico, and Taiwan (China), Brunello and Colussi (1998) for Italy, Hollister (2004) for the United States, and Lallemand, Plasman, and Rycx (2007) for Belgium, Denmark, Ireland, Italy, and Spain. Baker, Jensen, and Murphy (1988) document sectoral differences in size-wage gaps for CEOs. Meagher and Wilson (2004) and Fox (2009) find that the size-wage gap is larger for jobs with managerial responsibilities.

Then comes the question: is it possible to develop a coherent theoretical framework to understand the forces driving this result? We construct a two-stage wage-posting game with market imperfections and segmented markets. The solution of this game analytically characterizes wages as a function of firm size within a well-defined subgame-perfect equilibrium. Firms differ in size, but workers are homogeneous. Each firm posts a wage, workers observe all offers and device a symmetric application strategy. Large firms offer higher wages, because the vacancies posted by them are more valuable—as larger firms are more productive. This framework proposes two mechanisms as potential explanations for the new stylized fact we report. *First*, formal jobs are subject to taxes and informal jobs are not. In our theoretical setup, taxes impose a wedge between the size premium in informal jobs versus that in formal jobs; that is, the size-wage gap is lower for formal jobs than informal jobs, because formal jobs are more costly to the employer due to taxes. We present auxiliary empirical evidence supporting this theoretical prediction. We conclude that government policy may affect the magnitude of the firm-size wage premium.

The model is able to propose a *second* explanation even when the taxes are shut down. A large firm faces a key tradeoff. It has to post a high enough wage so as to guarantee that the productive position is filled. There is also a secondary mitigating effect. The firm also has to keep wages at reasonable levels, because higher wages will attract a lot of applicants, the extent of which will provide incentives to keep the wage offer somewhat lower (as the vacancy will be filled anyway with that many applicants). We argue that the high-wage informal jobs posted by larger firms does not receive that many applications; so, the secondary (mitigating) force is weak for those jobs. As a result, the size gradient of the wage function is steeper for informal jobs than formal jobs. The key point is that the mitigating force is weaker for informal jobs. Why is this the case? One explanation is related to the use of social networks in job search. By definition, information on informal job openings most likely spread through social contacts (i.e., friends, relatives, and acquaintances). This fact, by itself, can generate the theoretical prediction that the applicant pool for a high-wage informal job is likely smaller than that of a formal job with comparable pay. An alternative explanation is that formal jobs might be more preferable by applicants since they offer better non-pecuniary benefits. Thus, if the non-pecuniary aspects of a job are valued by applicants, then it is understandable that a formal job might receive a larger pool of applicants than an informal job with similar pay. Finally, informal jobs are risky (i.e., they are terminated if caught by the authorities); as a result, risk averse applicants might try to avoid interruptions in job spells.

Our theoretical model is similar to the wage-posting models of Montgomery (1991), Lang (1991), and Lang, Manove, and Dickens (2005). In line with these papers, we solve a two-stage wage-posting game in a subgame-perfect equilibrium. Different from them, we incorporate two pieces: (*i*) firms differ in size and (*ii*) the number of applicants for each position is an indirect function of firm size. Other than these two major differences, we adopt the idea that formal and informal jobs are posted in segmented markets. In this respect, our model is related to the dual labor markets literature arguing that informal and formal jobs are subject to market segmentation at least partially [see, for example, Stiglitz (1976), Dickens and Lang (1985), and Heckman and Hotz (1986)].[3]

This paper makes several contributions to the literature on the firm-size wage gaps. To start with, this is the first paper in the literature documenting that the firm-size wage gaps differ across informal and formal jobs. Around 25 percent of the working population in Turkey are employed in informal jobs; thus, the Turkish data offers a natural environment to investigate the differences in firm-size wage gap patterns between formal and informal jobs. Second, we develop a theoretical model to explain this phenomenon. One of the predictions of the model is that the firm-size wage gap is negatively related to the tax burden of formal jobs. In other words, the employers' tax burden is a potential determinant of the magnitude of the firm-size wage gaps. We confirm the validity of this prediction using state-level labor tax differences in the U.S. Finally, we argue—as the second prediction of our model—that the number of new applicants that an incremental increase in the wage offer will attract is smaller in informal jobs. This, itself, can explain the fact we document.

[3]See Magnac (1991) for an opposing view.

The plan of the paper is as follows. Section 2 provides summary statistics for our micro-level data from Turkey and presents the results of our empirical investigation. Section 3 constructs the benchmark model, solves it, assesses its main predictions, discusses potential policy implications, and performs additional empirical tests of the model with auxiliary data. Section 4 concludes.

2 Empirical Analysis

2.1 Data Description and Summary Statistics

We use the Turkish Household Labor Force Survey (THLFS) data collected and compiled by the Turkish Statistical Institute (TURKSTAT). This is a large, micro-level, survey-based, publicly-available, and nationally-representative dataset based on which the official unemployment and earnings figures have been calculated and published regularly. The micro-level data details are publicly available only with yearly frequency, so we use yearly data from 2006 to 2012. The sample we focus on consists of employed individuals of age 15 and above. The wage variable describes monthly wage earnings in the main job and it is deflated using the GDP deflator with 2010 being the base year. We also control for 27 occupation and 87 industry categories classified based on the standardized NACE Rev.2 rules. Moreover, we include 26 regional dummy variables—at the NUTS2 level—to capture potential regional variations in the firm-size wage gap patterns.

Our key variable, firm size, is defined *via* 6 dummy variables. We name these variables from Size 1 through Size 6, the latter being the largest firm. The Size 1 firm is a firm with the number of employees in the interval 1–10, Size 2 is 11–24, Size 3 is 25–49, Size 4 is 50–249, Size 5 is 250–499, and, finally, Size 6 is 500 and above. Education is represented by 6 dummy variables as follows: no degree, primary school, secondary school, high school, vocational high school, and college & above. We control for workers' age as a quadratic polynomial. We also construct dummy variables for gender, marital status, full-time/part-time job status, and permanency status of the job. A specific feature of the Turkish labor

	Informal		Formal	
Variable	**Mean**	**Std.Dev**	**Mean**	**Std.Dev**
Size 1	0.697	0.459	0.212	0.409
Size 2	0.121	0.326	0.126	0.331
Size 3	0.104	0.305	0.212	0.409
Size 4	0.063	0.242	0.275	0.446
Size 5	0.009	0.095	0.072	0.258
Size 6	0.006	0.077	0.103	0.305
Female	0.245	0.430	0.234	0.424
Married	0.564	0.496	0.709	0.454
Full-time	0.923	0.266	0.983	0.131
No Degree	0.117	0.321	0.015	0.123
Primary School	0.408	0.492	0.260	0.439
Secondary School	0.268	0.443	0.143	0.350
High School	0.093	0.290	0.141	0.348
Vocational High School	0.074	0.261	0.151	0.358
College & Above	0.041	0.199	0.290	0.454
Age	32.42	12.691	34.26	9.110
Log Real Wages (monthly)	6.408	0.593	7.054	0.526
Sample share	0.233		0.767	
# of Observations	139,353		446,416	

Table 1: **Summary Statistics:** Turkish Household Labor Force Survey data between 2006–2012 are used in the analysis. Wages are deflated taking 2012 as the base year. The first two columns describe the summary statistics for informal employment and the last two columns describe those for formal employment. Total number of observations is 585,769. Robust standard errors are reported in parantheses. Appropriate frequency weights are used in all calculations.

market is that a non-negligible fraction of workers (around 24 percent) are employed informally. This does not necessarily mean that they are employed by informal firms. Formal firms also offer informal employment opportunities. Section 3.2 provides a detailed discussion of this issue, which will help understanding the predictions of our theoretical model developed in Section 3.1. Table (1) reports the summary statistics for formal and informal employment separately. In our unweighted sample, we have 585,769 observations—446,416 of them are employed in formal jobs and 139,353 of them are employed informally. (Summary statistics for 87 industry categories, 27 occupation categories, and 26 geographical regions are not reported but are controlled for in our regressions.) Relevant frequency weights are used to construct the summary statistics and in the regressions.

2.2 Econometric Model and Results

We run a least squares regression of log monthly wages on a comprehensive set of control variables including gender, marital status, age (as a quadratic), education, firm size, full-

Dependent variable: Natural logarithm of monthly real wages

	Informal		Formal	
Covariate	**Coefficient**	**(SE)**	**Coefficient**	**(SE)**
Size 1	omitted		omitted	
Size 2	0.126***	(0.0003)	0.067***	(0.0002)
Size 3	0.145***	(0.0004)	0.072***	(0.0002)
Size 4	0.193***	(0.0005)	0.114***	(0.0002)
Size 5	0.248***	(0.0012)	0.154***	(0.0002)
Size 6	0.312***	(0.0019)	0.215***	(0.0003)
Female	-0.204***	(0.0003)	-0.115***	(0.0001)
Married	0.049***	(0.0003)	0.079***	(0.0002)
Full-time Job	0.685***	(0.0007)	0.291***	(0.0005)
Permanent Job	0.083***	(0.0005)	0.196***	(0.0004)
Primary School	-0.002***	(0.0004)	-0.0001	(0.0003)
Secondary School	-0.003***	(0.0004)	0.068***	(0.0003)
High School	0.076***	(0.0005)	0.150***	(0.0004)
Vocational High School	0.080***	(0.0005)	0.166***	(0.0003)
College & Above	0.224***	(0.0008)	0.376***	(0.0004)
Age	0.047***	(0.0001)	0.046***	(0.0001)
$\text{Age}^2/100$	-0.056***	(0.0001)	-0.048***	(0.0001)
Year Dummies	Yes		Yes	
Region Dummies	Yes		Yes	
Industry Dummies	Yes		Yes	
Occupation Dummies	Yes		Yes	
Constant	4.756***	(0.0025)	5.172***	(0.0018)
# of Observations	139,353		446,416	
R^2	0.42		0.57	

Table 2: **Estimation Results.** Size 1, male, non-married, part-time, and no degree categories are the ignored dummy variables; so, the coefficients are interpreted relative to these categories. Appropriate frequency weights are used.

time/part-time work status, permanency of the job as well as year, region, industry, and occupation dummies. So, we control for a wide range of individual-level, group-level, and job-specific characteristics. Separate regressions are estimated for formal and informal employment. Specifically, we use the following equation to estimate firm-size wage gaps for formal and informal jobs:

$$\ln(w_i) = \beta_0 + \beta_2 s_2 + \beta_3 s_3 + \beta_4 s_4 + \beta_5 s_5 + \beta_6 s_6 + \boldsymbol{\theta}' \boldsymbol{X}_i + \epsilon_i, \tag{2.1}$$

where s_1–s_6 denote the dummy variables for the six firm-size categories (note that size 1 is the omitted category), $\boldsymbol{X}_i$ is a vector of observed covariates, and ϵ_i is an error term.

Table (2) presents our estimates. According to our estimates, the wage gap between smallest and largest firms is 21.5 percent in formal employment, whereas it goes up to 31.2 percent in informal employment. Moreover, this difference increases monotonically as size increases from 1 to 6; that is, when we consider wages as a function of size, our finding means that the slope of this function is steeper for informal jobs than formal jobs.

Figure (2.1) provides a plot of our estimates for formal versus informal employment. The upper panel is for the coefficients and the lower panel is for the gap itself. It is clear that the firm-size wage gap has a different slope along the formal-informal divide. To be specific, the size wage gap is larger for informal employment than formal employment. To demonstrate this finding more clearly, we plot red dashed lines, which are just simple trend lines indicating that the wages increase faster with respect to size for informal employment than it does for formal employment. In the next section, we provide theoretical explanations for this empirical observation and discuss the underlying economic forces.

3 Theoretical Framework

In this section, we construct a theoretical model to explain/justify the empirical facts documented in the previous section. Our main purpose in this section is to theoretically identify the factors that can potentially lead to a larger size wage gap for informal employment than formal employment. We first develop a general framework that will serve as a benchmark model in our theoretical analysis. Then, we show how one can use this benchmark framework in understanding the differences in the observed firm-size wage gap patterns along the formal-informal divide. To be precise, we identify two potential channels. The first one argues that these differences can be attributed to government policies; that is, high taxes on formal employment may be generating a wedge between size wage gaps in the formal and informal jobs. This result implies a more general hypothesis: there is a negative relationship between the firm-size wage gap and the employment taxes. We use state-level microeconomic data from the U.S. to test the validity of this "implied" hypothesis. Second, we show that relatively lower demand for high-pay informal jobs (than high-pay formal jobs) can lead to a higher size wage gap for informal employment than formal employment.

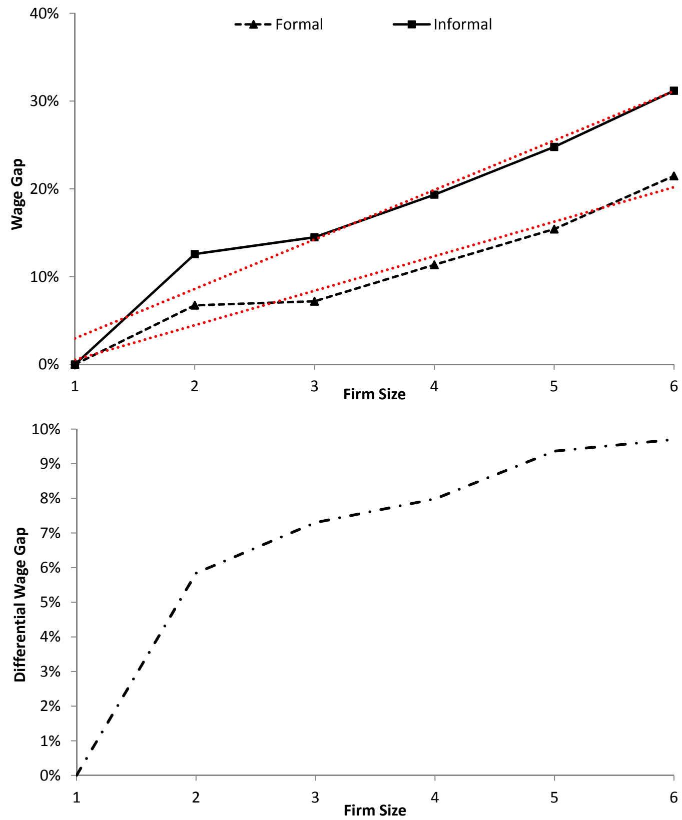

Figure 2.1: Plot of the estimates. The upper panel describes the firm-size wage gap relative to Size 1 for both formal and informal jobs. For example, a typical formal job at a Size 4 firm pays 11.4 percent more than a formal job at a Size 1 firm, while this gap is 19.3 percent for a typical informal job. The red dashed lines are simply reference lines indicating the slope differential between the two black lines. To make this differential more concrete, the lower panel plots the vertical distance between the two lines in the upper panel. See Table (1) for the exact numbers used to construct the plots.

3.1 A Wage-Posting Game

This sub-section describes the benchmark model without making a distinction between formal and informal employment. The formal-informal divide will be introduced in the next sub-section. The model draws on the simple wage-posting game developed by Montgomery (1991), Lang (1991), and Lang, Manove, and Dickens (2005). Workers are homogeneous, i.e., they are equally productive; so, firms do not make any distinctions/discrimination among them. Firms, on the other hand, are heterogeneous. These assumptions are consistent with the empirical analysis conducted in Section 2. Our regressions control for all observed worker characteristics, but we do not have much information about firm characteristics. All we know is the size of the firm that the worker is employed.[4] There is an extensive literature empirically documenting

[4]Throughout this section, "size" of a firm refers to the total number of workers employed by the firm.

the fact that firm size and productivity are strongly positively correlated. For example, Simon and Bonini (1958), Axtell (2001), and Luttmer (2007) show that the firm-size distribution is of the Pareto form, which suggests that firms on the right tail (i.e., larger firms) are scarce. This scarcity is due to the fact that they are, on average, more productive than the smaller firms. Let N denote the size of a firm and z is the productivity. We assume that (1) firms differ in their sizes N and (2) productivity z and size N are related via a continuously increasing and invertible function g, i.e., $z = g(N)$ with $g'(\cdot) > 0$.

Each firm has one vacant position. Vacancies come with a posted wage. Workers have perfect information on all posted wage offers and, given this menu of wages, they choose which firm to apply. Each worker can apply for only one position. Workers know that higher wage offers will attract more applicants, which means that the probability of getting accepted will be smaller when the posted wage is high. Vacancy creation and wage posting are simultaneous events; thus, firms do not know the exact number of applicants when they choose a posted wage offer. They, instead, form expectations on the number of applicants. Firms hope to attract at least one applicant, because not being able to fill the position will be costly. In forming expectations on the number of applicants they will receive, the firms act on the information that higher wage offers will increase the expected number of applicants, which means that the probability of ending up with an unfilled vacancy will be lower.

The equilibrium will be analyzed within a two-stage game in this model. At the first stage, firms simultaneously post wage offers. At the second stage, workers observe all of the posted wages and they simultaneously decide which job to apply. Firms' wage posting strategy will be a best response to the expected worker behavior and workers' application strategy will be a best response to the observed wage offers. The resulting equilibrium will be *subgame perfect*. However, this will not be a standard subgame-perfect Nash equilibrium. The reason is that, in Nash equilibrium, agents know that their own actions will generate a response in market prices. In the present model, workers are small (i.e., they are price takers) and their actions will not affect market prices in any sense, because firms will act on "expected" number of applications rather than the actual numbers. Thus, following Lang, Manove, and Dickens

(2005), we call our equilibrium a *subgame-perfect competitive equilibrium.*

There is a large (finite) number L of firms and the total number of job applicants in the job market is a random variable X, with mean μ_x. The realization of X is not observed by the firm; however, the firm knows and acts on μ_x. We assume that applicants come from a large population of workers, who make independent and equally probable decisions to enter the labor market. This definition implies that the total number of applicants, X, is Poisson distributed. We also assume that firms are able to commit to their equilibrium strategies, i.e., they will not change their posted wages after seeing the realization of X. In this setting, the firm will not hire anyone if it receives no applications; it will hire one worker at random if it receives more than one applications; and it will hire the sole applicant if it receives one and only one application.

Let j index the hiring firms. In this setup, posted wage offers can be represented by a vector $\boldsymbol{w}$ with firm-specific entries w_j's. Workers observe the wage profile $\boldsymbol{w}$ and develop a mixed strategy $\boldsymbol{h}(\boldsymbol{w})$, taken the wage offers as given. $\boldsymbol{h}(\boldsymbol{w})$ is a vector of application probabilities with entries $h_j(\boldsymbol{w})$, which describes the probability of applying to firm j given the entire wage offer profile $\boldsymbol{w}$. Workers are identical, so the strategy that they adopt is symmetric. As a result, the number of job applicants for any given firm j is drawn from a Poisson distribution with mean μ_j, which can be formulated as

$$\mu_j = h_j(\boldsymbol{w})\mu_x. \tag{3.1}$$

In other words, μ_j is the number of job applicants that firm j expects or hopes to attract, while μ_x is the expected number of total applicants in the job market. Then, firm j's expected profits can be expressed as

$$\pi_j = (1 - e^{-\mu_j})[g(N_j) - w_j], \tag{3.2}$$

where $g(N_j)$ is the value of a filled job's output as a function of firm size and $1 - e^{-\mu_j}$ is the probability that the vacancy is filled.[5] Now we are ready to describe the worker behavior, firm behavior, and the resulting subgame-perfect competitive equilibrium.

3.1.1 Job Application Strategy

In this subsection, we will describe the unique symmetric equilibrium in the worker application subgame. Let $f(\mu_j)$ describe the hiring strategy of firm j, who expects to receive μ_j applications with a posted wage w_j. More specifically, $f(\mu_j)$ is the probability that an additional designated applicant will be hired by firm j. We will describe how $f(\mu_j)$ is formulated in Section 3.1.2. Based on this definition, the expected income that any worker will receive by applying to firm j, which we denote with M_j, is simply

$$M_j = w_j f(\mu_j). \tag{3.3}$$

Given that all workers observe the entire profile of wage offers $\boldsymbol{w}$ and they observe $f(\mu_j)$'s, they construct a menu (or vector) $\boldsymbol{M}$ of expected incomes from all applications. Let $M = \max_j M_j$ is the maximum of all expected incomes. Workers will only apply to those firms with $M_j = M$. Following the terminology introduced by Lang, Manove, and Dickens (2005), we call M the "market expected income." So, in any symmetric equilibrium for the worker-application subgame, we have

$$M_j = \begin{cases} M, & \text{for } w_j \geq M, \\ w_j, & \text{for } w_j < M, \end{cases} \tag{3.4}$$

which suggests the following: (i) if the posted wage is less than the market expected income, then no worker will apply to such a firm; and (ii) if the posted wage offer is greater than or equal to the market expected income, then the firm will receive at least one application and the number of applications that the firm receives in the equilibrium will drive M_j down until

[5] As a property of the Poisson distribution, $e^{-\mu_j}$ is the probability that the firm receives no applications, given that the Poisson arrival rate is μ_j. Then $1 - e^{-\mu_j}$ is the probability that firm j receives at least one application. By the firm's hiring strategy described above, we know that the firm will definitely choose to hire if it receives at least one applications. As a result, $1 - e^{-\mu_j}$ is the probability that the vacancy is filled.

$M_j = M$ is reached. This can be expressed as follows:

$$\begin{cases} \mu_j > 0, & \text{for } w_j \geq M, \\ \mu_j = 0, & \text{for } w_j < M. \end{cases} \tag{3.5}$$

Using (3.3) and (3.5), and assuming that f is invertible, it is possible to solve for μ_j, when $w_j \geq M$, as follows:

$$\mu_j = f^{-1}(M/w_j). \tag{3.6}$$

The total expected number of job applicants is

$$\sum_j \mu_j = \mu_x = \sum_{j|w_j \geq M} f^{-1}(M/w_j). \tag{3.7}$$

Equation (3.7) can be used to determine the equilibrium value of M. The left-hand size is a constant and the right-hand side is a decreasing function of M. As a result, we obtain a unique equilibrium solution for M, which we denote with $M^*(\boldsymbol{w})$. Then, $M^*(\boldsymbol{w})$, Equation (3.6), and Equation (3.1) jointly define the unique symmetric equilibrium $\boldsymbol{h}^*(\boldsymbol{w})$ in the worker application subgame with posted wage offers $\boldsymbol{w}$, given that firms are behaving optimally. This completes the characterization of the worker's application strategy.

3.1.2 Hiring Strategy

Let the profile of posted wages be $\boldsymbol{w}$. There is a potential pool of applicants for firm j. Since these applicants are identical, each of them has the same probability of applying to firm j. As we discuss above, μ_j is the number of workers that the firm expects to receive an application. Suppose now that an additional worker applies to firm j. The probability that this additional designated applicant will be hired is

$$f(\mu_j) = \sum_{k=0}^{\infty} \frac{1}{k+1} \frac{e^{-\mu_j} \mu_j^k}{k!}. \tag{3.8}$$

After some algebra, it is possible to represent this probability simply as

$$f(\mu_j) = \begin{cases} 1, & \text{for } \mu_j = 0, \\ (1 - e^{-\mu_j})/\mu_j, & \text{for } \mu_j > 0. \end{cases} \tag{3.9}$$

In words, when the expected number of applicants to firm j is zero, then the designated applicant will be hired with probability 1. If, on the other hand, the expected number of applicants is strictly greater than zero, then the probability that an additional applicant will be hired is strictly less than 1 and is a function of the expected number of applicants.

3.1.3 The Subgame-Perfect Competitive Equilibrium

The game between firms and workers yields a subgame-perfect competitive equilibrium described by the pair of behavioral profiles $\{\boldsymbol{w}^*, \boldsymbol{h}(\cdot)\}$. In this equilibrium, the mixed strategy $\boldsymbol{h}^*(\cdot)$ is symmetric across workers given a wage profile $\boldsymbol{w}^*$. From Equation (3.6), we know that $w_j = M^*(\boldsymbol{w})/f(\mu_j)$. Substituting this expression into firm's expected profit function given by Equation (3.2) and using firm's hiring strategy given in Equation (3.9), we find

$$\pi_j = (1 - e^{-\mu_j})g(N_j) - M^*(\boldsymbol{w})\mu_j. \tag{3.10}$$

The firm takes workers' application strategy $M^*(\boldsymbol{w})$ as given and maximizes the expected profits over the expected number of applicants μ_j. The first-order condition for this maximization problem is simply

$$\mu_j = \log\left(\frac{g(N_j)}{M^*(\boldsymbol{w})}\right). \tag{3.11}$$

Manipulating Equation (3.11) yields the expression

$$M^*(\boldsymbol{w}) = g(N_j)e^{-\mu_j}. \tag{3.12}$$

The equilibrium operating profit of each firm then becomes

$$\pi_j = \left[1 - (1 + \mu_j)e^{-\mu_j}\right] g(N_j) \tag{3.13}$$

and the equilibrium posted wage for each firm j becomes

$$w_j = \frac{g(N_j)\mu_j}{e^{\mu_j} - 1}. \tag{3.14}$$

Equation (3.14) is the core result in this section. It formulates posted wages as a function of two objects: (1) the value or productivity of a vacancy, $g(\cdot)$, which itself is a function of firm size, N_j and (2) the expected number of applicants to the position posted by firm j. This formula suggests that larger firms pay higher wages, because they are more productive and they expects to receive a larger number of applicants per vacant position.

To map this formulation to our empirical analysis, we differentiate wages with respect to size, which will give us how wage offers change as a response to an incremental increase in firm size. Note that the expected number of applicants will also be affected in this differential system. Thus, to get the full response, we totally differentiate Equation (3.14) with respect to w_j, N_j, and μ_j, which, after some algebra, gives the following expression:

$$\frac{dw_j}{dN_j} = \frac{g'(N_j)\mu_j}{e^{\mu_j} - 1} + \frac{g(N_j)}{e^{\mu_j} - 1}\left[1 - \frac{\mu_j e^{\mu_j}}{e^{\mu_j} - 1}\right]\frac{d\mu_j}{dN_j} > 0. \tag{3.15}$$

This formula can be interpreted as follows. There is a consensus in the literature that larger firms pay higher wages to observationally equivalent workers. This is our observation also for Turkey. (See our estimates given in Table (2).) This fact is reflected above as $dw_j/dN_j > 0$. dw_j/dN_j has two components. The first component $g'(N_j)\mu_j/(e^{\mu_j} - 1) > 0$ says that larger firms pay higher wages because they are more productive. The sign of the second term is negative because the term $1 - (\mu_j e^{\mu_j})/(e^{\mu_j} - 1)$ is less than or equal to zero for $\mu_j \geq 0$. Based on the mechanism we describe, we also know that $d\mu_j/dN_j > 0$; that is, larger firms expect to attract a greater number of applicants, everything else is constant. This greater pool of applicants, however, generates a secondary effect: the effect of size on wages will be mitigated by the fact that, with such a large applicant pool, the firm can easily fill its vacancy without the need to pay a large size premium.

To summarize, our model suggests that the effect of size on wages operates through two channels: the productivity effect and the labor supply effect. The productivity effect makes a positive contribution, while the labor supply effect makes a negative contribution to the magnitude of dw_j/dN_j. But, in the overall, empirical evidence suggests that the productivity effect dominates and the sign of dw_j/dN_j remains positive. In the next subsection, we will extend this mechanism by assuming segmented markets and, then, use this benchmark model to explain the stylized fact we document in Section 2.

3.2 Firm-Size Wage Gap in Segmented Markets

From this point on, we assume that markets are segmented, i.e., formal and informal jobs are posted in separate markets. Before discussing the predictions of our model regarding the differences in firm-size wage gaps in formal and informal jobs, below we motivate our "segmented markets" assumption. This assumption is empirically justified and is often invoked in theoretical work. In particular, influential papers including Dickens and Lang (1985) and Heckman and Hotz (1986) segmented markets along the formal/informal divide exist in the real world. Following this tradition, we assume that there is such a segmentation in our theoretical environment. This means that the supply and demand conditions underlying the equilibrium solution are different for formal and informal jobs.

There are several reasons to believe that formal/informal segmentation is a realistic assumption for the labor markets in Turkey. First, the social security system in Turkey provides reasonable health and social insurance arrangements even for those who do not have any kind of official social security coverage. There are a lot of individuals aligned on this margin, who are willing to accept higher informal wages in exchange for better coverage in a lower-paying formal job. Second, the coverage provided by formal jobs is so generous that the spouses—in particular, wives who do not have a social security registration through a formal job—are also fully covered. This provides incentives for these spouses to work in informal jobs under more flexible terms. They are mostly not interested in the formal job market. Finally, firms also have incentives to create informal employment due to cost considerations. Taxes, social security contributions, and job security arrangements sum up to an important amount and can sometimes induce firms, especially the small ones, to search for workers in the informal market.

In the rest of this section, we present the detailed predictions of the benchmark model developed above by assuming that labor markets are segmented along the formal/informal divide, firms post separate job openings in formal and informal job markets, and workers' preferences toward jobs also support this segmentation. The predictions of the model are twofold. First, the model predicts (as we discuss in Section 3.2.1) that setting high tax rates on formal employment inserts a wedge between the firm-size wage gaps for formal and informal jobs. Second, and finally, high-paying informal jobs attract a smaller number of applicants than the high-paying formal jobs do. We discuss below in greater detail the theoretical predictions, our interpretations of them, and additional/auxiliary empirical evidence to check the validity of those predictions.

3.2.1 The Role of Taxes

An important difference between formal and informal jobs is that formal jobs are more costly tax-wise for both the employer and employee. For this reason, informal jobs are often associated with tax avoidance behavior. Taxes are dropped from the formulas in the previous subsection for expositional simplicity. Below we make the tax rate visible and discuss how taxes affect behavior in our model.

Suppose formal and informal jobs are offered in segmented markets, but the only difference between these two markets is that those working in formal jobs pay taxes while the informal workers do not. This suggests that the Equation (3.14) becomes

$$w_j = \frac{g(N_j)\mu_j}{(1+\tau)(e^{\mu_j}-1)}, \tag{3.16}$$

where $\tau \in (0, 1)$ is the tax burden on the formal job. The informal job sets $\tau = 0$, while for the formal job $\tau > 0$. So, it is also possible to re-label formal and informal jobs as high-tax and low-tax jobs, respectively. Using (3.15) and (3.16), it is clear that

$$\frac{d^2 w_j}{dN_j d\tau} < 0, \tag{3.17}$$

which means that the size gap is a decreasing function of taxes. In other words, the size-gradient of wages becomes smaller as the tax rate goes up. This formulation predicts that the size-wage gap should be higher for informal jobs than formal jobs. Taxes impose a wedge between the firm-size wage gaps in formal and informal jobs. However, this prediction does not only apply to jobs along the formal/informal divide and it can be translated into a more general one: firm-size wage gaps is a decreasing function of employment taxes. So, if we have, say, cross-regional data on firm-size wage gaps and employment taxes, then our prediction suggests that we should observe lower firm-size wage gaps in low-tax regions. Next we formally test this prediction.

To be specific, we convert our theoretical prediction into an empirically testable one by making the following statement: if the tax rate is a relevant factor affecting the firm-size wage gaps, then it has to be the case that the firm-size wage gap should be lower in regions with higher taxes on labor. We perform this test using data from the United States by utilizing the labor tax differentials across the states.

We use the Current Population Survey (CPS) March supplements from 2010 and 2011 to estimate the firm-size wage gaps for each state in our data set. We regress monthly log wages for full-time full-year workers employed by the firms in the private sector on gender, education, race, age (quadratic), marital status, occupation, industry, and firm size. The firm size is defined by a dummy variable taking 1 if the worker is employed by a firm with greater than 500 employees and taking 0 otherwise. We perform a separate regression for each of the states in our sample. To avoid the possible spurious size effects coming from unusual industry concentrations in smaller states, we focus on the 15 largest states in terms of their

Gross Domestic Products. These states are California, Florida, Georgia, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Texas, Virginia, and Washington.

The Federal taxes are fixed, but the state-level labor taxes exhibit significant variation across the states. The state-specific tax burden is calculated from the state-level labor tax information provided by the U.S. Department of Labor, Employment, and Training Administration. We multiply the maximum applicable salary reported with the corresponding tax rates to calculate the "maximum possible burdens" on employers in each state. This maximum burden is usually the regular burden for most of the states because the maximum applicable salary is fairly low for the average full-time full-year worker in the U.S.

We find a clear negative relationship between the labor tax rates and the firm-size wage gaps at the state level in the U.S. Figure (3.1) plots the state-level tax burden against the firm-size wage gap estimates. The negative relationship is even sharper when we rule out the outliers that emerge in our regressions (Florida, Massachusetts, and Washington). This result roughly confirms the validity of our theoretical predictions. We interpret this finding as follows. Each extra dollar offered by the firm is translated into less-than-a-dollar increase—due to taxes—in the wage offer received by the worker. This generates a downward pressure on the size premium in high-tax environments, while this pressure gets smaller as the tax rates decline. The informal job is the extreme case. As tax rates converge to zero, the firm-size wage gaps start increasing and, at the limit, it resembles the size premium in the informal job.

This finding suggests that labor-tax policy can affect how observationally equivalent workers fare in larger firms relative to smaller firms. In other words, we show that government policy can be a determinant of the magnitude of the firm-size wage gap and, therefore, the allocation of workers across firms of different sizes.

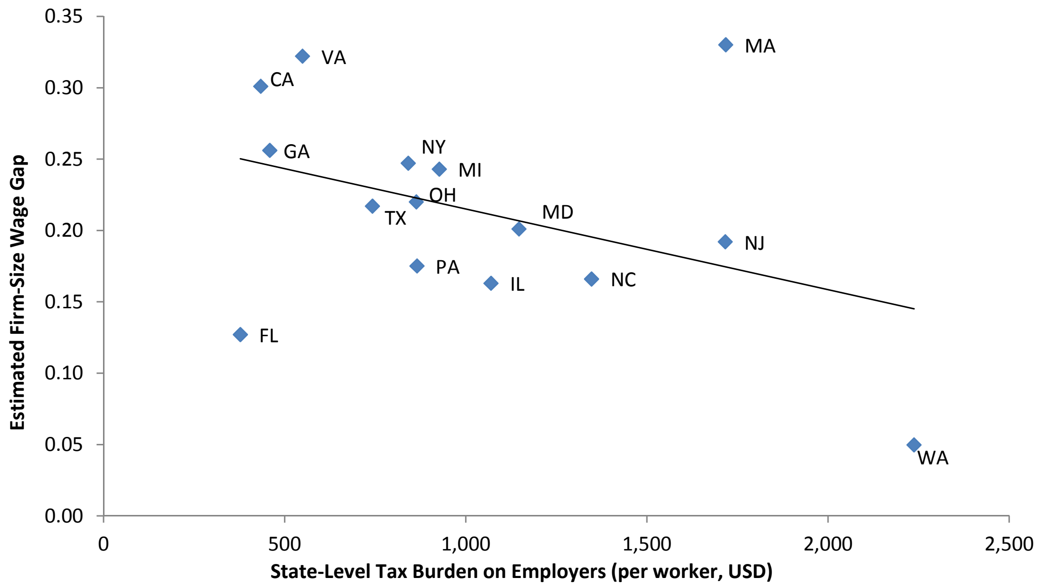

Figure 3.1: Firm-Size Wage Gap and Taxes.

3.2.2 An Alternative Mechanism

In this part, we will show that our model can explain the stylized fact documented in Section 2 even when the tax dimension is shut down. Again, we assume that markets are segmented. Our starting point is the Equation (3.15), which is the main prediction of our benchmark model. The model predicts that two forces jointly generate the firm-size wage gaps: (i) larger firms pay higher wages since they are more productive (the productivity effect) and (ii) larger firms expect to attract a larger number of applicants and the size of the applicant pool determines the size premium (the labor supply effect). The latter is a mitigating force; that is, when the pool of potential applicants is large, then the firm will tend to keep the size premium small.

Based on this prediction, the size gradient of equilibrium wages can be different between formal and informal jobs because of two reasons. First, it can be the case that formal jobs are more productive than informal jobs. In other words, given firm size, $g'(N)$ should be larger for formal jobs than informal jobs. However, we only have information about the formality status of the job, not the formality status of the firm. Informal jobs can be posted by formal firms and this is a common practice in Turkey. Without further evidence, asserting that formal jobs should be more productive than informal jobs may produce misleading results. Thus, we de-emphasize the potential differences in the productivity-effect channel.

The second reason is due to the potential differences in the size elasticity of the expected number of applicants. Larger firms offer higher wages (since they are more productive) than smaller firms. Higher wages, in turn, attract a larger number of applicants per job; thus, $d\mu_j/dN_j > 0$. However, the degree of this differential effect is potentially different between formal and informal jobs. Let d_i and d_f denote the magnitude of this differential effect $d\mu_j/dN_j > 0$ for informal and formal jobs, respectively. The stylized fact we report—that is, the firm-size wage gap is larger for informal employment than formal employment—implies that $d_i < d_f$, so that dw_j/dN_j is larger for informal jobs than formal jobs. In other words, the implication that $d_i < d_f$ can itself explain why the firm-size wage gap is larger for informal employment.

What does $d_i < d_f$ say? It means that the mitigating effect—i.e., the labor supply effect, which operates as a negative force—is weaker for informal jobs. In other words, higher wage offers bring in a smaller number of additional applicants in informal jobs than formal jobs. So, the firm-size wage gap is larger for informal jobs even when the productivity effect is deactivated. This mechanism may be operating due to several reasons. First, larger firms, on average, may have greater skill requirements both for the formal and informal jobs they offer. However, informal jobs with higher skill requirements may fail to attract a large number of applicants, since skilled workers are expected to opt for formal jobs. Second, applicants may be valuing other job-specific (pecuniary and/or non-pecuniary) amenities along with pay. This kind of amenity packages are weaker in informal jobs, by definition. This weakness may itself lead to a smaller applicant pool in informal jobs, if the weight assigned to these side amenities are high enough.

Finally, information on job opportunities in informal jobs are most likely disseminated through informal job search networks (such as relatives, friends, neighbors, and other acquaintances) rather than formal channels (such as ads). This can potentially reduce the size of the applicant pool for informal jobs. This effect might be even stronger for large firms due to higher

	Informal Jobs	Formal Jobs
Informal Search Methods	0.363	0.245
Formal Search Methods	0.637	0.755

Table 3: **Search Methods:** Turkish Household Labor Force Survey data between 2006–2012 are used in the analysis. Appropriate frequency weights are used.

visibility. The Turkish HLFS dataset provides information about the search method by which the employed workers found their current jobs. Informal job search corresponds to job search through one's friends, relatives, and acquaintances. Formal job search methods include direct contact with the employer, sending CVs, filling online application forms, visiting public or private employment agencies, unions, graduate placement offices, etc. Table (3) provides information on the job search methods used to find informal versus formal jobs.

The data suggest that around 36.3 percent of all informal job holders have found their jobs through their social contacts, while this number goes down to 24.5 percent for formal job holders. In other words, the incidence of finding a job through informal connections is 50 percent higher for informal jobs than formal jobs. We conclude that the potential differences among the job search strategies of the workers seeking informal versus those seeking formal jobs may also be a relevant channel in explaining formal-informal differences in the size-wage gap patterns.

Finally, we would like to mention an interesting generality that our model can exhibit. Suppose that there are two labor markets and these markets are segmented—which is the formal job market versus the informal job market in our context. Depending on the market structure, if higher wage offers in one market can bring in a lower number of applicants than the same offer can bring in the other market, then the size-wage gap is likely larger in the former than the latter. The finding presented in Fox (2009) hints that this conjecture is true. Specifically, using data from U.S. and Sweden, Fox (2009) finds—and explains employing a different theoretical model—that the firm-size wage gap is larger for jobs with managerial responsibilities than the standard jobs. Notice that this is another example of segmented markets. Managerial and non-managerial jobs are traded in a separate markets. If higher wage offers bring in a smaller number of additional applicants in managerial jobs than non-managerial jobs (which is most likely the case), then our theoretical framework predicts that that the firm-size wage gap should be greater for jobs with managerial responsibilities than the non-managerial jobs. This confirms that our theoretical model applies to other environments as well.

4 Concluding Remarks

It is well-documented in the literature that observationally equivalent workers receive higher wages in larger firms than smaller firms. In this paper, we report a new stylized fact using micro-level data from Turkey: the firm-size wage gap is larger for informal jobs than formal jobs. We develop a game-theoretical model to provide a systematic explanation for this fact. The model offers two alternative explanations. First, it suggests that high tax burden on formal jobs is the reason. We provide some auxiliary empirical support for this prediction using state-level tax differentials in the U.S. And, second, it predicts that the number of new applicants that an incremental increase in posted wages attracts will be lower for informal jobs. This, alone, can explain why larger firms need to offer higher wages to fill their most productive informal vacancies than their formal vacancies. Although the fact that we document is quite robust to alternative specifications, more empirical research is needed to check the validity of the finding that the firm-size wage gaps are larger for informal jobs than formal jobs. This task can best be performed by analyzing micro-level datasets from other developing countries with a large share of informal jobs.

References

Axtell, R. L. (2001): "Zipf Distribution of U.S. Firm Sizes," *Science*, 293, 1818–1820.

Baker, G. P., M. Jensen, and K. J. Murphy (1988): "Compensation and Incentives: Practice vs. Theory," *Journal of Finance*, 43, 593–615.

Brown, C. and J. Medoff (1989): "The Employer Size-Wage Effect," *Journal of Political Economy*, 97, 1027–1057.

Brunello, G. and A. Colussi (1998): "The Employer Size-Wage Effect: Evidence from Italy," *Labour Economics*, 5, 217–230.

Dickens, W. T. and K. Lang (1985): "A Test of Dual Labor Market Theory," *American Economic Review*, 75, 792–805.

Fox, J. T. (2009): "Firm-Size Wage Gaps, Job Responsibility, and Hierarchical Matching," *Journal of Labor Economics*, 27, 83–126.

Groshen, E. L. (1991): "Five Reasons Why Wages Vary Across Employers," *Industrial Relations*, 30, 350–381.

Heckman, J. J. and J. V. Hotz (1986): "An Investigation of the Labor Market Earnings of Panamanian Males Evaluating the Sources of Inequality," *Journal of Human Resources*, 21, 507–542.

Hollister, M. N. (2004): "Does Firm Size Matter Anymore? The New Economy and Firm Size Wage Effects," *American Sociological Review*, 69, 659–676.

Idson, T. L. (1996): "Employer Size and Labor Turnover," *Research in Labor Economics*, 15, 273–304.

Idson, T. L. and D. J. Feaster (1990): "A Selectivity Model of Employer-Size Wage Differentials," *Journal of Labor Economics*, 8, 99–122.

Idson, T. L. and W. Y. Oi (1999): "Workers are More Productive in Large Firms," *American Economic Review*, 89, 104–108.

Lallemand, T., R. Plasman, and F. Rycx (2007): "The Establishment-Size Wage Premium: Evidence from European Countries," *Empirica*, 34, 427–451.

Lang, K. (1991): "Persistent Wage Dispersion and Involuntary Unemployment," *Quarterly Journal of Economics*, 106, 181–202.

Lang, K., M. Manove, and W. T. Dickens (2005): "Racial Discrimination in Labor Markets with Posted Wage Offers," *American Economic Review*, 95, 1327–1340.

Luttmer, E. G. J. (2007): "Selection, Growth, and the Size Distribution of Firms," *Quarterly Journal of Economics*, 122, 1103–1144.

Magnac, T. (1991): "Segmented or Competitive Labor Markets," *Econometrica*, 59, 165–187.

Marcouiller, D., V. Ruiz de Castilla, and C. Woodruff (1997): "Formal Measures of the Informal-Sector Wage Gap in Mexico, El Salvador, and Peru," *Economic Development and Cultural Change*, 45, 367–392.

Meagher, K. J. and H. Wilson (2004): "Different Firm Size Effects on Wages for Supervisors and Workers," *Economics Letters*, 84, 225–230.

Mellow, W. (1982): "Employer Size and Wages," *Review of Economics and Statistics*, 64, 341–345.

Montgomery, J. D. (1991): "Equilibrium Wage Dispersion and Interindustry Wage Differentials," *Quarterly Journal of Economics*, 106, 163–179.

Oi, W. Y. and T. L. Idson (1999): "Firm Size and Wages," in *Handbook of Labor Economics*, ed. by O. Ashenfelter and D. Card, New York, NY: Elsevier, vol. 3, chap. 33, 2165–2214.

Simon, H. A. and C. P. Bonini (1958): "The Size Distribution of Business Firms," *American Economic Review*, 48, 607–617.

Stiglitz, J. E. (1976): "The Efficiency Wage Hypothesis, Surplus Labor, and the Distribution of Labour in LDCs," *Oxford Economic Papers*, 28, 185–207.

Tan, H. and G. Batra (1997): "Technology and Firm Size-Wage Differentials in Colombia, Mexico, and Taiwan (China)," *World Bank Economic Review*, 11, 59–83.

Troske, K. R. (1999): "Evidence on the Employer Size-Wage Premium from Worker-Establishment Matched Data," *Review of Economics and Statistics*, 81, 15–26.