Wage-Productivity Gap in Turkish Manufacturing Sector[1]

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Abstract

Perfectly competitive labor markets without distortionary taxes combined with a profit maximizing behavior of firms should imply that real wages should equal marginal product of labor (MPL). In this paper, we study the Turkish manufacturing industry and find that there exist a significant widening gap between real wages and marginal product of labor over the period 1950-2009. Using different time-series econometric techniques we show that this gap is foremost correlated with the unemployment rate over the period of study. To provide an economic mechanism for this relationship we build a search model of employment with endogenous bargaining. Our model implies that this observation is consistent with declining bargaining power of the workers, which is also supported by the data.

Keywords: Labor market, Turkey, search models, wage-productivity gap

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1 Introduction

In the absence of any market failures, perfectly competitive labor markets without the presence of distortionary taxes and combined with profit maximizing behavior of firms imply that real wages should equal marginal product of labor. When competitive firms take product and factor prices as given and maximize their profit function, it is immediate from the profit maximization problem of the firms that real wages should be equal to marginal product of labor.

However, various distortions or inefficiencies manifesting themselves as wedges might create a gap between the marginal product of labor and real wages. In this paper, we study the Turkish manufacturing industry and find that there exist a significant widening gap[4] between real wages and marginal product of labor over the period 1950-2009. We use different time-series econometric techniques and show that, among various potential economic factors, this gap is foremost (positively) correlated with the unemployment rate over the period of study. This observation is robust to different econometric specifications. On the other hand, potential factors other than unemployment; such as inflation, capital deepening, size of the informal sector and taxes do not seem to play a significant role in determining the observed wage-productivity gap in the data. Moreover, when being made subject to multivariate cointegration analysis, the data reveals that there exist a long-run relationship between the wage-productivity gap, unemployment rate and number of strikes[5] (which is interpreted as a proxy for the bargaining power of workers) and the positive correlation between unemployment and the wage-productivity gap goes along with declining bargaining power Moreover, to provide an economic mechanism for this relationship we develop a search model of employment with endogenous bargaining. Our model implies that this observation is consistent with declining bargaining power of the workers, which is also supported by the data as explained above.

The gap between productivity and real wages has been extensively studied in the literature. Researchers not only have used aggregate data to analyze this issue, but also found evidence towards the existence of such a gap from plant-level or firm-level data. Some examples include but are not limited to Persky and Tsang (1974), Zavodny (1999), Maliranta and Ilmakunnas (2005), and more recently Sulis (2008).

Moreover, there are also a number of studies analyzing the Turkish labor market from a similar perspective of ours. Berument, Dogan and Tansel (2006, 2009) investigate the behavior of unemployment with respect to macroeconomic policies and economic performance. Similarly, Agenor et. al. (2005) and Telli, Voyvoda and Yeldan (2006) analyze the effects of economic policy adjustment on unemployment in Turkey. Much more closely related to our paper, Ilkkaracan and Selim (2003)

[4] We use the ratio of marginal productivity of labor (MPL) to real wages as a measure of the gap between productivity and wages.
[5] Results do not change qualitatively when we use unionization rate instead of the number of strikes as a proxy for bargaining power.

find evidence towards the existence of a so-called “wage curve”, i.e. a negative correlation between regional unemployment rates and wages in Turkey. A more recent paper by Bayraktar Saglam and Gunalp (2012) investigates the efficiency of the Turkish labor market from the view of the Beveridge curve and finds evidence towards the existence of structural problems and rigidities in the Turkish labor market. In the literature on the Turkish labor market, our paper is distinct in the sense that it analyzes the Turkish manufacturing sector from an aggregate perspective and documents the existence of a positive correlation between the wage-productivity gap and unemployment. Moreover, to the best of our knowledge, our paper is unique in accounting for this relationship using a search-theoretic model, which also helps to find the economic mechanism behind this observation.

The rest of the paper proceeds as follows. Section 2 first lays out our empirical findings about the behavior of wages and marginal product of labor in the manufacturing sector of the Turkish economy. In this section, we also empirically document which factor(s) might possible be associated with the wage-productivity. Section 3 presents our model. Finally, section 4 concludes. Proofs of the two propositions we state in section 3 are delegated to the appendix.

2 Empirical Analysis

This section consists of four subsections. In the first one, we explain our data sources and particularly, how we create the marginal product of labor series. In the next subsection we document the evolution of the econometric variables and report results of a simple regression analysis which provides the first pass of the support for the existence of a positive correlation between wage-productivity gap and the unemployment rate. Then, in the third subsection we use cointegration techniques with and without the presence of a possible structural break to analyze the long run relationship between wage-productivity gap and the unemployment rate. Finally, the last subsection shows that bargaining power of workers play an important role in the relationship documented in the previous two subsections.

2.1 Data

We assume that the production in the manufacturing sector is characterized by the following constant returns to scale production function:

$$Y_t = A_t K^{\alpha}{}_t L_t^{1-\alpha} \tag{1}$$

Here Y_t is the total value added in manufacturing, K_t is the amount of capital and L_t is the amount of labor used in production. In order to calculate marginal product of labor, defined by MPL = $(1 - \alpha)\, Y_t / L_t$, we need an estimate of the capital share α. We obtain such an estimate by running the following regression equation:

$$\log(Y_t) = \beta_0 + \beta_1 \log K_t + \beta_2 \log L_t + \varepsilon_t \quad (2)$$

Here, obviously ε_t is the error term. Moreover, in order to create the capital series we employ the widely used perpetual inventory method using the following system of equations:

$$K_{t+1} = K_t(1-\delta) + I_t \quad (3)$$

$$\frac{K_{1950}}{Y_{1950}} = \frac{1}{10}\sum_{t=1951}^{1960}\frac{K_t}{Y_t} \quad (4)$$

Equation (3) is simply the standard law of motion of capital. Equation (4) is based on the assumption that the capital-output ratio of the initial period should match the average capital-output ratio over some reference period. Here, we choose the capital stock so that the capital-output ratio in 1950 matches its average over 1951 - 1960. These two equations, along with the amount of investment in year t, I_t, allows us to obtain the series of K_t, for all years t.

Estimating equation 2 above[6] yields an estimate for α i.e. the estimated value of β_1 turns out to be $b_1 = 0.5$. Considering other studies on Turkey, such as Ismihan and Metin-Ozcan (2006) or Altug, Filiztekin and Pamuk (2008), such a high value for the capital share is not surprising.

Once we have an estimate of α, we can easily create the marginal product of labor series, i.e. $MPL = (1 - b_1)Y_t/L_t$ and hence the MPL-to-W ratio.[7] This is what Persky and Tsang (1974) define as the Pigouvian exploitation rate.[8] In this study we will also refer to it as the wage-productivity gap. (or shortly gap)

According to Persky and Tsang (1974), variables that might have an effect on this ratio are; inflation rate, capital deepening (defined as the percentage change in the capital-output ratio), and the unionization rate. Additionally, another variable that can strongly affect the evolution of MPL-to-W ratio is the level of marginal taxes on the labor income[9]. Finally, motivating from our intention to provide a search-theoretic mechanism behind the evolution of the wage-productivity gap we will also include unemployment rate among the explanatory variables. Also, suspecting that the measure for the

[6] We do not present details of this estimation, as this has been extensively done by others and our estimate is not disturbingly different from other studies cited above.

[7] Real wage series in manufacturing is obtained from Statistical Yearbooks of TURKSTAT.

[8] Also see, Flatau (2001) for more details on Pigouvian exploitation.

[9] This is immediate from the profit maximization problem of a firm. If the firm pays taxes on it's output, one can obtain $MPL(1 - tax) = w$. Alternatively, if the firm pays taxes on wages then $MPL = (1 + tax)\,W$

unionization rate in Turkey might be prone to a significant measurement error[10], in some regressions we instrument it on the number of strikes in a given year. We will include all these variables in the first-pass of our empirical analysis below

Descriptive statistics of all the variables are provided in Table 1. We are using annual data in a time span of 60 years from 1950 to 2009.

Table 1. Descriptive Statistics

	Mean	Std. Dev.	Minimum	Maximum
Unionization	11.16	7.45	0.00	22.40
Unemployment Rate	8.08	1.77	3.41	13.20
MPL-to-W Ratio	1.14	0.40	0.65	2.11
Inflation	31.49	29.30	-1.10	106.30
Tax Rate	7.54	2.97	2.49	12.74
Capital Deepening	0.01	0.09	-0.21	0.26
Informal Sector	36.10	7.67	19.83	53.79
Strikes	65.40	89.25	0.00	458.00

Data needed to create the capital stock series in manufacturing sector is obtained from the State Planning Organization (SPO) and statistical yearbooks of the TURKSTAT. Wage data is extracted from the OECF and series for the output and employment in manufacturing and inflation are from SPO. (CPI based) Data for unionization and strikes are from Şahin (2002), Çelik and Lordoğlu (2006) and Ministry of Labor and Social Security websites, respectively. For the marginal taxes on labor income we rely on the findings of Cicek and Elgin (2011 a, b).

2.2 First Pass of Empirical Analysis

Figure 1 shows the ratio of marginal product of labor, calculated in the previous section, to the real wage rate in the manufacturing sector, with a normalization of its value to unity in 1972. Even though it was subject to some variation, the figure documents a rising trend in the wage-productivity gap, especially after late 1970s.

10 See Çelik and Lordoğlu (2006) for this.

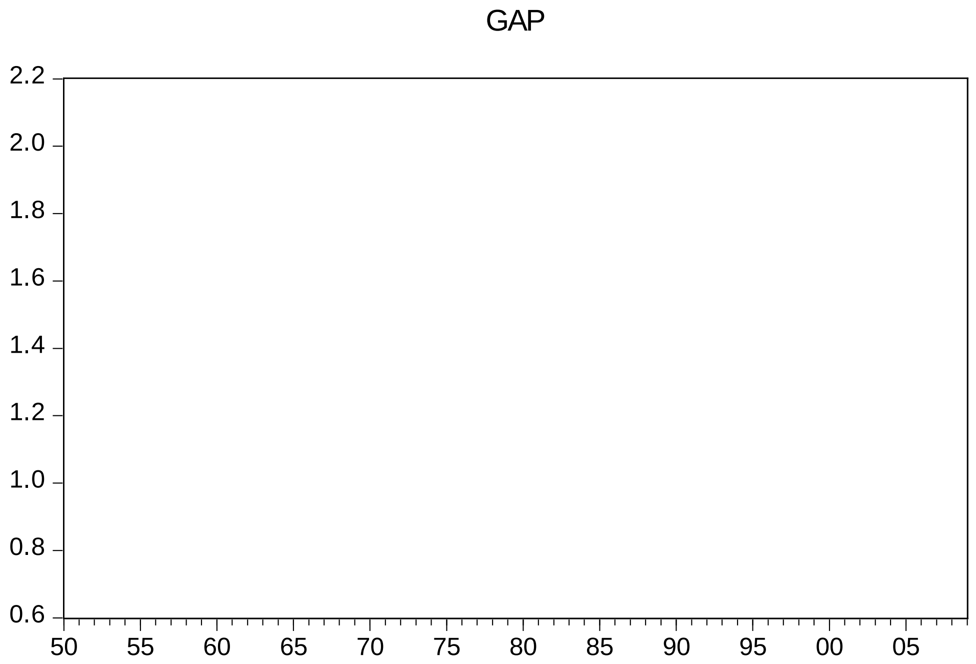

Figure 1

On the other hand, Figure 2 illustrates the joint behavior of the MPL-to-W ratio and the unemployment rate in Turkey from 1950 to 2008. Even by visual inspection we can observe a strong positive correlation between these two variables, especially after late 1970s.

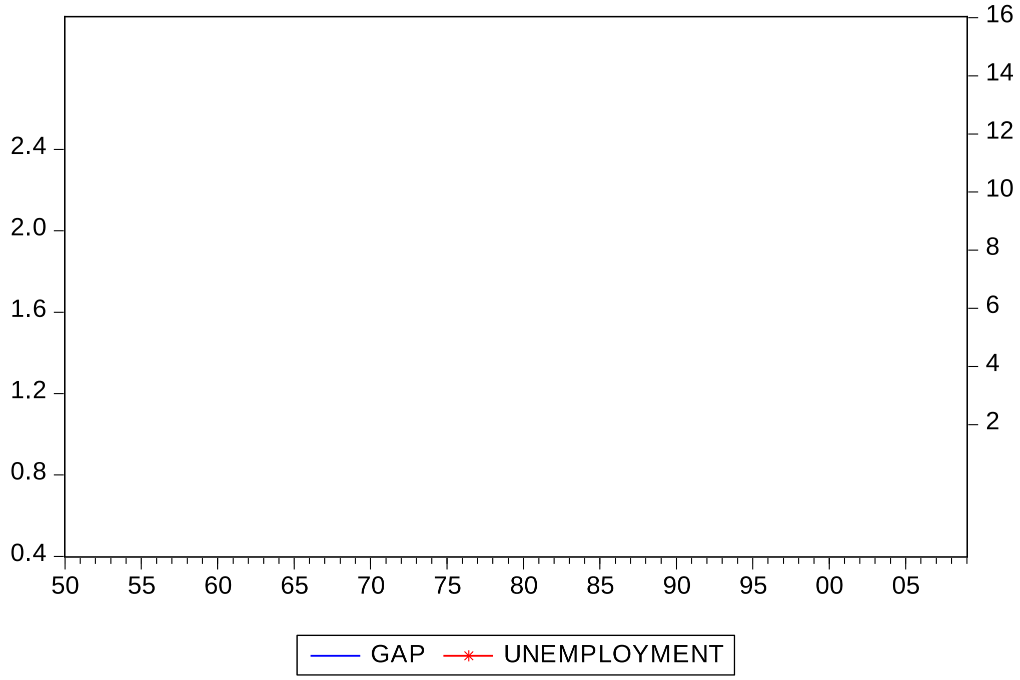

Figure 2

Having illustrated the behavior of these variables, we now estimate the following regression equation:

$$Gap_t = \beta_0 + \beta_1 U_t + \beta_k \sum_{k=2}^{n} X_{k,t} + \varepsilon_t$$

In this specification, GAP refers to the MPL-to-W ratio, U to the unemployment rate X_k for are the explanatory variables other than the unemployment rate for k=2,3…n. Finally, ε_t is the error term.

In Table 2, we present the results of this estimation using different estimation methods in 5 different runs. These are, ordinary least-squares (OLS), feasible generalized -east squares (FGLS), instrumental variable[11] technique with OLS and FGLS (denoted by OLS-IV and FGLS-IV respectively) and finally an OLS estimation with one-period lagged MPL-to-W ratio among the explanatory variables. The immediate conclusion drawn from Table 2 is that the coefficient of unemployment is statistically significant and positive in different regressions we have run. None of the explanatory variables, other than unemployment are significantly different from zero in a consistent and robust way.

Table 2: Simple Time Series Analysis

Dep. Var.: MPL-to-W Ratio

	OLS	FGLS	OLS-IV	FGLS-IV	OLS
Unemployment	0.08***	0.13***	0.11***	0.10**	0.02**
	(2.87)	(2.99)	(2.86)	(2.10)	(2.01)
Unionization	-0.01*	-0.008	0.007	0.004	0.0004
	(-1.87)	(-1.17)	(0.61)	(0.67)	(0.17)
Tax Rate	0.04*	0.003	0.02	0.02	0.004
	(1.68)	(0.19)	(0.53)	(0.60)	(0.42)
Inflation	0.001	0.002	0.002	0.002	0.003
	(0.29)	(1.25)	(0.69)	(0.98)	(0.92)
Capital Deepening	-0.26	-0.48***	-0.19	-0.62*	-0.80***
	(-0.46)	(-4.48)	(-0.30)	(-1.70)	(4.58)
Informal Sector	0.21*	0.14	0.19	0.12	0.18*
	(1.92)	(1.48)	(1.30)	(0.70)	(1.88)
MPL-to-W Ratio(-1)					0.97***
					(21.12)
R-squared	0.30	0.93	0.23	0.85	0.88
Observations	60	58	59	59	59
F-Test	4.29	91.79	4.57	13.15	19.20

[11] As we have explained in the previous subsection, we instrument unionization rate on the number of strikes, as the unionization data is very disputed in the Turkish case and therefore very much prone to measurement error.

2.3 Second Pass of Empirical Analysis

The estimation techniques we used in the first pass of our empirical analysis were implicitly assuming that the series we were considering are all stationary. However, as one can also visually suspect from the Figure 2, at least unemployment and the MPL-to-W ratio series might be non-stationary. To check this, Table 3 reports the results of the Augmented Dickey-Fuller tests we have performed for unemployment and MPL-to-W ratio. As the results clearly indicate there is strong evidence that both unemployment and MPL-to-W ratio are integrated[12] of order 1.

Table 3. ADF Tests for Unit Roots

Variable	Lag Length	t-statistic	95% CV
Unemployment	0	-1.93	-2.91
Differenced Unemployment	0	-5.56	-2.91
MPL-to-W Ratio	5	0.50	-2.92
Differenced MPL-to-W Ratio	4	-5.21	-2.92

Having documented that both series we are considering have a unit root, we now want to check whether there exists a cointegrating relationship between them and if it exists what the direction of this relationship is. For that purpose, we estimate the following standard cointegrating equation:

$$Gap_t = \alpha_1 + \alpha_2 u_t + \varepsilon_t$$

Moreover, following Gregory and Hansen (1996a, 1996b) we also take into account the possibility of a structural break in the cointegrating relationship.[13] To perform this we hypothesize 4 different structural break specifications: The first one implies a level shift in the cointegrating relationship:

$$Gap_t = \alpha_1 + \alpha_2 u_t + \alpha_3 \phi_{tb} + \varepsilon_t$$

In the above defined specification $\phi_{tb} = 0$ if $t < b$ and $\phi_{tb} = 1$ otherwise. In this specification b is the year of the potentially existing structural break. The second specification assumes a level shift with the presence of a time trend:

$$Gap_t = \alpha_1 + \alpha_2 u_t + \alpha_3 \phi_{tb} + \alpha_4 t + \varepsilon_t$$

[12] The only series, other than unemployment and the MPL-to-W ratio, which are integrated of order 1 are unionization and the number of strikes. For more details see the third subsection of this section.
[13] Visual inspection of the Figure 2 also reveals hints on the presence of a structural break either in late 70s or early 90s.

The third specification hypothesizes a cointegrating relationship with a regime shift where both intercept and slope coefficients change

$$Gap_t = \alpha_1 + \alpha_2 u_t + \alpha_3 \phi_{tb} + \alpha_4 u_t \phi_{tb} + \varepsilon_t$$

And finally, we also examine a relationship with a egime shift where the intercept and the slope coefficients change along with the trend, i.e.

$$Gap_t = \alpha_1 + \alpha_2 u_t + \alpha_3 \phi_{tb} + \alpha_4 t + \alpha_5 \phi_{tb} t + \alpha_6 \phi_{tb} u_t + \varepsilon_t$$

Table 4 below reports the results of the Gregory-Hansen structural break tests. The break year is endogenously reported by the test by estimating the cointegration equations for all possible break dates. The test then chooses a break date where the test statistic is the minimum or equivalently the absolute ADF test statistic is at its maximum.[14] The results in Table 4 imply that in all the four hypothesized relationships with structural breaks, there is cointegration between the wage productivity gap and unemployment.

Table 4. Gregory-Hansen Structural Break Tests

Test Equation	Break Year	Test statistic
Level Shift	1990	-6.39**
Level with Trend Change	1990	-6.46**
Regime Shift	1977	-7.37**
Regime Shift with Trend Change	1977	-7.92**

The break dates are 1990 in the first two specifications without the regime change and 1977 in the models with regime change. Moreover, the null hypothesis of no cointegration is rejected in all the four models with structural break.

As argued by Rao (2006), statistical techniques are only tools to summarize empirical facts and do not necessarily yield answers in line with economic theory and/or intuition. However, the structural break years determined by the tests we run are not very surprising. 1977 is a year which according to Çiçek and Elgin (2011b) is the starting year for the Turkish depression and 1990 is the initial year of a politically and economically very volatile decade for the Turkish economy. Not specifically preferring one model to the other, next we proceed to estimate the cointegrating equations for all of these four models with the Engle–Granger method. The first stage OLS equations are given below in Table 5

[14] See the cited papers for critical values.

together with the standard cointegration equation without any structural break[15]. The estimates of all these five models all imply a positive correlation between unemployment and MPL-to-W ratio. This illustrates that the positive correlation between unemployment and the wage-productivity gap is robust to different econometric specifications.

Table 5. Cointegrating Equations

	Standard	Lev. Sh.	Lev. w. Trend	Reg. Sh.	Reg. w. Trend
Intercept	-0.58	-0.41	-0.01	0.03	0.05*
	(-0.11)	(-0.82)	-(0.74)	(0.12)	(1.96)
Unemployment	0.21**	0.17**	0.09**	0.06***	0.09***
	(2.71)	(-2.09)	(-2.28)	(4.93)	(4.75)
Dummy×Intercept		0.49***	0.40	-0.83	-0.30
		(2.90)	1.59	(-1.85)	(-1.81)
Trend			0.03***		0.002
			(4.14)		(1.66)
Dummy×Trend					0.005
					(1.26)
Dummy×Unemployment				0.07	0.01
				(1.33)	(1.80)

Robust t-statistics are reported in parentheses. ***, **, * denote 1, 5 and 10% confidence levels, respectively.

2.4 Third Pass of Empirical Analysis

Finally, as a third pass of the empirical analysis, we investigate whether there exists a trivariate long run relationship between unemployment, wage-productivity gap and the number of strikes which we intend to use as a proxy for the bargaining power of workers.[16] Our motivation for conducting such an analysis is motivated from our intention to account for the observed positive correlation between unemployment and the wage-productivity gap through the bargaining power of workers using a search-matching model of employment.[17]

To perform the trivariate analysis, we first check whether the “strikes” series is integrated of order 1. The ADF test yields a value of -2.536 whereas the 5% critical value is 2.925. On the other hand, when differenced for one period ADF test statistic becomes -8.671 which lets us to conclude that the strikes series is integrated of order 1. Next, using the Johansen test for cointegration we check the cointegrating rank of the relationship and find out both the trace and eigenvalue tests indicate the presence of two cointegrating relationships at 5% critical value.[18]

[15] The cointegration tests we performed indicate the existence of one cointegrating relationship in the case without structural break. Due to space constraints we do not these test results. However, they are available upon request from the corresponding author.

[16] Our results do not change qualitatively when we use unionization instead of the number of strikes as a proxy for bargaining power.

[17] The intuition will be made clearer in the next section of the paper.

[18] Results of these tests are available upon request from the corresponding author.

The two estimated cointegraing equations are available in Table 6. As we can see from the table, both unemployment and the wage-productivity gap are negatively correlated with the number of strikes[19]. (i.e. bargaining power of workers.) What these results suggest is that declining (increasing) bargaining power of workers is associated with increasing (decreasing) unemployment and wage-productivity gap.

Table 6
Cointegrating vectors

LM Test Statistic[a]	Joint Jarque-Bera test statistic[b]	Cointegrated equation	λ_i^c
6.76	0.99	Gap = 0.61 - 0.002 strikes	-0.07
		(3.03***)	(0.03**)
		Unemp = 7.98 - 0.02 strikes	-0.06
		(2.79***)	(0.03**)

Number of observations= 60; optimal lag length = 1; (*), (**), (***) indicate 10%, 5% and 1% level of significance, respectively; and figures in the parentheses indicate standard errors.
[a] The null hypothesis of no serial correlation at lag order 1 is not rejected at the 5% level of significance.
[b] The null hypothesis of residuals are multivariate normal is not rejected at the 5% level of significance
[c]The coefficients of the error correction term for each cointegrated equation.

Having empirically established that the bargaining power plays a role in determining the relationship between unemployment and the wage-productivity gap, next, we turn to building a model to account for this relationship.

3. Model

The observed dispersion between marginal productivity of labor and wages suggests a deviation from the competitive equilibrium outcome in which workers are paid their marginal product. Walrasian equilibrium theory is an important benchmark to start with for modeling wage determination, however it fails when confronted with data which pave the way to models with frictions in the labor market. Main line of research in this area focuses on search frictions, which is pioneered by Mortensen and Pissarides[20]. In this section, our main focus is on the wage determination and the implications of Mortensen and Pissarides framework. Details of their model, which are not directly relevant to our analysis, are left out and reader is referred to Pissarides (2000) for a comprehensive exposition of their model.

3.1 Model Environment

Mortensen-Pissarides model considers a labor market with a costly search process both for workers and firms[21]. This imperfection in the labor market is characterized by a matching function which can

[19] Again, we want to emphasize that result are similar when we use unionization instead of number of strikes.
[20] See Mortensen and Pissarides (1994) for an extensive review of these models.
[21] The main difference in our approach is to endogenize the job finding rates in the bargaining game, which defines the probability of getting an outside offer and the continuation value in the game.

be thought as a reduced-form representation of these frictions, denoted by $M(u,v)$, where u is the number of unemployed workers who are searching for a job and v stands for the number of open vacancies. Matching function defines job finding probability, $\rho(\theta)$, for the workers and probability for a firm to fill an open vacancy, $q(\theta)$ where $\theta = v/u$ is the labor market tightness. Matching function exhibits constant returns to scale and strictly increasing and concave in both arguments which implies that $\rho(\theta)$ is an increasing function of labor market tightness and $q(\theta)$ is a decreasing function of θ. Workers and firms are risk-neutral hence they maximize the present discounted value of their lifetime income and the equilibrium is characterized by a series of Bellman equations. We do not introduce any heterogeneity to the model hence all workers and firms are identical. Whenever a worker and a firm form a match, they create a surplus to be divided according to a sharing rule. Pissarides model relies on the generalized Nash bargaining solution in determining the wage share of the worker and profit share of the firm. Shares of each party in the match is determined according to their bargaining powers and outside options. We denote the bargaining power of the worker by β. Bargaining power β, is the main force which drives the wage share and it is treated as exogenous by the model. The idea here is that whenever a worker and a firm are in a match, they form a monopoly on the surplus generated by the match, and it is not possible to talk about market clearing wage as in the Walrasian equilibrium.

Our theoretical goal in this section is to provide a model, which relates the bargaining power to the structural parameters, and understand how bargaining power responds to changes in market conditions. We will use the bargaining game proposed by Cahuc, Postel-Vinay and Robin (2003) as our benchmark and extend their game for search and matching models of the labor market.This will allow us to extend search-matching model explained above by endogenizing the bargaining power β.

The bargaining outcome of a match is modelled as an equilibirum of an infinite horizon alternating offers bargaining game a la Rubinstein (1982). We assume complete information such that both parties know the other party's type and all wage offers are common knowledge. Workers and firms are homogenous and make alternating offers. When worker makes an offer then it is either accepted or rejected by the firm. We denote wage offer by the worker as w_e and wage offer by the firm as w_f. If the offer accepted then worker and firm start producing. If firm rejects the offer then after a short period of time, Δ_t, firm makes a counter-offer to the worker, w_f. Bargaining game continues in this fashion over an infinite horizon. We assume that during the bargaining game workers and firms can execute their outside options. Workers get outside offers at rate $\rho(\theta)$, if thay take it they start bargaining with another firm, and similarly for the firms with the corresponding rate, $q(\theta)$. We assume that matches are separated at rate λ. Observe that continuation value of the worker and the firm when they take an outside offer is identical to the outcome of the initial game because workers and firms are homogenous therefore all wage bargains are identical.,

This game has a unique subgame perfect equilibrium which is characterized by strategies of the worker and the firm in which both parties offer a wage to make the other party indifferent between accepting or rejecting the offer. Therefore, w_e and w_f solves the following equations:

$$V(w_f) = \frac{1}{1+r\,\Delta_t}\left[(1-\lambda\Delta_t - \rho(\theta)\Delta_t)V(w_e) + \lambda\,\Delta_t V^u + \rho(\theta)\Delta_t\,\tilde{V}(w_f)\right] \quad (5)$$

$$J(w_e) = \frac{1}{1+r\,\Delta_t}\left[(1-\lambda\Delta_t - q(\theta)\Delta_t)J(w_f) + \lambda\,\Delta_t V + q(\theta)\Delta_t\,\tilde{J}(w_e)\right] \quad (6)$$

$V(w_f)$ is the value of a worker who accepts the offer of the firm, w_f . Right hand side of the equation gives the value of the worker if she rejects the offer. First term states the probability that match is not destroyed and worker does not get an outside offer in which case worker makes a counter offer w_e. With probability λ , match is destroyed and worker get the reservation value which is given by V^u and with probability $\rho(\theta)$ worker gets an outside offer and obtains the continuation value of the game. Note that if worker starts bargaining with another firm, the game is identical to the initial one, because firms and workers are homogenous. The second equation describes the situation of the firm.

An equilibrium is a pair of stationary strategies for the firm and the worker in which each party makes the other party indifferent between accepting or rejecting the offer at hand. The bargaining game has a unique subgame prefect equilibrium characterized by a fixed sharing rule of the surplus between agents. Equilibrium is characterized in the following proposition.

Proposition (1): In equilibrium there exists a unique wage offer w, which satisfies

$$\left(r+\lambda+\rho(\theta)\right)J(w) = \left(r+\lambda+q(\theta)\right)\left(V(w)-V^u\right) \quad (7)$$

Proof: Delegated to the appendix.

The unique equilibrium of this game can be approximated by the generalized Nash bargaining with exogenous share parameters. This proposition states that when we relate the outcome of the game to the structural parameters of the bargaining game, we can explicitly get the share parameters as a function of these parameters. The advantage of this approach is that we can derive the bargaining power endogenously. As a comparison, we reproduce the Nash bargaining outcome in the search and matching model with fixed bargaining power:

$$\beta J(w) = (1 - \beta)\,(V(w)\text{-}V^{u}) \qquad (8)$$

By using (7) and normalizing the share parameters we obtain the bargaining power in the range [0,1]. The bargaining power of the worker (and the firm) depends on the discount rate and the match separation rate, which is also called as the "level effect" because it affects both the worker and the firm in the same way. "Marginal effect" is the effect of match finding rates on the bargaining power, which is determined by labor market conditions. In this sense, the following proposition presents the relationship between the bargaining power and labor market tightness.

Proposition (2): Bargaining power of the worker is monotonically increasing in labor market tightness, i.e. $\frac{\partial \beta}{\partial \theta} > 0$ where $\beta = \frac{r+\lambda+\rho(\theta)}{2(r+\lambda)+\rho(\theta)+q(\theta)}$.

Proof: Delegated to the appendix.

If the aggregate unemployment level in the labor market is higher, then the bargaining power of the worker decreases and the worker tends to settle for a lower wage in the bargaining game, since higher unemployment implies higher matching rates for firms and lower matching rates for workers due to lower market tightness.

3.2 Calibration

In this subsection, we use our result from the previous subsection and estimate the bargaining power of the average worker (or firm) in Turkish manufacturing. In order to do that we calibrate the model by treating bargaining power as endogenous given by proposition (2). In the calibration analysis, we need to assign values to the parameters of the model, to the extent possible, based on long run or microeconomic data. Again, referring to Pissarides (2000) parameters of the model are discount rate r, job separation rate λ, cost of posting a vacancy c, productivity parameter p , unemployment benefit b and parameters, which identify the matching, function. In the calibration of the model we assume that matching function takes the following functional form:

$$M(u, v) = A\, u^{\alpha} v^{1-\alpha} \tag{9}$$

Here A is the parameter, which governs the efficiency of the matching process and α is the elasticity of the matching function with respect to unemployment. With the parameters of the matching function the total number of parameters is six. In the literature, additional to these parameters we need to choose a value for bargaining power, β, because it is another exogenous parameter of the model. The steady-state equations that one can use for the calibration are three[22]

$$u = \lambda/(\lambda + \rho(\theta)) \tag{10}$$

$$\frac{p-b}{r+\lambda+\beta q(\theta)} = \frac{c}{(1-\beta)q(\theta)} \tag{11}$$

$$w = \beta\,(\mathrm{p} + \mathrm{c}\,\theta) + (1-\beta)\,\mathrm{b} \tag{12}$$

Equation (10) gives the steady-state unemployment as a function of job separation rate and job finding rate of the workers. Equation (11) is the job creation condition and equation (12) derives the equilibrium wages at the steady state. As the reader may have noticed, together with the bargaining power, number of parameters in the model is seven, however we have three steady-state equations for calibration and in that sense calibration of the search and matching model is rather uncontroversial. Therefore results differ greatly across calibrations depending on different identification assumptions. We start with the parameters, which leave little room in assigning values. The calibration analysis follows closely Shimer (2005), Hall (2005) and Boz et.al (2009). We treat one unit of time in the model as representing a year dictated by our data set and we pick $r = 0.014$. We normalize productivity to unity and set $p = 1$. Elasticity of the matching function is obtained from Petrongolo and Pissarides (2001) and taken to be equal to $\alpha = 0.5$. The value for the unemployment benefit varies across calibrations. OECD Employment Outlook calculates the replacement rates. We pick the average and set $b = 0.4$. For the cost of posting a vacancy we rely on Boz et.al (2009) and pick their value

[22] See Pissarides (2000) for derivations.

$c = 0.127$ for our analysis. Finally, we set job separation rate $\lambda = 0.06$ following Taşçı and Tansel (2005).

Table 7: Calibrated Parameters

Parameter	***Value***	***Source***
Steady-State discount factor r	0.014	Real interest rate
Cost of posting Vacancy c	0.127	Boz et.al (2009)
Elasticity- matching function α	0.5	Petrongolo Pissarides (2001)
Unemployment benefit b	0.4	OECD (1996)
Productivity p	1	Normalized
Matching efficiency A	0.778	Boz et. al. (2009)
Job separation rate λ	0.06	Taşçı and Tansel (2005)

The calibrated parameters are presented in Table 7.

So far, we have used micro evidence and the insights from the literature to choose the parameter values. For the other parameters of the model, literature takes different approaches. Shimer (2005) does not use the wage equation in his calibration and set $\theta = 1$ and choose the bargaining power to be equal to the elasticity of the matching function. The main rationale behind this parameter choice is the Hosios condition which states that efficiency of the search and matching model requires $\beta = \alpha$. However, it is not clear why we should treat the market equilibrium as efficient. This choice is still the most intuitive way to pick the value for β because we do not have enough micro evidence to pin down the value for the bargaining power. This is an issue that we overcome in this paper by endogenizing the β.

Looking at the wage equation implied by the model, one can directly see that equilibrium wages depend explicitly on the choice of the bargaining power. Our approach differs mainly at this point. In the previous section, we have derived the bargaining power as a function of the exogenous and endogenous variables in the model. An advantage of doing this is that using this result, we can impose more discipline to our calibration exercise and then directly back out an estimate for the bargaining power of the workers in Turkish labor market.

Now we will use the steady-state equations (10), (11) and (12) to calibrate the remaining parameters and calculate the steady-state equilibrium. Equilibrium of this model is a triple, $\{w, u, \theta\}$. We will treat the bargaining power as endogenous and use Proposition (2) in our calibration. We target long-run averages in our data set. First, we calculate average unemployment rate, which is equal to 8.13% and set this value as our target. (Target 1). Second, we calculate the average wage-productivity ratio as 0.603 (Target 2). We need to pin down the values for labor market tightness, θ, and we will back out the value of the bargaining power of workers implied by the model.

Using the steady-state equations and our target values obtained from the long-run averages in the data, we are able to pin down uniquely the values for labor market tightness and the bargaining power of the worker.

The average labor market tightness θ is calculated as **0.8749**, which is close to the estimate by Saglam and Günalp (2012), which provides estimates for labor market tightness. Finally, as the main point of our analysis, we calculate the average bargaining power of the worker as $\boldsymbol{\beta = 0.4137}$ for the time period 1950-2009.

We also want to see how bargaining power has changed between 1950 and 2009. To see this we have divided our data set into six periods, 1950-1959, 1960-1969, 1970-1979, 1980-1989, 1990-1999 and 2000-2009. Then we repeat the same procedure to obtain estimates of the bargaining power for these subperiods. The following table summarizes our results.

Table 8: Bargaining Power Estimates and Unemployment Rate

Period	***Average Bargaining Power***	***Unemployment Rate***
1950-1959	0.5775	2.56
1960-1969	0.5465	3.26
1970-1979	0.4855	6.45
1980-1989	0.3761	7.76
1990-1999	0.3480	7.81
2000-2009	0.2775	9.88

First of all, as we can see from Table 8, there is a significant negative correlation between the bargaining power of the workers and the aggregate unemployment rate, which confirms our empirical results. When the unemployment rate is high, then workers' relative position in the bargaining is weakened, therefore they tend to settle for lower wages and as a result of that the wage-productivity gap widens. Another important point we observe from the Table 8 is the steady decline of the bargaining power of the workers in Turkish labor market. We think that this observation is due to the reduction in the power of labor unions. Notice that this is also consistent with the third pass of our empirical analysis in the previous section.

4. Conclusion

In this paper, we make a unique aggregate observation and document a positive correlation between wage-productivity gap and unemployment rate in Turkish manufacturing sector. According to our empirical results, this conclusion is robust to different econometric specifications and to the inclusion of a structural break in the time-series data.

Moreover, we also provide an economic mechanism, which can account for the observed relationship between wage-productivity gap and unemployment. Our theoretical approach relies on an extension of a search and matching model and tries to understand the implications of the model on the wage-productivity gap and its relation with unemployment. Our main observation is that bargaining power of the workers is crucial in the determining the evolution of the wage-productivity gap and it is also a driving force for the correlation between this gap and the unemployment rate. Our main theoretical result is that higher unemployment rate in the labor market is associated with higher wage-productivity gap and lower bargaining power in Turkish manufacturing.

This is not only a phenomenon of the Turkish labor market. In a companion paper, Elgin and Kuzubas (2012), we make a similar observation in a panel data setting for the OECD countries. In this paper, with the availability of more comprehensive data sets, a full-fledged stochastic general equilibrium model of the labor market will provide us with a better understanding of the issues discussed in this paper. These extensions we leave to future research.

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5. Appendix

Proof of Proposition 1: The unique subgame perfect equilibrium of the infinite horizon bargaining game is a pair of stationary strategies which solve the equations in the text.We reproduce them here for completeness.

$$V(w_f) = \frac{1}{1 + r\,\Delta_t}\left[(1 - \lambda\Delta_t - \rho(\theta)\Delta_t)V(w_e) + \lambda\,\Delta_t V^u + \rho(\theta)\Delta_t \tilde{V}(w_f)\right]$$

$$J(w_e) = \frac{1}{1 + r\,\Delta_t}\left[(1 - \lambda\Delta_t - q(\theta)\Delta_t)J(w_f) + \lambda\,\Delta_t V + q(\theta)\Delta_t \tilde{J}(w_e)\right]$$

Following Cahuc et.al. (2003), we rearrange these equations to obtain:

$$V(w_f) - V(w_e) = -\Delta_t\left[(\lambda + \rho(\theta))V(w_e) + r\,V(w_f) - \lambda V^u + \rho(\theta)\Delta_t \tilde{V}(w_f)\right]$$

$$J(w_e) - J(w_f) = -\Delta_t\left[(\lambda + q(\theta))J(w_f) + r\,J(w_e) - \lambda V + q(\theta)\tilde{J}(w_e)\right]$$

We divide these equations by $w_f - w_e$ and taking limit as $w_f \rightarrow w_e$ and let $\Delta_t \rightarrow 0$ we get:

$$-\left[\frac{\partial V}{\partial w} / \frac{\partial J}{\partial w}\right] = \frac{r+\lambda}{r+\lambda}\,\frac{(r+\lambda+\rho(\theta))V(w)-\lambda V^u+\rho(\theta)\tilde{V}(w)}{(r+\lambda+q(\theta))V(w)-\lambda V^u+q(\theta)\tilde{J}(w)}\,\frac{(r+\lambda+\rho(\theta))}{(r+\lambda+q(\theta))}$$

Note that $\frac{\partial V}{\partial w} / \frac{\partial J}{\partial w} = 1$, in search and matching model, left hand side is equal to 1. Rearranging the terms yields:

$$\frac{(r+\lambda+\rho(\theta))}{(r+\lambda+q(\theta))} = \frac{(r+\lambda)V(w)-\lambda V^u+\rho(\theta)(V(w)-\tilde{V}(w))}{(r+\lambda)J(w)-\lambda V+q(\theta)(J(w)-\tilde{J}(w))}$$

Note that the equilibrium value of posted vacancy $V = 0$ because of the free entry of the firms and $V(w) = \tilde{V}(w)$ because the subgame starts when either party takes an outside offer is identical to the whole game thus they yield the same equilibrium wage offer. The same reasoning holds for the firm, i.e $J(w) = \tilde{J}(w)$. We define the total surplus generated by the match to be divided between worker and firm is equal to:

$$S(w) = V(w) + J(w) - V^u$$

Imposing free entry and equality between the value from the game and continuation value we obtain

$$\frac{r+\lambda+\rho(\theta)}{r+\lambda+q(\theta)} = \frac{V(w)-V^u}{J(w)}$$

Rearranging yields the result.

Proof of Proposition 2: Proof of this proposition is straightforward and only requires differentiating

$$\beta = \frac{r + \lambda + \rho(\theta)}{2(r + \lambda) + \rho(\theta) + q(\theta)}$$

with respect to θ and using $\rho'(\theta) > 0$ and $q'(\theta) < 0$.