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Wage Inequality Dynamics in Turkey

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Abstract

This study aims to examine the evolution of wage inequality in Turkey between 2002 and 2019 using household labor force surveys. We find a significant decline in wage inequality over the period analyzed, which can be explained by a combination of (i) minimum wage adjustments (2004 and 2016), (ii) a stable aggregate demand curve, (iii) between-industry shifts in relative demand, and (iv) relative stagnation of post-secondary graduate wages. The two minimum wage adjustments led to real gains for lower wage earners and reduced the wage gap between upper and lower percentiles. The decomposition analysis based on DiNardo et al. (1996) shows that minimum wage adjustment had a strong wage (pricing) effect over the wage distribution. This impact even spilled over for wage earners above the median. We argue that minimum wage adjustments replace the role of central wage bargaining in an emerging economy with many low qualified jobs and almost no labor market institutions. Relative real wage erosion for the upper deciles further contributed to the reduction in inequality in recent years.

JEL classifications: J23; J31; J38; C14

Keywords: Minimum wage, Wage inequality, Turkey, Decomposition, Wage dynamics

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1 Introduction

Turkey's labor market has undergone several major transformations during the last two decades, with the transition to paid labor having the most significant effect on wage inequality. Younger generations, who are more educated than their parents, depend heavily on wage employment. In an economy where income inequality is already high and persistent, labor market rewards are crucial. Yet, despite several improvements in education policy [1], Turkey's labor market is still dominated by workers with limited schooling. The overall share of wage-earners in employment rose from 49.7 % in 2002 to 68.4 % in 2019 while the figures for female workers specifically are even more striking: from 36.9 % to 66.7 %. In terms of educational endowment, 45% of workers had less than secondary education in 2019 while the mean years of schooling for wage earners barely exceeded 10 years, which less than required for a high school diploma (Table 1). The fact that labor market is dominated by low skilled workers has implications for the efficiency of institutional regulations governing wage bargaining. With low unionization and weak collective bargaining, almost half of Turkey's wage-earners depend heavily on a floor wage or minimum wage adjustments.[2]

One alternative for lower educated workers is upgrading skills within the workplace since firm-specific skills can improve worker productivity and close the gap in terms of life-time earnings. As Table 1 shows, as firm-specific experience decreases in Turkey, job turn-over increases while the last two column indicate that nearly half (43 %) of low qualified workers are sorted into small firms (less than 10 workers) which are likely to offer less opportunities for skill development. In short, Table 1 suggests that despite some improvements in schooling, Turkey's labor market structure persists with only gradual changes.

The compositional changes reflected in the wage distribution are significant for inequality measures. Figure 1 compares the composition of endowments across the wage percentiles for 2002, 2020 and 2019. Mean years of schooling increased more at both ends of the distribution, which may reflect generational differences in schooling. Figure 1 Panel (b) shows that the proportion of working women has not risen uniformly across the wage distribution. While the lowest wage percentile became predominantly female in 2019, the segment above the median

[1] Compulsory schooling increased to 8 years after the education system was reformed in 1997 while access to higher education has increased since 2006.

[2] In this respect, political parties see minimum wage adjustments as a re-distributive policy. For a recent study, see Kahveci and Pelek (2021)

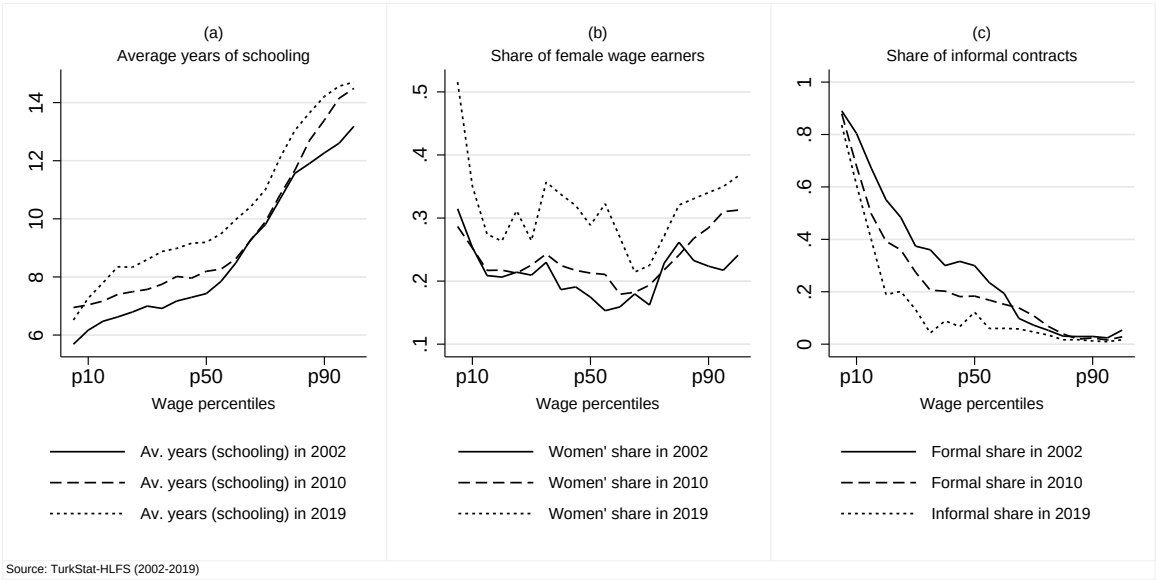
Table 1: Some characteristics of wage earners in Turkey

	Female (%)	Less than secondary share (%)	Years of Education	Informal share (%)	Firm specific experience for private sector*	Small firm share for LTS** workers	Large firm share for ST*** workers
2002	21.1	56.7	8.7	29.8	5.5	47.9	49.7
2003	20.8	54.8	8.9	29.7	5.8	49.2	49.5
2004	21.0	56.9	8.6	31.8	5.5	47.5	47.0
2005	21.3	54.7	8.9	30.6	5.1	45.8	46.8
2006	22.0	53.4	9.0	29.5	4.7	45.2	46.4
2007	22.2	52.4	9.1	27.2	4.7	44.8	45.7
2008	22.8	51.1	9.3	23.8	4.4	42.9	45.6
2009	23.3	50.1	9.4	22.9	4.3	43.9	45.8
2010	23.3	50.8	9.4	22.3	4.1	42.7	45.7
2011	24.0	50.5	9.5	21.9	4.0	43.5	44.6
2012	25.2	48.6	9.6	18.9	4.0	43.8	45.1
2013	26.3	48.1	9.7	17.2	4.0	43.4	45.4
2014	27.0	48.6	9.7	16.2	3.9	45.0	46.7
2015	28.0	47.5	9.9	15.3	3.9	44.8	46.8
2016	28.9	46.0	10.0	14.6	4.1	43.7	47.6
2017	29.4	45.2	10.1	14.7	4.1	44.1	48.5
2019	30.4	44.6	10.1	14.7	4.1	43.0	49.6

Source: TurkStat, HLFS 2002-18, Only positive wage earners are included in the sample.
*Tenure years in current job, ** LTS stands for less than secondary education level, ***ST stands for secondary or tertiary education level

remained less affected. For the top wage percentiles, the gender gap in employment share narrowed. A combination of two factors likely contributed to this disproportionate shift. First, Turkey's expansion of higher education has favored women due to their higher access Caner et al., 2019; Polat, 2017. Secondly, there has been a secular rise in labor market participation due to cohort effects (Tunalı et al., 2017).

Figure 1: Wage distribution and compositional change



Beside the structural changes experienced over the last two decades, three institutional fac-

tors may have helped determine wages. First, depending on compliance, the legal floor wage or minimum wage directly affects lower wage deciles. Second, centralized wage bargaining can set a lower bound for wages in specific sectors. Compared to other OECD countries, bargaining coverage is very limited in Turkey and union density is very low (Table 2). In the private sector, labor market institutions are too weak to enforce wage indexation, so minimum wage adjustment provides the only reference point in bargaining for low wage workers.

The third institutional factor is the collective bargaining power of public sector employees. The ICTWSS Data Base classification (Table 2) shows that, besides regulating minimum wages, Turkey's government is also the principal actor in setting public sector wages. Given that public sector[3] workers tend to be more educated, wages in the upper deciles are likely to be affected by government decisions. Thus, the major institutional actors of wage setting are missing within this framework while wage setting seems to only reflect political bargaining.

Table 2: Comparing Institutional Characteristics of Labor Markets

	Coordination of wage setting	Bargaining Coverage		Union density rate			Minimum
		Public sector	Private sector	Total	Public Sector	Private Sector	Wage Setting
Argentina	1	100.0 *a*	53.7 *a*	31.9 *b*			5
Canada	0	76.3 *d*	16.1 *d*	29.4 *c*	72.0 *e*	14.8 *e*	8
Chile	0			17.7 *d*	0.0 *c*	20.3 *c*	8
France	1	100.0 *c*	90.2 *c*	8.8	19.8 *a*	8.7 *a*	8
Germany	2	99.0 *c*	51.2 *c*	16.7 *e*	26.7 *c*	14.7 *c*	6
Korea, Republic of	1		5.0	10.5 *e*	16.5 *c*	9.1 *c*	-
Netherlands	3	96.0 *a*	83.9 *a*	16.4		15.2 *d*	7
Norway	2	100.0 *e*	52.0 *e*	49.2	80.0 *e*	38.0 *e*	1
Poland	0			12.7 *d*	22.0 *a*	10.0 *a*	5
Portugal	3			15.3 *d*	59.0 *a*	11.0 *a*	5
Romania	0	45.5 *a*	7.2 *a*	20.0 *d*			9
Spain	4	100.0 *e*	59.0 *e*	13.6	38.0 *a*	14.0 *a*	5
Sweden	2	100.0 *d*	84.0 *d*	65.6 *e*	79.0 *e*	64.0 *e*	1
Turkey	1	10.0 *d*	5.2 *d*	9.2	11.0 *d*	6.8 *d*	5
United Kingdom	0	58.9	14.7	23.4	52.5	13.2	6
United States of America	0	39.0 *c*	7.3 *e*		33.9	6.4	9

Source: Jelle Visser, ICTWSS Data base (2018) version 6.1.
Data available for the latest year. a=2013, b=2014, c=2015, d=2016, e=2017.
1) *Types of coordination of wage setting*: 0 = No specific mechanism identified; 1 = Government sets signals (public sector wages, minimum wage); 2 = Pattern bargaining; 3 = Intra-associational ("informal centralisation"); 4 = Inter-associational by peak associations.
2) *Bargaining (or Union) Coverage*: Employees covered by collective (wage) bargaining agreements as a proportion of all wage and salary earners in employment
3) *Union density rate*: Net union membership as a proportion of wage and salary earners in employment.
4) *Minimum wage setting*: 1 = Minimum wages are set by (sectoral) collective agreement or tripartite wage, boards in (some) sectors; 5 = National minimum wage is set by government after (non-binding) tripartite consultations; 6 = Minimum wage set by judges or expert committees, as in award-system; 7 = Minimum wage is set by government, bound by a fixed rule (index-based minimum wage); 8 = Minimum wage is set by government based on a fixed rule (index-based minimum wage) or target (growth, employment, poverty), but government can (and sometimes does) take a discretionary decision; 9 = Minimum wage is set by government, without a fixed rule.

The rise in inequality in the 1980s attracted research, particularly on the US labor market. The standard approach to understand wage differences is to analyze how supply and demand varies over time. Several studies conclude that the skill price adjusts with respect to increased supply through technological change (Acemoglu, 2002; Juhn et al., 1993; Katz

[3]The centralization of employment in the public sector is very high compared OECD countries. See OECD (2019), Government at a Glance 2019, OECD Publishing, Paris, table 3.4. https://doi.org/10.1787/888934032054

and Murphy, 1992; Krueger, 1993). However, by focusing on the demand side, the standard approach missed other dynamics of wage determination. The wage inequality literature therefore shifted the emphasis from technology to institutional factors by arguing that inequality is driven mostly by exogenous interventions like minimum wage adjustment (Card and DiNardo, 2002)or unionization (Card, 2001; Card et al., 2003; Freeman and Katz, 1997; Freeman, 1991; Machin, 1997). DiNardo et al. (1996) used decomposition analysis to detect changes in wage distributions, concluding that minimum wage adjustment can explain changes in wage inequality, particularly for women. Gabaix and Landier (2008) argue that changes in social norms have allowed top executive earnings to vary with market capitalization or firm size while Fortin and Lemieux (1997) argue that 1990s' deregulation may have caused the rise in inequality.

For Turkey, Bakis and Polat (2015) showed that the real minimum wage increase in 2004 explains the significant decrease in the wage gap between the 90/10 and 50/10. The sharp increase in the real minimum wage probably helped narrow the wage gap with the upper percentiles. One major finding of Bakis and Polat (2015) is that between-group rather than within-group effects have driven the rise in equality since 2004. Popli and Yılmaz (2017) argue that falling wage inequality in Turkey may be related to the decreasing price of unmeasured skills while large quality differences in higher education may explain the variation in skill pricing. An early paper by **?** using firm level data from the USA for 1980-2001 concluded that within-group effects indicate skill-biased technical change (SBTC) and skill upgrading in exporting firms, which supports the claim that technology adaptation increased relative demand.

In the present study, we concentrate on wage inequality dynamics between 2002 and 2019. Turkey provides a unique case regarding wage inequality reduction in emerging countries, where institutional factors have a limited role and minimum wage adjustments account for much of the distribution. During this period, there were two major minimum wage hikes (28% in 2004 and 22% in 2016 in real terms), which reduced the gap between lower and upper segments of the wage dispersion. The benevolent character of minimum wage hikes in reducing inequality is theoretically appealing as there is no evidence that increased wage bill had general equilibrium effects in either episode. In other words, when a minimum wage shock leads to real gains, a combination of price and quantity adjustments can be expected. In this

study, we do not deal with these macroeconomic general equilibrium effects following these wage (price) shocks.[4] Instead, our decomposition exercise uses counterfactuals effects.

The structure of the paper is as follows. We first describe the inequality trends for 2002-2019. We then quantify the role of the demand-supply framework using the methodology of Katz and Murphy (1992). Finally, we decompose the wage variance into price and composition using the methodology of DiNardo et al. (1996).

2 Wage Inequality Trends

The main data source is the annual HLFSs provided by TurkStat for 2002 and 2019.[5] The monthly wage data only covers wage earners and excludes the earnings of self-employed workers. Unless otherwise indicated, we impose no restrictions on the sample other than trimming. The top and bottom 0.1 % are trimmed using hourly wages, which are all expressed in 2019 prices.[6] Weekly regular hours are converted to monthly hours on the assumption that a typical wage earner spends 6 days at work per week and 26 days per month. Unless otherwise reported, TurkStat's population weights are used for each calculation. Workers reporting zero earnings or zero regular hours are omitted. Table 3 provides basic descriptive statistics for selected years.

Table 3: Summary Statistics

	2002		2006		2010		2014		2018	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Real hourly wage (log)	1.793	0.794	1.956	0.667	2.091	0.673	2.223	0.650	2.351	0.578
Real monthly wage (log)	7.150	0.698	7.343	0.576	7.451	0.589	7.552	0.575	7.641	0.525
Female	0.224	0.417	0.219	0.414	0.232	0.422	0.264	0.441	0.303	0.460
Years of schooling	8.762	4.078	8.949	4.113	9.432	4.177	9.686	4.216	10.061	4.212
Tenure years	7.906	7.788	6.967	7.593	6.417	7.490	6.223	7.759	6.265	7.827
Social Security (Formal Contracts)	0.707	0.455	0.709	0.454	0.774	0.418	0.828	0.378	0.851	0.357
Regular W.Hours	50.677	12.919	52.414	14.099	51.066	13.534	49.469	13.124	47.313	11.626
Private sector	0.676	0.468	0.728	0.445	0.744	0.437	0.740	0.438	0.702	0.457
Firm size $\leqslant 10$	0.352	0.478	0.350	0.477	0.331	0.471	0.355	0.478	0.327	0.469
Firm size 11-49	0.253	0.435	0.282	0.450	0.307	0.461	0.276	0.447	0.269	0.443
Firm size $\geqslant 50$	0.395	0.489	0.367	0.482	0.362	0.481	0.370	0.483	0.404	0.491
No. Obs.	45,178		74,206		84,689		93,856		96,707	

Source: TurkStat, HLFS 2002-18, Only positive wage earners are included in the sample. No sampling weights are used. Top and bottom 0.1% is trimmed using hourly wages.

Figure 2 presents the cumulative real hourly wage growth for different percentiles in Turkey

[4] See Fortin et al. (2011) for detailed discussion.

[5] Although TurkStat made several changes in survey design during the period (2002-03, 2004-2009, 2010-2014, and 2014-19), we do not believe these modifications affected the wage inequality trends. Several changes in the survey design took place in the periods given.

[6] Since wage inequality is related to wage order. Trimming 0.1% would have no effect on inequality measures.

between 2002 and 2019, using data from all workers. There is almost a perfect negative correlation between wage levels in 2002 and cumulative wage growth until 2019. Low wages in 2002 grew more over the period, which is the key to decreasing wage inequality in Turkey.

Figure 2: Cumulative percentile real hourly wage growth, 2002-2019

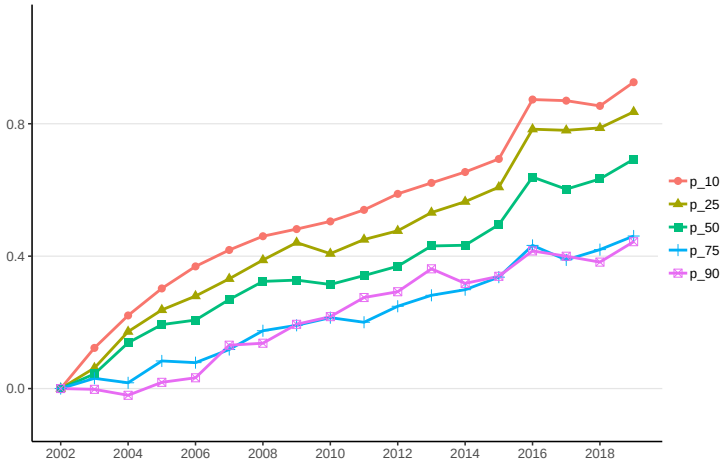
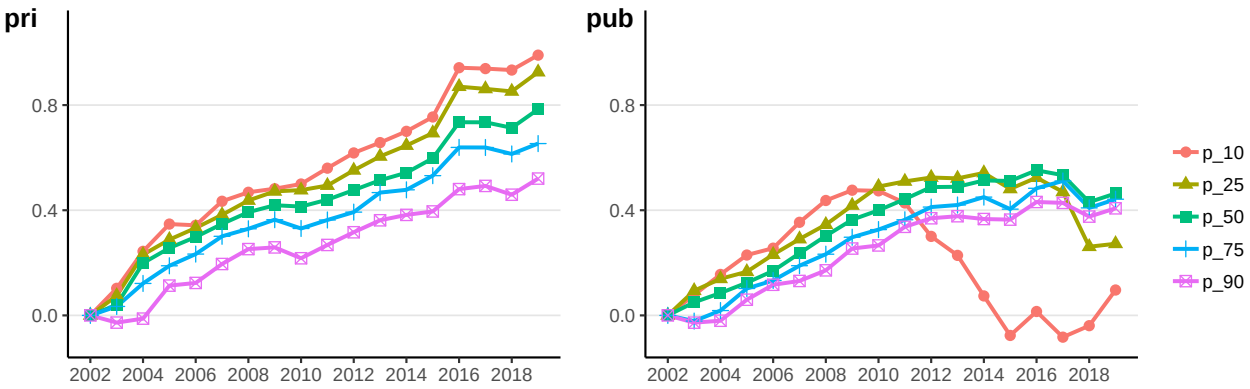


Figure 2 unfortunately obscures an important development regarding wage dynamics in Turkey, namely public sector wage dynamics. Figure 3, which contrasts the private and public sectors, reveals two important differences. First, private sector wages grew steadily whereas public sector wages stopped growing around 2012. Second, and more importantly, there is a clear difference in the lower tail of the public sector's wage distribution between 2002 and 2019. More specifically, cumulative real wage growth was almost zero for the 10th percentile in the public sector whereas it almost doubled for the same percentile in the private sector.

Figure 3: Public sector/private sector by selected percentiles
(cumulative real hourly wage growth, 2002-2019)



For a more detailed comparison, we calculate the ratio of public to private average wage ratio for selected percentiles ($p10$, $p25$, $p50$, $p75$, and $p90$) in Figure 4. There are four developments that need to be underlined. The first is the public/private wage ratio for the 10th percentile. While trends are similar for other percentiles, the 10th percentile is a clear outlier. The second observation concerns the minimum wage shock in 2004. For all selected percentiles, the public/private wage ratio declines suddenly, which suggests that wage increases were higher for the private sector in 2004, probably because of stronger spillover effects. The third observation is that the public/private wage ratio gradually returned to its 2002 level by 2012. Here, the variation in the middle of the wage distribution is higher than the lower (p10) and the upper (p90) tail. The fourth observation is that there was a steady decline in the public/private wage ratio at all levels after 2012 - with p10 being an outlier. Surprisingly, the minimum wage shock in 2016 looks like an ordinary point in the graph, unlike the shock in 2004, which was almost the same size.

Figure 4: Public sector/private sector by selected percentiles
(real hourly wage ratio, 2002-2019)

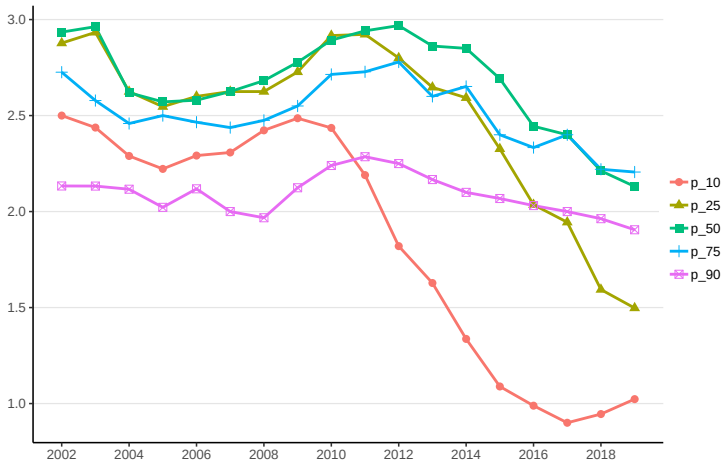


Figure 5 illustrates percentile and education wage inequality measures for the period. We prefer to contrast hourly (Figure 5) and monthly (Figure 6) wage inequality trends. Monthly wage inequality is lower than hourly wage inequality due to the fact that low wage jobs are associated with longer working hours. Note that longer working hours is a feature of job quality in Turkey.[7]

Figure 5 shows the percentile and education wage inequality measures for the study pe-

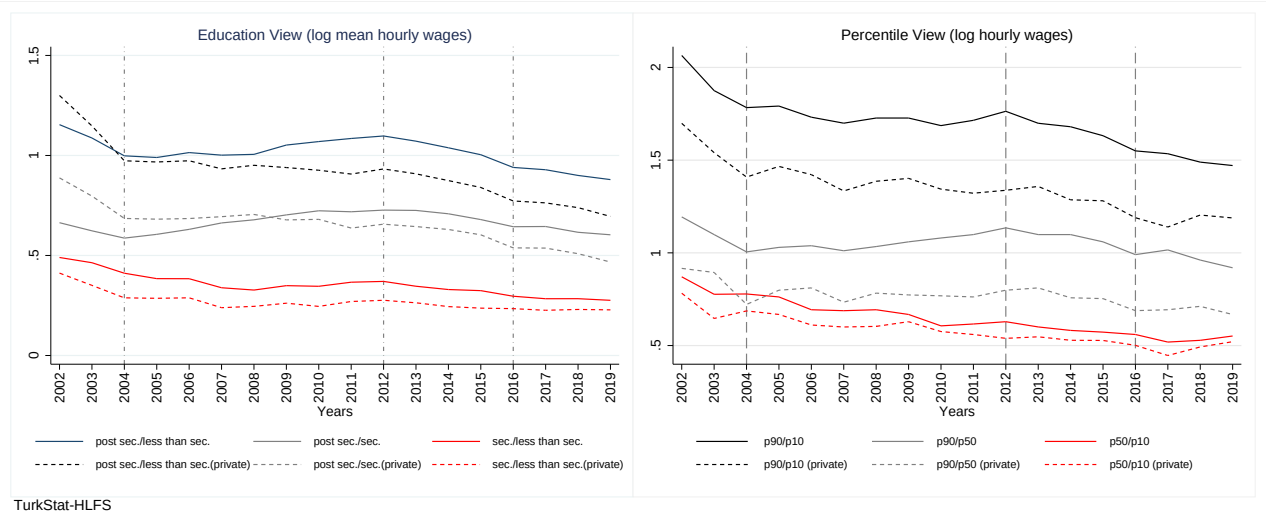
[7]For details, see Bakış et al. (2018)

riod. There were two major minimum wage shocks in the analyzed period. In both 2004 and 2016, the real minimum wage increased by approximately 25 percent, which significantly decreased all wage inequality measures: overall (p90/p10) wage inequality, upper-tail (p90/p50) wage inequality, and lower-tail (p50/p10) wage inequality (see Figure 5). The raw measures suggest a clear decrease in wage inequality following minimum wage shocks. The effect of the 2004 minimum wage adjustment was more visible than the increase in 2016 as the gap with the upper percentiles narrowed significantly. The evolution of wage inequality between p50/p10 suggests that the minimum wage did not clearly reduce wage gaps below the median. We will discuss in detail later the spill-over effect of minimum wages. Another interesting finding is the structural break around 2012. After the 2004 shock, there was a mostly steady increase in all wage inequality measures until 2012 followed by a mostly steady decline until 2016, the second major minimum wage shock. While this structural break is very clear in the education view, it is not as distinctive as in the percentile view.

Figure 5: Wage inequality trends by education and percentile ratios - hourly wages

In terms of education-based differences, the gap between higher and lower education groups narrowed following the 2004 minimum wage shock. It stayed relatively stable until 2008 before rising until 2012. After that, wage premiums for higher education groups gradually decreased compared to those for groups with less than secondary education. Using monthly or hourly measures does not alter the evolution of wages. Apart from 2002-2003,

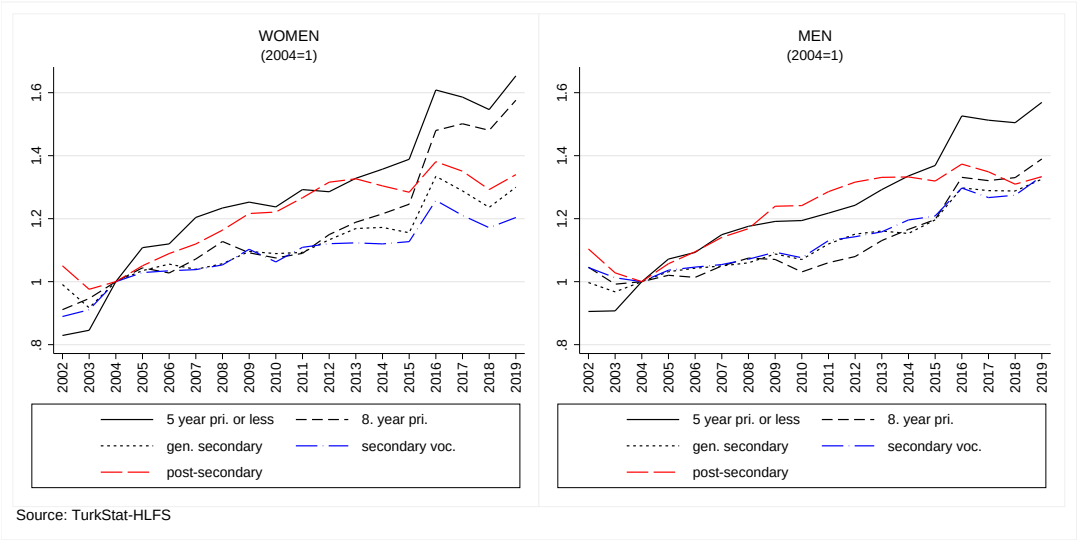
Figure 6: Wage inequality trends by education and percentile ratios - hourly wages



there was a clear break after 2012. We believe that the expansion in higher education after 2006 might be responsible for this trend. Either the increase in the supply led to a reduction in premiums or there was quality sorting, which presented with increased variance. In any case, it seems that demand for skilled labor did not increase to match supply. Hence, we cannot argue that a skill-biased technical change (SBTC) mechanism operated for the period following the higher education expansion.

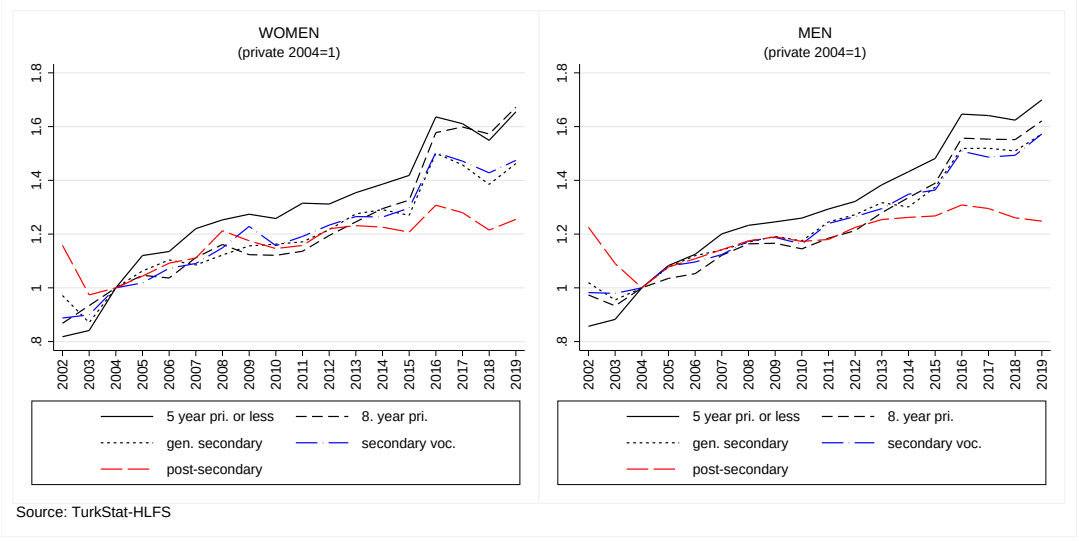
Figure 7 shows three significant episodes of educational wage inequality. The first was first episode is the catch up for the less educated workers through the minimum wage adjustment after 2004. The wages of post-secondary workers increased the most (the area between the red dashed line and the black line), which implies a rise in inequality. Bakis and Polat (2015) argue that this trend is a result of between effects, which indicates a structural transformation rather than SBTC. In other words, the rise in skilled labor demand was limited to certain sectors without producing an overall shift. In the last period, the sharp increase in minimum wage in 2016 led to a second catch-up moment for less educated workers while post-secondary level wages remained more stagnant, probably reflecting the expansion in tertiary education. Strikingly, the effect of the minimum wage hike in 2016 disappears as education level increases.

Figure 7: Real wage growth by education level and gender (public and private sector)



Source: TurkStat-HLFS

Figure 8: Real wage growth by education level and gender (private sector)

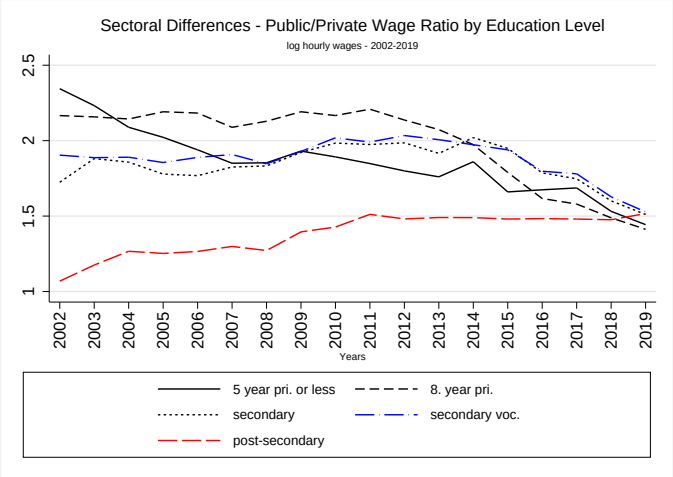


Source: TurkStat-HLFS

The fact that average wages for the post-secondary group increased more than others between 2008 and 2012 deserves more discussion. Even though it seems as if there was a structural transformation or rising skill price related to higher demand for post-secondary graduates, this would be misleading unless institutional factors are taken into account. As we already mentioned before, one key institutional factor is the centralized bargaining power of Turkey's public sector. Thus, excluding this sector from the analysis produces a different picture. As Figure 8 indicates, real wages in the private sector evolved very similarly for all education levels.

It seems that the increases in the wages of post-secondary education level workers were limited to public employees for this specific episode. Figure 8 displays the public-private sector wage ratio by educational level. It reflects the institutional dimension of wage bargaining in Turkey in several respects. Firstly, until 2012, public wages increased more than private wages for the tertiary education level due to public sector wage bargaining.[8]Secondly, for low education levels (5 years or fewer), public wages consistently increased less than private sector wages over the entire period analyzed. This is probably due to a recruitment policy shift that allowed subcontracting in some public services ('taşeron işçilik' in Turkish). Thirdly, while public and private sector wages evolved similarly for secondary, secondary vocational, and primary education (8 years) until 2012, the public/private wage ratio subsequently converged strongly at all education levels.

Figure 9: Public sector/private sector by education level (mean hourly wages), 2002-2019



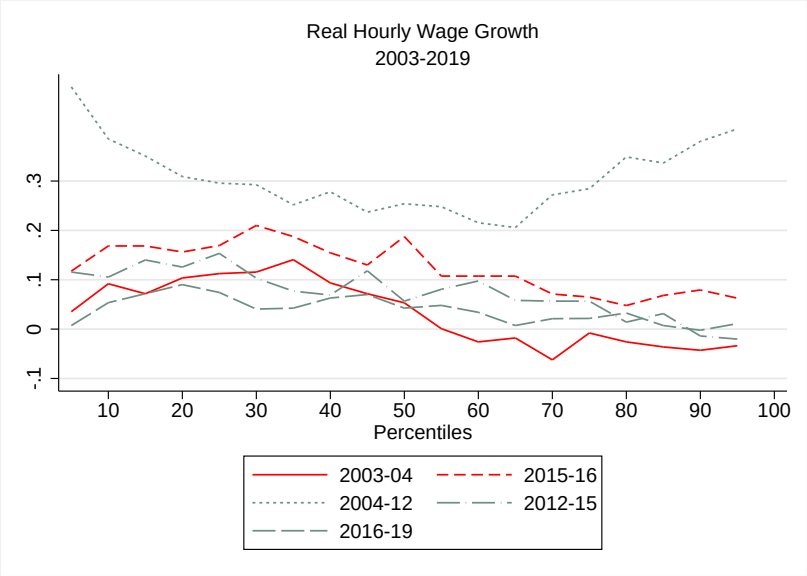
Two observations are worth noting regarding the percentile view of wage inequality trends. First, wage inequality decreased in 2003 prior to the 2004 minimum wage increase. The reduction in wage inequality was limited to lower segments, thereby reducing the gap between p90/p10 and p50/p10. We believe that the increase in p10 in 2003 is less related to exogenous factors. Following the 2001 crisis, GDP growth contributed to the recovery of real wages for lower segments. Although the sample design in 2002 and 2003 is different to that of 2004, it is plausible to assume that a rebounding effect is responsible for this increase.

The second observation concerns the wage inequality trend following the 2016 minimum

[8]Aktug et al. (2018) also provide evidence of sectoral (public versus private) differences in real wage adjustments for Turkey.

wage hike. For two consecutive years, wage gaps continued to shrink, albeit slightly. Between 2017 and 2018, upper decile real wages clearly eroded (Figure 10), which reduced the wage gap in favor of the lower wage distribution. Figure 10 provides more insight by presenting hourly wage growth across the wage distribution. Interestingly, the negative wage growth of higher deciles after 2016 reduced wage inequality without any intervention in minimum wages. Similarly, the real wage erosion in upper deciles in 2003 further reduced wage inequality. While we can offer no causal explanation for upper wage erosion in these years, it seems likely that specific sectoral shocks may have specifically affected higher wage percentiles or low total factor productivity due to slow economic growth created stagnation.

Figure 10: Real hourly wage growth, 2002-2019



Residual wage inequality concerns inequality in labor income within narrowly defined demographic (skill) groups. In Western countries, discussion focuses on whether increases in residual inequality can be explained by episodic (one-time) events. One potential explanatory variable is a change in labor force composition. Lemieux (2006), for instance, finds that compositional changes account for a large part of the growth in residual inequality in USA between 1973 and 2003. More importantly, he shows that changes in residual wage inequality are concentrated at the upper tail of the wage distribution (mainly college educated workers). In Turkey, we see that residual wage inequality decreased between 2002 and 2019. Of course, given Turkey's specific public sector wage dynamics, it is not surprising to see increasing residual wage inequality for the p90/p10 and p90/p10 ratios (Figure 12).

Figure 11: Real hourly wage growth, 2002-2019

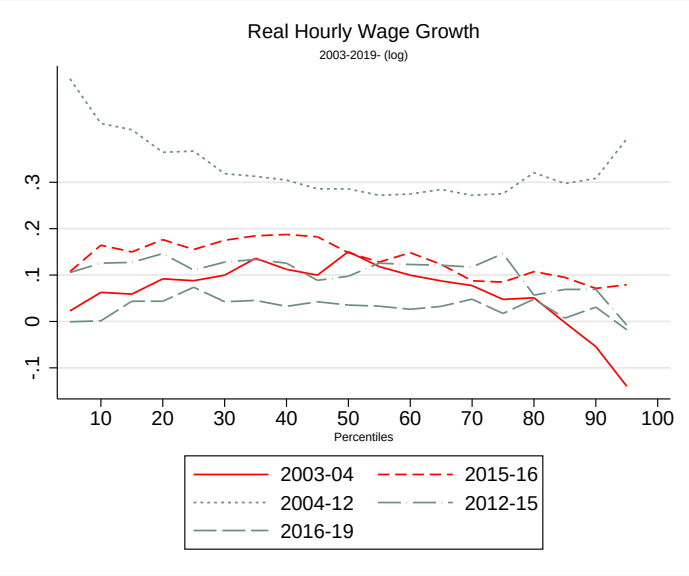
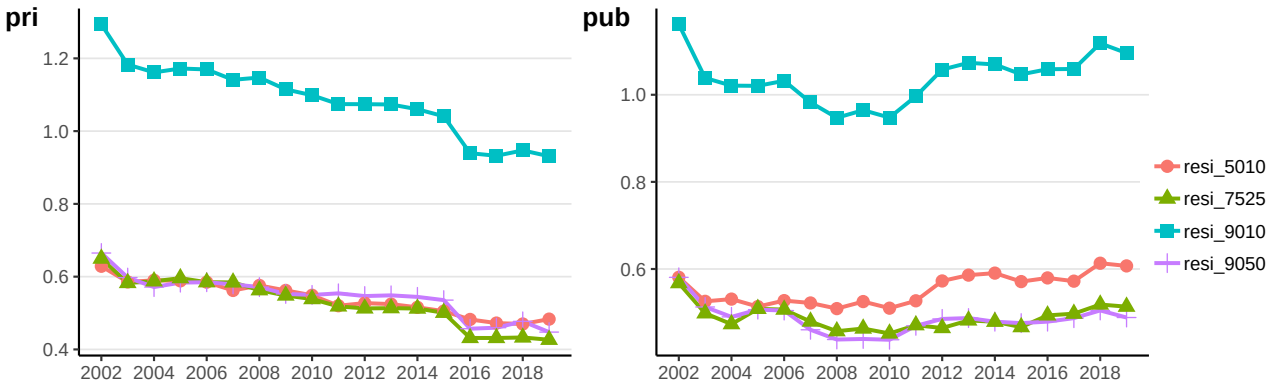


Figure 12: Residual wage inequality, 2002-2019



3 Studying wage dynamics within supply and demand framework

We use the approach of Katz and Murphy (1992) (hereafter KM) for studying wage dynamics in Turkey. Our presentation of this approach is brief, given that nothing new is added to the original methodology. For a detailed exposition, readers should consult Katz and Murphy (1992), Katz and Autor (1999) and Acemoglu and Autor (2011). For a previous application of the framework to wage dynamics in Turkey, see Bakis and Polat (2015). In the KM setup, one creates two samples, one for wages and one for supplies (quantities). Each sample has a finite number of cells defined by demographic characteristics. Typically, each cell is defined by gender, education, and experience. For our study, we create 50 gender-education-experience

cells: 2 for gender, 5 for education level (below primary, primary, high school, vocational high school, and college), and 5 for years of work experience (0-9, 10-19, 20-29, 30-39, 40-49).

For each cell, we compute average real wage and employment share (in total hours worked) using sample weights. Thus, the main data set is two matrices of 50 by 18 cells (for the number of years from 2002 to 2019) - one for the wage sample and the other for the quantity sample. We mostly compare broader categories, such as college graduate workers and high school graduates. For such broad categories, KM propose a fixed-wage approach whereby fixed wages are the average relative wages for each cell. Once a reference wage is chosen for each year, the average wage of the cell is divided by this reference wage to obtain the matrix of relative wages from which we get the vector of average relative wages by taking arithmetic mean of relative wages over the years. By multiplying regular hours worked in a cell by average relative wage we obtain labor supply in efficiency units to obtain the matrix of the quantity sample in terms of efficiency units.

Similarly, we compute the wage index for each broad category using a fixed-weight approach. The aggregate wage for broad categories is a weighted average in which the weights are the arithmetic mean of the raw employment share for each cell. The objective in using fixed weights is to control for changes in the composition of the cells forming the broad category. In the KM set up, these aggregates are called composition adjusted.

Table (4) shows the changes in the real hourly wages for different demographic groups for 2002-2019. The main difference between the calculations in Table (4) and standard measures of average real wages is that the calculations in Table (4) are composition adjusted. That is, they refer to the wages that would be observe if the demographic distribution of these broad groups remained fixed, as explained above. Over the entire period, average real wages increased by more than 50 percent: 51.9 percent for men and 53.4 percent for women. More importantly, we are sure that they do not reflect changes in wages due to a shift in the education or experience composition for men and women.

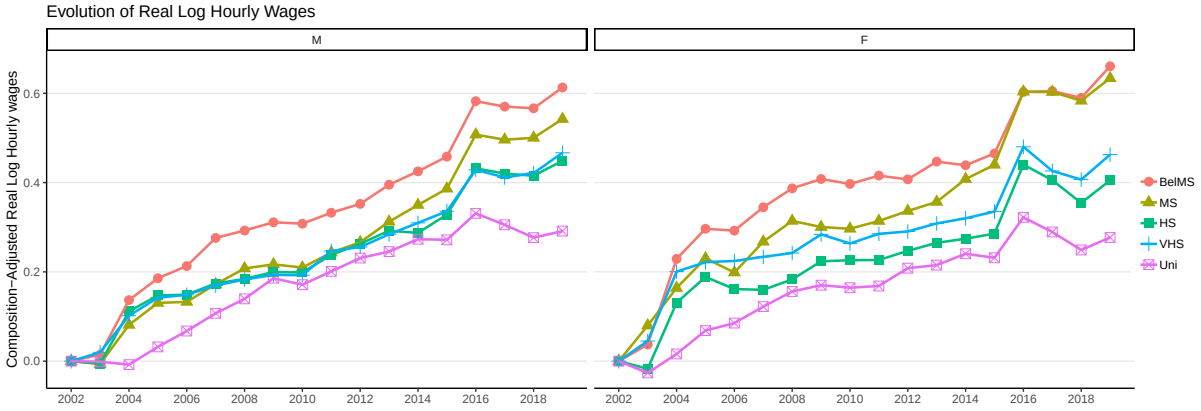
Table (4) shows that education level and real wage growth are negatively correlated. Between 2002 and 2019, average real wages rose by 28.6 percent for university graduates, 44 percent for high school graduates, 55.7 percent for middle school graduates, and 62.6 percent for below middle school graduates. Figure 13 shows the evolution of real wages for males (left) and females (right). The lower the education level, the stronger the real wage increase.

Table 4: Real hourly wages, 2002-2019

	2002	2007	2012	2019	Change
Gender					
Male	1.8	2.0	2.1	2.3	51.9
Female	1.6	1.9	1.9	2.1	53.4
Education					
BelMS	1.4	1.7	1.8	2.0	62.6
MS	1.5	1.7	1.8	2.1	55.7
HS	1.9	2.0	2.1	2.3	44.0
VHS	1.9	2.1	2.1	2.3	46.6
Uni	2.6	2.7	2.8	2.9	28.6
Experience					
0-9	1.5	1.8	1.9	2.1	62.2
10-19	1.8	2.0	2.1	2.3	49.7
20-29	1.8	2.0	2.1	2.3	45.7
30-39	1.8	2.0	2.0	2.3	49.5
40-49	1.4	1.7	1.8	2.0	61.8

Note: BelMS, MS, HS, VHS and Uni denote separate education groups (respectively, below middle school, middle school, high school, vocational high school and college graduates). "Change" column refers to the change in log average real hourly wages (multiplied by 100) over 2002-2019 period for broad demographic groups. First, the mean log real hourly wages are computed for 50 gender-education-experience cells in each year. Then, the mean log real hourly wages for broader groups are computed as the as weighted averages of these cell means using a fixed set of weights (the average employment share of the cell for the entire 2002-2019 period).

Figure 13: Changes in real log hourly wages



Note: Mean real hourly wages are computed for 50 sex-education-experience demographic groups, using all workers aged 15-64 who work between 8 and 84 hours and as wage earner. Total (weighted sum of) wage income is divided by total (weighted sum of) hours worked in each cell, where weights are sample weights of the HLFS. The mean log real hourly wages for broader categories are computed as a weighted average of the mean log wages where weights are given by average employment shares of the relevant sex-education-experience demographic groups. BelMS, MS, HS, VHS and Uni denote separate education groups (respectively, below middle school, middle school, high school, vocational high school and college graduates).

There were two similar minimum wage hikes, in 2004 and in 2016, where the minimum wage increased by almost 25 percent. The real wages of low educated groups grew steadily for both genders, although the difference between the wage changes of different education groups was larger for women.

In contrast to education differences, there seems to be no systematic relationship between work experience and average real wage growth over the study period. Real wages grew by about 62 percent for workers with 0-9 or 40-49 years of experience, about 50 percent for workers with 10-19 or 30-39 years of experience, and 45.7 percent for workers with 20-29 years of experience.

Table 5: Relative supply changes (multiplied by 100), 2002-2019

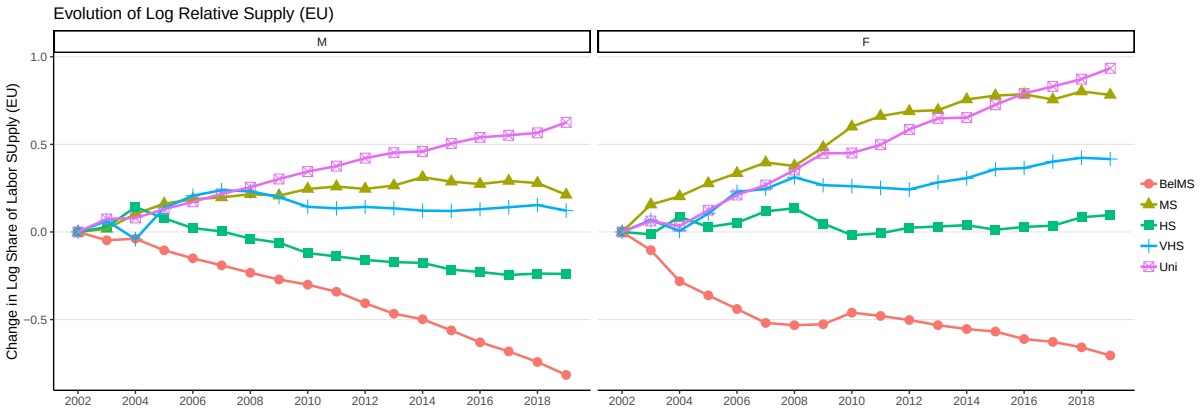
	2002	2007	2012	2019	Change
Gender					
Male	78.1	79.7	76.4	72.5	-7.4
Female	21.9	20.3	23.6	27.5	22.6
Education					
BelMS	47.0	36.2	30.6	21.4	-78.8
MS	10.1	12.5	13.6	13.4	28.5
HS	12.4	12.7	10.9	10.4	-17.3
VHS	9.2	11.7	10.8	10.9	17.2
Uni	21.3	26.8	34.1	43.9	72.2
Experience					
0-9	17.9	20.1	19.6	20.8	14.6
10-19	33.8	32.3	32.5	30.2	-11.3
20-29	27.9	28.3	27.0	26.5	-5.0
30-39	15.1	15.2	16.1	17.0	12.1
40-49	5.3	4.2	4.8	5.6	4.0

Note: BelMS, MS, HS, VHS and Uni denote separate education groups (respectively, below middle school, middle school, high school, vocational high school and college graduates). "Change" column refers to the change in log share of total labor supply measured in efficiency units (multiplied by 100). To find labor supply in efficiency units we first compute the average relative wage of each of 50 cells over the 2002-2019 period. Then, total hours worked in each cell are multiplied by these relative wages to get labor supply in efficiency units. Finally, we compute the employment share of each cell in efficiency units as the ratio of efficient labor supply of each cell divided by total efficient labor supply each year separately. For broad groups we just take the sum of these shares over the cells forming the broad group.

Table (5) presents the changes in relative labor supply measured in efficiency units for different demographic groups for 2002-2019. The main difference between the calculations in Table (5) and standard measures of employment shares is that the former include differences in productivity measured as average relative wages over the period. Women's share of hours

worked (measured in efficiency units) increased from 21.9 percent to 27.5 percent between 2002 and 2019. Thus, the change in women's log share of employment corresponds to an increase of 22.6 percent compared to only 7.4 percent for men.

Figure 14: Changes in log labor share



Note: Labor supply is computed using all workers aged 15-64 who worked between 8 and 84 hours as wage earner, self-employed or unpaid family worker. For each year, we have 50 gender-education-experience cells. The total actual hours worked by each demographic group are computed taking into account sample weights. Then, these hours are converted into efficiency units by multiplying total hours in the cell by the average relative wage (fixed wage) of the cell, and share of each cell in efficiency unit is calculated. The labor supply of each broad groups is computed as the sum of labor shares forming this aggregate group. BelMS, MS, HS, VHS and Uni denote separate education groups (respectively, below middle school, middle school, high school, vocational high school and college graduates).

Table (5) shows interesting dynamics regarding employment shares (measured in efficiency units) across education levels. The employment share of below middle school graduates fell sharply from 47 percent to 21.4 percent whereas that of university graduates increased from 21.3 percent to 43.9 percent. The employment share of middle school graduates and vocational high school graduates increased slightly while the share of regular high school graduates decreased moderately. As Figure 14 makes clear, at least part of the 'good' performance of low educated groups in real wage growth can be explained by the usual market forces. The steady decline in the share of below middle school educated workers, this may explain the strong increases in their wages whereas the relatively large increases in the share of college graduates can explain their 'poor' wage performance. Nevertheless, at least two puzzles in Figures 13 and 14 cannot be explained by the usual market forces. First, the share of middle school graduates in total supply is increasing for constant (females) or slightly decreasing (males), and was well above the level for high school graduates for both genders. However,

real wage growth was weaker for high school graduates than middle school graduates, which is puzzling.

There seems to be no systematic relationship between experience levels and changes in relative labor supply (measured in efficiency units). For workers with 10-19 and 20-29 years of experience, the share of hours worked decreased by 11.3 percent and 5 percent, respectively whereas, for workers with 0-9 and 30-39 years of experience, the share of hours worked increased by 14.6 percent and 12.1 percent, respectively. For workers with 40-49 years of experience, the share of hours worked increased slightly.

The most striking change in relative supply in Table (5) concerns education level, particularly the changes in labor supply of the least and most educated groups. This raises the question of where these changes come from. To better understand dynamics behind these changes, we analyze how standard measures of employment shares (share of hours worked) changed in industries and occupations in (6) and (7). This revealed important differences across industries and occupations, and large changes in the sectoral and occupational distributions of employment over time.

Table 6: Average industrial and occupational distributions of education groups, 2002-2019.

sector9/occup9	BelMS	MS	HS	VHS	Uni
Agriculture	34.1	15.0	7.0	6.0	1.7
Mining	0.5	0.6	0.5	0.6	0.4
Manufacturing	19.7	24.4	17.3	26.4	11.9
Electricity and Gas	0.6	0.6	0.6	1.5	0.8
Construction	8.2	8.3	5.1	5.5	3.6
Trade	19.8	29.0	35.1	27.7	15.9
Transport	5.3	6.2	7.4	6.5	5.2
Finance	1.1	1.8	5.2	4.7	12.5
Other servieces	10.7	14.1	21.8	20.9	48.0
Managers	5.7	6.9	12.0	8.4	15.4
Professionals	0.1	0.3	2.1	3.4	39.5
Technicians	1.5	3.3	8.6	13.1	14.2
Clerical workers	1.2	4.1	14.8	12.6	13.3
Service and sales workers	13.6	21.6	27.9	20.5	10.6
Skilled agricultural workers	28.0	11.4	5.6	4.9	1.2
Trade workers	17.7	21.0	10.3	17.1	2.9
Operators	12.7	14.6	9.5	11.9	1.6
Unskilled occupations	19.7	16.7	9.3	8.2	1.4

Note: BelMS, MS, HS, VHS and Uni denote separate education groups (respectively, below middle school, middle school, high school, vocational high school and college graduates). Sum of employment shares is 100 for each education group for both industries and occupations.

Table (6) shows average employment in different industries and occupations for 2002-2019. When the employment distribution of an industry or occupation changes, this is likely to affect the relative wages of concerned groups because of very large differences in employment distribution across industries and occupations. For example, more than half of university graduates work in other services while approximately one third of high school graduates work in trades and approximately one third of below middle school graduates work in agriculture. Thus, any expansion in other services necessarily increases labor demand for university graduates.

Table 7: Change in industry and occupation employment distributions, 2002-2019

sector9/occup9	2002	2007	2012	2019
Agriculture	31.3	19.1	19.7	14.6
Mining	0.5	0.6	0.5	0.5
Manufacturing	18.5	20.8	19.2	19.5
Electricity and gas	0.4	0.5	0.9	1.0
Construction	4.8	6.5	7.8	5.8
Trade	22.2	25.3	22.4	23.0
Transport	5.2	6.3	5.9	5.6
Finance	3.2	3.0	3.8	5.1
Other services	13.8	17.9	19.7	24.9
Managers	9.7	10.4	6.8	5.9
Professionals	5.1	5.3	7.4	9.9
Technicians	4.8	6.5	5.4	6.2
Clerical workers	5.1	6.3	5.8	6.8
Service and sales workers	11.7	14.1	19.0	22.7
Skilled agricultural workers	28.1	15.5	15.5	11.2
Trade workers	15.6	15.8	15.0	13.3
Operators	9.0	12.2	10.9	10.1
Unskilled occupations	11.0	13.8	14.1	13.8

Note: Sum of employment shares is 100 each year for both industries and occupations.

And as shown in Table (7), substantial changes occurred in the industrial and occupational distribution of employment over the 2002-2019 period. Table (7) is an imperfect proxy for "between-industry shifts". Share of agriculture in total employment went from 31.3 percent to 14.6 percent. Almost all of these displaced workers are most likely located in "other services" whose employment share increased more than 10 percentage points (from 13.8 percent to 24.9 percent). In the occupation side, share of "sales" workers increased more than 10 percentage points while share of skilled agriculture workers decreased almost 19 percentage points.

Given relative wages, shifts in labor demand may have two different sources: factors that

change the employment share of industries and factors that change the education composition within industries. Even if the education composition of industries stays constant, when the share of a given sector increases, the demand for each education level will be affected differently, given the share of each education group in the industry. This is the between effect. As Table (7) shows, there were strong between effects in Turkey's economy between 2002 and 2019 as well as factors that changed the education composition within industries. For various reasons, demand for certain education groups may increase over time. This is the within effect. Typical examples of within-industry shifts are price changes in non-labor inputs (e.g. computers), off-shoring, and skill-biased technological change (SBTC). The classic example of SBTC is the rise of computer-related tools in production that increases demand for college graduates in each sector. Between-industry shifts may be driven by shifts in product demand (say because of international trade or consumer preferences) or differences across industries in factor-neutral technological change.

3.1 Can changes in relative supplies explain changes in relative wages?

An important question when studying wage dynamics in Turkey is whether changes in relative supplies can explain changes in relative wages. We discuss this in the next section. To formally answer this question, we create two vectors for change in relative wages and change in relative supplies. Taking the dot product of these two vectors, we examine whether they are positively or negatively correlated, as summarized in 8 for grouped years and Table 9 for all years between 2002 and 2019. To decrease the risk of any measurement error, we first report the grouped data results (Table 8). We group the years as 2002-2004, 2005-2014, and 2015-2019 and take the arithmetic average of relative wages and labor share (in efficiency units) for each group. Each year (or group of years) has 50 cells for both wage and quantity samples. The results are consistent with the stable demand hypothesis, with almost all entries being negative. This implies that the relative price of a skill groups falls when its relative supply increases.

Table 8: Inner product of changes in relative wages with changes in relative supply for 50 ($= 2 \times 5 \times 5$) demographic groups. Public and private sector workers.

	02-04	05-14
05-14	0.00	
15-19	-0.04	-0.02

The yearly changes in Table 9 indicate that the zero entry in the grouped data is unlikely to be noise or measurement error. Instead, the entries between 2004 and 2014 are mostly positive, which suggests a lack of a negative relationship between changes in factor supplies and changes in relative wages. This would not happen with a stable demand curve. Thus, we need an explanation for 2004-2014, when there was probably a demand shift, such that demographic groups saw their relative supply increase experience at the same time as a rise in their relative wages.

Table 9: Inner product of changes in relative wages with changes in relative supply for 50 ($= 2 \times 5 \times 5$) demographic groups. Public and private sector workers.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2003	-0.00																
2004	-0.00	0.00															
2005	-0.01	-0.00	-0.00														
2006	-0.01	-0.00	0.00	0.00													
2007	-0.02	-0.01	0.00	0.00	-0.00												
2008	-0.02	-0.01	0.00	0.00	-0.00	-0.00											
2009	-0.01	-0.01	0.01	0.01	0.00	0.00	0.00										
2010	-0.01	-0.00	0.01	0.01	0.00	0.00	0.00	-0.00									
2011	-0.01	-0.00	0.01	0.01	0.00	0.01	0.00	-0.00	-0.00								
2012	-0.01	-0.00	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00							
2013	-0.01	-0.01	0.02	0.01	0.00	0.01	0.00	-0.00	-0.00	-0.00	-0.00						
2014	-0.02	-0.01	0.01	0.01	0.00	0.01	0.00	-0.00	-0.00	-0.00	0.00	0.00					
2015	-0.03	-0.02	0.01	0.00	-0.00	0.00	-0.00	-0.01	-0.01	-0.00	-0.00	0.00	-0.00				
2016	-0.05	-0.03	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01	-0.00	-0.01	-0.00			
2017	-0.06	-0.04	-0.02	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00		
2018	-0.07	-0.06	-0.03	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.01	-0.00	-0.00	
2019	-0.09	-0.08	-0.04	-0.04	-0.05	-0.04	-0.04	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01	-0.00	-0.00

Table 10: Inner product of changes in relative wages with changes in relative supply for 50 ($= 2 \times 5 \times 5$) demographic groups. Only private sector workers.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2003	-0.00																
2004	-0.01	0.00															
2005	-0.01	-0.00	-0.00														
2006	-0.01	-0.00	0.00	0.00													
2007	-0.02	-0.01	-0.00	0.00	-0.00												
2008	-0.02	-0.01	0.00	0.00	-0.00	0.00											
2009	-0.02	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00										
2010	-0.03	-0.01	-0.00	-0.01	-0.01	-0.00	-0.00	-0.00									
2011	-0.03	-0.02	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00								
2012	-0.04	-0.02	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	0.00							
2013	-0.05	-0.03	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00						
2014	-0.05	-0.03	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	0.00					
2015	-0.06	-0.04	-0.02	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00	0.00	-0.00				
2016	-0.08	-0.05	-0.03	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00			
2017	-0.09	-0.06	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.00	0.00		
2018	-0.10	-0.07	-0.04	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00	0.00	
2019	-0.12	-0.09	-0.06	-0.07	-0.07	-0.06	-0.06	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.00	-0.00	-0.00

Given Table 9, the logical next step is to search for the reasons behind the required demand shift in the KM setup. KM proposes a shift-share analysis to decompose increased demand

Table 11: Inner product of changes in relative wages with changes in relative supply for 50 ($= 2 \times 5 \times 5$) demographic groups. Only public sector workers.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2003	0.00																
2004	0.00	0.00															
2005	-0.00	0.00	0.00														
2006	0.00	0.00	0.00	-0.00													
2007	0.00	0.00	0.00	0.00	-0.00												
2008	0.00	0.00	0.00	0.00	-0.00	-0.00											
2009	0.00	0.00	0.01	0.00	0.00	0.00	0.00										
2010	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00									
2011	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00								
2012	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00							
2013	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.00	-0.00						
2014	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00					
2015	0.01	0.00	0.01	0.01	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00				
2016	0.00	0.00	0.01	0.01	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00			
2017	0.00	0.00	0.01	0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00		
2018	0.00	0.00	0.01	0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.00	-0.00	-0.01	-0.00	-0.00	-0.00	
2019	0.01	0.01	0.01	0.01	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	0.00

into within and between components. Bakis and Polat (2015) does this exercise for Turkey's economy between 2002 and 2011. However, as we discussed in the Introduction, wage setting practices in Turkey's public sector during the analyzed period did not follow market practices. Hence, we suspect that the positive entries in Table 9 may be due to the public sector. We therefore repeat the matrices of inner products for private sector employees (Table 10) and public sector employees (Table 11) separately. This shows a very different wage dynamics. In Table (10), almost all entries are negative, implying that the demand curve is fairly stable in the private sector whereas Table (11) shows changes in both relative demand and relative supply in the public sector. Surprisingly, most entries are positive apart from 2009-2011 and post-2014. Consequently, we claim that wage setting policy in Turkey's public sector is an important factor to explain the positive relationship between changes in relative supplies and changes in relative wages.

We conclude that the observed wage dynamics in the private sector can be explained through a simple supply and demand framework. A steady (or very slowly shifting) demand curve along with observed changes in the supply side are sufficient to explain the observed wage dynamics. In reality, even a smoothly shifting demand curve is allowed. It seems that any increase in the relative demand for some groups is offset by even stronger growth in the relative supply of the same group.

3.2 Can changes in the minimum wage explain changes in wage inequality?

To answer this question, we regressed each wage inequality measure (P90/P10, etc.) separately on a constant and real minimum wage for 2002-2019:

$$y_t = \beta_0 + \beta_1 mw_t + u_t, \quad t = 2002, \ldots, 2019$$

where y_t is one of the inequality measures and mw_t is real minimum wage in year t. We then compare the predicted and observed inequality measures. We repeat this using only private sector workers (Figure 15) and public sector workers (Figure 16). As these figures show, wage inequality can easily be explained by the real minimum wage for private sector workers whereas, for the public sector workers, the level of the real minimum wage can explain very little of the inequality dynamics.

Figure 15: Relative Wage and Supply Changes - Private sector

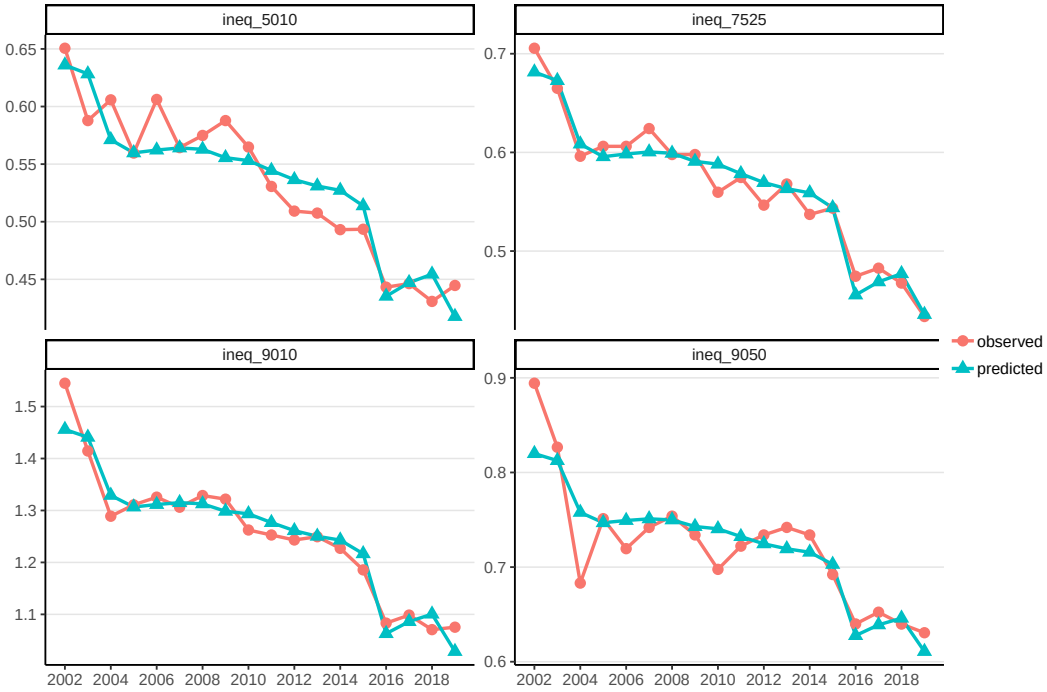
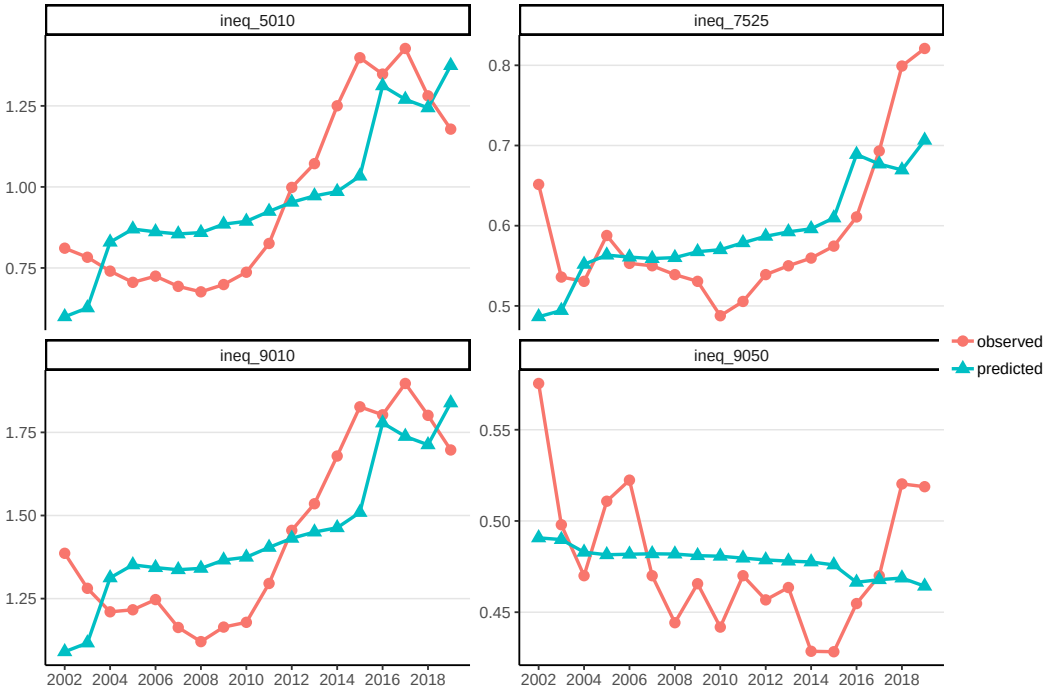


Figure 16: Relative Wage and Supply Changes - Public sector



4 Decomposing wage inequality

The raw wage differences between percentiles do not necessarily indicate a change in the wage schedule. We therefore need to decompose the wage difference to reflect changes in composition. In this section, we adopt the strategy used in Fortin and Lemieux (1997) to decompose the variance into wage (price) and composition components. The advantage of their approach is that it provides a counterfactual distribution over the entire wage dispersion. Unlike Oaxaca decomposition, it enables us to differentiate the effect at any point in the wage order.[9] The DFL approach basically involves estimating re-weighting factors (through non-parametric models) to ensure that the attributes specific to each year are similar. The difference between the actual and counterfactual constructed distribution for a given year (or group) gives the pricing (wage) effect. By assumption, the price (wage) effect is the residual of all the factors assumed to intervene as exogenous factors. For our case, real changes for shorter periods can be considered as price or wage effects since the composition can hardly change without an economy-wide shock. Large real wage effects over shorter periods suggest that the wage schedule (setting) is affected by institutional (non-market) factors, such as a minimum wage adjustment or collective bargaining.[10] As discussed in previous sections, collective wage bargaining in Turkey is limited to the public sector while very few unskilled workers are unionized. The only exogenous factor that could impinge on lower wages is thus minimum wage adjustment.

We use a probit model to estimate the counterfactuals used in the DFL decomposition. Table 12 and 13 show the results, using the same periodization as in Section 2. We use five subperiods (2002-04, 2005-12, 2012-15, 2015-16, and 2016-19) in decomposing real hourly wage growth. We first discuss the differences in the percentiles before considering the relevant changes in top and bottom wage inequalities. In addition to the total sample, decomposition results are given for the five subgroups to reflect gender and sector differences.

Table 12 indicates that the highest real wage growth over the whole study period occurred in the lowest decile, p10, by 97.5 log points. The increase is slightly higher in the private sector and for men. The second largest overall increase is for p25, which saw a real wage increase of 85.3 log point. Several observations can be made. First, there is a proportional reduction in

[9] Decomposition methods are discussed in Fortin et al. (2011).

[10] Fortin et al. (2011) argue that this can be interpreted as a treatment effect.

wage growth over the entire period moving toward higher wage deciles. Furthermore, while price effects clearly dominate below the median, above the median, changes in composition become more important. Regarding the wage distribution of private sector female wage earners, wages of the lower percentiles (p10, p25, and p50) grew significantly more than for men. However, it seems that much of this wage growth is due to differences in composition.

As expected, the minimum wage hikes in 2004 and 2016 caused huge real wage increases in the lower half of the distribution, mostly due to price effects. For private sector female wage earners, even at p75, the ripple effect of the minimum wage is quite evident for both periods. It is worth noting that the considerable endowment (educational) differences between private and public sector workers had a large spill-over effect. Among female wage earners, the share of post-secondary graduates is 42.3 percent in 2016 but only 31.3 percent in the private sector.[11] The ripple effect of the minimum wage beyond the median supports the reference wage hypothesis discussed earlier. Regarding gender differences, the 2016 minimum wage increase had a greater effect on women's wages than men's, particularly at p25 and p50. This finding is consistent with the minimum wage and inequality literature (DiNardo et al., 1996).

Wages grew differently in the upper percentiles (p75 and p90) than in the lower half of the distribution. They increased significantly between 2004 and 2012, but barely grew at all in the following sub-periods. This wage stagnation above the median (p50) is connected to negative price effects, particularly after 2016. Strikingly, wages at p90 in the private sector for both men and women faced negative price effects in almost every sub-period after 2012, except for 2016, when there was a minimum wage hike. It would be more accurate to interpret this t as a decrease in returns rather than a change in the wage schedule. The DFL method is not a detailed decomposition as it measures the price effect as a residual. What causes the total change to be positive is mostly differences in endowments, that is, the change in composition. For 2016-19, the upper half of the distribution experienced serious price effects, which require further explanation beyond decomposition.

The real wage (log) changes in percentiles shown in Table 12 also reveal how inequalities evolve in each period (Table 15). Over the entire period, there was a sharp decline in all wage inequality measures. Table 12 and 13 indicate that much of this reduction is driven by price changes that we attribute to minimum wage changes. It Strikingly, wage growth for lower

[11] Holding similar sample restrictions for men, it is 25.8 and 16.7, respectively.

deciles outpaced that of higher deciles, particularly for wages above the median. Although compositional changes in endowments, such as the expansion in higher education, boosted wage inequality, the wage (price) treatment more than off-set the effects generated by changes in labor force composition.

The DFL results show that, except for lower-tail wage inequality (p50/p10), the price effect largely dominates the reduction in inequalities. The minimum wage increases in 2004 and 2016 clearly helped to narrow the wage gap by raising the wage floor for the lower half of the distribution. However, some of this decline resulted from the wage stagnation experienced in the upper percentiles, mainly due to price effects, particularly during 2012-2019. Overall, upper-tail wage inequality (90/50) contracted by around 23-27 log points (25-31 %) despite a modest expansion between 2004 and 2012.

The p90/p10 wage gap narrowed significantly over the study period. While minimum wage adjustments made a significant contribution in 2004 and 2016, changes in endowments added to this reduction in inequality. Especially for women, a significant part of the change was due to compositional developments. As already mentioned, the limited wage growth in the upper tail p90 was the key factor responsible for falling inequality between 2012 and 19.

The evolution of lower tail wage inequality is particularly significant when discussing the puzzling effect of the minimum wage in Turkey. Between 2002 and 2019, the reduction in lower tail inequality was largely dominated by compositional changes (see Table 13). Specifically, female wage earners experienced significant inequality gains thanks to endowment. It is clear that, rather than minimum wage adjustments, inter-generational educational differences mainly explain the closing wage gap for lower-tail inequality. Minimum wage regulations affected the entire wage schedule in the lower half of the distribution, bringing it closer to the upper half. Taking p75 as a reference point, for example, the 2016 minimum wage increase has significantly reduced the p75/p25 and p75/p50 wage gaps through wage effects. In 2016, the p75/p50 wage gap was far more sensitive to minimum wage adjustment than lower-tail inequality (p50/p10). Similarly, when the price effect is taken as the minimum wage adjustment sensitivity measure, the reaction of the p75/p25 and p90/p25 wag gap was quite strong compared to other inequality measures. Both the 2004 and 2016 minimum wage increases produced very similar patterns in terms of wage effects. The DFL results indicate that the hourly wage distance of the 10th, 25th and 50th percentiles to the 75th and 90th fell in a similar fash-

ion after the two minimum wage shocks. Turkey's case is thus a unique experiment in which a similar wage effect is obtained by changing institutional structures. The fact that p50/p10 seems almost unaffected by the minimum wage hike supports the ripple effect argument. An increase in the minimum wage moves the wage distribution below the median to the right, thereby creating real wage increases and widespread spill-over effects.

Table 12: Decomposition of hourly wage growth using DFL method

	2002-04			2004-12			2012-15			2015-16			2016-19			2002-19		
	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price
p10																		
Total	0.226	-0.049	0.275	0.385	0.108	0.277	0.152	0.054	0.098	0.161	0.028	0.133	0.051	0.032	0.018	0.975	0.449	0.527
Men	0.241	-0.038	0.279	0.377	0.115	0.262	0.152	0.067	0.085	0.179	0.059	0.120	0.063	0.069	-0.006	1.012	0.350	0.663
Women	0.252	-0.065	0.316	0.491	0.126	0.365	0.048	0.057	-0.009	0.144	0.044	0.099	0.044	0.047	-0.003	0.978	0.437	0.541
Private	0.292	0.000	0.292	0.426	0.154	0.272	0.154	0.079	0.074	0.159	0.011	0.148	0.061	0.028	0.033	1.092	0.434	0.658
Private (Men)	0.203	0.000	0.203	0.454	0.161	0.293	0.132	0.069	0.064	0.170	0.017	0.152	0.044	0.018	0.025	1.003	0.357	0.646
Private (Women)	0.256	-0.044	0.300	0.603	0.174	0.429	0.192	0.134	0.059	0.169	0.043	0.126	0.069	0.041	0.028	1.291	0.665	0.626
p25																		
Total	0.181	-0.036	0.217	0.308	0.105	0.203	0.123	0.054	0.069	0.159	0.000	0.159	0.082	0.028	0.054	0.853	0.310	0.543
Men	0.166	-0.036	0.203	0.308	0.105	0.203	0.134	0.043	0.091	0.176	0.028	0.148	0.084	0.041	0.044	0.869	0.282	0.587
Women	0.239	-0.033	0.272	0.316	0.121	0.195	0.094	0.012	0.082	0.213	0.038	0.175	0.072	0.065	0.007	0.934	0.300	0.634
Private	0.252	-0.028	0.280	0.328	0.120	0.208	0.146	0.064	0.083	0.175	0.018	0.157	0.042	0.018	0.024	0.944	0.338	0.605
Private (Men)	0.252	0.000	0.252	0.308	0.105	0.203	0.138	0.049	0.089	0.175	0.018	0.157	0.042	0.020	0.022	0.916	0.338	0.577
Private (Women)	0.267	-0.022	0.290	0.390	0.182	0.207	0.152	0.095	0.057	0.198	0.018	0.179	0.042	0.010	0.033	1.049	0.557	0.492
p50																		
Total	0.134	-0.059	0.193	0.236	0.095	0.140	0.096	0.039	0.057	0.148	0.039	0.109	0.042	0.010	0.033	0.656	0.192	0.464
Men	0.102	-0.060	0.162	0.227	0.069	0.158	0.124	0.068	0.057	0.120	0.026	0.094	0.042	0.010	0.033	0.615	0.182	0.433
Women	0.123	-0.039	0.162	0.246	0.128	0.118	0.057	0.000	0.057	0.187	0.039	0.148	0.033	0.049	-0.016	0.646	0.172	0.474
Private	0.197	0.000	0.197	0.278	0.105	0.173	0.123	0.066	0.057	0.128	0.007	0.121	0.036	0.010	0.026	0.761	0.201	0.561
Private (Men)	0.203	0.000	0.203	0.272	0.095	0.177	0.152	0.065	0.087	0.102	0.010	0.092	0.035	0.012	0.023	0.764	0.195	0.569
Private (Women)	0.244	0.000	0.244	0.273	0.078	0.195	0.111	0.062	0.049	0.187	0.039	0.148	0.040	0.036	0.004	0.855	0.226	0.628
p75																		
Total	0.046	-0.051	0.097	0.313	0.172	0.141	0.024	0.063	-0.039	0.063	0.054	0.009	0.017	0.105	-0.088	0.464	0.329	0.135
Men	0.010	-0.087	0.097	0.254	0.077	0.177	0.057	0.049	0.008	0.071	0.041	0.030	0.031	0.093	-0.062	0.423	0.247	0.176
Women	0.016	-0.044	0.060	0.361	0.243	0.118	-0.068	0.000	-0.068	0.148	0.083	0.065	-0.062	0.090	-0.151	0.395	0.377	0.018
Private	0.107	0.000	0.107	0.280	0.136	0.144	0.118	0.044	0.075	0.101	0.033	0.068	0.039	0.065	-0.026	0.646	0.290	0.356
Private (Men)	0.107	-0.015	0.123	0.280	0.116	0.165	0.144	0.065	0.079	0.091	0.048	0.043	0.038	0.052	-0.014	0.662	0.293	0.369
Private (Women)	0.162	0.006	0.156	0.272	0.197	0.075	0.110	0.075	0.035	0.107	0.000	0.107	0.007	0.022	-0.015	0.659	0.246	0.413
p90																		
Total	-0.055	-0.035	-0.020	0.366	0.115	0.251	0.020	0.000	0.020	0.079	0.029	0.050	-0.028	0.013	-0.042	0.382	0.236	0.145
Men	-0.040	-0.019	-0.020	0.329	0.118	0.211	0.057	0.057	0.000	0.030	0.010	0.020	0.007	0.058	-0.050	0.384	0.223	0.161
Women	-0.028	-0.016	-0.012	0.377	0.110	0.268	-0.005	-0.003	-0.002	0.100	0.036	0.064	-0.042	0.051	-0.093	0.403	0.170	0.233
Private	0.002	-0.008	0.010	0.345	0.265	0.080	0.079	0.118	-0.039	0.065	0.034	0.030	0.022	0.090	-0.068	0.513	0.390	0.123
Private (Men)	-0.016	-0.011	-0.005	0.328	0.215	0.113	0.114	0.125	-0.011	0.030	0.025	0.005	0.032	0.076	-0.044	0.490	0.355	0.135
Private (Women)	0.002	0.028	-0.026	0.308	0.336	-0.028	0.054	0.085	-0.031	0.114	0.041	0.074	-0.046	0.051	-0.097	0.433	0.498	-0.065

Source: TurkStat, HLFS 2002-19, Only positive wage earners are included in the sample. Top and bottom 0.1 % is trimmed using hourly wages.
Basic endowment specification for probit model includes controls for gender, age, education (6 category), formal contracts, regular working hours and interaction terms for age, gender and education groups.

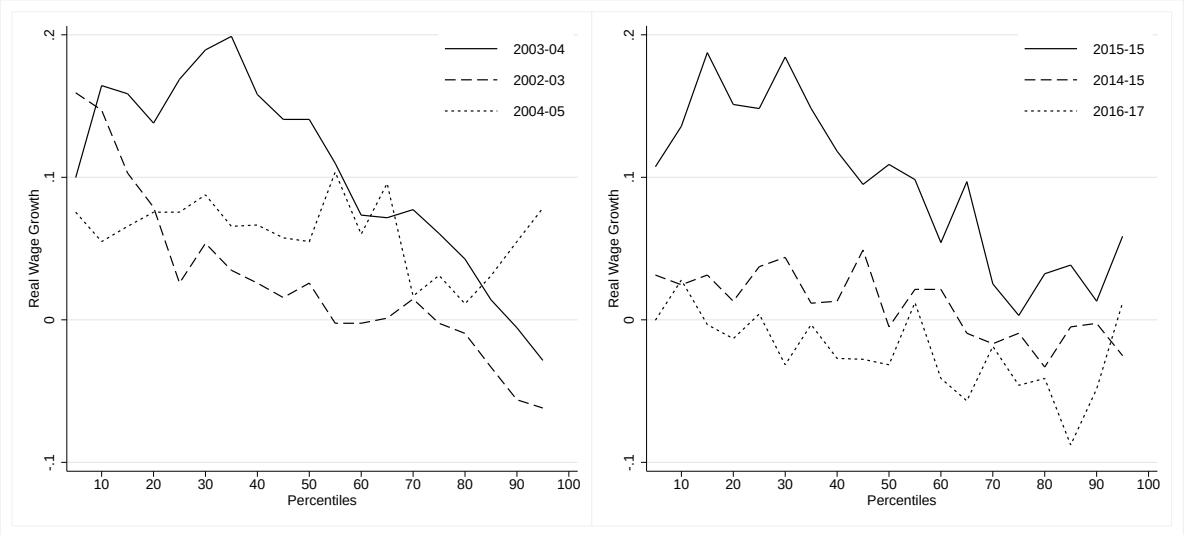
Table 13: Decomposition of hourly wage wage inequality using DFL method

		2002-04			2004-12			2012-15			2015-16			2016-19			2002-19		
		Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price	Total	Comp.	Price
p90/p10																			
	Total	-0.281	0.014	-0.295	-0.020	0.007	-0.027	-0.132	-0.054	-0.077	-0.082	0.001	-0.083	-0.079	-0.019	-0.060	-0.594	-0.212	-0.381
	Men	-0.280	0.019	-0.299	-0.048	0.003	-0.051	-0.095	-0.010	-0.085	-0.149	-0.049	-0.100	-0.056	-0.011	-0.045	-0.629	-0.127	-0.502
	Women	-0.279	0.049	-0.328	-0.113	-0.016	-0.097	-0.054	-0.060	0.007	-0.043	-0.008	-0.036	-0.085	0.004	-0.090	-0.575	-0.267	-0.307
	Private	-0.290	-0.008	-0.282	-0.081	0.111	-0.192	-0.075	0.038	-0.113	-0.094	0.023	-0.118	-0.039	0.061	-0.101	-0.579	-0.044	-0.536
	Private (Men)	-0.219	-0.011	-0.208	-0.126	0.054	-0.180	-0.019	0.056	-0.075	-0.139	0.008	-0.147	-0.011	0.058	-0.069	-0.513	-0.002	-0.511
	Private (Women)	-0.254	0.072	-0.326	-0.295	0.162	-0.457	-0.138	-0.048	-0.090	-0.055	-0.003	-0.052	-0.115	0.010	-0.126	-0.857	-0.167	-0.691
p90/p50																			
	Total	-0.189	0.024	-0.213	0.130	0.020	0.110	-0.076	-0.039	-0.036	-0.069	-0.010	-0.059	-0.071	0.003	-0.074	-0.274	0.044	-0.318
	Men	-0.142	0.041	-0.182	0.102	0.049	0.054	-0.068	-0.011	-0.057	-0.089	-0.016	-0.073	-0.035	0.048	-0.083	-0.231	0.041	-0.272
	Women	-0.150	0.023	-0.174	0.132	-0.018	0.150	-0.062	-0.003	-0.059	-0.087	-0.003	-0.084	-0.074	0.003	-0.077	-0.243	-0.002	-0.240
	Private	-0.194	-0.008	-0.186	0.067	0.160	-0.093	-0.044	0.051	-0.095	-0.063	0.027	-0.091	-0.014	0.080	-0.094	-0.249	0.189	-0.438
	Private (Men)	-0.219	-0.011	-0.208	0.056	0.119	-0.063	-0.038	0.061	-0.099	-0.071	0.016	-0.087	-0.003	0.064	-0.067	-0.274	0.160	-0.434
	Private (Women)	-0.241	0.028	-0.270	0.036	0.258	-0.223	-0.057	0.023	-0.080	-0.073	0.002	-0.075	-0.086	0.015	-0.101	-0.422	0.272	-0.693
p50/p10																			
	Total	-0.093	-0.010	-0.082	-0.150	-0.013	-0.137	-0.056	-0.015	-0.041	-0.013	0.011	-0.024	-0.008	-0.022	0.014	-0.319	-0.257	-0.063
	Men	-0.139	-0.022	-0.117	-0.151	-0.046	-0.105	-0.028	0.001	-0.028	-0.059	-0.033	-0.026	-0.021	-0.059	0.038	-0.397	-0.168	-0.230
	Women	-0.129	0.025	-0.154	-0.245	0.002	-0.247	0.008	-0.057	0.065	0.044	-0.005	0.049	-0.011	0.002	-0.013	-0.332	-0.265	-0.067
	Private	-0.096	0.000	-0.096	-0.148	-0.049	-0.099	-0.031	-0.013	-0.018	-0.031	-0.004	-0.027	-0.025	-0.018	-0.007	-0.331	-0.233	-0.098
	Private (Men)	0.000	0.000	0.000	-0.182	-0.066	-0.116	0.019	-0.004	0.024	-0.068	-0.008	-0.060	-0.008	-0.006	-0.002	-0.239	-0.162	-0.077
	Private (Women)	-0.013	0.044	-0.056	-0.331	-0.096	-0.235	-0.082	-0.072	-0.010	0.018	-0.004	0.022	-0.029	-0.005	-0.024	-0.436	-0.439	0.003
P90/p25																			
	Total	-0.236	0.002	-0.238	0.057	0.010	0.048	-0.103	-0.054	-0.049	-0.079	0.029	-0.108	-0.110	-0.015	-0.095	-0.471	-0.074	-0.397
	Men	-0.206	0.017	-0.223	0.021	0.012	0.008	-0.077	0.015	-0.092	-0.146	-0.018	-0.128	-0.077	0.017	-0.094	-0.486	-0.059	-0.427
	Women	-0.267	0.017	-0.284	0.062	-0.011	0.073	-0.100	-0.015	-0.084	-0.112	-0.001	-0.111	-0.113	-0.013	-0.100	-0.531	-0.130	-0.400
	Private	-0.249	0.020	-0.269	0.016	0.145	-0.129	-0.067	0.054	-0.121	-0.110	0.016	-0.126	-0.021	0.071	-0.092	-0.431	0.051	-0.482
	Private (Men)	-0.267	-0.011	-0.256	0.020	0.109	-0.090	-0.024	0.076	-0.101	-0.145	0.007	-0.152	-0.010	0.056	-0.067	-0.425	0.016	-0.442
	Private (Women)	-0.265	0.051	-0.316	-0.081	0.154	-0.236	-0.098	-0.010	-0.088	-0.083	0.022	-0.106	-0.089	0.041	-0.130	-0.616	-0.059	-0.557
p75/p25																			
	Total	-0.135	-0.015	-0.120	0.005	0.067	-0.062	-0.099	0.009	-0.108	-0.096	0.054	-0.150	-0.064	0.077	-0.142	-0.389	0.018	-0.407
	Men	-0.156	-0.051	-0.105	-0.055	-0.028	-0.026	-0.077	0.006	-0.083	-0.105	0.013	-0.118	-0.053	0.052	-0.105	-0.446	-0.035	-0.411
	Women	-0.223	-0.011	-0.212	0.045	0.122	-0.077	-0.163	-0.012	-0.150	-0.065	0.046	-0.110	-0.134	0.025	-0.159	-0.539	0.077	-0.616
	Private	-0.144	0.028	-0.172	-0.048	0.016	-0.064	-0.028	-0.020	-0.008	-0.074	0.014	-0.088	-0.004	0.046	-0.050	-0.298	-0.048	-0.249
	Private (Men)	-0.144	-0.015	-0.129	-0.028	0.010	-0.038	0.006	0.016	-0.010	-0.084	0.029	-0.114	-0.004	0.032	-0.036	-0.254	-0.045	-0.209
	Private (Women)	-0.105	0.029	-0.134	-0.118	0.015	-0.132	-0.042	-0.021	-0.021	-0.090	-0.018	-0.072	-0.035	0.013	-0.048	-0.391	-0.312	-0.079
p75/p50																			
	Total	-0.088	0.008	-0.095	0.077	0.077	0.001	-0.072	0.024	-0.095	-0.085	0.015	-0.101	-0.025	0.095	-0.121	-0.192	0.136	-0.329
	Men	-0.091	-0.027	-0.065	0.027	0.008	0.019	-0.068	-0.019	-0.049	-0.049	0.015	-0.063	-0.012	0.083	-0.094	-0.192	0.065	-0.257
	Women	-0.107	-0.004	-0.102	0.115	0.115	0.000	-0.125	0.000	-0.125	-0.039	0.044	-0.083	-0.094	0.041	-0.135	-0.251	0.205	-0.456
	Private	-0.089	0.000	-0.089	0.002	0.031	-0.029	-0.005	-0.023	0.018	-0.027	0.026	-0.053	0.003	0.055	-0.051	-0.115	0.089	-0.205
	Private (Men)	-0.095	-0.015	-0.080	0.008	0.020	-0.012	-0.008	0.000	-0.008	-0.011	0.038	-0.049	0.003	0.040	-0.037	-0.102	0.098	-0.201
	Private (Women)	-0.082	0.006	-0.088	-0.001	0.119	-0.119	-0.001	0.013	-0.014	-0.080	-0.039	-0.041	-0.033	-0.014	-0.019	-0.196	0.019	-0.215

Source: TurkStat, HLFS 2002-19, Only positive wage earners are included in the sample. Top and bottom 0.1 % is trimmed using hourly wages.
Basic endowment specification for probit model includes controls for gender, age, education (6 category), formal contracts, regular working hours and interaction terms for age, gender and education groups.

We further underline the specific single year minimum wage effects by highlighting the wage effect along the wage distribution before and after the minimum wage shocks. Figure 17 offers a clearer comparison of the two minimum wage shocks. The real gains triggered by the shocks exceeded the median wage and spread even to the 60th decile. There was no real wage increase effect specific to the lower segment in the years following the shock. However, the upper percentiles experienced real wage erosion or stagnation both before and after the shock. We believe that further investigation is needed to understand the factors behind these dynamics.

Figure 17: Comparing Minimum Wage Shocks 2002 vs 2016
Private Sector, Hourly Wages - 2002-05 vs 2014-17



Source: TurkStat, HLFS 2002-19, Only positive wage earners are included in the sample. Top and bottom 0.1 % is trimmed using hourly wages.
Note: Basic endowment specification for probit model includes controls for gender, age, education (6 category), formal contracts, regular working hours and interaction terms for age, gender and education groups.

5 Conclusion

In this paper, we examine the dynamics of wage inequality in Turkey between 2002 and 2019. We document an important decline in wage inequality over the period analyzed. This decline in wage inequality can be explained by several factors. First, real minimum wage hikes in 2004 and 2016 affected wage inequality, especially by increasing wages in lower deciles. Second, a simple supply-demand framework helped to understand how changes in relative supplies may yield lower relative wages by assuming a stable demand curve. Third, for pe-

riods and cases where a stable demand curve was not realistic, between-industry shifts in relative demand filled the gap to explain the observed wage dynamics. Finally, the stagnation of post-secondary graduate wages is an important component of the explanation for the observed wage dynamics.

The impact of the minimum wage adjustments in 2004 and 2016 is important in understanding decreasing wage inequality In Turkey. We use decomposition analysis developed by DiNardo et al. (1996) to provide evidence that the wage (pricing) effect exceeded median hourly wages and exhibited spill-over effects, even for wage earners above median. In Turkey, it seems that minimum wage adjustments replaced the role of central wage bargaining. It is therefore important to see whether other emerging countries have had similar experiences.

We find that, when a stable demand curve seems unrealistic, the likely explanation is structural transformation (strong between-industry shifts in relative demand) rather than skill-biased technological change (which would require strong between-industry shifts in relative demand). Given the evidence on skill-biased technological change, one wonders whether its lack in Turkey can be explained by the surge in the number of universities since 2005, which has reduced the quality of skills offered to fresh college graduates in recent years. Our preliminary findings show that this may be the case given the stagnation of post-secondary graduate wages in recent years. However, more detailed and systematic research is needed to provide convincing evidence on this question.

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