The Impact of Minimum Wage Shock on Robot Adaption in Turkey

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Introduction

- In recent years, the utilization of industrial robots in the manufacturing industry has experienced a notable surge.
- According to the International Federation of Robotics (IFR), the operational stock of robots has tripled since 2010.
- This transformative shift in manufacturing has prompted scholars to investigate the impact of robotics on employment and wages. While many studies suggest that the adoption of robots significantly reduces employment and earnings, especially in developed (US, France) countries there are also studies demonstrating no negative employment effects and, in some cases, positive effects of robotization in developing (Indonesia, Turkey) and certain developed countries (Finland, Italy, EU regions).
- Various mechanisms, such as productivity effects, diminishing returns, and product innovation, have been proposed to explain this puzzle.

Introduction

- However, in the literature, determinants of robot adoption, particularly cost-related variables, are not extensively studied due to two main challenges. The first challenge is the measurement issue of robots.
- Another issue in robot studies is the endogeneity of possible determinants with robot adoption.
- This study aims to investigate how a minimum wage shock alters the robot adoption decisions of Turkish enterprises. In 2016, Turkey implemented a sudden 33.5% increase in the minimum wage. This shock provides an opportunity to isolate exogenous shocks to labor costs and test the price mechanism.

Introduction

- Moreover, we can observe how labor market shocks affect the robotization process in a developing country at the early stages of automation.
- Our empirical strategy relies on differences-in-differences to examine how firms are affected by the 2016 minimum wage increase when considering the purchase of robots.

Literature

- Empirical evidence regarding the effect of labor market shocks on robot adoption is limited.
- As for causal evidence, Deng et al (2021) and Fan et al.(2021) use minimum wage variation as a quasi-natural experiment for Germany and China, respectively, and observe that the minimum wage shock is more likely to drive firms toward robot adoption.

Deng et al.

- Deng et al. use IAB establishment panel survey and merge it with employer-employee data.
- They utilized the natural experiment that Germany introduced for the first time its statutory minimum wage. But share of minimum wage employment in Germany is 11% approx.

Fan et al.

- Fan et al. utilized the variation of regional minimum wage.
- Like our study, they use custom data.
- Firms with high TFP are more likely to adopt a robot.
- SOEs do not insignificantly import robot.

Data

- We utilize two administrative datasets provided by Enterprise Information System (EIS) between 2009 and 2019.
  - Employer-employee dataset by Social security institute
  - Trade dataset by Ministry of Custom and Trade

Robot importers in Turkey

- Number of firms

Sector	Zero employment	Micro	Small	Medium	Large	Total
Manufacturing	199,135	211,073	46,725	10,120	2006	465,587
All	1,749,101	1,156,491	161,035	26,705	5,290	3,085,177

- Number of robot importers in 2010-2019

Sector	Zero employment	Micro	Small	Medium	Large	Total
Manufacturing	29	62	146	221	258	716
All	60	156	227	257	274	966

Employment composition of robot importers

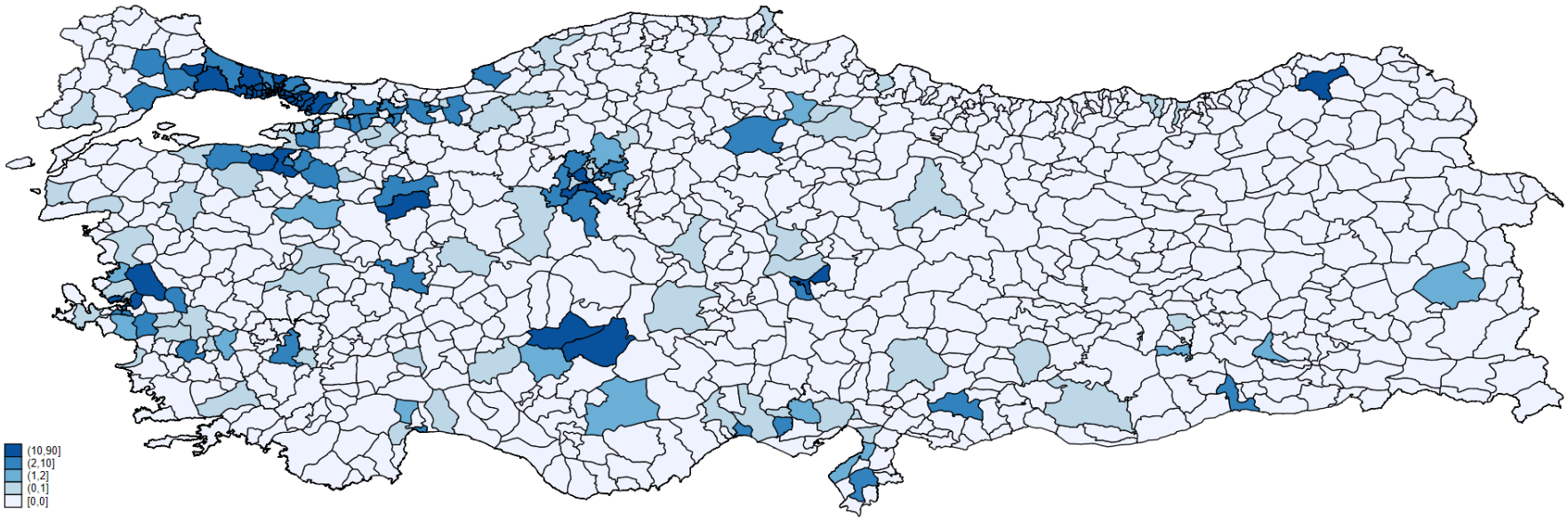
- Young-aged workers consist of 56% of total robot importer firms, which is higher compared to all manufacturing firms (50%)..
- Most of the employment (85%) is male.
- 4.8% of workers employed in robot importers earn minimum wage.

Number of minimum wage earners and total employment by size

Size	Min. wage earners	Total	Share (%)
Micro	424,420	483,199	88
Small	511,807	845,971	60
Medium	329,759	976,239	34
Large	147,902	1,337,369	11

Geographic distribution of robot importers

Number of firms by district (2010-2019)



Specification

- We employ difference-in-differences with continuous framework.Specifically, we estimate the following equation:

$$y_{it} = \alpha + X_{it}^{'}\Phi + \beta \text{minimum wage share}_{it} + D_i + D_t + D_{kt} + D_{pt} + \varepsilon_{it}$$

where the outcome variable y_{it} takes two forms. Firstly, the extensive margin is a dummy variable equal to 1 if firm i adopts robotization in its production at time t. As the second form of the outcome variable, the intensive margin is calculated as the log of cumulative monetary value and quantity (weight) of robot imports adopted by firm i.

- Finally, β denotes the effect of the ratio of the minimum wage employment share of a firm in 2015 on the likelihood of being a robot adapter. We track minimum wage employees using their daily wages.
- Additionally, we interact the variable of interest with firm size to test the hypothesis that large firms are more likely to implement robotization than their smaller counterpart.

Results

Extensive margin and intensive margin

Dependent Variables:	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
minimum wage share$_{it}$	0.0009	0.0081	0.0060	0.0008	0.0069	0.0052
	(0.0008)	(0.0091)	(0.0062)	(0.0008)	(0.0091)	(0.0062)
minimum wage share$_{it}$				**0.0045*****	**0.0457****	**0.0308*****
× medium				**(0.0011)**	**(0.0114)**	**(0.0080)**
minimum wage share$_{it}$				**0.0270*****	**0.3251*****	**0.2278*****
× large				**(0.0066)**	**(0.0740)**	**(0.0528)**
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
NACE × year	Yes	Yes	Yes	Yes	Yes	Yes
Province × year	Yes	Yes	Yes	Yes	Yes	Yes
Min. wage share	Yes	Yes	Yes	Yes	Yes	Yes
quantile FE × t.trend						
Fit statistics						
Observations	440,735	440,735	440,735	440,735	440,735	440,735
R^2	0.76755	0.76768	0.78697	0.76762	0.78301	0.78703
Within R^2	0.00620	0.00685	0.00770	0.00649	0.00780	0.00799

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Results

Extensive margin and intensive margin
min. wage share × blue collar employment intensity

Dependent Variables:	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
minimum wage share$_{it}$	0.0001	0.0001	-0.0008	0.0003	0.0024	0.0018
	(0.0009)	(0.0006)	(0.0070)	(0.0009)	(0.0102)	(0.0069)
minimum wage share$_{it}$				**0.0029****	**0.0287****	**0.0201****
× medium				**(0.0013)**	**(0.0135)**	**(0.0094)**
minimum wage share$_{it}$				0.0123	0.1437	0.1019
× large				(0.0083)	(0.0984)	(0.0702)
minimum wage share$_{it}$	0.0004	0.0049	0.0038	-0.0005	-0.0050	-0.0027
× blue collar share of min. wage	(0.0007)	(0.0073)	(0.0052)	(0.0006)	(0.0067)	(0.0048)
minimum wage share$_{it}$				0.0038	0.0404	0.0254
× blue collar share of min. wage × medium				(0.0030)	(0.0327)	(0.0234)
minimum wage share$_{it}$				**0.0259***	**0.3208****	**0.2213***
× blue collar share of min. wage × large				(0.0140)	**(0.1612)**	**(0.1142)**
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
NACE × year	Yes	Yes	Yes	Yes	Yes	Yes
Province × year	Yes	Yes	Yes	Yes	Yes	Yes
Min. wage share	Yes	Yes	Yes	Yes	Yes	Yes
quantile FE × t.trend						
Fit statistics						
Observations	392,718	392,718	392,718	392,718	392,718	392,718
R^2	0.76787	0.78434	0.78956	0.76797	0.78444	0.78966
Within R^2	0.01333	0.01687	0.01733	0.01377	0.01734	0.01779

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Results

Effect of minimum wage shock on robot adaption interacted by R & D expenditure

Dependent Variables:	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)
R&D definition	Log(R&D+1)	Log(R&D+1)	Log(R&D+1)	Log(R&D per capita+1)	Log(R&D per capita+1)	Log(R&D per capita+1)
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
minimum wage share$_{it}$	0.0006	0.0046	0.0033	0.0006	0.0048	0.0035
	(0.0011)	(0.0122)	(0.0085)	(0.0011)	(0.0122)	(0.0085)
minimum wage share$_{it}$	**0.0011****	**0.0129****	**0.0091****	0.0010	**0.0121***	**0.0085***
× Log(R&D expenditure+1)	**(0.0005)**	**(0.0053)**	**(0.0037)**	(0.0006)	(0.0062)	(0.0043)
Fixed-effects						
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
NACE × year	Yes	Yes	Yes	Yes	Yes	Yes
Province × year	Yes	Yes	Yes	Yes	Yes	Yes
Min. wage share	Yes	Yes	Yes	Yes	Yes	Yes
quantile FE × t.trend						
Fit statistics						
Observations	397,173	397,173	397,173	397,173	397,173	397,173
R^2	0.77968	0.79546	0.80150	0.77967	0.79545	0.80149
Within R^2	0.00476	0.00572	0.00578	0.00471	0.00567	0.00573

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Results

Extensive margin and intensive margin
min. wage share × HHI

Dependent Variables:	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)
Model:	(1)	(2)	(3)
Variables			
minimum wage share$_{it}$	**0.0045*****	**0.0522*****	**0.0362*****
	(0.0010)	**(0.0118)**	**(0.0081)**
minimum wage share$_{it}$	**-0.1195*****	**-1.4700*****	**-1.0120*****
× HHI	**(0.0248)**	**(0.2909)**	**(0.2032)**
Fixed-effects			
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
NACE × year	Yes	Yes	Yes
Province × year	Yes	Yes	Yes
Min. wage share quantile FE × t.trend	Yes	Yes	Yes
Fit statistics			
Observations	455,490	455,490	455,490
R^2	0.76423	0.77912	0.78291
Within R^2	0.00792	0.00847	0.00861

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Results

Extensive margin and intensive margin interacted by (export + import) / total sales

Dependent Variables:	Robot importer	Log(Cum. robot value+1)	Log(Cum. robot quantity+1)
Model:	(1)	(2)	(3)
Variables			
min wage share$_{it}$	0.0004	0.0029	0.0016
	(0.0008)	(0.0091)	(0.0063)
min wage share$_{it}$	**0.0073*****	**0.0752*****	**0.0499*****
$\times$ (export + import/sales)	**(0.0020)**	**(0.0207)**	**(0.0141)**
Fixed-effects			
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
NACE $\times$ year	Yes	Yes	Yes
Province $\times$ year	Yes	Yes	Yes
Min. wage share	Yes	Yes	Yes
quantile FE $\times$ t.trend			
Fit statistics			
Observations	444,327	444,327	444,327
R^2	0.76455	0.77749	0.78026
Within R^2	0.00624	0.00748	0.00758

Clustered (Firm) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Conclusion

- Our preliminary results reveal that minimum wage shock insignificantly effect robot adaption.
- On the other hand, we document that firm size matters. Medium and large firms are more likely to import robort when they face a huge labor cost shock.
- Task composition of firms is also an important issue to comprehend the robotization decision of firms.
- Firms engaging in R&D are associated with robotization.

Thank you for you listening!

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