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Akgündüz, Yusuf Emre; Torun, Huzeyfe

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Two and a half million Syrian refugees, skill mix and capital intensity

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Two and a half million Syrian refugees, skill mix and capital intensity*

Yusuf Emre Akgündüz †
Central Bank of the Republic of Turkey

Huzeyfe Torun ‡
Central Bank of the Republic of Turkey, GLO

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Abstract

We investigate how the rapid increase in the low-skilled labor supply induced by the inflow of 2.5 million Syrian refugees changed the tasks performed by native workers and the amount of capital used by firms in Turkey. Despite the unexpected nature of the refugee inflow, location choice of the refugees may be endogenous to the labor market opportunities of hosting regions. To handle this endogeneity issue, we use an instrument for the refugee intensity based on the distance of Turkish regions to the Syrian ones. The results based on Labor Force Survey suggest that the inflow of refugees increased natives' task complexity, reducing the intensity of manual tasks, and raising the intensity of abstract, routine and ICT tasks. This effect is particularly strong for natives with medium level of education. Exploiting the administrative firm data that contains the entirety of firms in the country, we find that the firms reduced their fixed assets. The fixed asset reduction is largest in machinery and equipment, which can be interpreted as a decline in the capital intensity of production. We conclude that tasks provided by Syrian refugees are substitutes for natives' manual tasks and firms' capital, and complementary to natives' more complex tasks.

JEL codes: F22; J24; J21; D24

Keywords: Migration, refugees, labor-capital substitution, skills, tasks.

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*The views expressed here are of our own and do not necessarily reflect those of the Central Bank of the Republic of Turkey. All errrors are ours.

†yusufemre.akgunduz@tcmb.gov.tr. Structural Economic Research Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

‡huzeyfe.torun@tcmb.gov.tr. Structural Economic Research Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

1 Introduction

The traditional approach to studying the economic effects of immigration has been to analyze its effects on wages and employment exploiting the variation in the number of immigrants across regions and time.[1] More recently researchers have also applied a task-based approach to analyzing immigration. A task-based approach is useful in explaining a number of labor market phonemomenan that the canonical models of the labor market are silent on (Acemoglu and Autor, 2011). Applying a task-based approach to immigration can reveal insights about the adjustments in production mix and firms' resulting demand for different skill groups. The task framework underlines that the causal channel by which immigration affects labor market is through the adjustment in the production mix.

In this paper we investigate how the rapid increase in the low-skilled labor supply induced by the inflow of 2.5 million Syrian refugees changed the tasks performed by native workers and the intensity of capital used by firms in Turkey. Our examination builds on the stylized fact that most Syrian refugees have very restricted skills that are valued in the Turkish labor market and the idea that the low-skill labor complements with certain types of tasks and substitutes for others. Majority of the adult Syrians in Turkey do not speak Turkish and only around 9 percent of them have a higher education (AFAD, 2013). Even those who have college degrees from Syria face very strong language and culture barriers in Turkey. Moreover, very few of the Syrian refugees have work permits. Consequently, refugees tend to take manual-intensive jobs in the informal sector which involve manual and physical rather than abstract and and interactive tasks. This potentially generates competition for the low-skilled jobs between least educated natives and the refugees. On the other hand there may be an indirect effect that raises the demand for native individuals who perform tasks that are complementary to manual tasks.

Despite the unexpected nature of the refugee inflow, location choice of the

[1] One set of studies report negligible effect of immigrants on natives' labor market outcomes (Card, 1990; Altonji and Card, 1991) while another set of studies report more sizable effects (Card, 2001; Borjas, 2003; Glitz, 2012).

refugees may be endogenous to the labor market opportunities of hosting regions. Syrian refugees have been located primarily in camps near the Turkish-Syrian border until 2014 when they started to spread to the rest of the country. We identify the causal effects of Syrian refugees by using the distance between the hosting cities in Turkey and hometowns in Syria in an instrumental variables approach that exploits the multiple border crossings between two countries. To test the effects on tasks, we calculate task scores using PIAAC 2015 for each occupation and match the scores with the Turkish Labor Force Survey (LFS). To analyze the effects on firms capital use, we use a large administrative dataset of all firms in Turkey that includes their balance sheet information. In effect, the analysis is comprised of two sections, one on tasks and the other on capital use but the methodology across the analyses remain similar.

We have four main findings. First, the refugee inflow pushed native employees from manual-intensive jobs towards more complex jobs that involve abstract and routine tasks which is in line with the hypotheses of Acemoglu and Autor (2011). In addition, occupations with high ICT use became more common among natives. The complexity of the natives' jobs increased through two channels. Some natives that worked in the manual intensive jobs are replaced by the refugees, and do not appear among employees any more. Also, those who keep their jobs switched to less manual tasks after the refugee inflow. Second, The results also shed light on the heterogenous effect of the refugee inflow across education levels. While middle school graduates shift to routine tasks, high school graduates move to more abstract tasks. The bottom and top of the skill distribution appear unaffected as we find no statistically significant effects on primary school and college graduates. Third, firms' fixed assets appear to fall. This fall is particularly concentrated in the machinery and equipment category, indicating a fall in capital use in production. Both capital use on average and aggregate capital at the regional level fall after the arrival of refugees despite an increase in the number of firms. Finally, we find suggestive evidence that the firms in the manual-intensive industries and firms in

industries with high informal employment shares are affected more by the refugee inflow.

Previous studies had studied the link between immigration and natvies' tasks; and immigration and capital use (Peri and Sparber, 2009; Lewis, 2011a; Ottaviano et al., 2013; D'Amuri and Peri, 2014; De Arcangelis et al., 2015). Dustmann and Glitz (2015) find that firms' labor and capital input adjustments are more substantial than changes in wages and employment levels. D'Amuri and Peri (2014) examine the impact of immigrants on the type and quantity of native jobs using data on 15 Western European countries. They find that the increase in the immigrant labor force pushes natives to occupations that require more complex tasks. They also find that this increase in the average complexity of natives' jobs occur through labor market flows. The complexity of jobs offered to new native hires is higher than the complexity of lost jobs. De Arcangelis et al. (2015) investigate the relation between migration and production structure of Italian provinces over the period 1995-2006 using data at the level of province. They find that the inflow of new migrants increases the relative supply of simple labor services, and raises the relative weight of simple-task intensive sectors in the overall economy. Lewis (2011a) compares technology adoption rates across U.S. metropolitan areas with different rates of high school dropouts induced by the recent wave of low-skilled immigration to the country. He finds that plants in the areas with high immigrant density adopted less automation machinery suggesting that automation machinery is a relative substitute for low-skill labor. On the other hand Mitaritonna et al. (2017) examine the effect of immigration on French manufacturing firms using micro-data spanning the period 1995-2005. First, they show that the net immigrant inflow during the sample period was skill-intensive. Next, they find that high-skilled immigrant inflow is associated with an increase in the total value of capital stock of the firms which support the skill-capital and skill-technology complementarity.

Among the countries that received immigration, the case of Turkey stands out

as an interesting one with the size and the suddennes of the refugee inflow. This nature of the refugee shock makes structural transformation in production likely and its effects measurable. The number of Syrian refugees in Turkey reached 2.5 million as of December 2015[2]. According to UNHCR data, for the fourth consecutive year, Turkey hosted the largest number of refugees worldwide, with more than 3.2 million people as of December 2017.[3]

As throughly explained in Dustmann et al. (2017) refugee migrants differ from economic migrants in a number of ways. The economic migrants not only choose whether or not to migrate but also the timing of the migration and the destination country. Their migration decision is an outcome of a deliberate optimization process, and most times economic migrants learn the institutions and labor market characteristics of destination countries. Refugee migrants, on the other hand, are often forced to leave their home country in a limited period of time, and to the closest country available. According to UNHCR (2015), in 2015, of the 10.1 million refugees from the five highest countries of origin, all but 1.1 million fled to a neigboring country. Syrian case was not an exception with great majority of the refugees fleeing to Turkey, Lebanon, Jordan and Iraq. Moreover, Syrian refugees fled their home country in a short period of time due to sudden violent clashes in their hometowns. Therefore, most refugees did not have the luxury of learning the language of the host country or getting familiar with the host country institutions. This fits with the empirical findings of Lewis (2011b) who shows that the segmentation of the occupations held by immigrants and natives can be explained by the differences in language skills. This unexpected nature of the inflow leaves the refugees unprepared and low-skilled in the labor market. Furthermore, Dustmann et al. (2017) note that unlike the refugee migration, in the case of economic migration the host countries have the economic integration of migrants as their

[2]Technically speaking, the Syrian population who fled to Turkey after the Syrian civil war are given the temporary protection status which is different from the full refugee status defined by the Geneva Convention for Refugees. Many countries including those from Western Europe developed different forms of temporary protection for civilians fleeing wars and civil conflicts (Dustmann et al., 2017). UNHCR use "refugee-like" term in a borader sense to include heterogenous forms of protection across countries. We adopt this definition of the term in line with the literature.

[3]As of the end of 2016, Turkey hosts 51 percent of the Syrian refugees, and 16 percent of all refugees around the world.

primary objective.

Our study is the first that identifies the effect on both tasks and capital use with the same shock. This allows us to identify the changes in the entirety of the production after the refugee inflow. Analyzing the effect on employment rates overlooks the adjustments in the task mix of native employees. Further including an analysis of the effect on natives' tasks may still be limited. While previous studies including the present paper suggest that natives move to more complex tasks, this may not necessarily have a positive effect on natives' long term productivity if capital is adversely affected. Our findings, suggest rapid adjustment on labor and capital margins. This swift adjustment explains the small effect of Syrian refugees on wage and employment of native population found in Ceritoglu et al. (2017) and Del Carpio and Wagner (2015) but also poses a risk to the host country in the long term. If refugees turn back to their home countries after the settlement of the crisis, refugee hosting regions will be left with low level of capital and native employees doing relatively more complex jobs.

The remainder of the paper is organized as follows. Section 2 discusses the institutional background of the Syrian refugee crisis in Turkey. Section 3 describes the IV methodology used in the analysis. Section 4 presents the data. Section 5 shows the results, first for task related outcomes and then for capital outcomes. Section 6 concludes.

2 Syrian refugees in Turkey

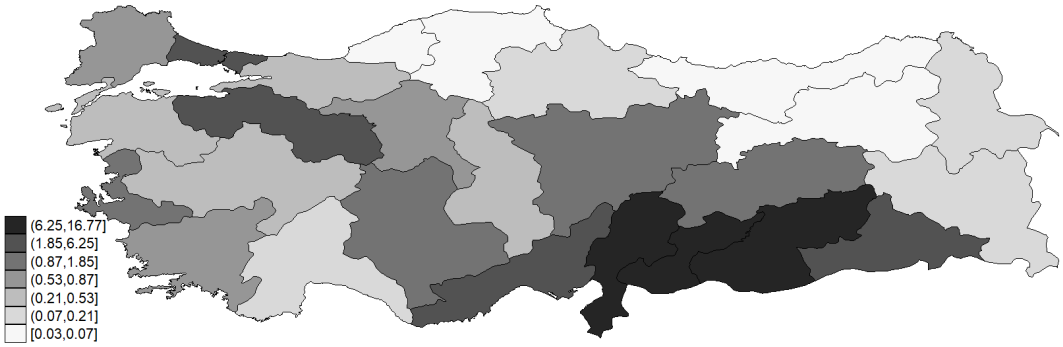
Internal conflict in Syria started in March 2011, and since then 4 million Syrians have sought refuge in the neighbouring countries, primarily Turkey, Lebanon, Jordan, Iraq and Egypt. As of December 2017, Turkey hosts the big majority of refugees with an official number of 3.2 million. Starting with an increase in the intensity of violent clashes in 2012, hundreds of thousands of Syrians fled their country. During this humanitarian crisis, Turkey had an open-door policy and

accepted all Syrians seeking refuge under the category of temporary protection. Syrians who entered Turkey through the border gates with their passports could potentially apply for residence permits and work permits. Yet, a great majority of Syrians came under the temporary protection category rather than with residence permit. Later, in 2016 Turkish government passed a law that gives opportunity for Syrians to apply for working permits. This happened after the sample period of this paper, yet even then the number of Syrians with official working permits stayed very low. Informal work is fairly common in Turkey however, comprising around a third of the labor force, and Syrians were widely employed in low skilled jobs. Since Syrians could only be employed as informal workers, even those with higher qualifications only had the option to take-up low skilled work.

D'Amuri and Peri (2014) examine the effect of the immigration in countries with strong Employment Protection Legislation (EPL) and weak EPL separately. They find that the natives' positive reallocation towards complex jobs is more intense in less-protected markets. According to OECD data Turkey has considerably high level of EPL especially for temporary employment contracts. However, high level of informality in the labor market facilitates both the empoyment of Syrian refugees and also the reallocation of native workforce across tasks. In the absence of working permits, Syrian refugees would not be able to earn their living in a completely formal labor market. On the other hand, if Syrians had the work permits but the economy had strong EPL and low informality, it would be hard for natives to reallocate across jobs.

The number of Syrian refugees in Turkey reached 2.5 million as of December 2015, and 3.2 million as of December 2017. Most of the refugees came to the provinces close to the Turkey-Syria border while another significant portion of them moved to the further away provinces such as Adana, Konya and Istanbul. In the beginning, most of the refugees were settled in camps that are constructed and operated by the Turkish government. Yet, as the number of refugees grew rapidly, the ratio of refugees living outside the camps rose. As of December 2015, the final

Figure 1: Distribution of Syrian refugees in 2015



year of analysis in this article, more than 80 percent of the refugees lived outside the camps.

Figure 1 presents the distribution of refugees by hosting provinces in 2015. The ratio of refugees to the native population increases as much as 40 percent in Kilis. Refugee-population ratio is particularly high in Kilis, Hatay, Gaziantep, Sanliurfa and Mardin. For hosting provinces the influx of so many refugees is a prominent shock to the economy. The gender composition of the refugees is balanced. The refugee population is predominantly young with 45 percent of them being under 18. 53 percent of the refugees have a primary school degree or no degree at all. Only 8 percent of them have attended higher education.

3 Methodology

For both task and capital related outcomes, we can estimate the specification given by equation 1 using OLS. Subscript i indicates individuals or firms, j the NUTS-2 region and t years. Y_{ijt} is the outcome of interest, R_{jt} is the ratio of refugees to the population, X_{ijt} are individual level controls and P_j andT_t are region and year fixed effects respectively.

$$Y_{ijt} = a + \rho R_{jt} + X_{ijt} + P_j + T_t + e_{ijt} \tag{1}$$

The issue with the OLS specification is that it does not take into account endogeneity driven by refugees' self selection into the destinations. The selection problem is well documented in the immigration literature (Dustmann et al., 2008). If refugees are more (less) likely to prefer regions where the production technology is getting more sophisticated and tasks are becoming more (less) complex, the estimated effect of refugees on task complexity will be upward (downward) biased. A similar bias is expected for firms' capital use. We therefore follow the previous studies on the Syrian refugees in Turkey and use a distance based instrument to estimate the effects using 2SLS (Del Carpio and Wagner, 2015; Akgunduz et al., forthcoming).

There are six main border crossings between Turkey and Syria. Google Maps was used to calculate the distances between each region's largest city and border crossing as well as the distance between each Syrian governerate's capital and border crossing. The instrument is defined by equation 2, where D_{sj} is the shortest travel distance between a given Syrian governerate and Turkish region in kilometres, π_s is the fraction of the Syrian population living in a governerate s prior to the civil war in 2010 and r_t is the total number of refugees in Turkey in 2014 and 2015, which are the years that we use as the treatment years. For each NUTS-2 region, we use the province with the highest population as the destination when we calculate distances. Since the resulting instrument takes all border crossings into account when calculating distances between a given Turkish and Syrian region, it does not perfectly correlate with the distance to the closest border crossing from a Turkish region. We can thus include a year-specific control for the (log of) distance to the shortest border crossing in order to control for other spillover effects that the Syrian Civil War may have on a region.

$$IV_{jt} = \sum_s \frac{1}{D_{sj}} \pi_s r_t \tag{2}$$

We exploit the rapidness of the Syrian refugees' arrival by including control

years when there were no Syrian refugees. Our treatment years are 2014 and 2015 and the years 2010 and 2011 are controls years. Years 2012 and 2013 are not included in the analysis due to several reasons. First, refugees were largely in camps in 2012 and 2013, which may limit their effects. Second, they were very concentrated around the Syrian border and a difference-in-differences set-up as used in Akgunduz et al. (forthcoming) and Ceritoglu et al. (2017) will necessarily include the effects of camps, aid and spillovers from the Syrian Civil War in the estimated parameters. In addition, we are interested in outcomes that are related to the production mix that require structural transformations that may take some time to see the effects of.

The 2SLS specifications we estimate are given by equations 3 and 4. The instrument is always significant at the 1% level in the first stage. The estimations differ slightly for capital and task based outcomes. For task outcomes we include several personal characteristics to control for basic compositional shifts: age, gender and high school graduation. For capital outcomes, where the firm is the unit of observation, we do not include any controls in the main specification since most other firm outcomes will be affected by the presence of refugees. Instead we test the robustness of the results by including firm fixed effects and thus estimating the effect on firms that existed both before and after the arrival of the refugees. The treatment of the standard errors is uniform across specifications. Since the primary sample consists of four years of data, we cluster the standard errors at the region level to deal with serial correlation (Bertrand et al., 2004). While clustering at the region level results in a suboptimal number of 26 clusters, the resulting standard errors appear larger and thus more cautious than clustering at the region-year level (Cameron and Miller, 2015).

$$R_{jt} = a + \gamma IV_{jt} + P_j + T_t + e_{jt} \tag{3}$$

$$Y_{ijt} = a + \rho \hat{R}_{jt} + P_j + T_t + \beta Distance_{jt} + e_{ijt} \tag{4}$$

4 Data

We use two primary data sources for the analysis: the Turkish Household Labor Force Survey (LFS) and the Enterprise Information System (EIS). We use the former to analyze the effects on tasks and the latter to analyze the effects on capital use of firms. We supplement these two datasets with data on the number of refugees in each of the 26 NUTS-2 regions of Turkey obtained from the Ministry of the Interior for 2014 and 2015 and the Survey of Adult Skills (PIAAC) dataset that we use to construct task scores for each occupation in the LFS.[4]

The LFS is an annual survey of Turkey conducted by the Turkish Statistical Institute. Each wave is comprised of around 400,000 persons. Since our primary interest is on tasks, we are only interested in individuals with a job. We limit the sample to employees in the age range of 15 to 64 who are paid employees. The self-employed are excluded from the analysis. Each wave includes around 100,000 observations once we limit the sample to employed persons between the ages of 15 and 64.

The Turkish LFS provides occupational information at the 2 digit level of the ISCO classification. Up until 2012, ISCO88 classification was used and the ISCO08 was reported in subsequent waves. There are 27 occupations in 2010-2011 waves and 40 in 2014-2015 waves. Since LFS does not include information on tasks, we use the PIAAC 2015 wave for Turkey to calculate the task scores of all occupations and match occupation level task scores to the LFS data. PIAAC occupations are classified using ISCO08 and cannot be matched directly with 2010-2011 LFS waves. We use the 2012 wave of LFS that contains both ISCO88 and ISCO08 classifications to calculate for each ISCO88 occupation shares of ISCO08 that comprises it. We

[4]The most recent data are avalable on the website of the ministry: http://www.goc.gov.tr/main/

then take the weighted average using these shares as weights to determine the task scores of each occupation in 2010 and 2011 waves.

In calculating the task scores of the occupations, we follow the approach of De La Rica and Gortazar (2017) who group questions in PIAAC as abstract, routine and manual with subcategories for abstract and routine tasks.[5] They further define an ICT index, which we also construct. Each item and category is presented in Table 1. Items are filled in by the respondents on a scale of 1 to 5. For categories with multiple questions, we reduce the dimensions of each category to one score by using the first factor obtained from a factor analysis. For the routine task index that has multiple categories, we construct the task index by again taking the first factor from a factor analysis where each category is treated as one dimension. All resulting task indices are rescaled to be between 0 and 1.

Table 1: Constructing task indices using PIAAC

Task	**Category**	**PIAAC Questionnaire Item**
Abstract	Cognitive and interpersonal	Read diagrams maps or schematics Write reports Persuading/influencing people Negotiating with people
Routine	Flexibility at job	Change sequence of tasks Change how to do work Change speed of work Change working hours
	Lack of adaptation	Learn work related things from co-workers Learning by doing tasks performed
	Manual	Hand/Finger skill accuracy
Manual	Manual (non-routine)	Physical work
	ICT (Computer use and skills)	Use internet for understanding issues related work Conduct transactions on the internet Use spreadsheet software Use a programming language Level of computer use

Based on De La Rica and Gortazar (2016).

Following the previous literature on task-based models (De La Rica and Gortazar, 2017; Ottaviano et al., 2013; Autor et al., 2003), we construct task scores for routine, manual and abstract tasks as a ratio of a given task index divided

[5] Previous literature that analyzes occupations and tasks in the U.S. generally uses the DOT and O*NET databases (Autor et al., 2003; Peri and Sparber, 2009) .

by the other two tasks' indices. For abstract tasks, the task score is defined as $log(abstract_score = abstract_index/(manual_index + routine_index))$. For manual and routine tasks scores, we switch the relevant task index to the numerator and the abstract score to the denominator. ICT tasks are different since they are unlikely to be substitutes with abstract tasks. Therefore, the ICT task score is defined as the ratio of the ICT index to the sum of the manual and routine task indices. The resulting task score averages for 2014 and 2015 by 9 category occupations are presented in Table 2.

Table 2: Task scores and occupations

	Manual	Routine	Abstract	ICT
Managers	-0.9852	-0.7063	-0.4190	-0.3393
Professionals	-0.8836	-0.6661	-0.5517	-0.3384
Technicians	-0.6014	-0.7077	-0.7867	-0.6666
Office workers	-1.0395	-0.4847	-0.6208	-0.2286
Retail workers	-0.0370	-0.9883	-1.2083	-1.4644
Skilled workers	1.2640	-4.7229	-1.3738	-1.6483
Artisans	0.1414	-1.0444	-1.3860	-1.7547
Machine operators	0.5302	-1.5633	-1.4564	-1.9138
Unskilled workers	0.7004	-1.6419	-1.6678	-2.1023

Table 3 presents the summary statistics for the LFS data for the control and treatment years. A clear trend for Turkey is that the proportion of college graduates in the labor force is rising at the expense of primary and high school graduates. Task scores for routine, abstract and ICT rise with education while manual scores fall. On average task scores have changed little over time, but there is a noticeable compositional shift. Abstract and ICT scores fall for the least educated and rise for the higher educated. There is also substantial variation in task complexity across regions. Figure 2 plots the average abstract scores in LFS by region in 2011. Southeastern regions that initially received refugees tend to have low abstract score jobs. However, larger western cities that refugees moved to by 2015 such as Izmir and Ankara tend to have high abstract score jobs.

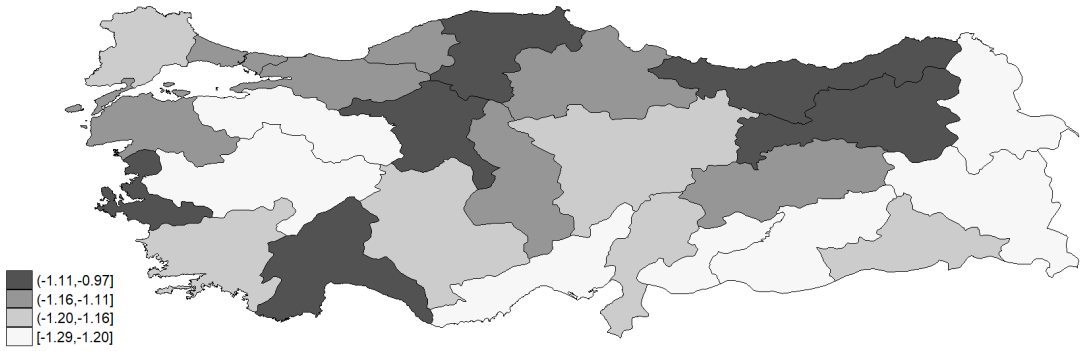
The Enterprise Information System (EIS) is an administrative dataset of firm

Table 3: LFS summary statistics

Control years: 2010-2011					
	All	Primary school	Middle school	High school	College
Age	34.0036	37.8576	28.106	32.336	34.7765
Female	0.2396	0.1924	0.1638	0.2318	0.3766
Manual score	-0.0893	0.3125	0.1439	-0.2301	-0.7125
Routine score	-1.0634	-1.3277	-1.1758	-0.949	-0.7089
Abstract score	-1.1401	-1.4052	-1.3092	-1.0612	-0.7022
ICT score	-1.2817	-1.7179	-1.5742	-1.145	-0.5572
N	190,652	64,210	34,578	46,421	45,443
Treatment years: 2014-2015					
	All	Primary education	Middle school	High school	College
Age	34.7909	40.5007	28.4512	33.2047	34.5685
Female	0.2745	0.2547	0.1814	0.2458	0.3891
Manual score	-0.0979	0.355	0.2072	-0.1853	-0.7429
Routine score	-1.0844	-1.3745	-1.2428	-1.0094	-0.7146
Abstract score	-1.1362	-1.4558	-1.3574	-1.0733	-0.6778
ICT score	-1.2972	-1.8281	-1.6631	-1.1918	-0.5373
N	206,162	62,904	40,313	47,713	55,232

All observations are weighted using the LFS weights. Task scores are all rescaled to be between 0 and 1.

Figure 2: Average abstract scores across regions in 2011



balance sheets managed by the Ministry of Industry, Science and Technology.[6] Although the data includes all firms in Turkey, small firms with no balance sheet information are excluded from this analysis. The size threshold for small firms is adjusted annually but the threshold was total sales worth 200,000 TL in 2011. We are primarily interested in the fixed assets section of the balance sheets. This includes information on total fixed assets as well as its components. We base our analysis on both the total fixed assets of a firm and the machinery and equipment component which can serve as a proxy for physical capital use in production. We log-transform these variables for a smoother distribution after adding 1 to all values to avoid dropping the 0s. All variables are deflated using annual CPI. The resulting summary statistics can be found in Table 4. Figure 3 shows the regional distribution of fixed capital per capita in Turkey. As expected before the arrival of Syrian refugees, fixed capital of the firms divided by the population of the region is high in western part of the country.

Similar to other administrative datasets of firm populations, there are some clear discrepancies in the data. We tried to refrain from excessively dropping observations but did apply several criteria for a firm to be included in the analysis. First, we dropped all firms that reported negative gross sales or fixed assets in a given year. Second, we excluded any observations above the 99th percentile in the fixed assets distribution. Some observations show extremely large fixed assets which are either errors in the balance sheet or firms that are too large to be representative. A final issue has to do with the locations of the firms. The data provides information on where the firms is registered and where it has plants and offices. Since our treatment is at the regional level, there may be a concern for measurement error if firms that do not operate in a region appear in that region in the data. We test the results by excluding firms in Istanbul from the data since a disproportionate number of firms appear to be registered there.[7]

[6] EIS is a confidential dataset that is available for researchers at the Ministry.

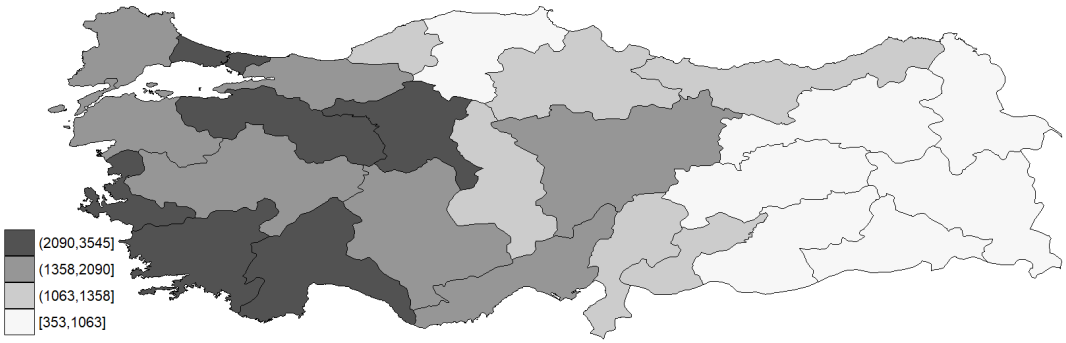
[7] We additionally performed a test by dropping firms that have more than 50% of their plants and offices in a different

Table 4: EIS summary statistics

	2010-2011	2014-2015
	All	All
Fixed assets	10.3336	10.4484
Machinery and equipment	3.6985	3.0028
Land	0.738	0.859
Buildings	1.5056	1.706
Land improvements	0.2652	0.2037
Fixtures	8.3458	8.2576
N	1,361,247	1,711,128

Fixed assets, machinery, real estate, buildings and fixtures are in natural logarithms.

Figure 3: Fixed capital per capita at the region level in 2011



5 Results

5.1 Impact on skills and computer use

We examine the effects of refugee inflows on natives' tasks in Table 5. The first panel presents estimates using OLS and the second one presents the IV estimates. The first four columns show the effects on task scores and the rightmost column the effect on employment. While overall employment is not significantly affected by refugee inflows, tasks are. The manual intensity of jobs falls while the intensity of other three tasks rises. The IV results suggest that natives in areas hosting refugees move from manual tasks towards more complex tasks. Based on the 2011 values, a one percentage increase in refugee to population ratio decreases manual task scores and raises abstract scores by around 0.75% of the difference between primary school and high school graduates' average scores. ICT scores rise by nearly 1% of the same difference. We find a larger effect for routine tasks in the IV estimation, but the effect is less precisely estimated. The estimated effect on overall employment is negative in line with the findings in Ceritoglu et al. (2017) and Del Carpio and Wagner (2015), yet lacks statistical significance.

Table 5: Effect of the refugee inflows on tasks

OLS	Abstract Score	Routine Score	Manual Score	ICT Score	Employment
Refugees/pop.	0.2380**	0.2558	-0.2862*	0.5709***	-0.1288
	(0.1123)	(0.1991)	(0.1450)	(0.1667)	(0.0781)
N	396,814	396,814	396,814	396,814	1,360,401
IV					
Refugees/pop.	0.2624**	0.7811*	-0.5210**	0.4398***	-0.1084
	(0.1020)	(0.4266)	(0.2527)	(0.1463)	(0.1608)
N	396,814	396,814	396,814	396,814	1,360,401

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include controls for personal characteristics, region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

The robustness of the results can be tested by limiting the treatment and control years. In Table 6, the first two panels show the results when we use 2011 as the

region from its headquarters region in robustness tests.

control year and 2014-2015 as treatment years in separate regressions. Overall, the direction of the effects remains similar but the effect on average abstract scores is no longer significant. However, the coefficients are three times as large which may be because the difference between the effect was already realized in 2014 and the increase in the number of refugees in 2015 had a limited effect after 2014. The final panel in Table 6 shows the results of a placebo test where the distribution of refugees in 2015 is assumed to have occurred in 2011.[8] We find no significant effects other than in the ICT task score, which seems to confirm that the IV strategy limits the pre-treatment trends.

Table 6: Estimations using alternative samples

	Abstract	Manual	Routine	ICT
2011-2014				
Refugees/pop.	0.6503	3.5218**	-1.8607*	1.2410*
	(0.5508)	(1.5307)	(1.0977)	(0.7516)
N	201,082	201,082	201,082	201,082
2011-2015				
Refugees/pop.	0.4607	1.2196**	-0.7511**	0.7547*
	(0.3960)	(0.4786)	(0.3273)	(0.4352)
N	202,414	202,414	202,414	202,414
2010-2011				
Refugees/pop.	0.3084	0.4297	-0.5841	0.3614*
	(0.2276)	(0.3786)	(0.3556)	(0.1950)
N	190,652	190,652	190,652	190,652

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include controls for personal characteristics, region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

The interaction between skills and tasks is a crucial part of the task based approach. The standard assumption is that highly skilled workers would be better at performing more complex tasks. Table 7 answers the question of how different skill levels change their tasks in response to refugee inflows. The groups making up the two tails of the skill distribution, those with primary and below education and college education do not appear to be affected. Middle school graduates have increased routine tasks in place of manual tasks. High school graduates are the most affected group with manual tasks declining and all other tasks rising signif-

[8] Using the 2014 distribution results in smaller and less significant coefficient estimates.

icantly. If we assume that routine tasks are less complex than abstract and more complex than manual tasks, we can conclude that middle school graduates replace their manual tasks with routine while high school graduates move higher up to abstract tasks. This result would fit the idea that more complex jobs are better performed by higher skilled workers. On the other hand, least educated persons do not seem to adjust at all which may be because they do not have the appropriate skills to carry out more complex tasks. Conversely, college graduates are already employed in high complexity jobs and are not affected by the task upgrading seen in less educated groups. Compared to the other major labor market phenomenon studied within the task based approach, namely computerization, our findings suggest substitution away from manual tasks rather than routine tasks which is only apparent in the middle of the education distribution. Autor et al. (2003) examine how computerization alters skill content of the jobs. They find that computerization associated with reduced labor input of routine manual and routine cognitive tasks and increased labor input of non-routine cognitive tasks. Unlike the findings in our paper, they find that the substitution was pervasive at all educational levels.

Finally, we split employees into age groups and estimate the effect of the refugee inflow separately. The first panel shows the effects on employees aged 15-34, the second panel 35-54, and the third panel 55-64. The reallocation of employees to more complex tasks seem to be happening among employees aged 15-34. Taken together with Table 7 the effect is concentrated among young employees with medium level education.

5.2 Impact on firm fixed assets

Table 9 shows the estimated effect of the refugees on fixed assets and its machinery and equipment subcategory. The results are presented in three panels. The first panel presents the OLS estimates. The second shows the IV while the third

Table 7: Effects on different skill levels

	Abstract	Routine	Manual	ICT	Employment
Primary and below					
Refugees/pop.	-0.0466	0.7409	-0.0456	-0.0454	-0.1411
	(0.1650)	(0.8343)	(0.3553)	(0.2192)	(0.1056)
N	127,114	127,114	127,114	127,114	666,427
Middle school					
Refugees/pop.	0.1192	1.0642***	-0.5619*	0.3561	-0.3014
	(0.3057)	(0.3039)	(0.3134)	(0.3332)	(0.2302)
N	74,891	74,891	74,891	74,891	289,076
High school					
Refugees/pop.	0.7147***	0.5525*	-0.9392***	1.1343***	0.005
	(0.2276)	(0.2959)	(0.3622)	(0.3836)	(0.2718)
N	94,134	94,134	94,134	94,134	246,561
College					
Refugees/pop.	-0.5709	-0.0281	0.5023	-0.7439	0.3395
	(0.3552)	(0.1563)	(0.3935)	(0.5005)	(0.3150)
N	100,675	100,675	100,675	100,675	158,337

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include controls for personal characteristics, region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

Table 8: Effects on different age groups

	Abstract	Routine	Manual	ICT	Employment
Aged 15-34					
Refugees/pop.	0.5580***	1.0573**	-0.9010**	0.8400***	-0.2000
	(0.2052)	(0.4363)	(0.3522)	(0.2926)	(0.2078)
N	198,139	198,139	198,139	198,139	618,371
Aged 35-54					
Refugees/pop.	-0.2174	0.3977	0.0589	-0.2114	0.0577
	(0.1637)	(0.4060)	(0.1740)	(0.1948)	(0.1459)
N	182,349	182,349	182,349	182,349	551,210
Aged 55-64					
Refugees/pop.	0.4153	0.8495	-0.4589	0.5122	-0.2012
	(0.5524)	(1.9212)	(1.2763)	(0.8026)	(0.1530)
N	115,686	115,686	115,686	115,686	190,820

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include controls for personal characteristics, region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

the IV estimates when excluding observations from Istanbul. Given the bunching of firm headquarters in Istanbul, excluding observations there reduces the number of observations by a third. In all panels, the first two columns show the base estimates while the latter two columns include firm fixed effects. The two can be interpreted differently, while the base estimates are the average treatment effects for all firms the fixed effect estimates apply only to two thirds of the full sample which existed before and after the arrival of Syrian refugees. The base estimates are statistically significant and negative in all estimations for both fixed assets and machinery. The IV estimate suggests that fixed assets declines by 0.9% and machinery by 2% for every percentage point increase in the refugee to population ratio. The results change little when firms with headquarters in Istanbul are excluded. Once firm fixed effects are included the coefficients become statistically insignificant for overall fixed assets. However, we still find a negative effect of 1% for the machinery and equipment category. While the average firms' fixed assets decline, for firms that exist in both periods, the effects are therefore smaller and largely concentrated on machinery.

Table 9: Impact on fixed assets and machinery use

	Base		Fixed effect	
	Fixed assets	Machinery and equipment	Fixed assets	Machinery and equipment
OLS				
Refugee/pop.	-0.6462*	-2.7271***	-0.9015	-0.9675
	(0.3746)	(0.4833)	(0.8302)	(0.5969)
N	3,041,651	3,041,651	2,840,713	2,840,713
IV				
Refugee/pop.	-0.9130***	-2.0375***	-0.2251	-0.9629*
	(0.3394)	(0.3845)	(0.4555)	(0.5227)
N	3,041,651	3,041,651	2,840,713	2,840,713
IV - excluding Istanbul				
Refugee/pop.	-0.9691***	-2.1081***	-0.2438	-1.0099*
	(0.3315)	(0.4540)	(0.3784)	(0.5215)
N	2,103,191	2,103,191	1,960,057	1,960,057

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

We use the same approach as in the task results to test the robustness by limit-

ing the treatment years to 2014 and 2015 separately. The first two panels of Table 10 shows the results of base and fixed effects IV estimates. Once again the results remain qualitatively consistent but the effects become larger in size. The explanation for the difference in results is likely to be similar to the case for tasks. The effect of the change in the number of refugees between 2014 and 2015 should be more limited than the effect of refugees' initial entry in 2014. Firms are likely to be able to predict that the number of refugees will rise in 2015 and adjust their production mix accordingly. The final panel of 10 shows the results of placebo tests where the distribution of refugees in 2015 is assumed to have occurred in 2011. A statistically significant effect is found for the machinery and equipment category when fixed effects are included. This may suggest a violation of the common trend assumption. However, this result seems to be driven by the potential measurement error in firm locations. Once firms in Istanbul are excluded, the estimate turns statistically insignificant. Alternatively, the result may be implying that the larger than average firms in Istanbul have a differing trend from the rest of the country in machinery and equipment use.

Table 10: Impact on fixed assets and machinery use

	IV		IV-FE	
	Fixed assets	Machinery and equipment	Fixed assets	Machinery and equipment
2011-2014				
Refugees/pop.	-1.9736***	-4.5916***	-2.9993*	-4.0342**
	(0.6562)	(0.6990)	(1.5602)	(1.9182)
N	1,520,314	1,520,314	1,083,188	1,083,188
2011-2015				
Refugees/pop.	-1.4655***	-4.4937***	-2.2920*	-3.0799**
	(0.4459)	(0.6443)	(1.2839)	(1.4936)
N	1,576,150	1,576,150	1,014,342	1,014,342
2010-2011				
Refugees/pop.	-0.3741	-0.5469	-0.5992	-1.4322**
	(0.2501)	(0.4418)	(0.4558)	(0.6790)
N	1,348,495	1,348,495	1,215,838	1,215,838

*** p<0.01, ** p <0.05, * p<0.1

Note:All models include region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

Since Syrians tend to work in manual intensive jobs in the informal sector, we

expect firms in manual-intensive industries and firms in industries with high informal employment shares to be affected more by the refugee inflow. In Table 11, we split the industries into categories according to their manual intensity, and shares of informal employment using LFS at the 2-digit sector level. Industries with average manual-intensity score above the cross-industry mean are categorized as high manual intensity, and under the mean as low manual intensity industries. Similarly, we define high and low informality industries according to the mean level of informal empoyment share across industries. We find that the capital decrease is greater in the industries with high manual intensity and high informality with the exception of base IV estimates of high and low informality industries.[9]

Table 11: Effects on highly manual intensive and informal sectors

	Base IV		Fixed effect IV	
	Fixed assets	Machinery and equipment	Fixed assets	Machinery and equipment
High manual intensity				
Refugee/pop.	-1.0445**	-2.0893***	-0.2935	-0.7498**
	(0.4587)	(0.7920)	(0.5155)	(0.3467)
N	1,494,788	1,494,788	1,368,174	1,494,788
Low manual intensity				
Refugee/pop.	-0.5977**	-1.8736***	0.0299	-0.6428
	(0.2715)	(0.5302)	(0.3808)	(0.5929)
N	1,546,863	1,546,863	1,429,284	1,429,284
High informality				
Refugee/pop.	-0.9784**	-1.5914***	-0.1293	-0.7663**
	(0.4395)	(0.4875)	(0.3941)	(0.3567)
N	1,948,789	1,948,789	1,793,398	1,793,398
Low informality				
Refugee/pop.	-0.7165***	-2.8143***	0.0398	-0.4156
	(0.2764)	(0.6212)	(0.6673)	(0.8180)
N	1,092,862	1,092,862	1,001,390	1,001,390

*** p<0.01, ** p <0.05, * p<0.1

Note:All models include region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

While our primary interest is on machinery and equipment, we can also test the

[9]The highest three NACE 2 industries in manual-intensity score are crop and animal production, hunting and related activities; fishing and aquaculture; construction of buildings. The three industries with the highest share of informality are crop and animal production, hunting and related activities; other personal activities; activities of households as employers of domestic personnel.

presence of any effects on other subcategories of fixed assets. Table 13 shows the IV estimation results for these subcategories. The base results suggest negative and statistically significant effects on the average firms' land improvement and building subcategories. When we include firm fixed effects in the regressions, the results become statistically insignificant for all outcomes. The overall suggestion seems to be that for firms existing in both treatment and control periods, the effects are limited to machinery and equipment while for the average firms all fixed asset categories decline.

Table 12: Impact on other fixed asset components

	Land	Buildings	Land improvements	Fixtures
IV				
Refugee/pop.	0.1495	-0.7462***	-0.0992**	-0.8679
	(0.3193)	(0.2855)	(0.0480)	(0.8293)
N	3,041,651	3,041,651	3,041,651	3,041,651
IV-FE				
Refugee/pop.	0.5103	0.2969	0.0166	-0.7671
	(0.3366)	(0.9394)	(0.0925)	(0.6569)
N	2,840,713	2,840,713	2,840,713	2,840,713

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

The results so far suggest that the average firm's fixed assets declined significantly, but that the effect is more limited to machinery and equipment for existing firms. The difference seen in results when firm fixed effects are included makes it more difficult to conclude whether overall capital use declined. If numerous smaller firms entered the market, overall capital use may have remained constant even though the average declined. To test whether this is the case, we analyse the fixed asset outcomes by aggregating them at the region level in Table 13. We constructed two types of variables. The first is the natural logarithm of total fixed assets and machinery reported by all firms in the region. The second is the natural logarithm of the same variables' per capita value, which allows us to keep the native population constant. In addition, we estimate the effect on the number of firms per capita in the region in the last column. The results confirm unambigu-

ously that total fixed assets and machinery declined in regions hosting refugees. This is despite the finding that the number of firms per capita increased, which is also in line with declining labor costs and rising demand (Hopenhayn, 1992). The estimates of the effect on machinery and equipment is particularly large, reaching 5% per one percentage point increase in the ratio of refugees to population.

Table 13: Impact on fixed assets at the region level

	Number of Firms per capital	Fixed assets per capita	Machinery and equipment per capita
Refugee/pop.	0.0123***	-2.2895***	-5.0529***
	(0.0034)	(0.5487)	(1.2965)
N	104	104	104

*** p<0.01, ** p <0.05, * p<0.1

Note: All models include region and year fixed effects and a year-specific control for distance to the closest border crossing with Syria. Standard errors are clustered at the region level in all regressions.

6 Conclusion

In this paper we examine how the rapid increase in the low-skilled labor supply induced by the Syrian refugee inflow affected the tasks performed by native workers and the amount of capital used by firms in Turkey. We find that the adjustment to the large scale refugee shock is rapid, varied for different skill and age groups and affects both labor tasks and capital inputs. The results show that medium educated natives moved to more complex tasks and firms reduced their capital use in the refugee-hosting regions implying a substitutability between refugee labor supply and manual tasks and capital; and complementarity between refugee labor supply and abstract, routine and ICT tasks. The estimated effects are robust to a number of specifications.

The education level of the natives determines the extent to which their tasks are affected by the arrival of refugees. Middle school graduates, who may be viewed as the middle-skilled group in the Turkish context, move to routine-intensive jobs while more educated high school graduates move to abstract-intensive jobs, both leaving the manual-intensive ones. The primary school graduates show no signifi-

cant change in the tasks they are employed for. The inability to adjust may explain why their employment and wage outcomes are the most negatively affected.

A more worrying trend is found in the firms' capital use. The average firm in refugee-hosting regions reports less fixed assets largely due to a strong decline in the machinery and equipment category. Together with the results of the Mitaritonna et al. (2017) and Lewis (2011a), we may conclude that low-skill immigration reduces and high-skill immigration raises firms' capital use. The reduction in capital would be particularly worrying if it damages long-term investments and productivity. Since Syrian refugees are presently employed informally, they are a source of low-cost labor compared to natives. Firms that rely on low-cost labor may outperform other firms in the short run, leading to an undesirable long term change in the composition of firms (Foster et al., 2008). Firms may end up reliant on informal refugee labor and may be left with a suboptimal mix of capital and labor inputs if the refugees return to Syria after the settlement of the crisis. For the same reason, it may also be challenging to integrate them into the formal labor market in the long run.

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