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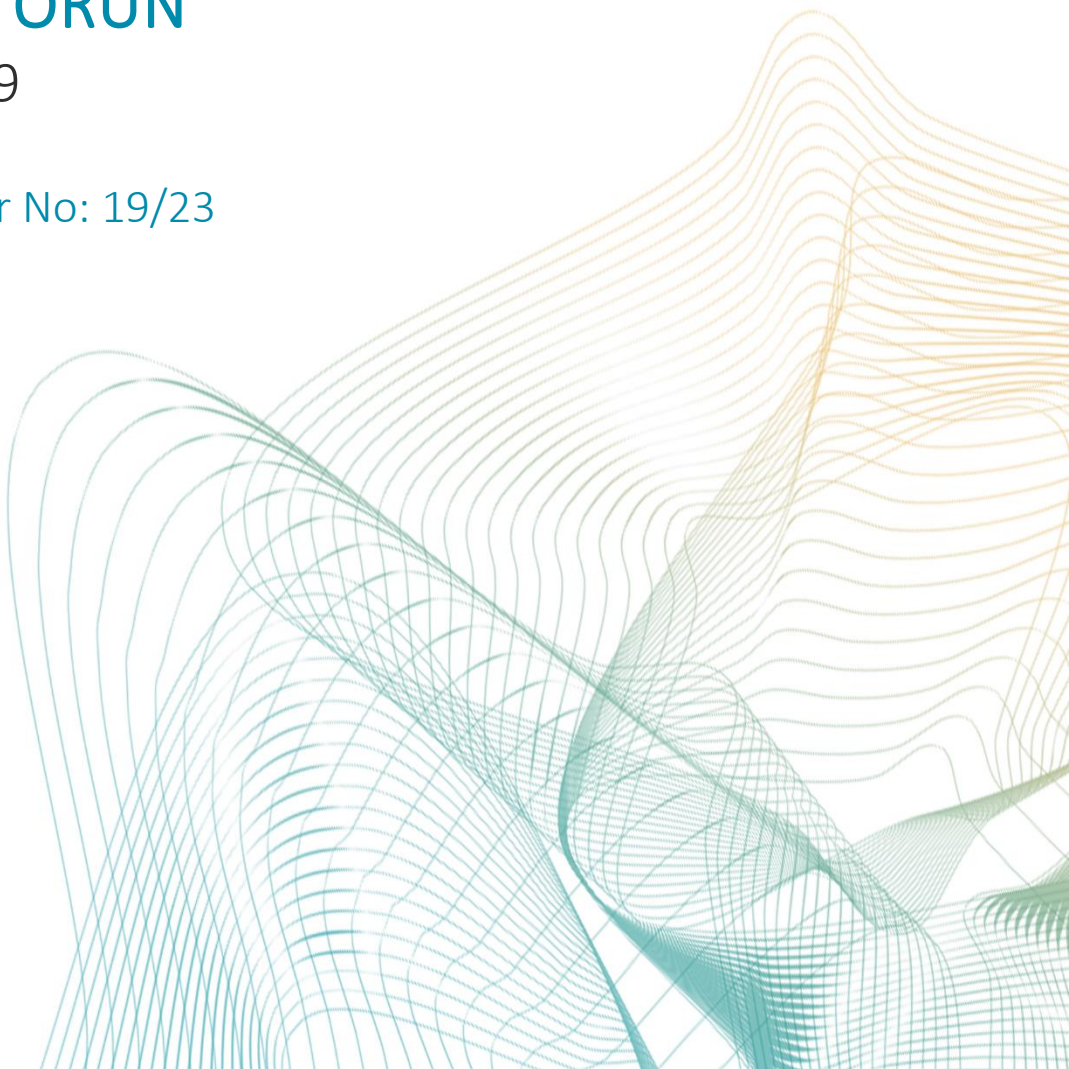

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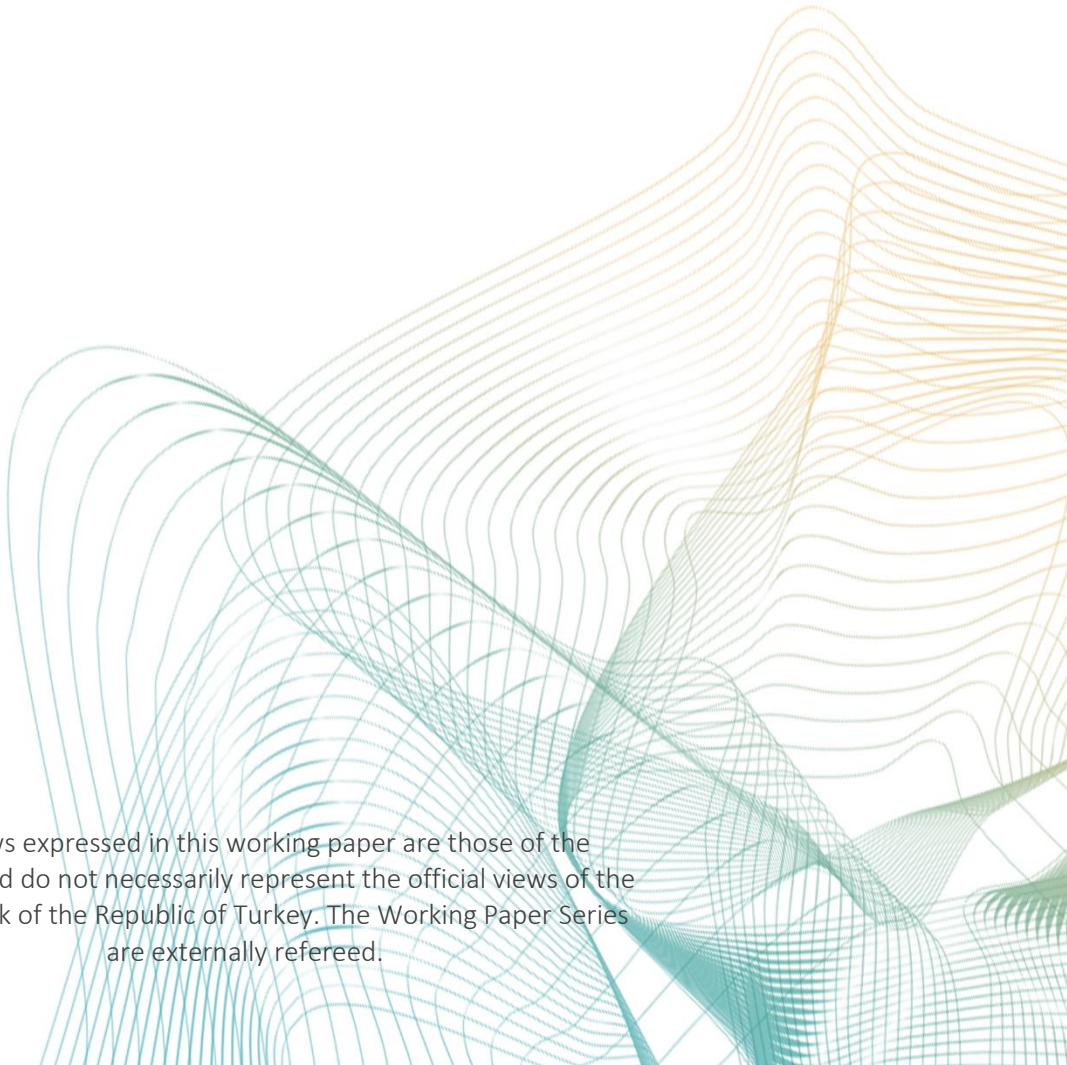

Two and a half million Syrian refugees, tasks and capital intensity

Yusuf Emre Akgündüz, Huzeyfe Torun

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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 capital intensity of firms in Turkey. We use both survey and administrative data to estimate the effects. The results based on the 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 tasks. This effect is driven by highly educated and young natives. Exploiting the administrative firm data that contains the entirety of firms in the country, we find that manufacturing firms reduced their capital intensity and investments. Reduction in capital intensity and investment is largely driven by smaller sized firms. We conclude that tasks provided by Syrian refugees are substitutes for manual tasks and capital inputs in production, and complements to more complex tasks.

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

JEL Codes: F22; J24; J21; D24.

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NON-TECHNICAL SUMMARY

Given the mixed findings with regard to the impact of immigration on employment, alternative economic adjustment processes in response to immigration have recently been investigated. Rather than the traditional production framework where output is produced by labor and capital, the task based approach explicitly models output as a function of abstract, routine, manual and capital inputs. 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 capital intensity of firms in Turkey.

The case of Syrian refugees in Turkey is ideal to empirically answer the question of input adjustments in response to immigration since the Syrian refugee inflow is large, unexpected and concentrated in regions close to the border. We identify the causal effects of Syrian refugees by using the distance between the hosting cities in Turkey and Syrian provinces in an instrumental variables approach. We utilize a variety of administrative and large scale survey datasets in the analysis. To test the effects on tasks, we calculate alternative task scores using O*NET and PIAAC for each occupation and match the scores with the Turkish Labor Force Survey (LFS). LFS is the largest available employment survey and provides a detailed picture of the effect on the average task scores of Turkish employees. To analyze the effects on capital intensity of production, we use an administrative dataset of all firms that report balance sheets for tax purposes in Turkey. This allows us to observe the change in investments and capital intensity of firms in refugee-hosting regions. The empirical analysis is comprised of two sections, one on tasks and the other on capital use but the identification strategies across the analyses remain similar.

We find that the refugee inflow pushed native employees from manual-intensive jobs towards more complex jobs that involve abstract tasks. There are heterogeneous effects by age and education. Young and highly educated natives move towards higher complexity jobs. With regards to capital input outcomes, we find a decline in both capital intensity and investment rates. This fall is particularly concentrated on small manufacturing firms. Overall, our findings suggest that labor provided by Syrian refugees is a complement for abstract tasks performed by natives and a substitute for capital use in production.

1. Introduction

The traditional approach to studying the economic effects of immigration has been to analyze its effects on wages and employment.[1] Given the mixed findings with regard to the impact of immigration on employment, alternative economic adjustment processes in response to immigration have recently been investigated. A task-based approach is useful in disciplining the study of adjustments in the inputs and sheds light on mechanisms that the canonical models of the labor market cannot (Acemoglu and Autor, 2011). Rather than the traditional production framework where output is produced by labor and capital, the task based approach explicitly models output as a function of abstract, routine, manual and capital inputs. The task framework is useful in underlining the causal channel by which immigration affects economic activity through the adjustments in inputs.

How is the input mix of natives' tasks and capital inputs affected in response to immigration? This is an empirically challenging question to answer since immigration usually happens gradually and its effects are difficult to identify causally. 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 capital intensity of firms in Turkey.[2] The case of Syrian refugees in Turkey is ideal to empirically answer the question of input adjustments in response to immigration since the Syrian refugee inflow is large, unexpected and concentrated in regions close to the border. We identify the causal effects of Syrian refugees by using the distance between the hosting cities in Turkey and Syrian provinces in an instrumental variables approach. Our empirical research builds on the stylized fact that most Syrian refugees have few skills that are valued in the Turkish labor market and that the low-skill labor they provide will be complements with some inputs and substitutes for others.

We utilize a variety of administrative and large scale survey datasets in the analysis. To test the effects on tasks, we calculate alternative task scores using O*NET and PIAAC for each occupation and match the scores with the Turkish Labor Force Survey (LFS). LFS is the largest available employment survey and provides a detailed picture of the effect on the average task scores of Turkish

[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 (Borjas, 2003; Glitz, 2012).

[2] The striking speed of the refugee inflow has led to a growing literature on the impact of Syrian refugees on various outcomes including employment and wages (Aksu et al., 2018; Ceritoglu et al., 2017; Del Carpio and Wagner, 2015), firm entry (Akgündüz et al., 2018), prices (Balkan and Tumen, 2016), and school choice (Tumen, 2019).

employees. To analyse the effects on capital intensity of production, we use an administrative dataset of all firms that report balance sheets for tax purposes in Turkey. This allows us to observe the change in investments and capital intensity of firms in refugee-hosting regions. The empirical analysis is comprised of two sections, one on tasks and the other on capital use but the identification strategies across the analyses remain similar.

We find that the refugee inflow pushed native employees from manual-intensive jobs towards more complex jobs that involve abstract tasks. There are heterogeneous effects by age and education. Young and highly educated natives move towards higher complexity jobs. With regards to capital input outcomes, we find a decline in both capital intensity and investment rates. This fall is particularly concentrated on small manufacturing firms. Overall, our findings suggest that labor provided by Syrian refugees is a complement for abstract tasks performed by natives and a substitute for capital use in production.

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 change in the input mix of tasks and capital. Analyzing the effect on employment rates alone overlooks the adjustments in the task mix of native employees. While previous studies including the present paper suggest that natives move to more complex tasks, this shift is not necessarily positive for natives if capital is simultaneously negatively affected. Our findings suggest rapid adjustment on both labor and capital margins. This swift adjustment in inputs can help explain the limited effect of Syrian refugees on wage and employment of native population found in previous studies (Ceritoglu et al., 2017; Del Carpio and Wagner, 2015).

There is a growing literature on the impact of immigration on the input and production mix in an economy (Peri and Sparber, 2009; Amuedo-Dorantes and De La Rica, 2011; 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 province level. 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. 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.

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 4 million Syrians had sought refuge in the neighbouring countries, primarily Turkey, Lebanon, Jordan, Iraq and Egypt by 2017. 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 the ensuing refugee crisis, Turkey had an open-door policy and accepted all Syrians seeking refuge.[3] 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,

[3] 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 broader sense to include heterogenous forms of protection across countries. We adopt this definition of the term in line with the literature.

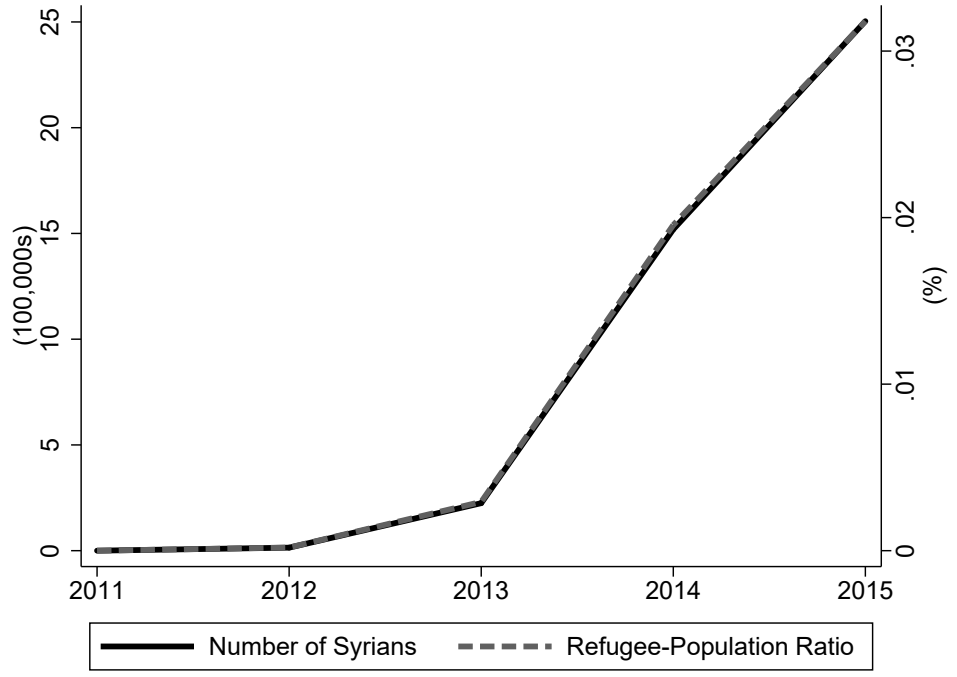
in 2016 Turkish government passed a law that gives opportunity for Syrians to apply for working permits. The switch to formal work permits took place after the sample period of this paper, yet even then the number of Syrians with official working permits stayed very low. Informal work is fairly common 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.

Among the countries that received immigration, the case of Turkey stands out due to the size and suddenness of the refugee inflow. Figure 1 shows the number of Syrian refugees and the ratio of Syrian refugees to the population of Turkey at the end of each year between 2011 and 2015. The number of Syrian refugees in Turkey reached 2.5 million as of December 2015, which corresponds to around 3% of the population. The size of the refugee shock makes structural transformation in production likely and its effects measurable. 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.[4]

As discussed by 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

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

FIGURE 1: SYRIAN REFUGEES IN TURKEY



Notes: Authors' calculations using data from the Ministry of the Interior and Turkish Statistics. The population figures used to compute the ratio of Syrian refugees to the population do no include the Syrians.

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 primary objective.

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

Figure 2 presents the distribution of refugees by hosting provinces in 2015. Refugee-population ratio is particularly high in the south-eastern region of Turkey, in particular the provinces of Kilis, Hatay, Gaziantep, Sanliurfa and Mardin. The ratio of refugees to the native population reaches 94% in Kilis. 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 (AFAD, 2013). Even those with college degrees from Syria face very strong language and culture barriers in Turkey.

FIGURE 2: DISTRIBUTION OF SYRIAN REFUGEES IN 2015

Notes: Authors' calculations using data from the Ministry of the Interior and Turkish Statistics. The population figures used to compute the ratio of Syrian refugees to the population do not include the Syrians. The numbers next to each color code in the legend indicate the ratio of refugees to the population and the number of NUTS-3 level provinces in a given category.

3. Methodology

To identify the effects of refugees on tasks and capital intensity, we exploit the rapidness of the Syrian refugees' arrival and the variation in their geographical distribution. Years 2012 and 2013 are not included in the analysis because the relatively low number of refugees were largely in camps in 2012 and 2013. Furthermore, refugees were largely concentrated around the Syrian border and a difference-in-differences set-up will necessarily include the effects of camps, aid and spillovers from the Syrian Civil War in the estimated parameters. Finally, 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. We therefore define 2014 and 2015 as treatment and 2010 and 2011 as controls years.

There are differences in our approach to estimating the impact on task and capital intensity outcomes due to the availability of data. In particular, firm balance sheets indicate regions at the NUTS-3 level while the LFS data provides information about the NUTS-2 region of a respondent. Furthermore, we can track firms over time, which allows us to exploit the panel nature of the balance sheet dataset. Nevertheless, the basic premise in estimating the effects on both task and capital intensity related outcomes is the same. The starting point would be to estimate the specification given by equation 1 using OLS. Subscript i indicates firms or individuals, j regions and t years.

Y_{ijt} is the outcome of interest, R_{jt} is the ratio of refugees to the population, and P_j andT_t are region and year fixed effects respectively. 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-year level to deal with serial correlation (Bertrand et al., 2004).

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

The OLS specification does not take into account endogeneity caused by refugees' self selection into the destinations. The selection problem is well documented in the immigration literature and may also apply to the present case (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 intensity. We therefore follow the previous studies on the Syrian refugees in Turkey and use a distance based instrument to estimate the effects using a distance based instrument and the 2SLS estimator (Del Carpio and Wagner, 2015).

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. When estimating effects at the NUTS-2 level, we use the province with the highest population as the destination when we calculate distances.

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

While the IV approach deals with the potential endogeneity of the refugee distribution in Turkey, the estimated 2SLS coefficient may still be biased if the time trends in outcomes between regions with more or less refugees are not parallel. The concentration of refugees in the less developed

south-eastern region of Turkey makes the parallel trends assumption implausible. The literature on the Syrian refugee crisis in Turkey has taken alternative approaches to dealing with region specific trends in outcomes. Aksu et al. (2018) argue that controlling for region specific trends is crucial and show that including region-specific time trends for 5 regions can significant change the results for employment outcomes.[5] In order to take into account regional trends and shocks, we take the most flexible approach and include year-specific region fixed effects for the 12 NUTS-1 regions in Turkey. All our estimates are then based on the variation within NUTS-1 regions, which limits the variation in the level of economic development between NUTS-2 and NUTS-3 regions and controls for regional shocks and trends. As robustness tests, we further show results where we include no year-specific region fixed effects and control for year-specific region fixed effects at the 5 region level.

A concern with the inclusion of region-year dummies or region specific time trends is that the variation within NUTS-1 regions may not be sufficient to have a precise first stage estimate when we instrument the ratio of refugees with the weighted distance instrument. However, the instrument remains statistically significant at the 1% level in the first stage of all presented regressions. As a more formal test of instrumental relevance, table 1 reports estimates from regressing region level refugee to population ratios on our weighted distance instrument while controlling for region and year fixed effects. The first two column regressions are at the NUTS-2, while columns 3 and 4 report the results of NUTS-3 level regressions. At the NUTS-2 level, the instrument is particularly strong with an F-test above 100. The F-tests are smaller, though still close to 10, at the NUTS-3 level. The instrument remains statistically significant after the inclusion of year-specific NUTS-1 fixed effects. In firm and individual level regressions, F-tests become larger compared to those presented in table 1.

The 2SLS specifications we use to estimate the effects on task outcomes are given by equations 3 and 4. The subscript j indicates regions at the NUTS-2 level, k at the NUTS-1 level. The θ_{kt} controls for NUTS-1 level region-specific year fixed effects. We include several personal characteristics, X_{it}, to control for basic compositional shifts: age, gender and high school graduation.

[5] The 5-regions are defined based on the 12 NUTS-1 regions: west (1 to 4), central (5 and 7), south (6), North (8 and 9) and East (10 to 12).

TABLE 1: INSTRUMENTAL RELEVANCE TESTS

	(1)	(2)	(3)	(4)
Instrument	0.0051	0.0017	0.0042	0.0051
	(0.0002)	(0.0001)	(0.00129)	(0.0018)
N	104	104	324	324
F-test	100.17	155.92	10.53	8.01
Nuts-2	+	+	-	-
Nuts-3	-	-	+	+
Year	+	+	+	+
Nuts 1 x year	-	+	-	+

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

Note: Robust standard errors in parenthesis. There are 26 NUTS-2 and 81 NUTS-3 regions in Turkey. The reported coefficients and standard errors are multiplied by 100 for legibility.

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

$$Y_{ijt} = a + \rho \hat{R}_{jt} + X_{it} + P_j + T_t + \theta_{jt} + e_{ijt} \tag{4}$$

For capital intensity outcomes, the data allow for richer specifications as given by equations 5 and 6. First, the subscript j in equations 5 and 6 indicates regions at the NUTS-3 level (i.e. provinces) rather than the NUTS-2 level. We further introduce the subscript s which indicates sectors at the 2-digit NACE level. Second, we include firm level fixed effects α_i, which controls for unobserved firm level heterogeneity and thus changes in the composition of firms. Third, we include sector-year specific fixed effects at the 2-digit NACE level. The inclusion of sector-year specific fixed effects, τ_{st} allow us to control for sector specific technological shocks that might affect the capital intensity of production in a given sector.[6]

$$R_{jt} = a + \gamma IV_{jt} + X_{it} + P_j + T_t + \theta_{jt} + \alpha_i + \tau_{st} + e_{jt} \tag{5}$$

[6] Excluding sector-year specific fixed effects do not make a qualitative difference in the results which suggests that there are no sectoral trends which drive the effects.

$$Y_{ijt} = a + \rho \hat{R}_{jt} + X_{it} + P_j + T_t + \theta_{jt} + \alpha_i + \tau_{st} + e_{ijt} \tag{6}$$

4. Data

Our primary data sources are the Turkish Household Labor Force Survey (LFS) obtained from Turkish Statistics and the Entrepreneurship Information System (EIS) made available to researchers by the Ministry of Industry and Science. We use the LFS and O*NET data to analyze the effects on tasks and the balance sheet data that is a part of the EIS to analyze the effects on capital intensity of firms. The annual number of refugees from the end of each year at the NUTS-3 level is obtained from the Ministry of the Interior. We convert these values to the NUTS-2 level for the analysis of task scores, but use the NUTS-3 level numbers for the analysis of capital intensity. The total number of refugees according to the Ministry data match numbers reported in alternative data sources like the UNHCR in 2014 and 2015.[7]

4.1. The Labor Force Survey and tasks

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 LFS reports data region data at the NUTS-2 level and the analysis of task scores therefore relies on the variation in Syrian refugee numbers between NUTS-2 regions.

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 O*NET database to calculate task scores following Acemoglu and Autor (2011) and Autor and Handel (2013). Each of the abstract, routine and

[7] See the Turkish response page of the UNHCR operational portal on Syrian refugee regional response at https://data2.unhcr.org/en/situations/syria/location/113.

manual scores are standardized sums of several subscales.[8] We compute occupation task scores in several steps. First, we merge all subscale values of 4-digit SOC (Standard Occupation Score) with the corresponding 4-digit ISCO08 codes. Second, we merge the 4-digit ISCO08 codes with the corresponding 4-digit ISCO88 codes. Finally, we collapse both 4-digit ISCO08 and ISCO88 codes to the 2 digit level and merge all subscale values with our LFS sample. Once merged with the LFS sample, we compute the standardized sums of the subscales to arrive at the abstract, routine and manual score of each occupation.

As an alternative approach to estimating the task scores, we used 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 then take the weighted average using these shares as weights to determine the task scores of each occupation in 2010 and 2011 waves. The items used to compute each task score and the results using the PIAAC scores are provided in the Appendix.

Following the previous literature on task-based models (Autor et al., 2003; Ottaviano et al., 2013), we construct task intensity for routine, manual and abstract tasks as a ratio of a given task score divided by the other two tasks' scores. For abstract tasks, the task intensity is defined as $log(abstract = abstract_s/(manual_s + routine_s))$.[9] For manual and routine tasks scores, we switch the corresponding task score to the numerator and the abstract score to the denominator. The resulting task intensity averages for 2011 by 9 category occupations are presented in Table 2. The task intensities in various occupations appear intuitive, with highest abstract intensities among managers and professionals and highest manual intensities among skilled and unskilled workers. In line with the job polarization literature, routine task intensity is highest among office workers

[8] The abstract score consists of *analyzing data/information*, *thinking creatively*, *interpreting information for others*, *establishing and maintaining personal relationships*, *guiding, directing and motivating subordinates* and *coaching and developing others* subscales. The routine score subscales are *importance of repeating the same tasks*, *importance of being exact or accurate*, *(reversed) structured versus unstructured work*, *controlling machines and processes* and *time spent making repetitive motions*. The manual score subscales are *operating vehicles, mechanized devices or equipment*, *time spent using hands to handle, control or feel objects, tools or controls*, *manual dexterity* and *spatial orientation*.

[9] In order to take the log of each score, the values have to be positive. Since the minimum value is in any score is around -5.8, we added 6 to each score before computing the task intensities.

(Goos et al., 2014).

Table 2: Average task intensity and occupations

	Abstract intensity	Routine intensity	Manual intensity
Managers	-1.0916	-2.1059	-2.0177
Professionals	-0.9366	-2.1282	-1.9786
Technicians	-1.5341	-1.8818	-1.9417
Office workers	-1.5673	-1.5597	-2.0592
Retail workers	-1.7027	-1.7889	-1.7106
Skilled workers	-1.9208	-2.0185	-1.4153
Artisans	-2.1018	-1.7488	-1.6826
Machine operators	-2.1057	-1.7344	-1.8057
Unskilled workers	-2.1464	-1.6650	-1.5081

Authors' calculations using the LFS 2011 wave. All means are weighted using LFS survey weights.

Table 3 presents the summary statistics for the LFS data. Since college graduates make-up a small proportion of the labor force, we define high education as high school graduation and above. The married variable takes the value of 1 for both married and divorced respondents. The differences between the control and treatment years illustrate three general trends in the Turkish labor market. The education level, average ages and female employment are all rising. On average task scores have changed little over time, but there is significant regional variation. Figure 3 plots the average abstract intensities by region in 2011. South-eastern 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 difference in the level of task complexity in western regions and refugee receiving south-eastern regions emphasizes the importance of including region specific year controls.

4.2. The Entrepreneurship Information System and the balance sheet data

The Enterprise Information System (EIS) is an administrative dataset of firm balance sheets managed by the Ministry of Industry and Technology.[10] In particular, we use the balance sheets reported by Turkish firms to the Revenue Administration for tax purposes. We observe the location of each firm's headquarters in the firm registry at the NUTS-3 level.[11] All incorporated firms and unlimited

[10] EIS is a confidential dataset and is only available for researchers working on-site at the Ministry.

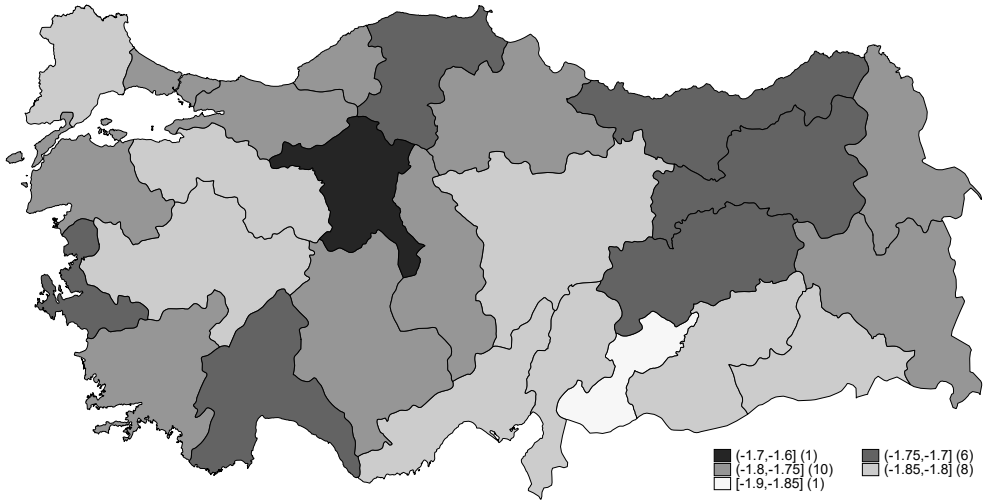
[11] Firms may be active in areas other than their headquarters location. Differences in active and headquarters locations are particularly an issue for Istanbul, where a significant proportion of headquarters are located. However, since

Table 3: LFS summary statistics

2010-2011	Mean	SD	p10	p50	p90
Abstract intensity	-1.7695	0.4165	-2.2727	-1.7567	-1.0919
Routine intensity	-1.7847	0.1960	-2.0944	-1.8205	-1.5747
Manual intensity	-1.7821	0.2026	-2.0608	-1.7817	-1.4550
High education	0.4768	0.4995	0	0	1
Age	34.0036	10.0158	22	33	48
Gender	0.2396	0.4269	0	0	1
Married	0.7049	0.4561	0	1	1
2014-2015	Mean	SD	p10	p50	p90
Abstract intensity	-1.7722	0.4674	-2.2343	-1.7556	-1.0533
Routine intensity	-1.7800	0.2328	-2.1237	-1.7652	-1.4760
Manual intensity	-1.7699	0.1947	-2.0390	-1.7292	-1.5749
High education	0.5037	0.5000	0	1	1
Age	34.7909	10.4168	22	34	49
Gender	0.2745	0.4462	0	0	1
Married	0.6890	0.4629	0	1	1

Authors' calculations using LFS. All observations are weighted using the LFS survey weights. The sample consists of 396,814 paid employees between the ages 15 and 64. There are 190,652 observations from 2010-2011 and 206,162 observations from 2014-2015.

Figure 3: Average abstract scores across regions in 2011



Notes: Authors' calculations using the LFS. All observations are weighted using the LFS survey weights. Abstract task intensity is computed using the formula $log(abstract = abstract_s/(manual_s + routine_s))$.

firms above a certain sales threshold[12] have to report balance sheets. Firms below the threshold may voluntarily report their balance sheet information. The EIS allows access to the data of all firms that report their balance sheets with the exception of public and finance sector firms.

There are 2,734,532 balance sheet observations during our sample period with at least one employee registered to the social security system. Since our main interest is the substitutability of capital and labor, we limit our baseline results to the manufacturing sector. There are 473,949 balance sheets reported by manufacturing firms. We impose several further sample restrictions following other studies using administrative firm data (De Loecker et al., 2014; Tintelnot et al., 2018). We exclude all firms that report less than 100 TL in net sales or fixed assets. The resulting sample size is 413,918. Finally, all firms that are observed a single time in the sample period are dropped due to firm fixed effects in our regression specification which leads to a sample size of 370,802.

We estimate the impact of the refugee inflows on capital intensity using two outcome variables: fixed assets to sales ratio and the annual change in fixed assets. The reported fixed assets are interpreted as the capital input of a firm. While capital to labor ratios are more commonly used in the literature, we can only observe a firm's formal employment. Since most Syrians work informally, formal employment will necessarily underestimate a firm's true employment. To avoid a potential mismeasurement, we measure capital intensity as the ratio of fixed assets to sales, where both variables are deflated using annual CPI. In order to test whether there is an effect on the level of capital input growth rather than capital intensity, we further use the investment rate which is computed as the change in CPI deflated fixed assets, C_t of the firm. To avoid outliers we use the investment, I_t, formula given by equation 7, which limits the range between -2 and 2.

$$I_t = \frac{\triangle C_t}{\frac{1}{2}(C_t + C_{t-1})} \tag{7}$$

The summary statistics for the two capital intensity outcomes are presented by table 4. We excluded any observations above the 99th percentile in the fixed assets distribution. Some firms report extremely large capital intensity (above 1000) which are likely to be errors in the balance

Istanbul is one of the 12 NUTS-1 regions by itself and we include NUTS-1 level region specific year fixed effects in our baseline estimations, the impact of using headquarters locations on our results should be limited.

[12] The threshold was around 200,000 Turkish Liras during our sample years and is adjusted annually for inflation.

sheets. While the 90th percentile of capital intensity is around 0.67, the value reaches 9.92 at the 99th percentile.[13] The final sample size is therefore slightly reduced ($N = 366,596$). We have fewer observations ($N = 318,133$) for investment since we need two consecutive annual observations to be able to construct it. While capital intensity remains consistent across periods, there is a downward trend in the investment rate of Turkish firms. The decline in investment is in line with the decline in GDP per capita growth in Turkey starting in 2013.

In table 4, we report summary statistics for both the full sample of firms and subsamples divided by period average employment size. Small firms have 1 to 9, medium firms 10 to 49 and large firms have more than 49 employees. Firm size in Turkey is negatively correlated with the likelihood of using informal employment. Since Syrians are overwhelmingly employment informally, we may expect smaller firms to be affected more by the refugee inflow. According to the 2011 Labor Force Survey, the overall informality rate in Turkish manufacturing was 21% and is highly heterogeneous across firm size categories. The informality rate is above 50% for firms with 1 to 9 employees. This rate falls to 25% among firms with 10 to 50 employees. For firms with more than 49 employees, the informality rate becomes negligible at 7%. Table 4 shows that capital intensity and investment rates have higher variance for smaller firms. Coupled with the finding that the elasticity of factor substitution is higher among smaller firms, we would expect the impact to be higher for smaller firms independent of the higher informality rate among smaller firms (Aquilina et al., 2006).

5. Results

5.1. Impact on tasks

We present the estimates for the effects of refugee inflows on natives' tasks in Table 5. Panel A presents estimates using OLS and panel B presents the IV estimates. The first three columns show the effects on task scores and the rightmost column the effect on employment. Panels C and D repeat the estimates for 2011 and 2015 only. We find a negative effect on employment that is highly statistically significant in the IV estimates. A 10 percentage point increase in the ratio of refugees to population reduces employment by 2.45 percentage points. The estimated effect on overall employment is negative in line with the findings in Ceritoglu et al. (2017) and Del Carpio

[13] As a robustness test, we excluded all capital intensity values above 2 in our baseline regression and found qualitatively similar results.

TABLE 4: EIS SUMMARY STATISTICS

Capital Intensity						
2010-2011	Mean	SD	p10	p50	p90	N
All	0.3086	0.6575	0.0151	0.1246	0.6667	167661
Small	0.3161	0.7276	0.0108	0.1073	0.6897	90388
Medium	0.2915	0.5783	0.0211	0.1306	0.6383	59296
Large	0.3276	0.5153	0.0391	0.1972	0.6715	17977
2014-2015	Mean	SD	p10	p50	p90	N
All	0.3129	0.6520	0.0170	0.1318	0.6785	198935
Small	0.3116	0.7019	0.0128	0.1141	0.6763	112901
Medium	0.3082	0.5986	0.0234	0.1419	0.6758	67153
Large	0.3366	0.5082	0.0408	0.2070	0.6916	18881
Investment Rate						
2010-2011	Mean	SD	p10	p50	p90	N
All	0.0829	0.5267	-0.3679	-0.0473	0.7750	146440
Small	0.0400	0.5536	-0.4449	-0.0627	0.7779	75121
Medium	0.1277	0.5164	-0.3188	0.0034	0.8187	54023
Large	0.1290	0.4110	-0.1882	0.0304	0.6308	17296
2014-2015	Mean	SD	p10	p50	p90	N
All	0.0458	0.4908	-0.3626	-0.0637	0.6527	171693
Small	0.0374	0.5204	-0.4004	-0.0739	0.7094	92128
Medium	0.0578	0.4740	-0.3367	-0.0390	0.6362	61582
Large	0.0480	0.3769	-0.2300	-0.0193	0.4693	17983

Note: Authors' calculations using EIS data. Capital intensity is defined as the ratio of fixed assets to sales. Investment rate is the annual percentage change in fixed assets. Firm size is defined by average employment over the sample period divided by the sum of current and lagged fixed assets. Small firms have an average employment of 1 to 9. Medium firms have average employment between 10 and 49. Large firms have more than 50 employees. There are 366,596 observations for capital intensity and 318,133 observations for investment rate.

and Wagner (2015). However, the effect is both less precise and smaller in the OLS estimates and is reduced in panels C and D where the sample is limited to 2011 and 2015.

The impact on tasks are estimated consistently across OLS and IV specifications. The manual intensity falls while abstract intensity rises. Based on the IV coefficients in panel B and the standard deviations reported in table 4, a 10 percentage point increase in the refugee to population ratio reduces manual task intensity by 3.5% of a standard deviation. A similar computation yields a 3.7% of a standard deviation increase in abstract intensity. The decline in manual intensity is 1.3%

of the difference between the means of managers and unskilled workers. The increase in abstract intensity corresponds to 3.3% of the difference in the means of managers and office workers. Panels C and D show that the effects on tasks remain similar when the sample is limited to 2011 and 2015.

TABLE 5: EFFECT OF THE REFUGEE INFLOWS ON TASKS

	Abstract	Routine	Manual	Employment
			Full Sample	
A- OLS				
Refugees/pop.	0.1644**	-0.0312	-0.0744**	-0.1607*
	(0.0668)	(0.0457)	(0.0312)	(0.0947)
B- IV				
Refugees/pop.	0.1549**	-0.0150	-0.0952***	-0.2450***
	(0.0679)	(0.0483)	(0.0281)	(0.0917)
N	396,814	396,814	396,814	1,360,401
			2011 - 2015	
C- OLS				
Refugees/pop.	0.1855**	-0.0532	-0.0600***	-0.0890
	(0.0731)	(0.0479)	(0.0221)	(0.0924)
D- IV				
Refugees/pop.	0.1595**	-0.0539	-0.0699***	-0.1433*
	(0.0717)	(0.0464)	(0.0201)	(0.0763)
N	202,414	202,414	202,414	677,425

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

Note: All models include region and year fixed effects and NUTS-1 level region specific year fixed effects. The refugee to population ratio variable is defined at the NUTS-2 (26 regions) level. Standard errors are clustered at the region level in all regressions.

We test the robustness of the results in several estimations presented by table 6. In panels A and B, we test the sensitivity of the 2SLS estimates to alternative regional controls. In panel A, we drop year-specific fixed effects for 12 NUTS-1 regions of Turkey from the specification. The estimates of the task effects become nearly twice as large and the effect on routine task intensity turns statistically significant. Once we include year-specific fixed effects for 5 Turkish regions, the effects are closer to the baseline estimates with year-specific fixed effects for 12 regions. The overall results suggest that our baseline results are the most conservative estimates of the impact of

refugee inflows on native tasks.

In columns C and D, we estimate placebo treatment effects to test whether our baseline estimates fulfil the parallel trends assumption. The specification and the control years of 2010 and 2011 remain identical to the baseline but we assume that the refugee distributions in 2014 and 2015 had occurred in 2012 and 2013. The number of refugees was low in 2012 and 2013 and they were largely in camps. We further expect the structural transformation in the input mix to take some time. None of the estimates appear to be statistically significant, which suggests that the effects found in 2014 and 2015 are not driven by regional pre-trends.

TABLE 6: TASK ESTIMATIONS USING ALTERNATIVE SAMPLES

	Abstract	Routine	Manual	Employment
		Alternative Controls - IV		
A- No regional controls				
Refugees/pop.	0.2803***	-0.1642***	-0.2104***	-0.2015*
	(0.0701)	(0.0606)	(0.0383)	(0.1134)
B- 5 region x year fixed effects				
Refugees/pop.	0.1986***	-0.0613*	-0.0885***	-0.1174*
	(0.0534)	(0.0346)	(0.0225)	(0.0638)
N	396,814	396,814	396,814	1,360,401
		Placebo Tests		
C- OLS				
Refugees/pop.	0.0442	-0.0073	0.0140	0.0316
	(0.0454)	(0.0243)	(0.0251)	(0.0644)
D- IV				
Refugees/pop.	0.0553	-0.0146	0.0060	0.0479
	(0.0478)	(0.0260)	(0.0271)	(0.0658)
N	394,243	394,243	394,243	1,354,859

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

Note: All models include region and year fixed effects. Panels C and D further include NUTS-1 level region specific year fixed effects. The refugee to population ratio variable is defined at the NUTS-2 (26 regions) level. 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 presents estimates for high and low educated employees in panels A and B. The task intensities of low educated are not affected at all, while their employment is negatively affected. The reverse is true for highly educated, whose employment and abstract intensity rises while routine and manual intensities fall. The emerging narrative is that the highly educated are better able to adapt their occupations to those that are complementary to the labor supply of refugees. Meanwhile, tasks performed by the lower educated appear to be substitutes with refugee labor and the lower educated are driven out of employment as result. The finding that highly educated drive the baseline results further suggests that the effect is not driven by a decline in the lower educated share of employment. While the employment of the lower educated indeed falls, the increase in task complexity is driven by the shift among the highly educated.

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. Autor et al. (2003) find that computerization is associated with reduced routine manual and routine cognitive tasks and increased of non-routine cognitive tasks. Unlike the findings in our case of Syrian refugees in Turkey, they find that the substitution was pervasive at all educational levels.

In panels C and D of table 7, we split the sample into younger (15-34) and older age groups (35-64). We find that the reallocation of employees to more complex tasks occur for younger employees aged 15-34. Taken together with the effects on different education groups, we can conclude that the effect is concentrated among young employees with high levels of education.

5.2. Impact on capital intensity

Table 8 shows the estimated effect of the refugees on capital intensity and investment rates. Panels A and B report the OLS and IV estimates for capital intensity while panels C and D report the estimates for the investment rate.[14] We find a negative effect on capital intensity where the IV coefficient implies a decline of 0.04 in response to an increase of 10 percentage points in the refugee to population ratio. Using the values reported by table 4, we can compute that this effect corresponds to a reduction of 6% of the standard deviation. The estimates by size show that the negative effect

[14] As a robustness test to further data cleaning, we used a balanced sample of firms that we observe in all 4 years. The resulting 2SLS coefficients are -0.3536 for capital intensity and -0.2591 for the investment rate. Both estimates are statistically significant at the 5% level.

TABLE 7: TASK EFFECTS BY SUBSAMPLE

	Abstract	Routine	Manual	Employment
			Education Level	
A- High Education				
Refugees/pop.	0.3443***	-0.1510***	-0.1113***	0.1543***
	(0.0886)	(0.0585)	(0.0255)	(0.0558)
N	194,809	194,809	194,809	404,898
B- Low Education				
Refugees/pop.	-0.0364	0.0698	-0.0479	-0.3755***
	(0.0844)	(0.0703)	(0.0390)	(0.1144)
N	202,005	202,005	202,005	955,503
			Age Group	
A- Young (15-34)				
Refugees/pop.	0.3007***	0.0264	-0.1794***	-0.2714**
	(0.0493)	(0.0364)	(0.0330)	(0.1225)
N	198,139	198,139	198,139	618,371
B- Old (35-64)				
Refugees/pop.	-0.0103	-0.0616	0.0046	-0.2084***
	(0.1241)	(0.0733)	(0.0397)	(0.0691)
N	198,675	198,675	198,675	742,030

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

Note: All models include region and year fixed effects and NUTS-1 level region specific year fixed effects. The refugee to population ratio variable is defined at the NUTS-2 (26 regions) level. Standard errors are clustered at the region-year level in all regressions.

is most precisely estimated for small firms. Both the precision and the size of the effect decline for large firms, which is in line with our expectation that small firms would be most directly affected by the informal labor supply of Syrian refugees.

The impact on the investment rate is parallel to that on capital intensity. The 2SLS specification estimates a decline in the investment rate of 0.025 in response to an increase of 10 percentage points in the refugee to population ratio. This decline corresponds to a 5% of a standard deviation decrease in the investment rate. The negative 2SLS estimate is larger and more precisely estimated for smaller firms compared to medium and large firms.

Table 8: Impact on capital intensity of manufacturing firms

	All	Small	Medium	Large
		Capital Intensity		
A- OLS				
Refugees/pop.	-0.4878**	-0.4277**	-0.6612*	-0.1281
	(0.2161)	(0.1858)	(0.3673)	(0.2468)
B- IV				
Refugees/pop.	-0.4144***	-0.3647*	-0.5014	-0.2120
	(0.1581)	(0.2145)	(0.3224)	(0.3786)
N	366,596	203,289	126,449	36,858
		Investment rate		
C- OLS				
Refugees/pop.	-0.1521*	-0.1033	-0.2207	-0.3327
	(0.0874)	(0.1331)	(0.1369)	(0.2789)
D- IV				
Refugees/pop.	-0.2486*	-0.3716***	-0.1809	-0.2046
	(0.1314)	(0.1358)	(0.2118)	(0.2915)
N	318,133	167,249	115,605	35,279

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

Note: All models include firm, region, year, NACE-2 level sector specific year and NUTS-1 level region specific year fixed effects. The refugee to population ratio variable is defined at the NUTS-3 (81 provinces) level. Standard errors are clustered at the region-year level in all regressions.

We employ the same tests as the task outcomes to determine the robustness of the results on capital intensity outcomes. Panel A shows the estimated effects when 2011 and 2015 estimates are used. The sample is less than half our baseline sample since each firm has to be observed twice and therefore appear in both 2011 and 2015 to contribute to the estimation. The results are overall similar, but there is a greater difference between OLS and IV estimates. Excluding the NUTS-1 level region specific year fixed effects in panel B reduces the size of the estimated effects. Once year-specific fixed effects are included for 5 regions in panel C, the effects become more similar to our baseline estimates. The difference between panels B, C and the baseline estimates suggest that refugees move towards regions with higher capital intensity and investment rate growth. Our final robustness test is the placebo estimates presented in Panel D where we assume the refugee

distributions in 2014 and 2015 had taken place in 2012 and 2013. Similar to task scores, we find no statistically significant estimates from the placebo treatments.

Table 9: Capital intensity robustness tests

	OLS		IV	
	Capital intensity	Investment	Capital intensity	Investment
A- 2011 - 2015 estimates				
Refugees/pop.	-0.7243**	-0.4625**	-0.1422	-0.2455**
	(0.3600)	(0.2007)	(0.0962)	(0.1016)
N	108,498	94,744	108,498	94,744
Alternative controls				
B- No regional controls				
Refugees/pop.	-0.1974	-0.2728***	0.0558	-0.3382**
	(0.1770)	(0.0734)	(0.1337)	(0.1320)
C- 5 region x year fixed effects				
Refugees/pop.	-0.4584**	-0.1742**	-0.4071***	-0.2174*
	(0.1807)	(0.0830)	(0.1294)	(0.1224)
N	366,596	318,133	366,596	318,133
D- Placebo tests				
Refugees/pop.	-0.0707	0.0577	-0.2612	0.0333
	(0.1441)	(0.1110)	(0.1617)	(0.0787)
N	348,807	299,609	348,807	299,609

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

Note: All models include firm, region, NACE-2 level sector specific year and year fixed effects. The refugee to population ratio variable is defined at the NUTS-3 (81 provinces) level. Panels A and C further include NUTS-1 level region specific year fixed effects. The placebo test is performed by assuming that the refugee distributions in 2014 and 2015 had occurred in 2012 and 2013. Controls years are still 2010-2011 in the placebo estimation. Standard errors are clustered at the region-year level in all regressions.

While substitution or complementarity between capital and Syrian refugee labor is more likely in the manufacturing sector, we test whether the effects extend to the entire economy by using all available observations in our dataset.[15] Table 10 presents the results. Once again we find a negative effect on capital intensity though the impact on the investment rate loses its statistical significance. The size of the effect on capital intensity is less than half the found for the manufacturing sample.

[15] We still excluded agricultural sectors which correspond NACE-2 sector codes 1 to 9.

Unlike manufacturing, we find no clear pattern in the heterogeneity of effects by firm size. Overall, the main effect appears to be driven by the manufacturing sector.

TABLE 10: IMPACT ON CAPITAL INTENSITY OF ALL FIRMS

	All	Small	Medium	Large
	Capital Intensity			
A- OLS				
Refugees/pop.	-0.1710***	-0.1858***	-0.1220*	-0.0584
	(0.0479)	(0.0554)	(0.0707)	(0.1348)
B- IV				
Refugees/pop.	-0.1758**	-0.1605*	-0.1469	-0.4312***
	(0.0698)	(0.0858)	(0.0979)	(0.1622)
N	2,010,028	1,438,793	477,574	93,654
	Investment Rate			
C- OLS				
Refugees/pop.	-0.0828	-0.0298	-0.1887***	-0.2359*
	(0.0663)	(0.0789)	(0.0591)	(0.1304)
D- IV				
Refugees/pop.	-0.0986	-0.0602	-0.2041**	-0.2589
	(0.1008)	(0.1185)	(0.0859)	(0.1797)
N	1,678,107	1,164,602	425,530	87,968

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

Note: All models include firm, region, year, NACE-2 level sector specific year and NUTS-1 level region specific year fixed effects. The refugee to population ratio variable is defined at the NUTS-3 (81 provinces) level. Standard errors are clustered at the region-year level in all regressions.

6. Conclusion

This paper examined 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 capital intensity and investment of 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 highly 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 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. The increase in abstract intensity is found to be driven by highly educated employees. The lower educated employees show no significant change in their tasks and also drive the negative effect on native employment. Their inability to adjust to tasks that are complementary to Syrian labor inputs may explain why their employment outcomes are negative affected.

Once the impact on firms' capital intensity is taken into account, more worrying trend emerges than that suggested by studies focusing only on native tasks. The average manufacturing firm in refugee-hosting regions reports lower capital intensity and investment rate. This effect is particularly strong for small firms which drive employment growth (Decker et al., 2014). 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 relying on low-cost labor may outperform other firms in the short run, leading to an undesirable long term change in the composition of firms in terms of capital intensity (Foster et al., 2008). The hosting regions may be left with a suboptimal mix of capital and labor inputs if the refugees enter the formal labor market in large numbers or return to Syria after the settlement of the crisis.

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Appendix - Tasks using PIAAC

As an alternative to task scores computed from the O*NET database, we estimated the task scores using the PIAAC 2015 survey for Turkey. The main disadvantage of PIAAC is that there are only around 2,100 observations with reported occupations in the sample for Turkey. The resulting task scores at the 2-digit occupation level are then unlikely to be representative. In calculating the task scores of occupations using PIAAC, 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.[16] They further define an ICT score, which we also construct. Each item and category is presented in Table 11. 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 score that has multiple categories, we construct the task score by again taking the first factor from a factor analysis where each category is treated as one dimension. All resulting task scores are rescaled to be between 0 and 1.

Similar to our baseline approach, we construct task intensities for routine, manual and abstract tasks as a ratio of a given task index divided by the other two tasks' indices. For abstract tasks, the task score is defined as $log(abstract_s = abstract_s/(manual_s + routine_s))$. 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 results using PIAAC scores are presented by table 12. The results for routine tasks are different and appear to be increasing in response to refugees when using PIAAC scores. However, the overall shift towards more complex tasks does not change as manual task intensity is reduced and abstract task intensity increases.

[16] Previous literature that analyzes occupations and tasks generally uses the DOT and O*NET databases, which is what we use for our baseline estimations (Autor et al., 2003; Peri and Sparber, 2009).

TABLE 11: 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

Note: Based on De La Rica and Gortazar (2016).

TABLE 12: EFFECTS ON TASKS USING PIAAC SCORES

	Abstract	Routine	Manual	ICT
A- OLS				
Refugees/pop.	0.1458***	0.4449***	-0.6126***	0.4611***
	(0.0485)	(0.1232)	(0.0822)	(0.0697)
B- IV				
Refugees/pop.	0.1384***	0.5149***	-0.6284***	0.4755***
	(0.0440)	(0.1262)	(0.0751)	(0.0657)
N	396,814	396,814	396,814	396,814

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

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

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