Interaction of Education and Industrial Policies in Space[1]

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Extended Abstract

Governments worldwide invest heavily in regional development through provision of public goods or place-based policies, yet the agencies responsible for these investments rarely coordinate. Education departments decide where to build new schools and universities; industry ministries decide where and which economic activities to subsidize. This lack of coordination can lead to spatial misallocation where subsidies may flow to regions that lack the skilled workers to use them productively, or universities may produce graduates in places with few high skill jobs. This paper investigates how much this coordination failure matters. First, I evaluate two government policies that are closely related but implemented by two separate government agencies. These policies are: (i) the R&D support given to Turkish firms which reduced the cost of hiring high-skill workers (implemented by the Ministry of Industry), and (ii) university expansion reform that significantly increased access to higher education, especially for people in relatively remote regions (new university locations were advised by the Higher Education Council). Then, I examine the interaction of the higher education expansion and R&D subsidies and optimal policy in the presence of productivity spillovers through the lens of a spatial equilibrium model with migration for education and work.

During early 1990's and mid-2000's, Turkey has undergone two higher education (HE) expansion reforms that were mainly motivated by politicians' objective to raise income and economic activity in their election regions. In this paper, I focus on the most recent reform since it was more comprehensive, and its consequences were more drastic. Between 2005-2008, the number of HE institutions and regional coverage increased by more than 100%. This large-scale expansion increased human capital supply significantly and reduced the cost of higher education attainment by people in remote regions. Around the same time, in 2008, the Law on Support for R&D Activities was enacted. The law's main objectives were to raise innovation, technology, and eventually productivity in the country by expanding the R&D capacity. According to the law, firms with dedicated

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R&D centers that satisfy certain criteria qualify to receive generous R&D tax rebates, exemptions and subsidies that reduce the cost of employing R&D personnel.

To measure the causal effect of the expansion on educational attainment, employment and wages, I use spatial and temporal variation in individuals' exposure to increase in available slots as a result of the university expansion reform. Information on the individual's major choice allows me to measure the differential response in STEM degree attainment. I find that HE reform is associated with higher market access to universities and rising density of college graduates on average (especially in previously less dense regions). However, the returns in the labor market for recent graduates are lower relative to older cohorts. This result signals the falling quality of education and lack of resources needed for a functioning higher education system (Caner et al., 2022). In a similar vein, it can also be argued that there are too many universities and the location choices for them are suboptimal due to lack of faculty and experience.

In order to identify the causal effect of R&D support receipt on firms' financial and innovative outcomes, I exploit an exogenous change in the R&D personnel requirement in a difference-in-differences design. After a change in the law in 2016, the minimum R&D personnel a firm has to employ was dropped from 50 to 15, expanding the number of eligible firms significantly. I find that relaxing eligibility requirements increase take-up and R&D support given under the law has positive and statistically significant effects on innovation and profitability. The treatment effects and take-up are more pronounced for larger firms. Furthermore, the HE expansion and R&D subsidies are closely related through input channel: I find that 50% of the R&D personnel employed in treated firms are graduates from the universities established after the first university expansion in 1992. 28% of them are graduates from universities that are established during the second wave of expansion starting in 2005.

These two government policies that took place around the same time with closely related goals: regional and aggregate economic development and growth. However, they were designed and implemented by separate government authorities without any formal consideration of welfare loss that may stem from coordination failures. The first policy, HE expansion, determines the formation and spatial distribution of human capital through location and quality of newly established universities. The second, R&D subsidies, target productivity through innovation which relies on the high-skill labor as a crucial input.

As shown by an extensive literature, innovation and R&D benefit from agglomeration externalities, i.e., knowledge spillovers, that come from regional human capital (Carlino & Kerr, 2015). In the theoretical model, I assume that regions differ in terms of how strong their agglomeration forces are, which affects their productivity through the total population of high-skill workers in the region. Industrial policy reduces the cost of hiring high-skill workers (college graduates), whereas education policy raises the quality and capacity of education in a region, which determines the population of high-skill workers. Therefore, coordination between education and industrial policy is necessary for both to be successful to achieve their goals. When these policies do not coordinate, the resulting

allocation suffers from spatial misalignment: college graduates are produced in one location while subsidized jobs and economic activities are created in another. Under coordinated policy, we observe higher subsidies given to the regions with stronger agglomeration forces. Education policy aligns with industrial policy and new universities and/or more resources are allocated to regions with highest agglomeration forces.

This paper makes two main contributions. First, it uses administrative micro data to measure the causal effects of two interrelated government policies on firm performance and individuals' educational attainment and labor market outcomes. Second, it explicitly models the interaction of different government policies in a spatial equilibrium setting. Furthermore, I consider the joint general equilibrium effects of policies targeting human capital supply and productivity in the presence of economies of scale. Given the contemporary experiences of many countries with unsuccessful industrial policies, this paper provides empirical and theoretical evidence to inform policy discussion.

Datasets

I use a combination of survey and administrative micro datasets along with digitized public records to evaluate two government policies introduced above.

Individual earnings and education data come from Turkstat Household Labor Force Surveys (HLFS). I use surveys from 2005-2018 which enables me to observe different cohorts that are exposed and less exposed to the higher education expansion reform. The datasets include information on individual's age, region of residence, education level (and major if individual is a college graduate), sector of employment, occupation, monthly wage and hours worked. Survey years after 2012 also include the year that individual started living in the region they are residing in which helps me infer if an individual migrated for education. To link empirical findings with the theoretical model and compute migration costs, I supplement HLFS with General Census of Population from 2000 which has information on individual's place of birth, current place of residence, place of residence 5 years ago, reason for migration, education level, occupation and employment status. For a clean comparison, I restrict the sample to include at least high-school graduates and individuals aged 25-49. Main outcomes of interest are log hourly wages and college attainment.

To construct the treatment variable, I use publicly available records on university slots from 2005-2018 to measure exposure to higher education expansion for each province and NUTS-2 region. I digitize university placement records on all degree programs from Measuring, Selection and Placement Center (*Ölçme, Seçme ve Yerleştirme Merkezi, or ÖSYM* in Turkish) almanacs. I construct my exposure measure by comparing available slots in a region in post-expansion years with available slots in 2005, one year before university expansion reform started. To account for the demand-side dynamics, I divide the expansion in available slots to the population of 18-year-olds who are the most likely to take the university entrance exam. I also consider overall market access for universities as an alternative exposure measure to capture the mechanisms in the theoretical model.

To evaluate the firm-level effects of the R&D subsidies, I use Entrepreneur Information System (EIS) made available by the Ministry of Industry and Technology which covers the economic activities of more than 3 million corporate taxpayers, and income taxpayers that earn commercial income as well as public institutions and organizations such as local governments that keep records on the balance sheet basis. EIS integrates nearly all available information on a firm's performance including balance sheet, tax returns, linked employer-employee data and patent filings for years 2006-2024. Data on various government support provided under different industrial policies are also available in the EIS, including a registry for establishments that receive R&D centers support. This registry allows me to observe R&D personnel's bachelor's, master's and PhD degree names and the names of universities. All administrative datasets in the EIS can be merged using a unique firm identifier. As the main outcome variables, I use firm's financial and innovative performance measured by profits, revenue, net sales and patents. To define the eligibility, I construct potential R&D related employment using occupation information available in the matched employer-employee dataset.

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