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Getting Incentives Right: Human Capital Investment and Natural Resource Booms

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Abstract

The accumulation of human capital is usually considered an important corner stone in a country's economic development. While the use of resource rents to improve an educational system and, thus, increase the level of human capital appears to be an attractive option, resource rich economies frequently struggle with an efficient management of resource revenues. In this paper, we ask whether private individuals can at least partly compensate for government's failures by analysing the consequences of a resource boom on private demand for education. To do this we use the Household Budget Survey of Kazakhstan covering the period of 2001–2005. The oil boom provides us with the necessary exogenous variation to establish causality. We show that, in resource-rich districts of Kazakhstan, the resource boom increases the probability of employment in the formal sector for the educated labour force and the likelihood that households pay tuition fees for tertiary education. We are able to refute the conjecture that our effect is driven merely by the growing income of the households, by the growing supply of educational opportunities or by the immigration of educated households.

JEL-Classification: Q33, I25

Keywords: Resource Booms, Education

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1. Introduction

Accumulation of human capital is widely acknowledged as one of the key preconditions for economic development. A persistent feature of many countries in development traps is low private human capital investment, see e.g. Atal, Basu, Gray, and Lee (2010). One constraint that private demand for education faces is the lack of resources of the households (Glewwe and Jacoby, 2004). However, an equally important problem is that in many cases demand for education is constrained by the lack of job opportunities for the educated labour force. In many African countries, for example, low physical capital investments mean that the demand for labour remains low; at the same time, the growth of population leads to a rising labour supply. If the educated labour force grows faster than the overall labour force, the wage for educated workers goes down as well, creating disincentives for acquiring education (Teal, 2000). The lack of employment opportunities constrains not only the demand for education, but also the ability of education to contribute to economic growth (Pritchett, 2001). However, while the argument seems to be compelling, empirical evidence is still limited, particularly since it is difficult to establish a causal link between the demand for an educated labour force and the demand for education.

This paper aims to contribute to the literature by explicitly showing how growing employment opportunities result in a growing demand for education in a developing country. To avoid endogeneity, our identification strategy necessary to establish the causal effect relies on looking for an exogenous shock, which influenced the labour market, changing the employment chances for educated labour and, as a response, triggered demand for education. From this point of view, we investigate the oil boom in the first half of the 2000s in Kazakhstan. Kazakhstan is an oil rich country, and the oil price increase of the 2000s had a major influence on its economic development. It is, however, not a country capable of influencing the global oil market; thus, it is safe to say that the rapid increase of oil prices in the first half of the 2000s constituted an exogenous shock for Kazakhstan. At the same time, the demand for the educated labour force from the oil industry of Kazakhstan is substantial due to, first, the technological complexities of oil extraction in harsh climatic conditions in the heart of Eurasia and, second, rigorous local content requirements imposed by the Kazakhstani government on oil companies, which are therefore forced to hire primarily from the local labour market. The identification we use is similar to that of Loken (2010), who, while investigating the impact of Norwegian oil boom, focuses on the effect of growing income on demand for education (while we study the effect of changes in employment opportunities), and Black, McKinnish, and Sanders (2005), who look at the effect of the coal boom in the US on demand for education in the 1970s.

Our results are based on a unique dataset from the Kazakhstan Household Budget Survey, providing detailed information on the spending and income structure of a panel of Kazakhstani households. We utilize the fact that oil and gas deposits are allocated unequally across the territory of Kazakhstan, providing us with the necessary variation in terms of the effect of a resource boom on different households within the country. We then use difference-in-difference and difference-in-difference-in-difference strategy to identify the effect of the oil boom.

We show that, as a consequence of the oil boom, in oil-rich districts the probability of formal employment for educated labour went up; as a result, there was an increase in private spending on education (measured by the likelihood of paying tuition fees for tertiary education, i.e., university studies or vocational training). This result suggests that a link of the resource extractive industry to local labour markets might at least partly compensate for a lack in educational expenditure with the goal of increasing human capital. However, we stress that a necessary condition of our result is that the oil boom indeed results in a growing demand for educated labour. Stated otherwise, we argue that in some cases resource booms represent not simply ‘manna from heaven’, but rather an opportunity for larger revenues, which can be realized only through intensive use of necessary inputs - particularly, educated labour.

The paper is thus related to two literatures. First, our paper is related to the literature investigating the contribution of resource booms to the accumulation of human capital. A well-known result of the resource curse literature is that governments often struggle with an efficient management of resources (van der Ploeg and Venables, 2012; Ross, 2012). While using the resource revenue to improve the educational level of the population seems to be an attractive option, it is debatable whether governments manage to seize this opportunity. Several studies show that resource abundance causes governments to provide insufficient investments in education (Gylfason, 2001; Birdsall, Pinckney, and Sabot, 2000; Blanco and Grier, 2012; Suslova and Volchkova, 2013) or finance education in a very inefficient way (Vicente, 2010; Caselli and Michaels, 2013). The reason for this outcome is the lack of ability and interest of a rentier state to provide public goods in general. Other papers come to different conclusions: Stijns (2006, 2009), Pineda and Rodriguez (2010) and Davis (1995) argue that mineral resource wealth may be associated with elevated human capital levels. But independent of how the government performs in terms of education provision, the question remains whether private demand for education reacts differently to the resource boom than the public supply. The empirical evidence in this area is limited; most papers investigate developed countries and reach inconclusive results. While some papers argue that changes in the labour market due to the resource boom are likely to reduce the demand for education by private households, at least in the short run (Black, McKinnish, and Sanders, 2005; Walker, 2012), others conclude that the resource boom merely delays the timing of schooling but not the long-term outcome (Emery, Ferrer, and Green, 2012) which may have a positive impact on schooling (Michaels, 2011; Braakmann, 2011), has no causal impact at all (Loken, 2010) or has a heterogeneous effect depending on the quality of political institutions (Cabrales and Hauk, 2011).

Second, and more generally, we contribute to the investigations concerning the impact of employment opportunities for educated labour on demand for education by offering a novel identification approach and previously unexplored empirical evidence. There exists a growing, but still small literature, focusing on developing countries and showing the positive effects of labour market opportunities on demand for education. Federman and Levine (2004) show that in Indonesia industrialization, leading to the growing demand for an educated labour force, resulted in a growing demand for education. Le Brun, Helper, and Levine (2011) make a similar conclusion for Mexico, while Atkin (2016) suggests that growing employment opportunities in the low-skill sector (e.g. factory openings) resulted in a higher number of school dropouts in this country. Heath and Mobarak (2012), on the case of Bangladesh, compare how demand for education reacts on job market opportunities and on direct subsidization of education. They show that a growing demand for education is associated with the former. Oster and Steinberg (2013) argue that in India new jobs originating from an IT service centre in a vicinity of a school increase enrolment in this school. Munshi and Rosenzweig (2006) use the Indian case and show that new jobs, which were accessible to members of various casts, created incentives for low-caste girls to invest more in education; Jensen (2010b), in a field experiment, shows a similar effect of recruitment services for women on educational investments in girls. Still, as early as 1974, Fields (1974) points out that demand for education may remain high even if employment opportunities for educated labour are low.[1]

[1] Furthermore, there exists a rich literature mostly for developed countries, which looks at the substitution effects between demand for education and job opportunities: if the latter are sufficiently numerous and the return on education is low enough, the growing job market could crowd out education (Duncan, 1965; Neumark and Wascher, 1995; Rees and Mocan, 1997; Di Pietro, 2006). Decline of employment opportunities can (at least

The paper is organized as follows. The next section discusses the institutional background of the case of Kazakhstan. In the third section, we present a simple theoretical model, which allows us to derive the main predictions for the empirical analysis. The fourth section describes the data. The fifth section presents the econometric strategy of our analysis. The sixth section summarizes the main results. In the seventh section, we discuss some of our concerns. The last section concludes.

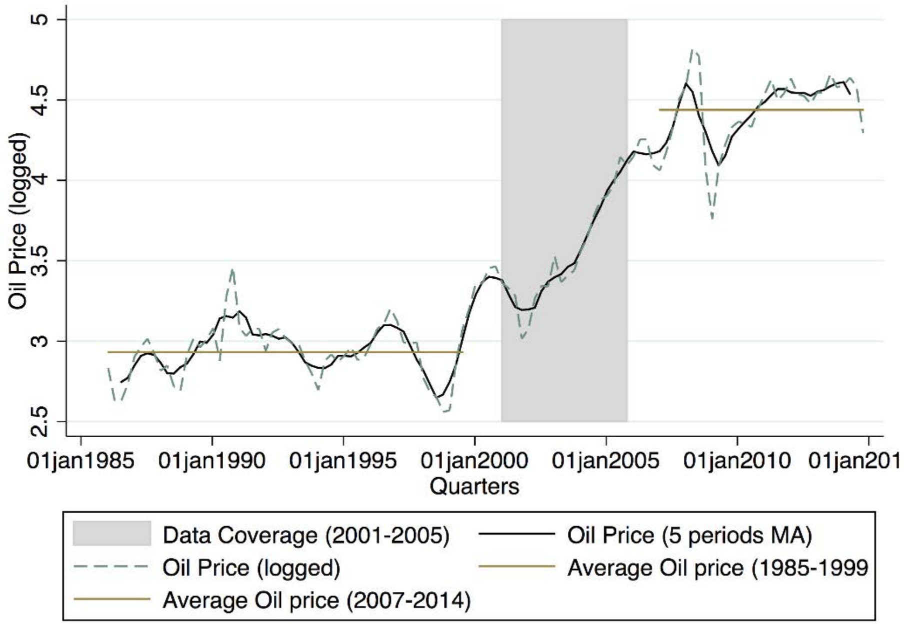
temporarily) lead to a growing demand for education as a ‘waiting strategy’ during the low phase of the business cycles (Betts and McFarland, 1995). In developing countries, where the pressure to earn money is higher, the counter-cyclical demand for education is unlikely to be as strong; nevertheless, excessive demand for university education, in an attempt to delay market entry in a hostile environment has been argued to be present in transition countries as well, see Kuzminov (2004).

2. Oil and gas sector, labour markets and education

Kazakhstan is one of the largest oil and gas producers in the world, ranking 17th in terms of total oil production in 2011 according to the Energy Information Administration data. In recent years oil and gas accounted for more than 70% of the country's exports. Thus, it is a classical resource-rich country, in which negative effects of resource orientation on public supply of education are possible.

In the early 2000s Kazakhstan experienced an oil price boom, associated with skyrocketing prices on the global oil markets. Figure 1 plots the dynamics of the oil prices over the period in question: one can see that since 2001 there was an almost steady increase in oil prices. As a result, investment and employment in Kazakhstan's oil and gas industry grew at a very fast pace (Toews, 2014). Thus, the resource boom of the 2000s provides the natural experiment necessary for the investigation of our paper.

Figure 1: Quarterly oil price in US$ per barrel (Cushing, OK WTI Spot Price FOB) (EIA 2012)



Oil extraction in Kazakhstan is due to environmental and ecological conditions and the geographical location (far from convenient export ports) much more challenging than in e.g. Gulf countries. The conclusion that Kazakhstan poses a particular technological challenge for oil extraction is widespread (Kaiser and Pulsipher, 2007). This is especially true for the major offshore oil fields. Addressing the requirements for the equipment to be used at Kashagan,[2] Hampton Fowler, Halliburton's production manager, described the conditions as an unusual combination of "arctic conditions, high pressure, sour service, zero discharge operations" (Lang, 2003). Under these conditions, it is not surprising that oil extraction is particularly demanding in terms of a well-trained staff in oil companies. In fact, the lack of qualified personnel is a recognized problem, repeatedly pointed out by the oil companies themselves.[3] As a result, it is safe to say that in Kazakhstan there is strong demand for an educated labour force from the oil sector.

The oil sector has a major influence on employment in oil rich districts. According to Toews (2014), in the two main oil rich provinces – Atyrau and Mangistau – every 10th and every 5th worker, respectively, works in the oil and gas sector. The non-tradable service sector is closely linked to the oil sector as well. Of seven major oil producers, three are Kazakhstani domestic companies mostly employing a local labour force; four are multinationals, with the share of local labour force exceeding 90% for three of them and 80% for one of them.

There are three reasons for this employment pattern. First, Kazakhstan is located in the centre of Eurasia, has very harsh climate conditions[4] and a relatively strict visa regime,[5] making foreign labour (except for the neighbouring countries of Central Asia and Russia) relatively expensive to import. Second, the Kazakhstani government requires all oil and gas companies to procure most goods and services through tenders giving preference to local suppliers. The 1995 Petroleum Law required most subcontractors to be Kazakhstani organizations, and the 1996 Law on Subsurface and Subsurface Use set requirements for using local personnel (Ospanova, 2012). Thus, the link between the oil sector and the local labour market is protected through 'local content' requirements. Third, oil companies can rely on a relatively well-trained staff and education system inherited from the Soviet period – we will discuss this in what follows.

Kazakhstan inherited a developed educational infrastructure from the Soviet Union, including a network of universities and vocational training facilities in all major cities of the country. In 2005, the gross secondary school enrolment accounted for 95%, and the gross

[2] One of the biggest recent discoveries offshore in the world.

[3] E.g. http://articles.gazeta.kz/art.asp?aid=57521, accessed July 30, 2013, or http://oilkz.kz/ru/news/article/376, accessed July 30, 2013.

[4] To provide an example, in Atyrau the average monthly temperature varies from –6.4o Celsius to 26.8o Celsius over the year, with extreme temperatures recorded as varying between –37.9o and 42.7o Celsius.

[5] Except for post-Soviet countries, visa-free entry to Kazakhstan for regular travellers is provided only for Mongolia, Turkey, Hong Kong and Serbia.

tertiary school enrolment for 53%. It is debatable whether this education system produces workers of sufficient quality, but the situation is definitively much better than in many developing countries. In developing countries local educational systems frequently do not exist and even simple literacy of the labour force is not guaranteed. In Kazakhstan illiteracy is negligible. Actually, in international comparison, Kazakhstan performs quite well. For example, in the Global Competitiveness Report (2013–2014) it scored 54th among 148 countries in terms of 'Higher Education and Training'. Throughout the last five years, Kazakhstan has been consistently included in the top five countries in the world in the UNESCO 'Education for All Development Index'.[6] Also, the World Bank (2005a) acknowledges that Kazakhstan has a solid base for training of professionals in the oil sector.

In Kazakhstan the number of individuals without secondary education is very small. So we do not obtain the necessary variation in this respect; the state still ensures that almost all children attend a secondary school. The main education decision to be made by households is whether to invest in tertiary education. Limiting our attention to university education would be too restrictive, since an oil boom is likely to have an effect not only on a very small group of employees with university education, but also on specialized blue-collar workers. Tertiary education in Kazakhstan consists of universities and *technikums* (vocational training education institutions in the Soviet Union countries providing training for specialized blue-collar jobs based on 3-year programs). Before 2004, admission to *technikums* and universities was based on entrance exams. These were determined by the educational facilities jointly with governmental agencies. Since 2004, the entrance exams were replaced by the Single National Test, a unified exam sat by all high school graduates in the country. The autonomy of educational institutions in Kazakhstan is limited by constant supervision and control by the governmental agencies; standardized curricula are taught throughout the country.

Education generally requires the payment of tuition fees; there is a system of governmental grants covering costs of education in a variety of disciplines and universities. As of 2011, 77% of university students have had to pay tuition fees though. Therefore, and crucially for our research question, the decision to obtain tertiary education in Kazakhstan is costly.

[6] One has to acknowledge that this is to a large extent determined by the quality of primary and secondary education.

3. Theoretical framework

Based on the discussion above we suggest the following theoretical framework. The representative profit maximizing firm combines capital K, educated (skilled) and uneducated labour, L_s and L_u respectively, using a constant return to scale production function to extract a natural resource $X_r = q(K; L_s; L_u)$. The good is traded internationally for the price p_r. There is a minimum wage in both labour markets (educated and uneducated) such that $w_s > \overline{w_s} = w_s^*$ and $w_u > \overline{w_u} = w_u^*$, where * indicates the market clearing wage. The assumption of a minimum wage may be debatable for developing countries, where governments typically fail to maintain strict labour market regulations.[7] But there are several more realistic ways to interpret it. First, it may be the 'socially acceptable' wage which educated and uneducated labour is ready to work for in a particular country due to social status. Second, it may be the wage necessary to cover the exogenous costs of living, which may be relatively high.[8] The price of the natural resource, the production technology and the minimum wage are determined exogenously. Firms rent the optimal level of capital from international capital markets and decide on the optimal level of employment such that $r = p_r q_k{}'$, $w_s = p_r q_{L_s}{}'$ and $w_u = p_r q_{L_u}{}'$.

The total number of educated and uneducated workers is given by $N = N_s + N_u$. As a result of the minimum wage, there is involuntary unemployment in both markets. It is assumed that uneducated workers cannot be employed as educated workers. Moreover, we assume that due to better outside options educated workers prefer to remain unemployed if not offered a position which befits their education (Teal, 2011). In both labour markets places are attributed randomly. Thus, the probabilites of being employed as an educated worker and as an uneducated worker are $\frac{L_s}{N_s}$ and $\frac{L_u}{N_u}$ respectively. As in Harris and Todaro (1970), the expected wages of educated and uneducated workers are given by

$$w_u = \overline{w_u}\frac{L_u}{N_u}$$
$$w_s = \overline{w_s}\frac{L_s}{N_s} \qquad (1)$$

[7] In Kazakhstan, a minimal wage imposed by the government has officially existed since the collapse of the Soviet Union; this wage is not always enforced and typically is below the minimal costs of living.

[8] This is very important in the case of Kazakhstan due to its harsh climatic conditions; these make costs of housing (to reach a minimum quality standard), winter clothing, etc. high, while necessary for survival.

By construction the change in expected wages is determined by the probability of being employed in a particular capacity. Note that the relative change in expected wages is driven by the educated labour intensity in the industry and the relative size of the labour market.

Every household consists of one worker and one child. Individuals live for one period only and have the following utility $u_i = \ln c_{1,i} + \beta \ln c_{2,i}$. $c_{1,i}$ is representing the current consumption of household i. $c_{2,i}$ represents the child's consumption in the subsequent period which is weighted with β. The intertemporal budget constraint is given by $y_i + \frac{w_{2,u}}{1+r} + \frac{e_i(w_{2,s}-w_{2,u})}{1+r} - e_i\theta = c_{1,i} + \frac{c_{2.i}}{1+r}$. $y_i \in \{w_i; \overline{w_s}; \overline{w_u}\}$ indicates the household income in period i, whereas w_i represents income from the informal sector. e_i is equal to one if the household decides that the child should receive tertiary education and is zero otherwise. If the child successfully completes her education she is considered to be an educated worker. There is heterogeneity among children in their ability to receive education and it is costlier to educate a less able child. Ability is assumed to be uniformly distributed such that the costs of receiving education are also uniformly distributed $\theta_i \sim U[0; \Theta]$.$\Theta$ indicates the costliest education. Households are perfectly informed about the conditions in the labour market and the ability of their own child such that income maximizing households make their decision based on the following rule:

$$\frac{w_{2,s}-w_{2,u}}{1+r} = \theta^* \qquad (2).$$

The costs of the marginal child to get education $\theta*$ increases as the expected return from education increases. Denoting the share of children who have an incentive to receive tertiary education by S_{θ^*} and using the assumption of the uniform distribution we get:

$$\frac{w_{2,s}-w_{2,u}}{(1+r)\Theta} = S_{\theta^*} \qquad (3).$$

Denoting total absorption $A = L_s\overline{w_s} + L_u\overline{w_u} + (N - L_s - L_u)w_i$ we can derive an expression for the average share of expenditure on education

$$\frac{1}{A}\int_0^{\theta^*} \frac{1}{\Theta}\theta d\theta \qquad (4).$$

Taking the first derivative with respect to $\theta*$ gives $\frac{\theta^*}{A\Theta}$ which is positive, suggesting that the share of total expenditure spent on education should increase as the ability of the marginal worker decreases. The intuition of this simple model is straightforward. In the first period agents observe the current labour market and adjust their expectations about the future. According to the expectations formed, agents decide whether to invest in their children's tertiary education. During an oil price boom p_r increases and affects the relative expected wage of educated and uneducated labour (see equation 1).

Proposition 1: If expected return to tertiary education increases during the resource boom the share of households investing in tertiary education increases.

4. Data

The data employed in the analysis is from the Household Budget Survey of Kazakhstan (2001–2005). The survey was created by the SARK in cooperation with the World Bank (World Bank, 2004). Since then it has been conducted on a quarterly basis and was positively evaluated by IMF (2003) in 2003. The questionnaire contains detailed information on wages, employment, and, most importantly for the underlying research question, education.

The data is a stratified multi stage cluster sample consisting of 12,000 households in each round (IMF, 2003; World Bank, 2004). The household sample has been selected from a household register, which is based on the 1999 population census. The survey is considered to be representative on provincial and national levels. In the first stage, within each province (except Almaty and Astana), areas have been appointed into 4 strata: large cities, medium cities, small towns, and rural settlements. In the second stage, primary sampling units with at least 150 households have been chosen in each stratum. Within each primary sampling unit, households were sampled with sampling probability proportional to the size of the household and thirty households were listed (10 additional households were listed as replacements). Given the homogeneity in weights, the sample can be considered to be self-weighted. Thus, we prefer to use the unweighted specification and weighted results are available upon request.

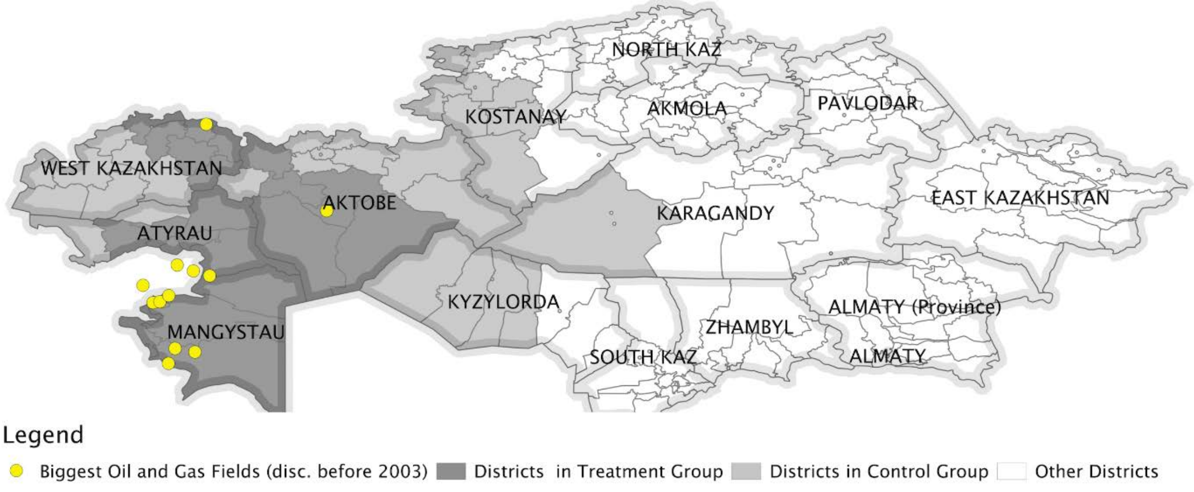
Officially the data set is categorized as a repeated cross section. It is a perfectly balanced panel within a year as households are surveyed quarterly. Yearly, approximately 25% of the households are replaced by new households. Thus, some households are surveyed for only one year, whereas others remained in the survey for more than 4 years. The introduced rotation allows us to construct an unbalanced panel across years by identifying households who remain in the sample. The household ID does not change as long as the household remains part of the survey. Once a household is dropped from the survey, the ID is assigned to another household which is newly added to the survey. Hence, we use household characteristics unlikely to change, to identify the panel dimension of the household. In particular, we use household ID, dwelling type, size of the dwelling, the year the house was build, sex, date of birth and ethnicity of the household head. We conduct the analysis of wages and employment on the quarterly level. Information on education expenditure is collapsed up to the yearly level. This is done to avoid fluctuations of education expenditure within a year.

The panel structure is subject to attrition. Households and individuals which did not participate in the survey for a complete year have been dropped. The complete case method has been chosen because dropping households and individuals resulted in a loss of 3% of the total sample on the household level and 5% on the individual level. Both numbers represent a small share of the sample and thus are quite unlikely to affect the consistency of our estimates.

In Table 4 a description of the main variables may be found. Means and standard deviations are presented for the oil rich districts (ORD) and the oil poor districts (OPD) (see next section for a definition of the oil rich districts). The data on provincial inflation has been taken from the SARK (2011). The geometric mean of yearly inflation is used to receive real values. The exchange rate at the end of the year 2000 was 144.5 Tenge/US$, such that average yearly real household expenditure in the sample is around 2450 US$ in the oil rich districts and the average real household expenditure is slightly above 1820 US$ in the oil poor districts.

For spatial identification of the resource rich districts, we construct a dataset with the location of oil and gas fields which are operated by the biggest consortia (producing in total circa 95% of oil and gas in 2004) in Kazakhstan. We spatially link the location of the oil fields to the location of households on the district level. Unfortunately, the SARK was not willing to share the precise location of households. Information on the consortia, most importantly their location, is provided in Table 3 and Figure 2.

Figure 2: Oil rich provinces of Kazakhstan



Notes: The locations of the major consortia listed in Table 3 have been used to identify treatment and control groups. Consortium: a partnership of more than one individual, firm or government (or any combination of these) with the mission to achieve a common goal by participating in a common activity and polling resources

Figure 3: Proportion of households reporting the payment of tuition fees

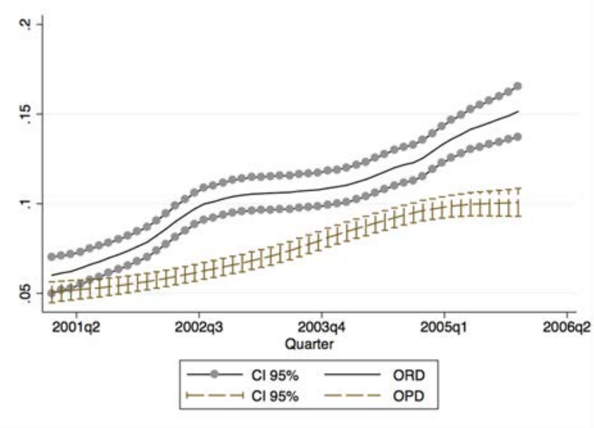
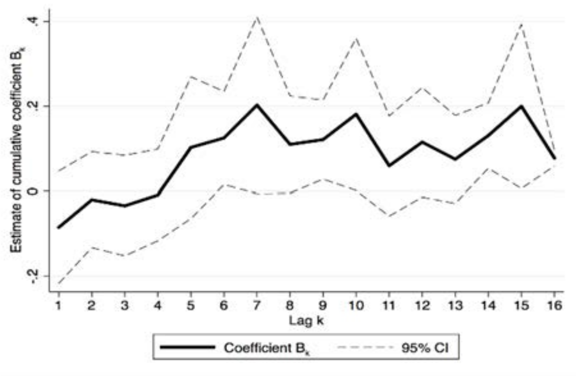


Figure 4: Employment in the Formal Sector



Notes: Here we plot the lagged coefficients β_k from the specification 5. Note that the β_k is bold, which captures the fact that this is the estimate of the cumulative effect of the oil price on the outcome variables and is essentially the sum of the β_k up to lag k in specification 5 (see the discussion on the linear transformation of the model in the previous section)

The data for the oil price was taken from EIA (2012), where the oil price is reported on a monthly basis in US$ per barrel for West Texas Intermediate (Spot Price FOB). The quarterly oil price is calculated by taking the arithmetic mean of the monthly oil prices. The oil price has been transformed into logged values for the empirical analysis to allow for a simpler interpretation of the results.[9]

[9] We understand that part of the oil and gas exported by Kazakhstan is sold to its neighbour countries of the former Soviet Union (especially Russia), with the price level typically lower than on the global markets. However, this price is highly correlated with the price on the global market.

5. Identification and estimation

Our identification strategy is basically a difference-in-difference or difference-in-difference-in-difference estimators, depending on the hypothesis we test. In our difference-in-difference specification we exploit two types of variation. Firstly, we look at the distribution of oil fields across districts. The treatment group is composed of households living in oil-rich districts; the control group consists of households living in oil-poor districts. Districts are defined as being oil rich if an oil or gas field which is operated by one of the biggest consortia[10] (producing in total circa 95% of oil and gas in 2004) is located within a district. The locations of the major consortia are listed in Table 3. Unfortunately, our identification strategy does not allow us to identify cities as being oil rich. This is because cities rarely contain an oil or gas field within their borders. On the other hand, cities in oil rich regions typically significantly benefit from a boom due to developing forward and backward linkages and, more importantly, the spending effect (Corden and Neary, 1982). Thus, we add Atyrau and Aktau, the two cities which are located in the core of the oil rich district to the group of oil rich districts. There is plenty of evidence that both cities significantly benefit from the oil boom (Auty, 2008; Pomfret, 2005). Dropping the cities does not significantly affect our results.

Figure 2 illustrates the allocation of oil poor and oil rich districts (denoted as OPD and ORD henceforth) in the five provinces of Kazakhstan we investigate. We focus on the five provinces in Kazakhstan in which the total amount of oil is produced (see Figure 9). While using sub-national variations in general it is helpful to limit the unobserved heterogeneity (Snyder, 2001), focusing on a limited number of provinces located in a particular part of the country allows us to reduce this problem even further by looking at territories with homogenous climate, environment, ethnic and economic structure.[11]

Second, the exogenous fluctuations in the oil price affect economic profitability of oil and gas reservoirs, change the level of activity in the oil and gas sector and eventually affect local

[10] Consortium: a partnership of more than one individual, firm or government (or any combination of these) with the mission to achieve a common goal by participating in a common activity and polling resources.

[11] One could argue that fixed effects could be used to account for these differences. However, fixed effects do not account for different trends which might result from difference in initial conditions and thus violate our identification strategy. We have repeated our analysis using the rest of Kazakhstan as a control group and our results do not differ significantly.

labour markets in oil rich districts. Kazakhstan is not part of any cartel on the resource markets (like the OPEC), does not dominate the oil markets (even locally, where it has to compete with Russia and other fossil-fuel-rich Central Asian states) and can be essentially considered a price-taker on the global oil markets.

For our diff-in-diff-in-diff specification we require one more source of variation which is the individual's level of education for which we construct a dummy. We define as educated an individual, who possesses some form of tertiary education: either a university degree or vocational training (*technikum*). The decision to look at the dummy for tuition fees as a dependent variable is driven by several considerations. First, it is more appropriate in terms of our theoretical model, which looks at educational investment as binary choice. Second, the information on the exact amount of spending for education is often imprecise, partly because of widespread corruption in the Kazakhstani educational system, but also because it is not easy for households to clearly attribute certain types of expenditure to 'education'. Paying tuition fee, however, clearly indicates that a member of the household is receiving education, and we can avoid these measurement problems.

Regression 5 presented below is estimated using quarterly data (the highest frequency data available to us). Model 6 is estimated using annual data. This is because tuition fees are typically paid once a year and thus the quarterly variation of this indicator is not informative (typically, it results from difference in the accounting procedures of schools).

We expect that the effect of a resource boom on the local labour market may not be immediate and may be delayed by several quarters or years. For example, enrolment in an educational facility is typically possible only in a particular month (September) and may require specific preparations and a substantial search effort. Wage increases and hiring decisions are also not realized immediately. Thus, we estimate a set of distributed lag models. Including several lags of the oil price directly would result in substantial multicollinearity. Hence, we follow the standard approach of the time series econometrics and transform the equation, transforming all the lags but the last into first difference.[12] This transformation eliminates the problem of multicollinearity and at the same time allows us to interpret the estimated coefficients as an accumulated effect of the oil price on economic outcomes.

[12] In particular, a linear transformation is employed in the following form (where y is a function of x): $y_t = \beta_1 x_t + \beta_2 x_{t-1} + \cdots + \beta_{z+1} x_{t-z} = \beta_1 \Delta x_t + (\beta_1 + \beta_2)\Delta x_{t-1} + \cdots . + (\beta_1 + \beta_2 + \cdots + \beta_{z+1}) x_{t-z}$

To formally test whether returns to education increased during the boom, we estimate equation 5 by focusing on two variables affecting returns to education, the real wage and the probability to be employed as an educated or an uneducated worker (see equation 1):

$$y_{i,d,t} = \sum_{k=1}^{16} \alpha_k \ln(OP_{t+1-k}) D_d + \sum_{k=1}^{16} \beta_k \ln(OP_{t+1-k}) D_d e_i + x_{i,d,t}{}'\zeta + \epsilon_{i,d,t} \qquad (5)$$

$$\epsilon_{i,d,t} = d_d + \gamma_t + e_i + e_i d_d + e_i \gamma_t + \upsilon_{i,d,t}$$

$y_{i,d,t}$ is the outcome variable of individual i, in district *d* in period *t* and is either the logged real wage of individuals employed in the formal sector or the probability to be employed as an educated worker (see Table 4). The latter is captured by a binary variable indicating whether or not an individual is employed in the formal sector (private and public).

The use of these dependent variables requires clarification. Kazakhstan, as many other developing countries, has a large informal employment. As of 2009, roughly one third of Kazakhstani employment occurred in the informal sector, with 62% of this informal employment being agricultural (for discussion of informal employment see Rutkowski (2011)). For the purpose of this paper, however, we concentrate on employment in the formal sector. This for two reasons: a conceptual one and a data-driven one. First, the wage premium associated with the need to use high-educated labour in oil and oil-related sectors is unlikely to be paid to informal employees. It also holds for the data in our sample: the average wage received in the formal sector is seven times larger than the wage received in the informal sector. In addition, foreign investors and state-owned companies, which dominate the Kazakhstani oil sector, are restricted in their ability to use informal labour, particularly in those positions with certain responsibilities (as are most educated labour jobs). It is not surprising therefore that the share of informal employment for professional and technical positions in the total employment is very low (as of 2009, it was 3% and 9% respectively, according to Rutkowski (2011)). Second, while the data we have contains numerous respondents, who identified themselves as being engaged in various forms of informal employment (particularly in the agricultural sector), in the case of Kazakhstan it is very difficult to actually separate informal employment from unemployment. Given the very low level of unemployment benefits, most unemployed are forced to take at least short-term jobs or engage in subsistence agriculture (true even for an urban population). Thus, we apply a restrictive definition, focusing on long-term formal employment. We look at both public and private employment, because oil extraction in Kazakhstan is partly carried out by the state-owned company, KazMunaiGaz.

OP_{t-x} is the yearly logged oil price in US$. We allow up to four years for the oil price to trickle down and a affect the local labour markets and the individual house-hold decisions; *Ds* is a dummy variable, which takes the value one if the household is located in an oil rich district and zero otherwise; e_i is a binary variable indicating whether an individual has received a tertiary education or not (as de ned above); $x_{i,s,t}$ is a vector of individual specific characteristics controlling for observables: sex, age and ethnicity; d_s are district specific fixed effects; γ_t are quarterly fixed effects to control for common quarterly shocks; $\upsilon_{i,s,t}$ is the individual specific error. Thus, we allow the resource boom to have different effects on the educated and the uneducated labour forces. Hence, the purpose of this model is to identify a change in incentives to receive a tertiary education in the oil rich relative to the oil poor districts.

To evaluate our main proposition we estimate the following specification:

$$y_{h,d,t} = \sum_{k=1}^{4} \beta_k \ln(OP_{t+1-k}) D_d + x'_{h,s,t}\zeta + \alpha_h + \gamma_t + \upsilon_{h,d,t} \tag{6}$$

$y_{h,d,t}$ is the outcome variable of household h, in district d, in year t. The outcome variable is a binary variable indicating whether a household reported paying tuition fees for a university or a *technikum*; $x_{h,d,t}$ is a vector of household specific characteristics controlling for observables: education and sector of occupation (public, private, agriculture) of the household head, household size and household size squared; α_h is household fixed effect; $\upsilon_{h,d,t}$ is the household specific error. This model tests whether there is indeed an increase in spending on education as a response to changing incentives.[13]

Assuming that the error may be correlated over time within a household and across households from the same district in the same period, Angrist and Pischke (2009) suggest clustering at the district level, the highest possible level of clustering.

[13] All estimations for binary dependent variables are obtained using linear probability model (LPM). The application of LPM vs. logit or probit in this context is subject to debate; LPM is advocated, for example, by Angrist and Pischke (2009), particularly for the case of large samples. For us, using LPM is important because our analysis heavily relies on multiple interaction terms and a complex panel data structure, which makes interpretation of marginal effects in logit or probit extremely difficult (on interaction terms in probit or logit see Ai and Norton, 2003).

Essentially, this means that we estimate two models. In the first model we employ district fixed effects and compare labour market outcomes following the oil price boom on the wage of the educated, and the probability of being employed as an educated worker in comparison to the uneducated. Here our units of observation are individuals and we use quarterly data. In our second specification our units of observation are households and we use yearly data. Here we test whether households actually increase their expenditure on tertiary education using household fixed effects.

6. Results

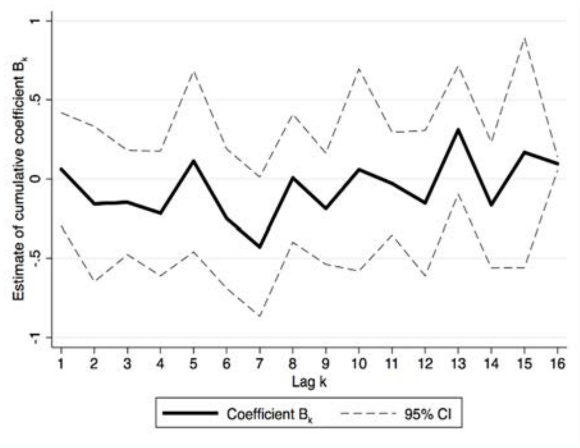
As a first step in discussing the implications of the resource boom for educational expenditures, we start with a simple comparison of means for resource-rich and resource-poor districts in the beginning and at the end of our sample. This should give us the first intuition regarding the change in the spending patterns and, essentially, represents the simplest form of the difference-in-difference approach. Results are reported in Table 1. One can see that the share of expenditures on food and on daily non-food items decreased significantly during the oil boom. This is consistent with Engel's law which suggests that income elasticity of demand for food is between 0 and 1. On the other hand, expenditure shares on services and education seemed to have increased significantly during the resource boom, suggesting an income elasticity of above one. In particular, expenditure on education doubled during the resource boom increasing the share spent on education from 3% to 6%. Figure 3 plots our main variable of interest (binary variable, which equals 1 if a household reported the payment of tuition fees for graduate studies) over time. Thus, it looks as if the oil boom was indeed associated with growing educational spending on tuition fees in graduate education.

Table 1: Shares of total household expenditure on different types of goods across districts and years

Variables	ORD[+] (2005)	ORD (2001)	ORD Difference	OPD[++] (2005)	OPD (2001)	OPD Difference	Diff –in-Diff
Food	44%	59%	–15%	45%	56%	–11%	–4%*
Daily Expenditure (excl. Food)	8%	11%	–3%	11%	10%	–1%	–2%*
Clothing	11%	7%	4%	10%	7%	3%	1%
Durable Expenditure (excl. Clothing)	6%	2%	4%	4%	2%	2%	2%*
Education	6%	3%	3%	4%	2%	2%	1%**
Health	2%	2%	0%	2%	2%	0%	0%
Services	4%	2%	2%	3%	2%	1%	1%**
Transport	3%	3%	0%	3%	3%	0%	1%
Utilities	6%	6%	0%	6%	6%	0%	0%
Fuels	2%	2%	0%	4%	4%	0%	0%
Sum	>90%	>90%		>90%	>90%		

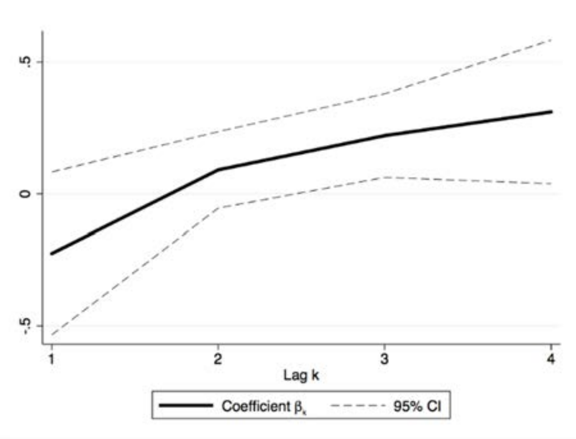
[+]Oil Rich Districts, [++]Oil Poor Districts.

Figure 5: Real Quarterly Wage in the Formal Sector (logged)



Notes: Here we plot the lagged coefficients β_k from the specification 5. Note that the β_k is bold, which captures the fact that this is the estimate of the cumulative effect of the oil price on the outcome variables and is essentially the sum of the β_k up to lag k in specification 5 (see the discussion on the linear transformation of the model in the previous section).

Figure 6: Probability that a household pays tuition fees



Notes: Here we plot the lagged coefficients β_k from the specification 6. Note that the β_k is bold, which captures the fact that this is the estimate of the cumulative effect of the oil price on the outcome variables and is essentially the sum of the β_k up to lag k in specification 6 (see the discussion on the linear transformation of the model in the previous section).

A more thorough analysis is based on specifications presented in the previous section. The results from estimating (5) using the logged real wage and the probability to be employed in the formal sector are presented in Figures 5 and 6, respectively. Here we plot the lagged coefficients β_k from the specification (5). Note, however, that the β_k is bold, which should capture the fact that this is the estimate of the cumulative effect of oil price on the outcome variables and is essentially the sum of the β_k up to lag k in specification (5) (see the discussion on the linear transformation of the model in the previous section). Thus, Figure 4 suggests that the cumulative effect of oil price fluctuations becomes significant after slightly more than a year. The coefficient suggests that a 10% increase in the oil price increases the probability of being employed as an educated worker in the formal sector relative to an uneducated worker by 1 percentage point. Figure 5 plots the cumulative coefficients for the wage regression and shows that it is not affected by the resource boom. While it fits our model, this may be partly driven by the fact that the resource boom triggers a substantial immigration of educated labour force into resource-rich districts, thus diluting the possible wage response; this will be further discussed in the next section.

The results from estimating specification 6 are presented for several alternative specifications in Table 2. Most of the specifications will be discussed in the next section on the robustness of our results. Here, the main result (column two in Table 2) is plotted analogously to the results above in Figure 6 (again, using annual and not quarterly data). The results are unambiguous: an oil price boom leads to an increase in the probability of a household paying tuition fees with a two-year lag. In particular, a 10% increase in the oil price increased the probability that households pay tuition fees by 3 percentage points. This should be interpreted as evidence that at least some members of the household have begun studies at a university or vocational training institution. The results are entirely consistent with the theoretical model we developed and, ultimately, demonstrate that a resource boom in Kazakhstan triggered both an increase in employment opportunities and also in demand for education.

Table 2: Dependent variable: Binary variable indicating expenditure on tuition fees for tertiary education

	FE1 (1)	FE2 (2)	FE3 (3)	FE4 (4)	FE5 (5)	FE6 (6)
β_1	–.226 (0.157)	–.227 (0.157)	–.246 (0.165)	–.348 (0.29)		–.520 (0.234)**
$\beta_1 + \beta_2$	0.09 (0.074)	0.092 (0.073)	0.094 (0.074)	0.262 (0.117)**	0.166 (0.132)	0.135 (0.093)
$\beta_1 + \beta_2 + \beta_3$	0.22 (0.081)***	0.218 (0.081)***	0.206 (0.081)**	0.306 (0.146)**	0.31 (0.159)*	0.233 (0.133)*
$\beta_1 + \beta_2 + \beta_3 + \beta_4$	0.311 (0.139)**	0.306 (0.139)**	0.304 (0.141)**	0.616 (0.279)**	0.406 (0.232)*	0.53 (0.248)**
Controls	N	Y	Y	Y	Y	Y
Tertiary Institutions	N	N	Y	N	N	N
Province-Year FE	N	N	N	Y	N	N
District Trend	N	N	N	N	Y	N
Reduced Sample	N	N	N	N	N	Y
Obs.	6521	6521	6521	6521	6521	2308

Notes: Standard errors adjusted for clustering at the district level are in parentheses : *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Household fixed effects, time fixed effects, household size and household size squared are included in every regression. The full set of household head characteristics includes education and occupation. In column 3 we control for the number of tertiary institutions on the province level. In column 4 we control for province year fixed effects. In column 5 we control for district specific trends. In column 6 we keep only households, which have been part of the sample since the beginning of the boom (2001).

Table 3: Accumulative Production of main oil and gas consortia between 2001–2005 (Oil and Gas in 1000 tonnes), ownership and location (Munayshy Public Foundation, 2005)

Name	Major Owner	Cum. Prod.	Share (in %)	Province	District	Webpage
Kazakhstan	–	265000	100%	Aktobe, Atyrau, Kyzylorda, Mangystau, West Kazakhstan	–	–
TengizChevroil	Chevron, ExxonMobil, KazMunayGas, LukArco	65500	25%	Atyrau, Mangystau	Zhylyoyskiy (Atyrau), Beyneusky (Mangystau)	www.tengizchevroil.com
EmbaMunayGas	KazMunayGas	13000	5%	Atyrau	Kzylkoginsky, Isatayisky, Makhambetskiy, Makatskiy, Zhylyoyskiy, Atyrau (city)	www.kmg.kz
UzenMunayGas	KazMunayGas	27000	10%	Mangystau	Manghystauskiy, Karakhiyanskiy, Zhanozen (city)	www.kmg.kz
MangystauMunay Gas	Central Asia Petroleum Ltd. (until 2009)	25000	9%	Mangystau	Manghystauskiy, Karakhiyanskiy, Tupkaragansky, Zhanozen (city), Aktau (city)	www.mmg.kz
Karazhan-basmunai	Canada's Nations Energy Ltd. (until 2006)	10000	4%	Mangystau	Tupkaragansky, Manghystauskiy	www.kbm.kz
Karasha-ganak	BP Group, ENI	36000	13%	West Kazakhstan	Burlinski	www.kpo.kz
Actobemunaigaz	CNPC	24000	9%	Actobe	Temirskiy, Mugalzharskiy, Baiganinskiy	www.cnpc.ch
Kazakhoil Actobe	KazMunayGaz, LukOil	3500	1%	Actobe	Temirskiy, Mugalzharskiy, Baiganinskiy	www.koa.kz
PetroKazakhstan	PetroKazakhstan (until 2005)	23000	9%	Kyzylorda	Syrdarinskiy	www.petrokazakhstan.kz
PetroleumTurgai	LukOil, Hurricane Kumkol Munai	13000	5%	Kyzylorda	Syrdarinskiy	www.turgai.kz
KazGermunai	JSC Yuzhneftegaz, Feba Oil AG, Erbdol, Erdgras Gommern	8500	3%	Kyzylorda	Syrdarinskiy	www.kazgermunai.kz

Table 4: Description, mean and standard deviation of the main variables on the individual and the household level

Variables	Description	Mean (ORD)	SD (OPD)	Mean (OPD)	SD (OPD)
Sample Size	Number of Household observations Cross-section *Time periods (N*T)	3069	–	6036	–
Yearly real household expenditure (logged).	Aggregated yearly household expenditure in Tenge. Provincial inflation from the SARK (2011) is used to discount the values to the end of 2000.	12.62	0.56	12.34	0.52
Education Share	Share of total expenditure spent on tuition fees	0.02	0.05	0.014	0.04
Household Size	Total number of people in a household.	4.7	2.3	4	2
Sample Size	Number of Individual observations Cross-section *Time periods (NT)	33084	–	53520	–
Higher Education	Proportion of individuals who received a higher education	0.11	0.32	0.16	0.36
Vocational Training	Proportion of individuals who received vocational training	0.37	0.48	0.32	0.47
No Tertiary Education	Proportion of individuals who received up to complete secondary education	0.52	0.5	0.52	0.5
Employment	Share of those who reported to be employed in the formal sector (public sector or firms in the private sector (incl. farms))	0.45	0.5	0.43	0.49
Quarterly real wage (logged)	Quarterly real wage of those employed in the formal sector. Provincial inflation from the SARK (2011) is used to discount the wage to the end of 2000	10.5	0.82	10.1	0.74

Table 5: Number of *Technikums*/Universities in oil-rich provinces of Kazakhstan

	Number of *Technikums*					Number of Universities				
Years	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
Aktobe	13	13	13	15	16	6	6	6	7	7
Atyrau	9	8	10	11	11	3	3	3	3	3
Kyzylorda	11	14	15	18	18	8	7	6	6	6
Mangystau	11	11	12	13	14	4	4	5	4	3
West Kazakhstan	9	9	10	10	10	5	5	6	6	7

7. Discussion

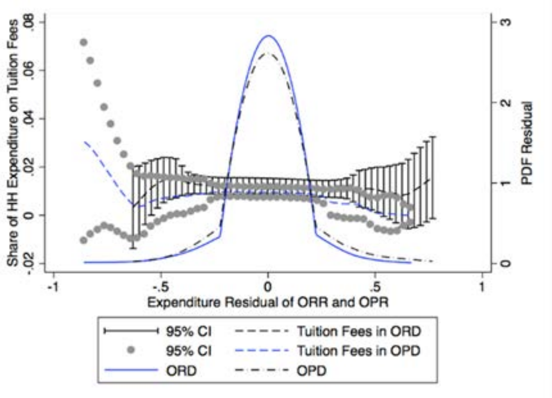
7.1 Is our result driven by Engel curve?

The results reported so far are definitively consistent with our original theory. However, we still have to rule out another equally important explanation: our results may simply represent the Engel curve effect. Since, oil-rich districts experienced a faster growth in income, one could expect the share of expenditure in superior goods (including education) to increase relative to other expenditure. In what follows we present some evidence that this is unlikely to drive the results.

Engel curves in resource-rich and resource-poor districts: Assume that we look at two households in oil-rich and in oil-poor districts, who have exactly the same absolute level of expenditure. Then these households, given the Engel curve effect, should have the same share of educational expenditure. This does not mean that the aggregate expenditure for education in oil-rich and oil-poor districts are the same: the population of oil-rich districts may include a larger number of households with higher expenditure, spending relatively more on education. The match should persist throughout the resource boom: its only effect would then be growing expenditure of the population, translated into a larger number of high-expenditure individuals with a larger share of expenditure on education. Graphically, if we plot the Engel curves (i.e., the effect of income on the share of educational expenditure) for both groups, these graphs should coincide. On the other hand, if households in the oil rich districts have a higher incentive to invest in education, the Engel curve for educational expenditure should shift upwards after the beginning of the boom. This is theoretically captured in equation 4.

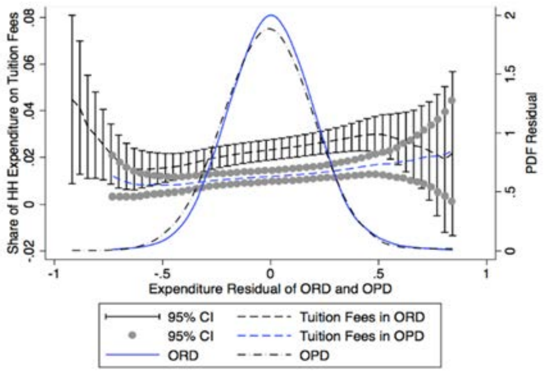
Figures 7 and 8 depict the shape of Engel curves for the resource-rich and resource-poor districts in 2001 (i.e. the beginning of the resource boom) and 2002–2005 (during the boom). The coefficient of logged household expenditure is estimated using non-parametric polynomial smoothing after partialing out household fixed effects, time fixed effects and household size. As shown in Figure 7, the Engel curves of both groups are almost identical in 2001. After 2001, however, the situation looks entirely different as presented in Figure 8. The Engel curve for the resource-rich districts is significantly above the Engel curve for the oil poor districts for the central part of the distribution. This suggests that, from the beginning of the boom households in the resource-rich districts spent more on tertiary education than comparable households in the resource-poor districts.

Figure 7: Engel Curve in 2001



Notes: Non-parametric (local polynomial smoother) estimation of the slope coefficient of logged household expenditure after partialing out time fixed effects, household fixed effects and house-hold size. The distribution of logged household expenditure after partialing out time fixed effects, household fixed effects and household size is plotted in the background.

Figure 8: Engel Curve after 2001



Notes: Non-parametric (local polynomial smoother) estimation of the slope coefficient of logged household expenditure after partialing out time fixed effects, household fixed effects and house-hold size. The distribution of logged household expenditure after partialing out time fixed effects, household fixed effects and household size is plotted in the background.

Figure 9: Share of National Oil Production (SARK, 2011)

Figure 10: Growth rates of the number of students enrolled in *technicums* in Kazakhstan, based on official statistics

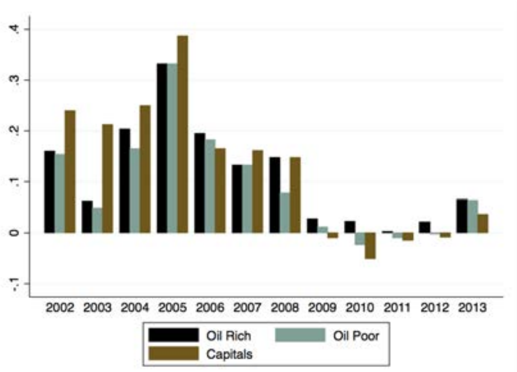
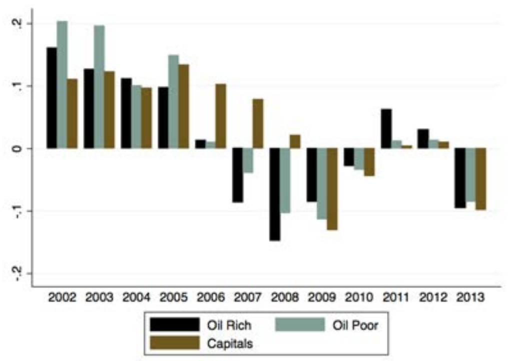


Figure 11: Growth rates of the number of students enrolled in universities or equivalent educational institutions in Kazakhstan, based on official statistics



Income and expenditures: An indirect argument against the Engel curve interpretation of our results can be extracted from Toews (2014), who shows that in Kazakhstan in oil-rich districts the increase of reported income as a result of the resource-boom was substantially stronger than the increase of reported expenditure, which essentially remained the same. If that is the case, we should not expect the Engel curve effects to drive our results. Toews (2014) explains his finding by the shift of employment from the informal to the formal sector, which made people more honest in acknowledging their income in the survey. This is also a possible interpretation of our results: as mentioned, we define employment merely as 'formal employment'; the alternative is likely to be not only 'pure' unemployment, but also various forms of informal labour activity. However, educated workers typically receive a larger premium from formal employment relative to that received by uneducated workers (e.g. Gunther and Launov (2012)). Hence, the increase of opportunities for formal employment (even if these mean a shift from the informal to the formal sector) should be an incentive strong enough to stimulate educational expenditures.

7.2 Is our result driven by an increased supply of education?

The growing educational expenditures may have been driven by the supply effect. This implies that the oil boom resulted in a substantial growth of the availability of tertiary education (e.g. new universities and *technikums* were established, more funding to the educational system was provided), and as a result people received greater opportunities to study. Stated otherwise, the supply effect still suggests that there is a positive link from resource booms to education. However, it is not driven by the demand of households, but by the increased provision of public goods by the government. In our model this would be equivalent to a decrease in θ. Much of the tertiary education in Kazakhstan is still provided by the government, and most decisions regarding the supply of tertiary education are made at the central or provincial levels. District authorities have negligible powers in the political hierarchy in Kazakhstan. More importantly, provinces are a typical unit of educational planning (World Bank, 2005b). Thus, any supply effect is invariant for all households located in the same province in a particular period of time.

There are at least two ways to deal with the possible supply effect: quantity and quality of the tertiary education provided. In the first step we control for the number of universities and *technikums* in a particular province and year. The results of this specification are presented in the third column of Table 2. Controlling for the number of tertiary institutions on the province level does not affect our estimated coefficients significantly. From the raw data presented in Table 5, we know that the numbers of universities and *technikums* were quite similar and followed a similar development. The number of *technikums* in five provinces we focus on increased by 31.9%. In comparison, the number increased by 32.2% in the 'capital cities' (Almaty and Astana)[14] and in the rest of the country (resource-poor provinces) by 30.1%. The number of universities has barely been affected across provinces.

Second, the supply effect was possibly driven by an improvement in the quality of education provided in different parts of Kazakhstan. Here we have to rely on province-level analysis; however, as mentioned, decisions regarding educational expenditure are made at province level. Since 2008, Kazakhstani government has been publishing a rating of provinces of Kazakhstan in terms of education. The rating is based on several proxies (access to education, staff, financial and material resources and outputs), but most precisely capture the quality of educational services supplied. The oil-rich provinces, however, do not score well in these ratings. Atyrau in 2008–2010 scored 10th, 9th and 9th respectively out of 16 provinces; Kyzylorda scored 14th, 14th and 11th; Mangistau scored 12th, 10th and 12th. The results are somewhat better for Aktobe (5th, 8th and 14th) and for Western Kazakhstan (8th, 5th and 6th), but even these provinces do not show impressive performances, as opposed to some oil-poor provinces, like Pavlodar, Kostanai or Karaganda (Ministry of Education of Kazakhstan, 2011). One could of course hypothesize that the situation in the oil-rich districts was even worse before the start of the boom. However, this is unlikely because Kazakhstan inherited its educational system from the Soviet Union, and in the USSR the regional variation the educational quality (except for a very few leading centres) was very low due to the targeted efforts of the central government.

More generally, educational expenditure on the province level implies that all supply changes should be captured by province-time fixed effects. The results of this specification are presented in the fourth column of Table 2. If anything, the results suggest that the effect should become stronger. Certainly, the private educational sector is not constrained by these

[14] Throughout the Soviet period, the capital of the Kazakh Soviet Republic was Almaty. It remained the capital of independent Kazakhstan until 1997, when the government was transferred to the new capital, Astana. However, Almaty remains an important business and education hub, and thus should be treated, similarly to Astana, as a special region of Kazakhstan. In particular, most important universities have been traditionally established in the capital cities.

institutional features in its development; but it is unlikely that private educational facilities are created unless there is a demand for their services, and therefore the supply effect cannot be driven by this group.[15]

7.3 Is our result driven by educated immigrants?

One could argue that more educated households moved into the oil rich districts during the boom. If educated households are more likely to spend a larger share of expenditure on education, the proportion of households reporting the payment of tuition fees should increase naturally. Thus, despite controlling for household fixed effects in our main specification, migration is an important confounding factor in our analysis and must be discussed.

On the one hand, while generally the inter-provincial migration in Kazakhstan is not very high,[16] it is likely to be much higher within provinces. On the other hand, large spatial distances across the regions of Kazakhstan[17] ensure that, for example, inhabitants of resource poor districts cannot accept a job in an oil or oil-related sector without migrating to the districts where the oil is extracted; therefore migration costs should have an effect on employment decisions. Unfortunately, we do not have information on the migration on district level. Thus, we conduct two additional tests to control for robustness.

First, we control for district specific trends which we expect to capture migration on the district level. The results are presented in column 5 of Table 2. Additionally, we re-estimate our main specification by focusing on those households which had remained part of the survey since 2001. The results are presented in column 6 of Table 2. The results in the case of the former and in the case of the latter suggest a larger and still significant cumulative effect in comparison to our main specification. In the case of the latter this is quite intuitive: households residing in the oil rich districts since the beginning of the boom did not have to consider migration costs and thus were more likely to invest in education. Note, however, that we obtain a significant and negative contemporaneous effect of the resource boom on the probability to invest in education. The

[15] Endowment universities and other forms of private schools operating through generous funding and thus not bound to short-term profit maximization are almost unheard of in Kazakhstan.

[16] Still, according to the Census data, in 1999–2009 internal migration in Kazakhstan increased almost fivefold; internal immigration to Kyzylorda and Atyrau provinces increased overproportionally by 12.1 and 9.8 times, respectively (Sange Research Center, 2009).

[17] The territory we are looking at is 4 times the size of UK or about 10% of the US.

intuition behind this result is likely to be the following. Following the increase in the oil price the first and most straightforward result is an increasing demand for the labour force, which decreases the willingness of local population to study given the immediate benefits to realize on the labour market (for the population in other districts the effect is absent – to benefit from resource boom, they need to migrate first, and it does not happen immediately). In the longer run, however, both local and non-local population start investing in education, to benefit from the opportunities provided by the resource boom to the educated labour force.

7.4 Is our result driven by peer effects and educational signalling?

The discussion so far has been based on an assumption that the growing oil sector is more likely to employ *any* individual with a tertiary education (university or vocational training degree). This point of view is entirely applicable if we look at education merely through the 'educational signalling' perspective, i.e. education does not result in increase of human capital, but rather makes it possible for the employer to separate the high-quality from the low-quality applicants. Otherwise, however, oil companies could be more likely to employ educated workers, but only if their education profile fits the demands of an oil company. This profile does not necessarily include only oil-related degrees: oil companies may be also interested in hiring general engineering or IT specialists or accounting and business experts. Unfortunately, Kazakhstani oil companies do not disclose detailed information on the educational background of their employees, and our data do not contain information on what the members of the households in our sample actually study. Still, in this section we attempt to collect some information on how the study profiles fit the possible demand of the oil industry to refine our conclusions.

To start with, as mentioned, in our data we define as 'education' two types of degrees: university education (which was originally based on the Soviet-style 5 to 6 years 'specialist' programs, and is currently organized in the BSc / MSc programs) and the vocational training (in *technikums*). However, in our sample only 10–15% of the population has a university degree; 30–40%, in contrast, have a *technikum* degree. Thus, it is most probable that our results are driven by those receiving education in *technikums*. Moreover, it is quite common in Kazakhstan to move to the capitals to study at university. Figures 10 and 11 in the Appendix report the change in the number of students at the universities and *technikums* in three areas of Kazakhstan: five oil-rich provinces, two 'capital cities' and the remainder of the country. For *technikums*, the results are straightforward: throughout the last decade, the number of *technikum* students in the oil-rich provinces was growing faster than in the rest of the country. Occasionally, it grew slower than in Astana and Almaty; however, one has to recognize that the main educational centres of the country are located in these cities, which therefore train many more students than are trained in any other part of the country (even the oil and gas industry heavily relies on educational facilities in the capital cities). At the same time, in terms of the number of students studying at universities, oil-rich provinces underperform as opposed to oil-poor provinces. Certainly, it is possible that students from oil-rich provinces study in other parts of the country as well (most likely in the capital cities), but, again, this confirms that the results we observe are probably driven primarily by *technikums*.[18]

The basic design of the Kazakhstani system of *technikums* is, as mentioned, inherited from the Soviet Union. These institutions concentrate on training students to become qualified workers and craftsmen. However, there have been certain changes in terms of enrolment rate, in specialization and in the financing mode, all of which we have to take into account. Most importantly, the structure of specializations undergone by the *technikum* students greatly changed during the post-Soviet era. UNDP (2004) claims that, for Kazakhstan, 60% of *technikum* students study the humanities, business or teaching. There is no detailed data on the district level, but some information can be obtained if we look at the number and specializations of *technikums* in various parts of Kazakhstan. As of 2012, five oil-rich provinces contained 96 public and 58 private *technikums*. Of these public *technikums*, only 7 specialized in the oil, gas and energy professions; and only one in construction. Fifty *technikums* did not list any particular specialization, and some also are known to offer more oil-related specializations (among other specializations). Twelve *technikums*, however, offered education in the humanities, the arts, business and teaching. In the private *technikum* sector, there was only one specialized oil and gas *technikum* (there were 2 construction *technikums* as well) versus 18 general-purpose and 29 humanities, law, arts and business *technikums*. Of course, the number of *technikums* may

[18] Interestingly, in Russia, which is probably the closest case in terms of comparison to Kazakhstan, we obtain a very similar outcome: in Tyumen province, which is the main oil extracting region of the country (and is also located in a rather hostile environment) the number of *technikums* increased between 2000 and 2003 by 30.1%, while the average growth rate in the Russian Federation excluding Moscow and St. Petersburg was 8.7%; in Kazakhstan the respective indicators were 23% for oil-rich and 20.8% for oil-poor provinces excluding capital cities.

not be representative for the number of students, but it is still unlikely that training for the oil and gas professions dominates the educational structure of the students.

Thus, in order to explain the actual growth of demand for education in Kazakhstan, we may need to adjust the original model. There are three possible explanations for what we find. First, as mentioned, is the educational signal argument: not the content of education, but the mere fact of having an education (and thus distinguishing oneself from other labour market participants) matters. It is important to point out that in many transition countries the link between actual specialization and the occupation became diluted during the post-Soviet transition, when the labour markets underwent fundamental change: we may be capturing the consequences of this effect. Second, the behaviour of students may be driven by peer effects. For example, if 'the best' students go to oil and gas related *technikums* and can benefit greatly from a higher income, other students may go to *technikums* merely imitating the behaviour of the best or in an attempt to keep up their social networks, even if their employment opportunities actually do not go up. There is evidence of this type of behaviour in developing countries as reported e.g. by Bobonis and Finan (2009); Kremer and Holla (2009). Third, Nguyen (2008), Jensen (2010a) and Emerson and McGough (2011) point out that the crucial feature in demand for education is not the actual education premium itself, but rather the expected returns to education, as assumed in out model. As discussed above, in many developing countries, this rather acts as a constraint on the demand for education. However, one could argue that, during an oil boom, expectations become overly optimistic, if fuelled by the observation of the actually growing demand of the oil industry for any kind of qualified labour.

We should stress that, if the second and third explanations are true, the demand for educated labour from the oil companies is still great enough to drive the observed increasing employment probability for educated labour in oil-rich districts. Nevertheless, we must point out that the actual mechanism driving the results of the study may be more complex than the stylized model we reported.

8. Conclusion

The paper intends to investigate whether increasing job market opportunities for educated labour may trigger private demand for education. Using a unique micro-level panel dataset from Kazakhstan, and applying the oil boom this country experienced in 2001–2005 as the identification strategy, we indeed confirm that the private demand for education went up. Our results are robust to various estimation techniques and controls. We are also able to show that the effect we see is not driven merely by the fact that education is a superior good and thus demand for education goes up simply because earnings go up.

We find that following the increased probability of being employed as an educated worker, the probability that households pay for tertiary education increases. There are two major implications of our results. First, more generally, we confirm that lack of employment opportunities constitutes a major constraint in demand for education in developing countries. Removing this constraint (or even providing a credible signal that it is going to be removed) may have a strong positive effect on demand for education. However, we acknowledge that in Kazakhstan, first, costs of education are not prohibitive due to the remaining educational infrastructure of the Soviet period and, second, the population already possesses a good basic education level, reducing the impact of possible information asymmetries. These assumptions do not always hold in developing countries and may constrain the effectiveness of the mechanism we have described in our paper.

Second, our paper also contributes to the general discussion of how resource boom can affect human capital accumulation. Basically, we claim that private households can at least partly compensate for the well-known inefficiencies of the government in terms of dealing with the resource revenue for education. However, this holds only under certain conditions, most prominently strong linkages of the oil sector to the local labour market (i.e. resource boom triggers increase of labour opportunities) and high educated labour intensity of the oil sector (due to technological and environmental challenges). For many developing countries these conditions may not be fulfilled, as the role of the local labour force in the oil extraction is very low. Furthermore, in our case there was very limited direct redistribution of oil gains for welfare purposes (Kazakhstan’s social security system is very weak); if this were greater, it could possibly discourage educational investments as well. Thus, our results can be seen as a set of conditions on how the private demand for education can be generated in the case of resource boom; whether these conditions hold depends on political economy considerations.

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