

Yusupov, Nurmukhammad

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Measuring the impact of road infrastructure on household well-being: Evidence from Azerbaijan

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ADB Working Paper Series

**MEASURING THE IMPACT OF
ROAD INFRASTRUCTURE ON
HOUSEHOLD WELL-BEING:
EVIDENCE FROM AZERBAIJAN**

Nurmukhammad Yusupov

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Nurmukhammad Yusupov is an assistant professor of finance at the Solbridge International School of Business in Daejeon, Republic of Korea.

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Please contact the authors for information about this paper.

Email: nyusupov@solbridge.ac.kr

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

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Abstract

Infrastructure is often seen as a critical factor in economic development. However, impact assessment for infrastructure projects is a challenge due to a number of methodological issues. Both developing economies and countries in transition could benefit from such studies to better inform their future policies. In this paper, we assess the impact of road construction on some aspects of household financial wealth in the target communities in Azerbaijan. To that end, we construct a two-wave data set with regional data and household characteristics, spanning the course of eight years, and estimate the differentials created by regional-level access to national roads. The results show that road treatment increased monthly rent by AZN83–AZN110 per month, which is 50%–60% of the mean monthly rent in the baseline year. Also, the self-assessed wealth increased by 0.9 to 3.1 units as a result of road construction, which is economically significant. Our study finds that gaining access to roads does indeed have a positive effect on financial wealth in some contexts. This may have implications for the selection of target communities or spatial sequencing in the infrastructure improvement efforts of policy makers.

Keywords: infrastructure, development, transition economies, Azerbaijan, household welfare

JEL Classification: O18, P23, G51

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1. INTRODUCTION

Roads are arteries of economic activity. Indeed, roads link economic agents and markets – producers with consumers, workers with employers, students with schools – and therefore play an essential role in any development agenda.¹ Thus, expansion of road infrastructure in the form of highways promises to increase wealth and create new opportunities for local businesses and households. Ultimately, it is to generate spillover effects through relocation of businesses, higher incomes of households, and increases in tax revenues for governments, as well as boosting overall economic activity in the affected localities.

Thus, the economic impact of infrastructure is a multidimensional and complex construct. Understanding how the development of transportation infrastructure affects economic development in general has substantial policy implications as such understanding can inform policymaking. Capital constraints for infrastructure initiatives are particularly hard for developing economies with thin domestic financial markets. This is especially relevant for transition economies such as Azerbaijan, for which, following the collapse of the Soviet Union, infrastructure development became a pressing issue. In the case of Azerbaijan, about three quarters of the country's entire road network was in poor condition in the early years of independence.

In this paper, we aim to measure the economic impact of road infrastructure in Azerbaijan, particularly in the context of labor market outcomes. To that end, we build a two-wave data set of household and community data based on publicly available official statistical data for the years 2010–2016. Overall results seem to suggest that gaining access to national roads in Azerbaijan does have a positive effect on wealth as opposed to the less developed communities excluded from access to national roads.

The rest of the paper is structured as follows. The following section provides a brief review of the literature on the relationship between infrastructure and economic growth. Section 3 discusses the context of Azerbaijan. Section 4 explains the estimation strategy, data, and empirical results. Section 5 concludes.

2. LITERATURE REVIEW

2.1 Infrastructure and Economic Development

In theory, road improvements, leading to lower transportation costs and enhanced mobility, offer a variety of benefits to businesses, including logistical benefits, easier business travel, and organizational improvements, that can be instrumental in boosting productivity. Such improvements in doing business might alter firms' input choices if transportation is a factor of production (Holl 2006). Higher productivity can, in turn, lead to increases in wages if productivity is capitalized, or decreases in wages if they depend on commuting costs (Gibbons and Machin 2006). Real estate values and land ownership are also likely to be affected in response to changes in location-specific advantages. Subsequently, such dynamics in income levels and real estate prices can alter the use of production inputs such as labor. Lower input costs can translate into lower output prices and therefore higher demand. While such effects can be offset, at least partially,

¹ The World Bank, one of the key development agencies in the international arena, lends more for roads than for education, health, and social services combined (reference).

by capitalization in commercial rents, overall, they can drive changes in employment levels and labor productivity.

The literature also stipulates a set of “wider economic benefits” of road infrastructure improvements, including the total factor productivity effects stemming from agglomeration economies (Graham 2007). Such effects are rooted in resource sharing, worker-employer matching, and learning through knowledge exchange (Duranton and Puga 2004). Despite being usually linked to spatial effects, such as urbanization or industrial clusters, these impacts can simply be due to higher travel efficiencies in linkages between workers and firms. According to Gibbons and Overman (2009), agglomeration benefits can be seen as shifts in production function reflecting higher amounts produced with a given set of inputs.

Improved transportation capabilities can also impact the spatial allocation of businesses via selection and sorting mechanisms (Baldwin and Okubo 2006). Better road infrastructure may make it easier to start businesses and increase their chances of survival by decreasing operating costs, or enabling increasing returns to scale. At the same time, infrastructure improvements can push low-productivity projects out of business if they had previously been protected from competition by high transportation costs. In the long run, such push factors will also result in aggregate productivity gains (Melitz 2003) and consumer surpluses. Although, in some literature, the role of transportation infrastructure factors into spatial analysis,² robust theoretical models projecting transportation infrastructure onto spatial economic outcomes are scarce.

The extant theory does not define approaches on how to measure the effects of infrastructure improvements on businesses, in terms of specific metrics as well as causality chains between the dimensions of such metrics, especially in the context of imperfectly competitive markets. The same can be said about the theoretical underpinnings of transportation infrastructure improvement effects on local economic outcomes. The traditional approach to these issues assumes a perfectly competitive world with all economic effects being attributable to travel time savings and induced demand (Small 2007). More recent literature, however, recognizes the incompleteness of such a depiction of reality, both from the academic point of view (Gibbons and Machin 2006; Gibbons and Overman 2009; Venables 2007) and ‘from the perspective of the’ policy-related community (Eddington 2006). By and large, given the theoretical challenges, the magnitude and direction of the impact that infrastructure improvements have on the economic lives of households and businesses remains mostly an empirical research question (Gibbons and Machin 2006).

Although the body of empirical research on the socioeconomic impact of infrastructure interventions is growing, the literature on specific microeconomic effects remains somewhat thin. Most of the extant studies seem to focus on macroeconomic outcomes of transport and infrastructure improvement policies. Straub (2011) provides a well-cited overview of the relevant research literature. Most of these papers use aggregated Cobb-Douglas production functions with infrastructure investments entering the function as a production factor (Garcia-Mila et al. 1996). Unfortunately, these investigations fail to properly resolve the issues of endogeneity and networks. For the most part, empirical results in these papers seem to be mixed. Focusing on Japan and Thailand, Yoshino and Nakahigashi (2000) used a production function approach to estimate the infrastructure development’s productivity effect. In their paper, the effect turns out to be greater in tertiary industry than in primary and secondary. The information and telecommunications sectors and the environmental sectors produced the largest

² See, for example, Combes and Lafoucarde (2001), Puga (2002), Behrens et al. (2004), and Venables (2007).

impact. In line with our previous discussion, the regions with large urban concentrations seem to generate the strongest levels of infrastructure impact.

Nevertheless, recently, some papers have employed identification strategies to successfully estimate the impact of roads on a set of economic indicators: urban development (Duranton and Turner 2012), suburbanization (Baum-Snow 2007), dynamics of trade (Duranton, Morrow, and Turner 2012), automotive traffic (Duranton and Turner 2011), patterns of commuting (Baum-Snow 2010), and demand for skilled labor (Michaels 2008). Normally, these studies estimate the impact of transport through network links or spatial density indicators. Identification is based on instrumental variables for historical characteristics of networks or strategic development plans, whether those plans are confirmed (Eisner 1994) or contradicted (Harmatuck 1996; Hulten and Schwab 1991). Due to the availability of high-quality data, most of the studies seem to focus on high-income countries, where the issue of infrastructure investments comes up quite regularly in political debates, partly motivated by the US case (Arslanalp et al. 2010).

The body of literature on middle-income countries has grown in recent years; however, the former Soviet countries seem to have avoided research attention, possibly because of the lack of reliable data. This is due to growing interest in those economies coupled with their successful growth performance and improved data availability. Literature on the economies in the Central Asian and Caucasus regions, however, remains thin.

2.2 Financing through Public–Private Partnerships

One popular approach to financing and implementing infrastructure projects has been through public–private partnerships. The term “public–private partnership” (PPP) was reportedly first used in the United States, in the context of educational programs and utilities sector projects. Towards the end of the 20th century, the PPP approach became very popular in the European Union, starting with the United Kingdom (Iossa and Martimort 2015). Under the PPP arrangement, the government typically contracts a private sector partner to develop the project as well as to operate and service it afterwards. The partner may have to take on substantial risk and even conduct fundraising from private sources of capital. Its revenue is generated by a combination of payments from the government and end-user fees. In some instances, a PPP contract may entail significant upgrading of the preexisting infrastructure rather than a brand-new construction from scratch. However, acquisition or management of preexisting public infrastructure units by a private sector agent without any significant new capital injections or upgrading would not be considered a PPP. In a similar fashion, the provision of soft infrastructure capabilities by private agents, which involves no major investment in fixed assets (and thus has no private sector capital requirements), would likely be classified as “outsourcing” instead of PPPs. Nevertheless, the boundary between the two lacks precision as soft services often require hard infrastructure to implement them. Finally, a PPP is not a simple joint-venture project coinvested in by the public and private sectors.

However, what the PPP pros and cons are remains a complex issue. The main reason for the recent growth of PPPs is rooted in the flexibility they offer in financing without requiring immediate public sector funding, instead allowing the costs to be spread out over a project’s lifetime (Maskin and Tirole 2008). A PPP approach thus enables public sector agencies to resolve their budget constraints on public infrastructure investments stemming from insufficient tax revenues and limited availability of public sector borrowing opportunities. If seed investment in a PPP project is not possible from the public funds, this arrangement enables the public agencies to implement infrastructure investment

projects in infrastructure that otherwise would not have been supported at all or could have been delayed. Thus, a typical tradeoff for a public sector agent operating with strict budget constraints is between a PPP and no investment at all, not between a PPP and public sector procurement.

Theoretical economists, in opposing the PPP approach, may argue that if public investment increases, private investment gets “crowded out,” and so the net result is the same whether investment is public or private. However, the existing limited evidence fails to provide robust support for that conjecture. Importantly, in general, PPP forms are chosen as supplementary to other forms of investments by the public sector, not as substitutes for it. There is a range of contractual arrangements that can qualify as PPPs, so some types of infrastructure projects are more suitable for a specific type of PPP while others are not. Some infrastructure projects, such as roads, for example, would not be generally considered for privatization. Thus, the only way of bringing in private sector resources would be via a PPP scheme. For other infrastructure needs such as water, the literature offers contrasting takes on whether a PPP or a conventional privatization approach is better. In other cases, such as creating mobile-phone networks, the conventional view is that licensing out to private firms in a competitive way is more appropriate.

On the other hand, financing through private capital for a PPP clearly costs more than public sector finance as the government creditors are not assuming any significant risk on their loans. However, simply because the funding is coming from a public sector doesn't mean that the project's risks are no longer there – therefore, the public sector agency has to take on risks that constitute a hidden cost, which, along with the lower cost of public capital, makes the overall costs comparable with the costs of PPP financing. At the same time, the public sector can spread out the risks more efficiently than private firms, and so the real cost of public sector funding of a project, even with all risks taken into consideration, is actually lower than the capital and management costs if the project is funded and run by a private sector agent. But quantifying the risk transfer to a PPP is a challenge.

Because a PPP can help accelerate public investments in infrastructure projects, in some cases economies of scale are possible to reach. In construction, for example, there can be savings in capital cost, or speeding up construction may prevent construction cost inflation. On the other hand, a large increase in demand for PPP-based construction works can trigger capacity problems in the local construction sector, and drive up prices, thereby offsetting other benefits that might be obtained from the PPP scheme. For example, British schools and hospitals, as well as Portuguese roads, both of which have taken on large-scale PPP arrangements, have witnessed a significant growth in construction costs. At the same time, the size and complexity of projects structured in the form of PPPs provide disincentives for bidding from smaller contractors, thus hurting competition, which may negatively affect the economy as a whole. Another economic cost of PPPs comes in the form of asymmetry of information enabling potential excess profits for a private sector agent supplying inputs, but the long-term nature of a PPP scheme implies that such asymmetries have more time to develop.

Very often, under a PPP scheme the public agency acts as a regulator, and thus concentrates on service planning and performance monitoring. Doing so allows it to avoid overstressing itself by getting involved in the day-to-day operations for service delivery. However, the loss of continuous management control over public facilities gives rise to a set of its own problems. If a given sector is given a small number of PPP-based projects, it may create a benchmark against which costs and service delivery for other public sector-run projects in the same industry can be compared. Doing so leads to improvements in services and procurement by the public sector as well. In fact, a few

countries (e.g., Norway) have launched PPP initiatives specifically in order to test PPPs against conventional procurement by the public sector rather than for budgetary reasons.

On the other hand, a PPP approach may become more complex than a normal public procurement scheme. This complexity entails a longer procurement period, jeopardizing some of the above-mentioned advantages. Indeed, costs of procurement via PPP can be as high as 5%–10% of the capital cost for a large project, and may not be lower for smaller projects. Hence, PPPs are not necessarily cost-effective if applied to very small-scale projects, but should be more appropriate for bigger ones, i.e., stable longer-term projects; for example, construction of roads and other transport infrastructure is a good match with the PPP approach. Conversely, those projects where the public agency cannot make a credible long-term commitment, or which are dependent on rapidly changing technology solutions, are not the most suitable for PPPs.

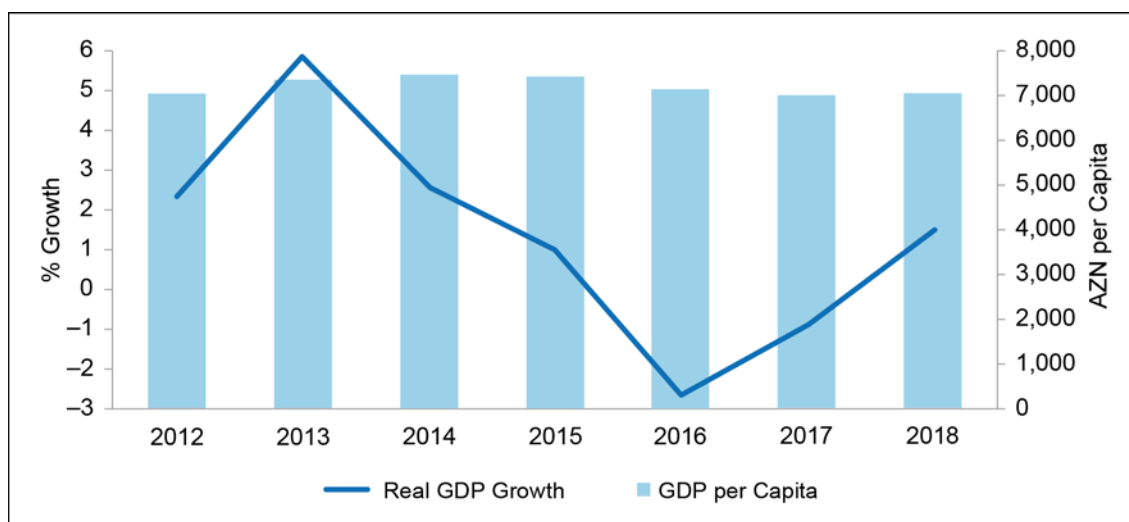
Given the focus of PPPs on otherwise publicly delivered services, they often end up as the object of heavy political debate. Absent political stability or commitment or changing political winds are likely to derail the process and jeopardize the PPP's chances of success. One reason for this is that PPPs may be viewed as a form of privatization, which may give rise to corruption and political opposition. This is especially important if the public finds out that private sector investors are making "windfall" profits, possibly through high initial rates of return on investment, debt refinancing, or sale of their equity holdings. In such circumstances, increasing transparency to avoid political opposition can backfire. For example, the cost procurement through a PPP cost, including long-term operation, may be incorrectly disputed by the public in light of the lower initial capital cost for public sector procurement only. Similarly, offering greater transparency of PPPs can make mistakes more obvious. On the other hand, claims of substantial cost savings compared to conventional public procurement, often made by the participating public agency, cannot be proved objectively and can be used to score quick political points. It is thus difficult to ensure a balanced and depoliticized debate.

Given the novel nature of PPP arrangements among various agents, the existence of firm legal foundations is important for successful implementation of the projects. Some countries, such as Mongolia, for example, are known for quick development of one of the world's most widely praised legislative frameworks.

3. COUNTRY CONTEXT

3.1 Basic Information about Azerbaijan's Economy

The Republic of Azerbaijan, which gained its independence from the Soviet Union in August 1991, lies in the eastern Transcaucasian region, bordering the Caspian Sea from Grozny to Baku. The economy performed impressively throughout most of the past decade with real GDP per capita more than doubling. Growth in nonoil GDP was brisk with output rising by around 15% per year during this period. According to the World Bank, Azerbaijan's middle class increased from 4% of the population in the early 2000s to 29% by 2013. However, this trend was reversed when oil prices fell. The economy performed erratically in the last few years and contracted in 2016 and 2017 (see Figure 1).

Figure 1: Azerbaijan's Recent Economic Growth

Source: Euromonitor International from national statistics/Eurostat/OECD/UN/IMF.

Azerbaijan's excessive reliance on oil exports has made it vulnerable to international economic shocks. Although oil production fell sharply, an increase in public spending helped to slow the economy's decline. Therefore, the government is now spending heavily on transport infrastructure to bolster its role as a trading link between Asia and Europe. In 2017, the Baku–Tbilisi–Kars railway line linking the Caspian districts with Turkey was completed. Another key project is development of the \$46 billion Southern Gas Corridor, which will be used to ship natural gas to Europe.

Azerbaijan is in the process of restructuring its government following a constitutional amendment in September 2016 making it a presidential republic. These changes come at a critical time due to the recent drop in oil prices, increased inflation, and a crisis in the financial sector. The government is striving to address these issues by accelerating the reform process, including adjustments to the traditional expansionary fiscal policies. With this in mind, the government launched a strategic road map to help the development of the country's economy and its main sectors in December 2016.

3.2 Investments and Infrastructure

Many workers in the 10 million-strong population of Azerbaijan are dependent on the informal sector for jobs, with agriculture employing 36.2% of all workers. About half of all households are dependent on farming as their primary source of income. Additionally, Azerbaijan is highly dependent on its natural resources. These products account for more than a third of GDP, over half of all fiscal revenue, and close to 90% of exports.

As a result, the economy is very vulnerable to external shocks. Therefore, the government has launched extensive efforts to build its infrastructure. Recent agreements with a Western consortium include the construction of pipelines to make the delivery of Azeri gas to European markets possible from 2018. There is a plan to invest \$3.5 billion in information and communications technology over the next 10 years. Azerbaijan is also working with the EU to boost its exports and bolster investment potential. The large-scale project of the Shah Deniz II gas field designed to facilitate the delivery of Azeri gas initially to Turkey, followed by Europe, is nearing completion. A pickup in gas exports once this project comes on stream should benefit

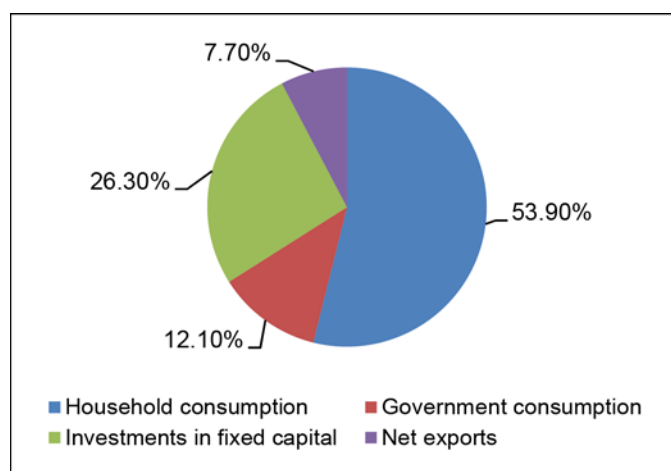
economic performance. The share of the nonoil sector should also increase, surpassing 15% of GDP in the medium term. Finally, credit growth will rise if the government can implement a successful restructuring of the financial sector. Annual rates of growth in real GDP should reach about 3.3% per year by 2025.

Policymakers hope to convert Azerbaijan into a crucial energy supply and transportation hub in the longer term. Azerbaijan is actively working with neighboring countries to develop East–West and North–South transport corridors. Altogether, the related projects are valued at \$40 billion, representing one of the biggest undertakings in the global oil and gas industry.

In terms of roads, a decade-long Road Network Development Program (RNDP) was to be implemented between 2006 and 2015 with financial backing from major international donors and investors, including the World Bank, the European Bank for Reconstruction and Development (EBRD), and the Asian Development Bank (ADB); however, due to macroeconomic volatility since the 2008 crisis, the RNDP was still ongoing in 2018.

The end use of GDP in Azerbaijan, according to the CIA Network, looks like that in Figure 2. According to this diagram, infrastructure investments account for over a quarter of the country's GDP.

Figure 2: End Use of GDP



The government has also been actively seeking to increase the level of foreign direct investments (recent data are shown in Table 1). In particular, Azerbaijan needs more foreign investment in the nonenergy sector. Azerbaijan is seeking access to new markets for exports other than oil and gas, mainly for its agricultural producers. For example, some of their efforts have resulted in agreements with Gulf Cooperation Council member countries, the US, and others. Azerbaijan is also investing in improvements to Baku airport as well as to the Caspian Sea port of Alat, which will be used as a regional logistics and transportation hub. In October 2017, the long-awaited Baku–Tbilisi–Kars railway, connecting the Azerbaijani capital to Kars in Northeastern Turkey, began operating on a limited scale.

Table 1: Foreign Direct Investments in Azerbaijan

	2014	2015	2016
FDI Inward Flow (<i>million USD</i>)	4,430	4,048	4,500
FDI Stock (<i>million USD</i>)	18,181	22,229	26,683
Number of Greenfield Investments*	30	19	25
FDI Inwards (<i>in % of GFCF**</i>)	25.6	29.8	47.8
FDI Stock (<i>in % of GDP</i>)	24.2	43.7	71.0

* Green Field Investments are a form of foreign direct investment where a parent company starts a new venture in a foreign country by constructing new operational facilities from the ground up. ** Gross fixed capital formation (GFCF) measures the value of additions to fixed assets purchased by businesses, government, and households less disposals of fixed assets sold off or scrapped.

Source: UNCTAD 2018.

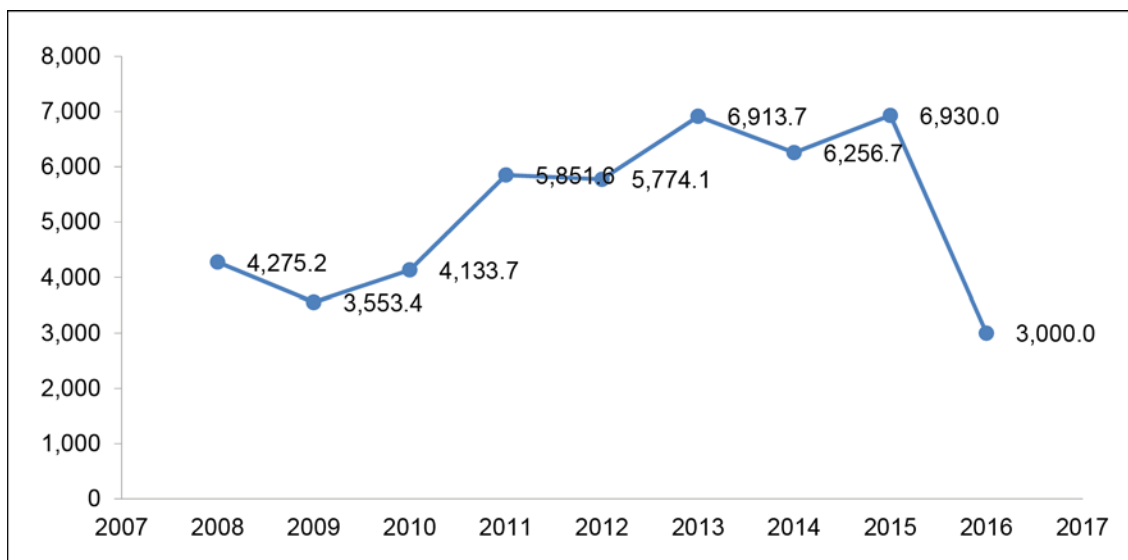
There is no clear-cut definition of a PPP, although a conventional approach is to define it as a business venture that is operated and financed by a partnership between a private company and a government agency. This arrangement does not fit the traditional public investment model, where the government designs and finances an asset, while construction is outsourced to a private sector agent. Under a PPP, the common forms of contractual agreements include the following:

- Build–Operate–Transfer (BOT): The private firm builds the infrastructure or facility, operates it during the contractual term, generating revenue and recovering investment costs, and eventually transfers the project to the public agency.
- Design–Build (DB): The private firm both designs and builds the infrastructure or facility.
- Design–Build–Finance–Maintain–Operate (DBFMO): The private firm is tasked with designing, building, financing, and operating an asset, eventually leasing it (for a long term) back to the government.

3.3 Government Spending on Infrastructure Between 2008 and 2016

Spending on investments from the state budget during the period covered by this study, 2008–2016, was volatile, largely due to price fluctuations in the oil/energy markets (see Figure 3). In 2016, an additional AZN3,021.3 million was projected to be spent on infrastructure projects out of the State Oil Fund (SOFAZ).

Up to 2016, there had been no legal foundations for the growth of PPP operations to support any PPP-based development. The first domestic legislation specifically governing the legal aspects of project financing seems to be the 2016 law on BOT projects (Niftaliyev 2019). According to the law, the BOT model allows recovery of an investor's costs through the sale of goods and services by the investor to customers and designated executive bodies. Nevertheless, a PPP model could bring a lot of benefits to infrastructure development, and projects with PPP-like features had been governed by more generic legislation – the Civil Code, and regulations of the Central Bank, the Ministry of Finance, and similar agencies.

Figure 3: Investment Spending from State Budget in Azerbaijan, in AZN million

In Azerbaijan, PPPs are a fairly recent practice and the PPP legislation in Azerbaijan tends to provide legal groundings mostly for the BOT model only. The extant laws specify conditions and requirements to investors for the implementation of investment projects, terms and conditions of agreements between the investors and implementing agency, and the rules for the determination of costs of goods and services produced as a result of investments.

3.4 Road Infrastructure Projects

The Government of Azerbaijan has declared and followed an ambitious plan to rebuild its road infrastructure, which includes the following projects:

- Rural Investment Project (AzRIP), total cost \$21.1 million, including \$15 million from the World Bank
- Second Rural Investment Project (P122944), the World Bank, \$30 million
- Road Network Development Program (RNDP), the World Bank, EBRD, ADB

The centerpiece of Azerbaijan's road network is two major highways, both of about 500 km in length, originally built during the time of the Soviet Union but significantly improved and upgraded since then, including with the financial support of international development banks:

1. The East–West highway, connecting the capital, Baku, with the Georgian border;
2. The North–South highway running from the Russian Federation border to the Iranian border via Baku.

The total length of public roads in Azerbaijan, including secondary and local roads, is about 25,000 kilometers, with a road density of about 288 km/1,000 sq. km. The road network provides connection to all the administrative centers and transportation hubs (airports, seaports, railway stations, etc.).

The transport industry constitutes a significant share of the economy, accounting for 6% of gross domestic product. Roads are the dominant mode of freight and passenger transport, with services being offered by private operators only.³ Azerbaijan's transport sector contributes heavily to regional trade, owing to the country's important geographical position with roads connecting the Black and Caspian seas, linking the Russian Federation to Georgia, Turkey, and Iran.

The development of transport infrastructure is one of the government's key tasks in order to sustain growth in the gross domestic product and promote trade with neighboring countries. The poor condition of the national road network poses a challenge. Some 56% of the main road network is in poor condition and urgently needs repair. The East–West corridor (Baku–Ganja–Georgia border through Alyat and a more direct route through Shamakhi) and the North–South corridor (Russian Federation border–Baku–Alyat–Iran border) are crucial to addressing the transport barriers to national development and poverty reduction.

Within this context, the government has been actively pursuing infrastructure projects with significant road infrastructure improvement components:

- Rural Investment Project (AzRIP):

This project was designed as an investment project to support community-based infrastructure development in the country's five economic regions, with a view to improving the living standards in the target communities by expanding their access to infrastructure services. One of its three components is building and/or repairing roads, footbridges, health clinics, electrical resources, schools, potable water resources, and drainage and irrigation systems. This project was launched in January 2005. About 70% of its \$47.1 million cost was allocated to the infrastructure component.

- Second Rural Investment Project (AzRIP-2):

The objective of this project, launched in early 2013, was to improve the accessibility and usability of community-driven rural infrastructure initiatives and foster economic activities for households in rural areas. Two of its three components were focused on rural infrastructure, either by funding local infrastructure projects or through technical assistance. Examples of basic public infrastructure supported by the projects included rural roads, potable water, drainage and tertiary irrigation, etc. The cost of the project was \$30 million and it was scheduled to be completed in September 2019.⁴

- Road Network Development Program (RNDP):

Originally intended to be implemented between 2006 and 2015, with an overall budget of \$3.4 billion, this initiative was aimed at upgrading and rehabilitating the road system as well as reforming the road management and operation methods. The ultimate goal is to create a modern road network that can facilitate safe, efficient, and sustainable transportation services, leading to more general economic and social development.

³ That includes individuals, or sole entrepreneurs, offering transportation services.

⁴ A final assessment of project results does not seem to be available yet. The most recent project document available on the World Bank's Projects and Operations website is an audit report dated 22 July 2019.

- Azerbaijan Highway 3 Additional Financing (AF):
The objective of the AF for Highway 3 was “to contribute to a more efficient and safer Baku–Shamakhi road and higher-quality road services as part of the upgrading to motorway standards, and to improve the management of the nascent motorway network.” This project, with a total budget of \$155.5 million, was to be implemented between 2016 and 2019. The AF will also support the modernization of motorway management and maintenance through financing technical assistance and one-time capital investment for the establishment of regional motorway maintenance units.

4. EMPIRICAL ANALYSIS

4.1 Choice of Infrastructure Project and Available Data

In this project we will focus on road construction projects. Azerbaijan’s road network includes, in addition to local as well as secondary roads, two main highways: (i) the East–West highway connecting the capital city of Baku to the Georgian border; and (ii) the North–South highway providing connection between the Russian Federation border and the Iranian border via the city of Baku. The roughly 500 kilometer-long East–West highway is one of Azerbaijan’s main transport links to the western region and for external trade. The network was developed primarily before the country gained independence, when the traffic volume was much higher. The shortage of resources needed for maintenance and vehicle axle overloading put about 75% of the entire network of Azerbaijan’s roads in poor condition. Although changes in macroeconomic environments leading to unprecedented increases in prices for fuel, key road construction materials, and utilities significantly increased the construction costs, the RNDP was still ongoing in 2018 while a number of important road construction projects have already been implemented. For example, most of the East–West highway, linking Azerbaijan with the Georgian border, has been improved.

This paper aims to assess the impact of the completed road construction projects on labor market opportunities, i.e., job creation, in Azerbaijan over the decade spanning from 2006 to 2016 and to assess the implication for public financing.

However, access to reliable data seems to be an issue in modern Azerbaijan. Specifically, we used public online sources to put together a database for our empirical analysis. Unfortunately, as can be seen below, the resulting estimations fail to produce statistical significance while where the results are significant, they suggest an opposite effect to what is expected.

4.2 Methods and Data

To estimate the effects of road infrastructure on perceived household wealth, we shall use the Life in Transition Survey (LiTS) administered in collaboration by the World Bank and the EBRD during the period 2006–2016 across about 30 transition countries, including Azerbaijan. One of the benefits of LiTS is that it covers a nationally representative sample of households within each country. Specifically, we are interested in the effect of gained access to national roads on income/wealth proxies. For the latter, we shall resort to two metrics: perceptions of the rental value of housing and the relative wealth of the household.

LiTS is a combined household and attitudinal survey, focusing on transition countries, that collects information on the socioeconomic status of respondents and includes perception-based questions on economic, political, and social topics. The first round of LiTS (LiTS I) was conducted in 27 countries in 2006, and the second round (LiTS II) was conducted in 35 countries in 2010. The third round of the survey (LiTS III) was conducted between the end of 2015 and the beginning of 2016 in 34 countries. The second and third waves also included developed comparator countries. All three rounds were implemented by the EBRD in collaboration with the World Bank. The third wave also received collaboration from Transparency International. The first two waves included 1000 households while the third one targeted 1,500 households per country.

The number of households with successfully completed interviews and respondents differs by country, and in Azerbaijan the number of observations in the third wave was 1,510, with a male-to-female ratio of 40.13:59.87, and almost 80% of the respondents were aged 25 to 64. The interviews were conducted with the household head or a knowledgeable member to glean information on household roster, members' gender, age, and relationship to the head, as well as questions on assets, incomes, and expenses. Parts of the survey are administered to the adult member of the household with the most recent birthday. Collected information covers a range of topics, including employment history, type of establishment where they work, duration of their employment, current occupation, etc. Overall, the data generated by LiTS are of high quality and have been used in numerous academic papers.

Data on road infrastructure projects are available in public sources, such as the website of the Central Asia Regional Economic Cooperation (CAREC) program.⁵ Such data normally enable identification of communities, districts (rayons), or municipalities (bələdiyyəsi)⁶ that gained access to roads, and hence qualify as treatment communities, and those that did not gain access, and are hence viewed as control communities. We have collected such data and merged them with LiTS. However, due to inconsistency in spelling as well as the sampling choice of localities, our approach yields a very small number of communities in the first wave of LiTS that match the publicly available data. Therefore, all of our analysis is based on the two final waves of LiTS coupled with official district-level data from the Azerbaijan Statistical Agency.

The data on access to roads, our treatment variable, were created by visually overlapping the map of roads from the RNDP with the administrative map of Azerbaijan. The data we have collected allow us to estimate the effect of the treatment via new roads using an approach similar to the difference-in-difference estimation employed by Yoshino and Abidhadjaev (2017). However, our data set is not longitudinal because LiTS is not a panel survey. One way to build a panel would be to aggregate household-level responses at the community level, but that would lead to a very small sample size. Therefore, we continue our analysis with a repeated cross section. To estimate the effects of road construction projects, we set out to exploit the close proximity of respondents' locality to the roads for impact assessment.

For empirical estimation, we employ the following strategy, which is a popular approach for causality detection in social sciences. Specifically, we estimate a model with the following form:

⁵ See https://www.carecprogram.org/?page_id=1726.

⁶ Azerbaijan has 10 regions, including an autonomous republic, and 59 districts, which contain municipalities as smaller administrative units.

$$y_{jt} = \beta_0 + \beta_1 * S_t + \beta_2 * r_i + \beta_3 * S_t * r_i + \sum \gamma_m * x_{it} + \sum \delta_m * z_{jt} + \varepsilon_{jt}$$

Treatment effect in such a model can be captured via $s_t * r_i$, an interaction term between time, s_t , and treatment group, r_i , dummy variables in a regression model. Here subscript i denotes community i 's aggregate respondent information and j implies household j . Newly gained access to roads between the two waves (the treatment variable) in community i is given by r_i . The set of controls pertaining to community i at time t is given by x_{it} , and z_{jt} is the vector household-level characteristics. Since we are only using two waves, time or survey wave t denotes fixed effects represented by a binary variable. Descriptive statistics of the sample are given in Table 2 below.

Table 2: Descriptive Statistics

	2008		2016	
	Obs.	Mean (St. Dev.)	Obs.	Mean (St. Dev.)
Road treatment*	–	–	2,211	0.099 (0.299)
Age, years*	901	2.979 (1.476)	1,310	2.924 (1.361)
Female, dummy	900	0.662 (0.473)	1,310	0.560 (0.497)
Married, dummy	901	0.705 (0.456)	1,310	0.777 (0.416)
University degree, dummy	901	0.211 (0.408)	1,310	0.099 (0.299)
Rent, AZN per month	463	172.94 (122.33)	583	209.88 (104.74)
Relative household wealth, ranked deciles within population	898	4.043 (1.862)	1,300	4.338 (2.152)
Natural logarithm of regional employment measured in thousands of employed people in the district	881	4.961 (1.356)	1,010	5.079 (1.264)
Social capital, frequency of meeting with friends*	893	2.606 (1.138)	1,266	2.781 (1.006)
Subjective health, 5-point Likert scale*	901	2.717 (0.831)	1,298	2.561 (0.832)
Duration of residence, years of living in current locality	864	4.848 (3.008)	1,251	4.934 (3.054)

* The road treatment variable is defined as the existence of national roads in the district in 2016 less the existence of national roads in the district in 2010. Social capital is classified into five categories: on most days, once or twice a week, once or twice a month, less than once a month, and never. In Subjective health, 1 corresponds to "very good" and 5 to "very bad." Age is reported in categories with 2.979 observations corresponding to 35–44 years of age.

Whether a respondent has been exposed to the road proximity, r , amounts to an indicator of whether or not a road has been built to his/her community. All such communities in our data turn out to be located in the central northern part of the country.⁷ Therefore, to avoid possible contamination of our data by outlier communities, we exclude the districts of Lenkeran, Yardimli, Masalli, Bilesuvar, and Balaken from our data. The first four are the southernmost areas covered by our data set, and the last is the northernmost district,

⁷ One possible explanation we have for this is that the Life in Transition Survey, from which we obtain the household-level characteristics, was not administered equally throughout the country.

located at the end of the peninsula-like extension separated by two other districts from the main core of the country's territory.

For the dependent variable, y , we only report two variables, which can serve as a proxy for economic well-being or financial wealth. They are (i) respondents' subjective assessments of the market value of the dwelling in which the household resides, while the other one is (ii) the perceptions of the relative wealth of the household. Both of these variables are self-reported.

Also, we distinguish between two different control groups: Districts that displayed no national roads in either wave are labeled 00 districts, while those that appeared to have national roads in both waves are marked 11 districts.

Specifically, the market value of the dwelling is based on a hypothetical question worded as:

“How much do you think you would pay as a monthly rent (at market prices) if you were a tenant of this dwelling?”

The relative household wealth variable stems from a question formulated as:

“Please imagine a ten-step ladder where on the bottom, the first step, stand the poorest 10% of people in our country, and on the highest step, the tenth, stand the richest 10% of people in our country. On which of the ten steps is your household today?”

Information on the latter is then collected based on a ten-point Likert scale.

We drop observations of zero rent from the data set. The resulting control and treatment groups in the final data set can be described as follows in Table 3.

Table 3: Characteristics of Treatment vs. Control Districts

Rent	Before Treatment	After Treatment
Treatment districts	137.609 (46)	255.556 (36)
No treatment among 00 districts	201.569 (325)	209.221 (449)
No treatment among 11 districts	91.444 (90)	196.122 (98)
Relative Wealth	Before Treatment	After Treatment
Treatment districts	3.46 (100)	4.40 (120)
No treatment among 00 districts	4.28 (576)	4.30 (882)
No treatment among 11 districts	3.67 (220)	4.43 (298)

Number of observations for each category in parentheses.

4.3 Results

Our main results with respect to the market value of the housing are reported in Table 4. Regression results are reported in two output tables – Panel A and Panel B – for 11 districts and 00 districts, respectively.

Table 4: Perceived Market Value of Housing – OLS Estimations

Panel A. Treatment against 11 districts								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Road treatment	46.16*	61.38**	61.36**	60.73**	61.34**	45.26*	63.12**	60.54**
	(24.04)	(22.28)	(22.08)	(23.73)	(22.28)	(24.65)	(24.95)	(22.92)
Time	104.7***	86.27**	85.61**	86.54**	85.86**	144.8***	91.80***	87.29***
	(34.38)	(34.07)	(30.02)	(33.67)	(34.22)	(45.55)	(22.55)	(21.67)
Time × Road treatment	13.27	34.18	33.37	35.69	34.49	−26.98	23.83	27.02
	(36.12)	(34.37)	(39.26)	(38.24)	(34.27)	(40.34)	(32.59)	(29.29)
Age		−1.669	−1.706	−1.496	−1.650		2.531	−11.05
		(2.083)	(2.106)	(2.249)	(2.093)		(4.845)	(13.46)
Age ²			−2.408			2.333	5.210	2.797
			(18.52)			(8.260)	(21.49)	(17.14)
Female		50.72***	50.42***	50.26***	50.69***		57.84**	56.92**
		(15.52)	(16.44)	(15.52)	(15.54)		(24.50)	(22.61)
Log of employment				−5.552			4.294	−4.041
				(15.46)			(13.26)	(18.83)
Married					−2.358		−3.246	
					(11.46)		(11.87)	
University degree						−10.75*	−17.12*	
						(5.671)	(8.052)	
Social capital						0.633	−0.476	
						(2.753)	(1.379)	
Risk preferences						0.0508		
						(0.223)		
Duration of residence							−12.77	−17.83*
							(9.297)	(8.812)
Subjective health								2.082
								(2.016)
Constant	91.44***	−111.8*	−109.0	−106.1	−111.3*	112.1***	−75.93	−80.00
	(21.69)	(59.96)	(65.89)	(62.97)	(60.30)	(28.47)	(86.06)	(84.42)
Observations	270	234	234	234	234	140	227	234
R-squared	0.348	0.380	0.380	0.380	0.380	0.262	0.439	0.411

Robust standard errors in parentheses, clustered at the district level.

Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1.

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Table 4 *continued*

Panel B. Treatment against 00 districts								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Road treatment	-63.96*	-8.866	-8.468	-9.106	-3.586	-62.46**	-1.672	-9.451
	(31.80)	(25.04)	(24.99)	(25.17)	(24.67)	(28.35)	(21.73)	(21.24)
Time	7.651	22.40	22.72	22.46	28.68	2.473	30.93	24.14
	(27.07)	(30.87)	(30.93)	(31.09)	(29.93)	(25.26)	(27.88)	(24.81)
Time × Road treatment	110.3***	102.5***	97.58***	105.1***	97.82***	83.57**	103.7***	102.5***
	(29.17)	(31.87)	(29.45)	(30.91)	(31.09)	(33.29)	(29.66)	(23.63)
Age		-1.748	-1.753	-1.068	-2.335		-2.964	6.467
		(2.518)	(2.482)	(2.223)	(2.174)		(2.333)	(9.269)
Age ²								-1.419
								(1.581)
Female			-7.202			11.33	-4.688	-8.803
			(6.999)			(14.12)	(7.140)	(6.479)
Log of employment		26.17***	26.41***	26.00***	26.04***		27.35***	26.40***
		(6.003)	(5.946)	(6.055)	(6.023)		(5.649)	(8.652)
Married				-8.341			-9.477	-10.52
				(7.700)			(10.75)	(12.15)
University degree					37.70***		40.77***	
					(8.732)		(8.034)	
Social capital						3.496	-0.740	
						(8.178)	(5.897)	
Risk preferences						5.878**	2.467	
						(2.796)	(1.443)	
Duration of residence						-0.266*		
						(0.145)		
Subjective health							11.12***	9.517
							(3.511)	(6.001)
Constant	201.6***	52.13	55.38	56.76	42.52	172.1***	3.852	29.90
	(30.12)	(47.68)	(50.54)	(49.63)	(47.01)	(48.05)	(50.69)	(54.78)
Observations	856	744	744	744	744	460	713	743
R-squared	0.028	0.120	0.121	0.121	0.138	0.057	0.157	0.127

Robust standard errors in parentheses, clustered at the district level.

Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1.

In these OLS estimations, we cluster the standard errors by districts. As our data set is not longitudinal, one must use caution while interpreting these results. Specifically, the unit of observation in our data is the household within a repeated cross section, and the road treatment variable enters at the community level, being the same in both waves for a given community. Therefore, the road treatment should be interpreted as treatment district. It is indicative of the intercept differential in the usual graphical representation of the difference-in-difference approach. Thus, a positive and statistically significant coefficient in Panel A suggests that the treated districts started out with lower perceived rental values before treatment as opposed to the districts that had access to roads prior to the treatment (and therefore did not receive treatment). Negative coefficients in Panel B imply that the treated districts might have started out a bit better off than those that never had access to national roads. However, the evidence from this should only be taken as suggestive due to a relatively weak statistical significance in many specifications.

The time variable can be interpreted in the usual way in DiD estimations as the total effect within the time frame.

The interaction term in our case probably comes closer to the treatment effect than any other variable in our estimations, as it captures the total effect within the treated districts. Results suggest that against the 11 districts, which are a priori better off, the treatment effect seems to be insignificant (Panel A), but against the less well-off districts the treatment seems to generate a positive and statistically significant effect on the perceived rental value of housing real estate (Panel B).

Given the categorical nature of the other dependent variables, we conduct two types of estimations and report both. Although it may be viewed as a stretch to view the relative wealth of the household as a continuous variable, we still run OLS estimations in the hope of gaining more insight. Our main results, however, are based on the ordered logit approach. We report both results for robustness.

**Table 5: Subjective Household Wealth Relative to Others in the Society
– OLS estimations**

Panel A. Treatment against 11 districts							
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Road Treatment	–0.213 (0.401)	–0.209 (0.461)	–0.237 (0.445)	–0.178 (0.460)	–0.365 (0.442)	–0.320 (0.459)	–0.414 (0.425)
Time	0.760 (0.596)	0.763 (0.698)	0.735 (0.691)	0.761 (0.692)	1.520* (0.809)	1.138 (1.179)	1.556* (0.818)
Time_treatment	0.180 (0.667)	0.449 (0.709)	0.552 (0.634)	0.378 (0.702)	1.413* (0.755)	1.591 (1.103)	1.121 (0.794)
Age		–0.0650 (0.339)	–0.0485 (0.334)	0.0285 (0.0813)			0.0611 (0.0948)
Age ²		0.0151 (0.0521)	0.0104 (0.0544)				
Subjective_health			0.0659 (0.281)				–0.425** (0.175)
Meet_friends			0.0934 (0.0850)		0.127 (0.138)		0.191 (0.138)
Log of employment		0.00657 (0.506)	0.0199 (0.511)	0.0204 (0.507)	–0.262 (0.452)	–0.305 (0.450)	–0.238 (0.390)
Non-Baku (district dummy)		–		–			
Married				0.237 (0.249)		0.0560 (0.239)	0.115 (0.238)
University_degree				0.199 (0.178)	0.264 (0.239)	0.259 (0.195)	0.288 (0.209)
Female					0.257 (0.229)		0.355 (0.222)
Live_in_locality					0.00257 (0.00413)	0.00184 (0.00406)	0.00204 (0.00377)
Risk_preferences							0.0304 (0.0451)
Constant	3.673*** (0.293)	3.672 (2.150)	3.215 (2.209)	3.284 (2.149)	4.029* (1.925)	4.696** (1.971)	4.517** (1.586)
Observations	738	619	600	619	329	332	315
R-squared	0.041	0.051	0.058	0.054	0.042	0.025	0.089

Robust standard errors in parentheses, clustered at the regional level.

Significance levels: *** p < 0.01, ** p < 0.05, * p < 0.1, # p < 0.15.

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Table 5 continued

Panel B. Treatment against 00 districts							
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Road treatment	-0.816** (0.345)	-1.036** (0.479)	-0.931** (0.400)	-0.987* (0.475)	-0.983* (0.509)	-1.033** (0.477)	-1.133** (0.448)
Time	0.0221 (0.221)	-0.113 (0.288)	-0.120 (0.263)	-0.0389 (0.281)	-0.0865 (0.352)	-0.139 (0.326)	-0.0864 (0.297)
Time × Road treatment	0.918** (0.368)	1.393*** (0.406)	1.261*** (0.360)	1.336*** (0.426)	3.335*** (0.458)	2.965*** (0.380)	3.090*** (0.356)
Age		-0.394** (0.147)	-0.319** (0.130)	-0.195*** (0.0565)			-0.0175 (0.0419)
Age ²		0.0313 (0.0255)	0.0355 (0.0224)				
Subjective health			-0.447*** (0.0890)				-0.494*** (0.130)
Social capital			-0.129* (0.0741)		-0.168 (0.129)		-0.0969 (0.134)
Log of employment		-0.140 (0.532)	-0.0976 (0.0876)	-0.203 (0.523)	-0.118 (0.125)	-0.149 (0.116)	-0.162 (0.118)
Non-Baku (district dummy)		-0.0811 (1.430)		-0.219 (1.397)			
Married				-0.0236 (0.224)		-0.111 (0.174)	0.0127 (0.205)
University degree				0.663*** (0.0941)	0.617*** (0.105)	0.630*** (0.0856)	0.602*** (0.121)
Female					0.499** (0.212)		0.611*** (0.173)
Duration of residence					0.00350 (0.00263)	0.00249 (0.00254)	0.00374 (0.00264)
Risk preferences							0.124*** (0.0312)
Constant	4.276*** (0.213)	5.929 (3.754)	6.902*** (0.786)	5.954 (3.643)	4.638*** (0.847)	4.857*** (0.930)	5.377*** (0.910)
Observations	1,678	1,439	1,404	1,439	816	823	775
R-squared	0.010	0.039	0.073	0.053	0.073	0.052	0.156

Robust standard errors in parentheses, clustered at the regional level.

Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, # $p < 0.15$.

As Table 5 shows, the impact of the roads on subjective household wealth is not significant when we contrast the treated districts against the better-off communities serving as controls (Panel A). However, when contrasting with the less well-off communities (Panel B) the OLS results suggest that there is a statistically significant and positive effect of treating districts with access to national roads as opposed to districts without direct access to such roads. In Panel B, the negative and statistically significant coefficient of *Treated regions* suggests that people in regions where road construction has taken place report being poorer than others in the first wave. This is suggestive evidence that road construction projects could have particularly targeted underdeveloped regions.

On the other hand, the statistically significant and positive coefficient on the interaction of *Treated regions* with a dummy *Time* suggests that self-assessed wealth increased by 0.918 to 3.090 units as a result of road construction. A one to three change in self-assessed income is also economically significant given that the dependent variable on the self-assessed wealth varies between 1 and 10, each representing a hypothetical income ladder. Note, however, that in Panel A none of these coefficients are statistically significant, suggesting that changes in relative self-assessed wealth in the treated regions relative to the areas with the existing road infrastructure are negligible. This is likely to be due to a possible spillover effect of the road construction project on regions with existing road infrastructure due to improved connectivity.

In Table 6, we report the results of ordered logit estimations, which suggest that the relationship between treatment with access to roads relative to household wealth is positive and significant in general (Column 1) if the less well-off districts are chosen as controls (Column 2). This relationship does not find statistical support if the better-off districts are used control communities (Column 3). We run this regression to test the robustness of our estimates for an alternative estimation method. Coefficients here stand for the log-odds ratio of the probability of a higher-category response. The estimated coefficients, by and large, confirm our conclusions from Table 5.

**Table 6: Subjective Household Wealth Relative to Others in the Society
– Ordered Logit Estimations**

Variables	(1) Pooled	(2) Against 00 districts	(3) Against 11 districts
Road treatment	−0.474*** (0.180)	−0.632*** (0.185)	−0.0836 (0.206)
Time	0.198** (0.0807)	0.0248 (0.0944)	0.694*** (0.160)
Time × Road treatment	0.550** (0.242)	0.732*** (0.248)	0.0841 (0.280)
Observations	2,196	1,678	738

Standard errors in parentheses.

Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, # $p < 0.15$.

5. CONCLUDING REMARKS

This paper has examined the impact of access to national roads in Azerbaijan to provide empirical estimation of the impact on household wealth, proxied by real estate prices and self-reported perceptions of relative household wealth. The results suggest a significant positive effect at the district level.

To that end, we constructed two waves of data that include household-level information as well as district-level characteristics in Azerbaijan. We then ran estimations similar to a difference-in-difference approach. However, our data are a repeated cross section at the household level, not longitudinal. Therefore, our estimations concern the differences between households in treated vs. control districts. Overall, the results provide empirical support for our conjecture that gaining access to national roads has a positive impact on the well-being of the households located in such communities. Specifically, we find that monthly rent grew by AZN83–AZN110 per month, which is 50%–60% of the mean monthly rent. On the other hand, self-assessed wealth increased by 0.918 to 3.090 units as a result of road construction.

These results have important policy implications in providing empirical support for the impact of expansion of road infrastructure. However, our study has its own limitations. For example, the data for the dependent variables are in the form of stated information. Therefore, it may suffer from some subjective biases, e.g., hindsight bias. In addition to that, we only have two waves of nonlongitudinal data. For a robust estimation of impacts, one would normally want to use a well-balanced panel with multiple waves.

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