Report No: AUS17153

Georgia

Economic Impact of EW Highway Phase 2

Assessing the Impact of East-West Highway Investments on Exports through Gravity Modeling

GTI03

EUROPE AND CENTRAL ASIA

CURRENCY EQUIVALENTS

(Exchange Rate Effective May 30, 2016)

Currency Unit – Georgian Lari
Georgian Lari 2.15 = 1 USD

WEIGHT AND MEASURES
Metric system

FISCAL YEAR
January 1 – December 31

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ABBREVIATIONS AND ACRONYMS

CES	Constant Elasticity of Substitution
CGE	Computable General Equilibrium
CIS	Commonwealth of Independent States
CTC	Caucasus Transit Corridor
EU	European Union
EWH	East-West Highway
GDP	Gross Domestic Product
GEL	Georgian Lari
HS	Harmonized System
IFI	International Financial Institution
KM	Kilometer
OLS	Ordinary Least Squares
SAM	Social Accounting Matrix
TRACECA	Transport Corridor Europe Caucasus Asia
USD	United States Dollars

ACKNOWLEDGEMENTS

This paper was prepared by Banu Demir, Assistant Professor in the Department of Economics, Bilkent University for the World Bank under the guidance of Carolina Monsalve (Senior Transport Economist). Special thanks go to the team comprising Daniel Saslavsky (Trade Specialist), Mona Prasad (Senior Country Economist), and Mustapha Benmaamar (Senior Transport Specialist). The team would also like to thank Mercy Tembon (Country Director), Juan Gaviria (Practice Manager), Eavan O'Halloran (Country Program Coordinator), peer reviewers Jose Guilherme Reis (Practice Manager), Cecilia Briceno-Garmendia (Lead Economist), Atsushi Iimi (Senior Economist), and Charles Kunaka (Senior Trade Specialist), as well as Ekaterine Avaliani (Operations Officer, IFC), Funda Canli (Program Assistant), and Giang Thanh Huong Le (Program Assistant). The team would also like to acknowledge the support and contributions from the Roads Department of Georgia and the Ministry of Infrastructure and Regional Development.

EXECUTIVE SUMMARY

The objective of this study is to assess the impact of the East-West Highway improvement program on Georgia's ability to access international markets. As highlighted extensively in the literature, improving transport infrastructure and the efficiency of the logistics sector can help countries gain competitiveness in international export markets, which can translate into faster economic growth and higher income. This study hypothesizes that investments in the EWH have reduced the cost of shipping Georgian goods to the rest of the world, and such reductions should be more significant for goods transported by road. To estimate the effect of cost reductions generated by improvements in the EWH, a gravity-type model in first-differences has been estimated.

In the simplest gravity model of trade, the volume of bilateral trade depends positively on the sizes of trade partners and negatively on the distance between them (proxy for trade costs). Using data for the 2005-2015 period, we regress the annual growth rate of exports, disaggregated by products, customs offices clearing them and modes of transport, on annual improvements in the EWH and its interaction with a binary variable indicating road transport. First-differencing controls for all time-invariant product, customs office and transport mode specific factors affecting Georgia's exports.

The results show that (i) a 10 percent increase in the length of upgraded road network predicts a 1.1 percent increase in exports transported by road while no significant effect is estimated for exports on other transport modes (rail, sea, and air); (ii) the resulting increase in exports by road was reflected by a decrease in exports transported by sea; (iii) the effect is statistically and economically significant only for customs offices located along the EWH; (iv) only exports of time-sensitive products responded positively and significantly to improvements in the EWH during the 2006-2015 period; (v) upgrading the entire EWH is estimated to generate additional export revenues between USD 776 million and USD 1,466 million. It is important to note that the overall trade generating effect of the investment is expected to be somewhat lower as the results suggest some substitution between road and sea transport, but the overall impact is a significant boost to exports.

1.1 Introduction

1. Located at the crossroads of Europe and Central Asia, Georgia is a transit country connecting several important economic regions with a total population in excess of 800 million people, including the EU (508 million), CIS (277 million), Turkey (75 million) and the Caucasus Region (17 million). The Caucasus Transit Corridor (CTC) is a key transit route between Western Europe and Central Asia for transportation of oil and gas as well as dry cargo. CTC is part of the international and regional corridor TRACECA. The TRACECA corridor is the shortest route between Europe and the Caucasus and Central Asian countries through the Black sea ports. TRACECA is an alternative to the north corridor running through the Russian Federation and Belarus and the southern corridor running through Turkey and Iran, the latter has become less competitive due to international sanctions imposed on Iran. The East-West Highway (EWH) traversing Georgia is part of the CTC.

2. The EWH carries over 60 percent of total foreign trade and is seen as a central piece in the Government's strategy of transforming Georgia into a transport and logistics hub for trade between Central Asia and the Far East on the one hand and Turkey and Europe on the other hand.[1] The EWH runs from the Red Bridge at the Azerbaijan Border to the Poti Port at the Black Sea coast for around 392 kilometers—2 percent of the Georgian road network length, and slightly less than a quarter of the international road network—with an average traffic of around 7,800 vehicles per day and traffic annual growth rate of around 7.0 percent. The EWH accounts for 23 percent of vehicle utilization in Georgian roads and 47 percent of vehicle utilization of Georgian international roads.

3. The Government of Georgia is committed to completing the EWH investment program by 2022. The investments will improve connectivity between the Caspian and Black Sea, lower the cost of transport and logistics, and improve Georgia's connection to global markets. The Government has in recent years accorded high priority to completing the upgrading of the EWH (392 km) to international motorway standards (2x2 lanes). In addition to the time savings generated from the upgrade to international motorway standard, which raises the travel speed, the introduction of new alignments in some sub-sections of the EWH will reduce the overall length of the corridor and further contribute to reduce travel time. The Government has opted to financing this important investment program using its own budget and significant support of the international financing institutions (IFIs). The total estimated cost of upgrading the EWH is USD 2.265 billion, which is equivalent to 13.7 percent of Georgia's GDP in 2014.[2] The World Bank has financed five road improvement projects along the EWH to complement the Government's initial investment from Tbilisi, and financing is also being provided by other IFIs. Approximately 160.5 kilometers of the EWH have already been upgraded, of which 96 km were funded by the World Bank through the first two highway improvement projects (Highway Improvement Project 1 and 2). Works are ongoing to complete an additional 177 km by 2016 with the support of the World Bank, the Asian Development Bank, the European Investment Bank, and the Japanese International Cooperation Agency.

4. In 2015 the World Bank completed a study aimed at quantifying economy wide benefits of investment in the EWH, through the assessment of indirect impacts of cumulative investments (World Bank 2015). Explicitly excluded from the analysis were the direct impacts associated with the civil works, which

[1] The East West Highway is part of the European route E-60, which is the second longest E-road running from Brest, France (on the Atlantic coast), to Irkeshtam, Kyrgyzstan (on the border with People's Republic of China).
[2] As per the IMF's World Economic Outlook database of April 2015, Georgia's estimated GDP in 2014 was USD 16.5 billion.

would have large impacts on real GDP and employment. In order to assess the medium and long-term economy-wide benefits of the EWH this study used a computable general equilibrium (CGE) model, which simulates indirect benefits associated with the completion of the upgraded road corridor. In their most basic form, CGE models characterize a target economy (in this case, Georgia) using detailed consumption and production functions, together with a depiction of the market prices and price distortions (e.g., taxes or regulatory controls), providing a depiction of the economy "as is" in a static framework and then applying a shock. Such a depiction is contained in the Social Accounting Matrix (SAM), a comprehensive, economy-wide data table which represents how the different sectors of the economy interact.

5. The results showed that the reduction in travel costs resulting from upgrading the EWH had a positive effect on growth and welfare. Compared with outcomes in the absence of an upgrade, Georgia's real GDP would be 4.2 percent higher in the long term. This figure would be somewhat lower if externalities such as global and local pollutants from generated traffic had been added to the analysis. On the other hand, the overall impact on GDP of the EWH would be larger than 4.2 percent, once the impacts of construction itself have been included. Other long-run gains exceeding 4 percent in real terms were in exports, household consumption, and household income, with rural income gaining slightly more than urban. All quintiles of household income made long-term welfare gains ranging from 2.6 percent for the lowest quintile to 4.4 percent for the highest, lower quintile group. The first two quintiles with the lowest income—the bottom 40 percent with annual income up to GEL 1000 (USD 465)—gain relatively less than other household groups reflecting lower usage of transport for that group.

6. The objective of this follow on study is to assess the impact of upgrading the EWH on Georgia's ability to access international markets. As highlighted extensively in the literature, improving transport infrastructure and the efficiency of the logistics sector can help countries gain competitiveness in international export markets, which could translate into faster economic growth and higher income. As noted in a recent study (World Bank 2013), in order to address the challenge of improving exports prospects, Georgia needs to further improve trade and logistics infrastructure. Exports have played a much smaller role in driving growth in Georgia during the last decade than in regional and global comparators. Over 2014-2015 Georgia was faced by a regional slow-down and currency depreciations, and experienced lower exports, but exports are expected to pick up from 2017.[3]

7. To assess the effect of cost reductions generated by improvements in the EWH, a gravity-type model in first-differences has been estimated.[4] Gravity models of trade predict bilateral trade flows based on the economic size and distance between two units. The gravity model assumes that the trips produced at an origin and attracted to a destination are directly proportional to the total trip productions at the origin and the total attractions at the destination. The calibrating term or "friction factor" (F) represents the reluctance or impedance of persons to make trips of various duration or distances. The general friction factor indicates that as travel times increase, travelers are increasingly less likely to make trips of such lengths. Calibration of the gravity model involves adjusting the friction factor.

8. Using data for the 2005-2015 period, we regress the annual growth rate of exports, disaggregated by products, customs offices clearing them and modes of transport, on annual improvements in the EWH and its

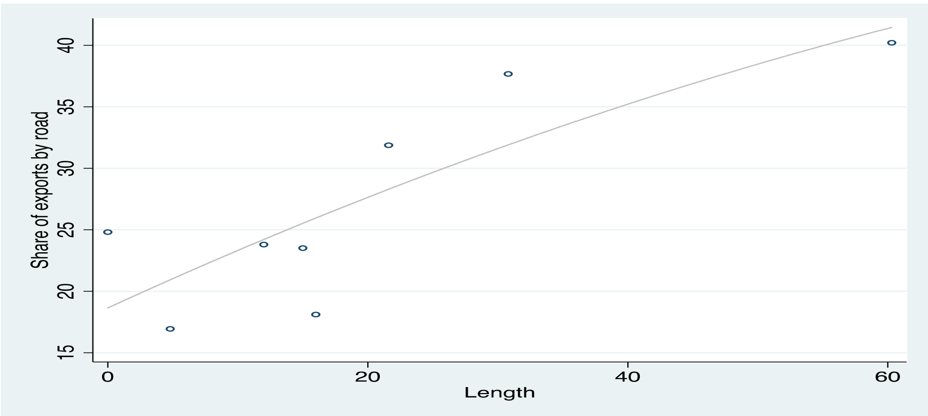
[3] The top four destinations of Georgia's exports are Azerbaijan, Armenia, Russia, and Turkey. The one big change in Georgia's export structure has been the reorientation away from the Russian market after 2005, with more goods going to neighboring Azerbaijan, Armenia, and Ukraine. The commodity structure of Georgia's merchandise exports have not changed much over the last decade, with resource-based products such as minerals and metals still dominant. This study hypothesizes that improvements in the EWH have reduced the cost of shipping Georgian goods to the rest of the world, and such reductions should be more significant for goods transported by road.

[4] First-difference estimator is the obtained by running a regression of ΔY_{it} on ΔX_{it}, instead of a regression of Y_{it} on X_{it}.

interaction with a binary variable indicating road transport. First-differencing controls for all time-invariant product, customs office and transport mode specific factors affecting Georgia's exports. It also controls for potential selection of products or customs offices into transport modes.[5] The analysis controls for potential contaminating factors affecting trade flows when estimating improvements in the EWH on Georgian exports. This paper also investigates whether improvements in the EWH have had positive economic spillovers in a neighboring country, Azerbaijan.

9. Using data on international trade in Georgia, Armenia, and Azerbaijan, the analysis aims to assess the impact of changes to the quality of the international road corridor on the volume and composition of international trade, in order to assess what changes have been taken place to date, given the sections of the EWH that have been upgraded to motorway standard and to simulate impacts once the entire corridor is completed. The methodological approach proposed follows that of a recently published paper which aimed to understand how internal transportation infrastructure affects regional access to international markets (Coşar and Demir 2016).

Figure 1: Share of Georgian Exports by Road and Length of Upgraded Roads (2006-2015)



Notes: The x-axis shows the length of upgraded roads, measured in kilometers, on the EWH each year between 2006-2015.
Source: Road Department of Georgia, World Bank estimates.

10. The primary effect of the EWH upgrading program would be a reduction in travel costs and time for goods transported by land. Therefore, one could expect to see a relatively stronger increase in Georgia's exports transported by road than other modes of transport. The patterns observed in Figure 1 confirm such expectations: the share of Georgia's exports transported by road correlate positively with the length of upgraded roads along the EWH over the 2006-2015 period.[6] One could argue that exports transported by road and upgrading on the EWH are driven by a common trend, which is not necessarily generated by a causal link. We address this concern by adding (product and customs office specific) time trends as additional controls in the regression analysis.[7]

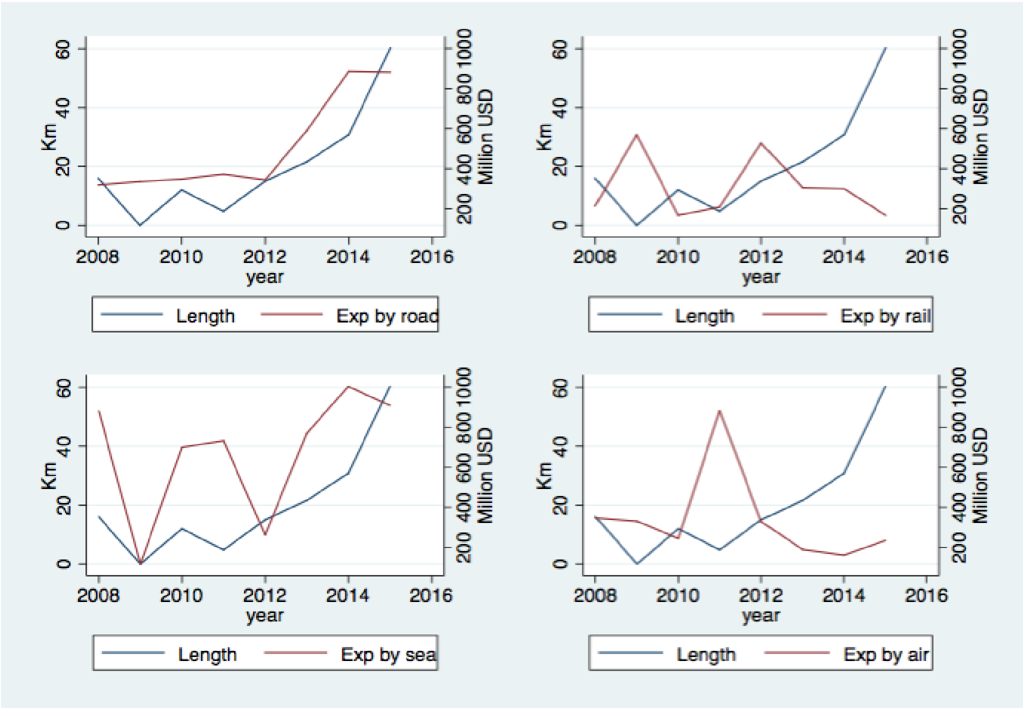
[5] Some factors affecting international trade flows do not change over time, e.g. sharing a common border. When annual change in trade flows, instead of their levels, are used as the dependent variable in a regression analysis, such factors are eliminated as they are constant over time. In our analysis, selection of flows into a particular transport mode could be an issue. For instance, pipelines are used to transport crude oil and natural gas. Since this selection is specific to products and transport modes, i.e. it does not change over time, first-differencing also eliminates such selection.

[6] Although we use data for the 2005-2015 period, the sample used in the regression analysis covers the 2006-2015 period as we use first-differences.

[7] Border-crossing customs offices will be referred to as customs offices throughout the paper.

11. Figure 2 provides further support to the hypothesis that improvements in the EWH are correlated with a reduction of the cost of shipping Georgian goods to the rest of the world, and such reductions should be more significant for goods transported by road. Over the 2008-2015 period, Georgian exports transported by road follows a similar trend as the roads upgrading on the EWH while exports on other transport modes do not show a similar pattern.

Figure 2: Georgian Exports by Mode of Transport and Length of Upgraded Roads



Notes: The x-axis shows the length of upgraded roads, measured in kilometers, on the EWH each year between 2006-2015.
Source: Author's calculations.

1.2 Modelling Approach

12. Since the seminal work of Tinbergen (1962), the gravity model has become the workhorse of the empirical trade literature. In the simplest gravity model of trade, the volume of bilateral trade depends positively on the sizes of trade partners and negatively on the distance between them. The theoretical trade literature has shown that the success of the gravity model in explaining bilateral trade flows was not surprising. Indeed, a gravity specification can be derived from almost all standard trade models. The gravity model takes the following general form:

$$X_{ij} = GS_iM_jt_{ij}^{-\delta}, \qquad (1)$$

where X_{ij} denotes the value of exports shipped from source i to destination j, G is the famous gravity constant, S_i denotes source-specific factors that determine its supply potential, M_j denotes destination-specific factors that determine its demand potential, and t_{ij} is the level of bilateral trade costs between i and j. δ is the elasticity of trade flows with respect to trade costs, measuring the percentage change in the value of exports shipped from source i to destination j as a response to a one-percent change in trade costs.

13. The model can easily be estimated using ordinary least squares (OLS) after taking the logarithm of both sides. The literature has traditionally been using GDP as a proxy for supply and demand potential of trade partners, and distance between the capital cities of the trade partners as a proxy for the level of bilateral trade costs between them. Estimating gravity as a linear model after taking the logarithm of both sides has two advantages. First, estimating linear models is easier. Second, expressing trade values and the explanatory variables in logarithms means that the estimated coefficients can be interpreted as elasticities.[8]

14. The main challenge faced by researchers when estimating the gravity model of trade is related to the modeling of bilateral trade costs. Obviously, distance is not the only determinant of bilateral trade costs. Trade costs are usually modeled as a function of a number of time-invariant factors including bilateral distance, common language, tariffs, and quality of infrastructure, which is a potentially time-varying factor.

15. While distance reflects costs related to geography, common language is related to information costs associated with marketing in the destination market. Tariff barriers are usually proxied by membership in a common regional trade agreement. One of the important, yet difficult to measure, factor affecting bilateral trade costs is the quality of transport infrastructure. Among the studies that estimate the quality of transport infrastructure on trade, the earlier studies (e.g. Limao and Venables (2001)) use cross-country data and the estimates they report potentially suffer from endogeneity bias: do countries with better transport infrastructure trade more, or those who trade more invest more in transport infrastructure to improve its quality? More recent studies (e.g. Volpe and Blyde (2013); Duranton et al. (2014); Coşar and Demir (2016)) focus on particular countries and episodes to bypass such problems.

16. In the empirical analysis, a modified gravity model is used to estimate the effect of the upgrading of the EWH on Georgia's exports. The upgrading should have reduced the cost of shipping Georgian goods to the rest of the world over time, and such cost reductions should have a more significant effect on goods transported by road. Since we are interested in estimating the trade-generating effects of improvements in the EWH, we will focus on annual growth of exports over the 2006-2015 period, which corresponds to the period from the start of the EWH investment project to the latest year available in our dataset.[9]

1.3 Data

17. Data on Georgian exports was provided by the Revenue Service of Georgia and cover the universe of Georgian exports disaggregated by mode of transport (road, rail, sea, air), customs office and 6-digit Harmonized System (HS) product categories for the 2005-2015 period.[10] The upper panel of Table 1 presents the value of Georgia's exports by transport mode over the 2005-2015 period. It is easy to see that exports transported by road posted the largest increase (almost quadrupled) over the period under consideration. There is a also a significant increase in the number of products exported by road over the same period. In the empirical analysis, we will investigate whether the observed diversification of Georgian exports could be explained by the upgrading of the EWH.

[8] The recent literature has highlighted the importance of adding relative trade costs: costs country i (j) faces when trading with j (i) relative to the costs it faces when trading with the rest of the world. These are the so-called multilateral resistance terms, which are derived from the theory (as explained below), and therefore ignoring them would create a bias in the estimates obtained from the gravity model.

[9] It is worth noting that the gravity model of trade does not necessarily fix the overall exports volume of a country. While gravity equations derived from Armington-type models (e.g. Anderson and vanWincoop (2003)) imply that the total volume of exports of a country is fixed, gravity equations derived from Ricardian models (e.g. Eaton and Kortum (2002)) allow total export volume of a country to change with productivity and trade costs.

[10] Harmonized System is an international nomenclature to classify traded goods, which was developed and has been maintained by the World Customs Organization. The HS Nomenclature includes about 5,000 products identified by a 6-digit code.

Table 1: Georgia's Exports by Transport Mode during 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Value of exports (Million USD)	*3,530*	*5,140*	*7,500*	*8,800*	*6,660*	*6,840*	*5,780*	*4,900*	*6,890*	*10,360*	*9,690*
Road	850	1,400	2,500	2,700	2,300	2,200	1,200	1,100	2,200	4,300	4,000
Rail	620	880	1,200	1,400	2,400	940	880	1,200	830	870	690
Sea	1,600	2,000	2,700	3,300	660	2,600	2,200	1,400	2,900	4,200	3,600
Air	460	860	1,100	1,400	1,300	1,100	1,500	1,200	960	990	1,400
Number of products (6-Digit HS)											
Road	1037	3798	3811	3725	3738	3692	2997	2706	3594	3992	4047
Rail	593	1719	1712	1396	3063	935	695	776	461	632	543
Sea	924	3238	3096	3056	1013	2877	2350	2073	2824	3114	3187
Air	777	2415	2437	2530	2455	2477	2640	2733	2745	2737	2772

Source: Revenue Service of Georgia

Table 2: EWH Civil Works Contracts (2006-2015)

EWH Section	Length (km)	Start date	Completion date
Natakhtari Agaiani	16.0	Apr/2006	Jul/2008
Agaiani Igoeti	12.0	2007	2010
Igoeti Sveneti	15.0	2009	2012
Sveneti Ruisi Lot 1	4.8	Jul/2009	Oct/2011
Sveneti Ruisi Lot 2	11.5	Jul/2009	May/2013
Sveneti Ruisi Lot 3	8.3	Jul/2009	Jun/2013
Ruisi Agara road	19.0	Dec/2012	Dec/2015
Agara Zemo Osiauri Road	12.0	Sep/2014	Dec/2016
Rehabilitation of Rikoti tunnel	1.8	Jun/2010	Aug/2013
Zestafoni Kutaisi Bypass road	15.2	Jul/2013	Jul/2016
Kutaisi bypass road	17.3	Dec/2011	Feb/2015
Kutaisi bypass Samtredia road	24.0	Jul/2012	Dec/2015
Samtredia Grigoleti Lot 1	11.5	May/2014	Nov/2016
Samtredia Grigoleti Lot 4	9.6	May/2015	May/2017
Kobuleti bypass road Lot 1	15.4	Sep/2011	Jun/2014
Kobuleti bypass road Lot 2	18.9	May/2013	Jul/2017

Source: Roads Department of Georgia.

18. We also use data on road upgrading on the EWH. Table 2 presents the details of projects related to the upgrading of particular road segments on the EWH. Until 2015, a total of 160.5 km road has been upgraded, which corresponds to about 40 percent of the total length of the EWH.[11] As will be explained in detail in the next section, our variable of interest in the empirical analysis will be the total length of roads upgraded in each year. Given that the total length of the road network is fixed, an increase in the length of upgraded roads on the EWH is associated with an improvement in the quality of road infrastructure.

[11] The upgrading is comprehensive along the EWH. While we are not aware of any selection based on economic potential, there could be selection based on geography as some segments could be easier to upgrade than others. Since we treat any upgrading equally regardless of the location of the respective segments, our estimates can be seen as an average effect.

1.4 Empirical Strategy

19. The main aim of Georgia's EWH improvement program is to improve connectivity by reducing travel times and transport costs, and increasing road capacity. Increasing the country's overall export performance has not been mentioned as an explicit aim of the series of projects, as the projects' objectives focus on direct impacts. Our identification strategy relies on two sources of variation.[12] First, as mentioned earlier, we hypothesize that exports transported by road should have benefited (relatively) more from reductions in transport costs, driven by improvements in the EWH. Second, exports cleared at customs offices located on the EWH (e.g. Kutaisi) should have benefited more from the upgrading of the EWH. The aim of the project was not to invest in those customs offices but they have benefited from the investments because they are "accidentally" located on the EWH. We will exploit both variations in our empirical analysis.

20. We use a modified gravity framework to derive our estimating equation. As explained earlier the gravity model of trade specifies the volume of bilateral trade as a function of the sizes of trade partners and the distance between them. Our data inform us about Georgia's exports disaggregated by mode of transport (road, rail, sea, air), customs office and 6-digit Harmonized System (HS) product categories, and aggregated over Georgian provinces for the 2005-2015 period. Focusing on Georgia's exports transported by road, we can modify the gravity equation in (1) to add product and time dimension as follows:

$$X_{pot}^{m} = GS_{pt}M_{ot}t_{ot}^{-\delta}\,, \qquad (2)$$

where *o* indexes customs office, *p* products, *m* transport mode (e.g. road), and *t* year. X_{pot} denotes the value of exports of product p shipped through customs office o at time t; S_{pt} and M_{ot} denote time–varying product-specific and customs office-specific factors affecting Georgia's exports, respectively. t_{ot} denotes (potentially) time-varying trade costs incurred when exporting through customs office o.

21. We face a number of challenges arising from data limitations. The customs-level data used in this analysis do not inform us about the destination or source, within Georgia, of export flows. Availability of such data would certainly improve the identification of the effect of the EWH upgrade on Georgia's exports.[13] Lack of such detailed data forces us to reinterpret the gravity equation. In equation (2), S_{pt} captures Georgia's time-varying product-specific supply potential and changes in overall world demand for this particular product while M_{ot} captures demand generated in the destinations served by a particular customs office, e.g. income in destination countries that can be reached through it. This would be valid if exports destined for a particular destination market are usually cleared at a given customs office.

22. We assume that trade costs, represented by t_{ot}, depend on a combination of time-invariant and time-varying factors. For instance, geographical remoteness of destination countries reached through a given customs office is a time-invariant factor influencing trade costs incurred when exporting through that customs office. We conjecture that the upgrading of the EWH leads to a reduction in customs office-specific trade costs over time. We aim to estimate the effect of such reduction on Georgia's exports.

23. When estimating equation (2), we adopt the approach suggested by Baier et al. (2014) and use first-differencing:

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[12] In empirical economics, we almost always use observational data, which are not generated by a randomized experiment. The ultimate aim of using econometric techniques on such data is to identify the causal effect of a variable (covariate) on the outcome variable. The way we use econometric tools on observational data to approximate a real experiment is referred to as an identification strategy. It involves addressing issues related to potential endogeneity of the covariates. In particular, all factors included in the outcome variable, which could explain variation in the covariates, need to be controlled for in the regression.

[13] Needless to say, using more detailed data, e.g. firm level, would be ideal.

$$\Delta lnX_{pot}^{m} = \Delta lnS_{pt} + \Delta lnM_{ot} - \delta \Delta lnt_{ot} + \epsilon_{pot}, \qquad (3)$$

where ΔlnX denotes the annual change in the natural logarithm of exports, and ϵ_{pot} denotes the error term. As Baier et al. (2014) explain in detail, first-differencing has a number of advantages over alternative estimation methods (e.g. fixed effects) when estimating gravity models. First, first-differencing yields more efficient estimates when errors terms are serially-correlated. Second, it eliminates all time-invariant product, customs office and transport mode specific factors affecting Georgia's exports. Finally, it controls for potential selection of products or customs offices into transport modes.

24. Using equation (3), we derive our estimating equation as follows:

$$\Delta lnX_{pot}^{m} = \gamma_o + \gamma_1 lnLength_t + \gamma_2 Trend_{ot} + \gamma_3 Trend_{pt} + \eta_{po} + e_{pot}, \qquad (4)$$

where $Trend_{ot}$ and $Trend_{pt}$ are customs and product specific trends, respectively. η_{po} is a set of binary variables that are specific to product and customs offices. Equation (4) explains the annual change in exports (outcome variable) as a function of the length of upgraded roads on the EWH, customs office and product specific trends, and customs office-product specific factors as captured by η_{op}. As the total length of the EWH is unchanged, the variable $lnLength_t$ would capture the improvements in roads along the EWH. Therefore, our coefficient of interest is γ_1: obtaining a positive and statistically significant γ_1 estimate for exports transported by road and customs offices located along the EWH would be consistent with our initial hypothesis.[14]

25. It is worth noting that equation (4) represents a more demanding specification than equation (3). First, including product and customs office specific trends in our baseline specification controls for differential growth rates of the supply and demand-specific factors, respectively.[15] Second, adding customs office-product specific factors (η_{po}) in a first-differencing specification controls for *po-specific* "secular growth" rates (Trefler (2004)).

26. We estimate equation (4) using OLS and cluster standard errors at the customs-office year level. When constructing the growth rate of exports at the customs-office, product, year level, we use the mid-point growth formula:

$$\Delta X = \frac{X_t - X_{t-1}}{0.5 * (X_t + X_{t-1})}$$

The mid-point growth rate is an approximation to a logarithmic growth rate and has the advantage of taking newly created and disappearing flows into account. The next section summarizes the results obtained from estimating equation (4) and a number of robustness checks.

1.5 Estimation Results

27. Results obtained from estimating equation (4) for each transport mode are reported in Table 3. Roads upgrading on the EWH had a positive and statistically significant effects only for exports transported by road. The results also suggest that there was a substitution from sea to road transport with the upgrading of

[14] We also have information on the location of upgraded segments. Nevertheless, such information is not useful given the lack of data on the source of export flows – we cannot track the route of particular flows.
[15] The former also captures general economic growth and changes in the geography of trade of Georgia.

the EWH (column 2). There was no significant change in growth of exports transported by rail and air associated with the upgrading over the 2006-2015 period. The estimate reported in the first column implies an elasticity of exports transported by road with respect to roads upgrading of 0.11. The effect is also economically significant: upgrading a segment of 25km on the EWH in a year would increase exports transported by road by 11 percent.[16] We will discuss the interpretation of the results in more detail later.

Table 3: Baseline Results

	ΔlnX_{opt}^{road}	ΔlnX_{opt}^{rail}	ΔlnX_{opt}^{sea}	ΔlnX_{opt}^{air}
$lnLength_t$	0.111***	0.341	-1.321**	0.0548
	(0.0351)	(0.401)	(0.538)	(0.0477)
N	21933	3570	2279	6032
R2	0.205	0.262	0.394	0.143
Regression	OLS	OLS	OLS	OLS

Notes: All columns include product-customs office dummies, customs office specific trends and product specific trends, which are not reported to save space. * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at the customs-year level

28. After showing that the upgrading of roads on the EWH affected only exports transported by road positively and significantly over the 2005-2015 period, we run the following more parsimonious specification by pooling observations on all transport modes together:

$$\Delta lnX_{opmt} = \beta_o + \beta_1 Road_m x lnLength_t + \beta_2 Road_m + \alpha_{ot} + \alpha_{pt} + e_{cpt}, \quad (5)$$

where m indexes mode of transport, and $Road_m$ is a binary variable that takes on the value one for exports transported by road and zero otherwise. We aggregate exports by rail, sea and air together and compare their trend to exports transported by road. This specification allows us to directly control for time-varying customs office (α_{ot}) and time-varying product specific (α_{pt}) factors that could potentially affect the growth rate of exports over the 2006-2015 period.[17] Since it gives us a cleaner identification, equation (5) is our preferred specification. The coefficient on $Road_m$ measures the annual change in exports transported by road relative to other transport modes. The coefficient of interest is β_1: the coefficient on the interaction term between the binary variable $Road_m$ and the length of upgraded roads on the EWH. It measures the growth of exports transported by road as more roads are upgraded on the EWH, and we expect it to be positive.

29. Results estimating from equation (5) are reported in the first column of Table 4. As expected, the coefficient on the interaction term $Road_m x lnLength_t$ is estimated to be positive and significant. This result is consistent with the results reported in Table 4 and our initial hypothesis that exports transported by road should have benefited (relatively) more from reductions in transport costs, driven by improvements in the EWH.

30. Columns 2 and 3 of Table 4 report results obtained from running equation (5) on two subsamples: first subsample only covers customs offices that are located off the EWH (e.g. Batumi) and the other only covers customs offices that are located on the EWH. Consistent with our initial hypothesis, upgrading of roads on the EWH was associated with an increase in exports transported by road only for those flows

[16] This calculation is based on a one-percent increase at the mean length, which is 2.5km.

[17] Adding time-varying customs office specific dummies in equation (3) absorbs the effect of $lnLength_t$, thus it is not included separately in the equation.

cleared at customs offices located on the EWH. This result lends further support for our identification strategy.

Table 4: Results from the Preferred Specification

	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}
$Road_m x lnLength_t$	0.157*	0.142	0.173*
	(0.0942)	(0.168)	(0.102)
$Road_m$	0.0154	0.499	-0.135
	(0.208)	(0.489)	(0.201)
N	32590	16792	15798
R2	0.431	0.640	0.571
Regression	OLS	OLS	OLS
Sample	All	Customs offices off the EWH	Customs offices on the EWH

Notes: All columns include product-year and customs office-year dummies, which are not reported to save space. * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at the customs-year level

31. To unveil possible mechanisms behind our results, we use an alternative measure of improvements in the EWH. Instead of total length of roads upgraded in a given year, we use total time savings on improved roads as a share of time required to travel before the investment.[18] Results are presented in Table 5. Column (1) shows results obtained from estimating equation (4) using time savings instead of total length of upgraded roads. The coefficient of interest is estimated to be positive and significant, implying that time savings generated by the improvement in the EWH led to increase in Georgian exports. Column (2) shows results from our preferred specification in (5) using the alternative measure. As expected, the coefficient on the interaction term $Road_m x lnLength_t$ is positive and statistically significant.

Table 5: Results Using Time Savings

	ΔlnX_{opt}^{road}	ΔlnX_{opmt}
$Time\ Saving_t$	1.720*	
	(0.975)	
$Road_m x Time\ Saving_t$		1.937*
		(1.200)
$Road_m$		0.0421
		(0.210)
N	21933	32590
R2	0.207	0.431
Regression	OLS	OLS

Notes: Column (1) includes product-customs office dummies, customs office specific trends and product specific trends, and column (2) includes product-year and customs office-year dummies, which are not reported to save space. * p<0.10, ** p<0.05, *** p<0.01. P-value of the coefficient on $Road_m x Time\ Saving_t is$ 0.106. Robust standard errors clustered at the customs-year level

[18] We use actual speed before and after the improvements for each road segment to calculate time-savings, and then we express them as a share of total time required to travel along the road segment before the investment.

32. Next we run equation (5) for each HS chapter separately. Results are presented in Table 6. The coefficient of interest is estimated to be positive and significant for two industries: machinery/electrical, and transportation equipment. Surprisingly, agricultural and other perishable products are not found to have been affected significantly by the upgrading on the EWH. According to the Country Economic Memorandum, published by the World Bank in 2013, transport equipment is one of the sectors with greatest representation in Georgia's export basket. Also, the sector is identified among those with high productivity growth performance during the 2005-2010 period.

33. Regarding the heterogeneous effects of transport infrastructure across product types, the current literature identifies two channels: time-sensitivity (Hummels and Schaur (2013)) and heaviness (Duranton et al., 2014; Coşar and Demir, 2016). Hummels and Schaur (2013) use US imports data and estimate consumers' valuation of time at the product-level. Their findings suggest that the most time-sensitive product type is parts and components. Using data on trade flows between US cities, Duranton et al. (2014) find that cities with more highways specialize in sectors producing heavy goods. Coşar and Demir (2016) estimate that improvements in the quality of road infrastructure in Turkey during 2000s had larger trade-generating effects on heavy goods. Results reported in Table 5 are too aggregated to be able to identify the underlying channels. So, we use the time-sensitivity measure developed by Hummels and Schaur (2013) and weight-to-value ratio of US imports in 2005 at the 2-digit HS level to categorize goods as "time sensitive" or "heavy". Then we rerun our preferred specification in (5) for goods with time-sensitivity index above/below the median and weight-to-value ratio above/below the median. As presented in Table 7, only time sensitive and light goods responded positively and significantly to improvements in the EWH (columns 2, 3, and 5). Results presented in Tables 6 and 7 imply that reductions in transport costs driven by improvements in the EWH boosted Georgia's exports of light and time-sensitive goods in machinery/electrical and transportation equipment industries. This is consistent with the findings of Hummels and Schaur (2013) if those goods involve parts and components that need to be delivered just-in-time.

Table 6: Results by Industry

	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}
$Road_m xlnLength_t$	0.0342	-0.0571	0.365	0.192	0.105	-0.369	0.0982	-0.102	-0.0209	0.0510	0.186	**0.341*****	**0.558*****
	(0.123)	(0.144)	(0.320)	(0.224)	(0.199)	(0.416)	(0.156)	(0.197)	(0.420)	(0.293)	(0.161)	(0.0793)	(0.197)
$Road_m$	0.00576	0.148	-0.169	0.0347	0.177	1.265	-0.0990	0.577	0.475	0.153	-0.0935	-0.169	-0.242
	(0.338)	(0.396)	(0.901)	(0.583)	(0.420)	(1.225)	(0.360)	(0.530)	(1.064)	(0.683)	(0.419)	(0.159)	(0.423)
N	1888	1765	476	2359	1793	495	1788	3664	541	1184	3747	7771	1210
R2	0.582	0.447	0.626	0.498	0.442	0.473	0.456	0.523	0.530	0.477	0.422	0.420	0.587
Regression	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Sample	Agriculture	Foodstuff	Mineral Products	Chemicals	Plastics / Rubbers	Raw Hides, Skins, Leather, & Furs	Wood & Wood Products	Textiles	Footwear /Headgear	Stone / Glass	Metals	Machinery /Electrical	Transportation

Notes: All columns include product-year and customs office-year, which are not reported to save space. * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at the customs-year level

Table 7: Time Sensitivity and Heaviness

	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}	ΔlnX_{opmt}
$Road_m xlnLength_t$	0.177	0.139*	0.239***	0.0959	0.244***	0.123
	(0.114)	(0.085)	(0.0819)	(0.12)	(0.0911)	(0.156)
$Road_m$	-0.0164	0.0491	0.0323	0.0261	0.0249	-0.0241
	(0.277)	(0.179)	(0.179)	(0.268)	(0.196)	(0.354)
N	13567	19023	16061	16529	9306	6812
R2	0.414	0.448	0.44	0.43	0.455	0.407
Regression	OLS	OLS	OLS	OLS	OLS	OLS
Sample	Time sensitivity below median	Time sensitivity above median	Heaviness below median	Heaviness above median	Time sensitivity above median & Heaviness below median	Time sensitivity below median & Heaviness above median

Notes: All columns include product-year and customs office-year dummies, which are not reported to save space. We use the time sensitivity measure constructed by Hummels and Schaur (2013). Heaviness is measured as the weight-to-value ratio of a given 2-digit HS product category for US imports in 2005 using Hummels and Schaur (2013) data. * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at the customs-year level.

34. What is the economic significance of our results?[19] To get a sense of the quantitative importance of our baseline elasticity estimate of 0.111, consider the following discussion. Over the 2005-2015 period, a total length of 160 km roads has been upgraded on the EWH. When calculated at the value of exports by road in the beginning of the period (2005), the investment is estimated to have generated an additional USD 600 million export flows transported by road. Given that Georgia's exports by road increased from USD 850 million to USD 4,000 million over the 2005-2015 period (see Table 1), export flows generated by the EWH investment accounts for about 19 percent of the overall increase. The baseline estimate also implies that upgrading the entire corridor (392km) would generate an additional USD 1,466 million worth of export revenues by road. It is important to note that, the overall trade generating effect of the investment is expected to be lower as our results suggest a substitution between road and sea transport (see Table 3).

35. Another interesting question is how our results for Georgia compare to those obtained for other countries. One example is the large-scale public investment in roads in Turkey during 2000s. Coşar and Demir (2016) use international trade data for Turkish provinces and the change of capacity of roads connecting them to international gateways to estimate the distance elasticity of trade associated with roads of varying capacity. They report two important findings. First, Turkish provinces that experienced a greater improvement in their connectivity to the country's international gateways posted a higher increase in their trade flows. Second, the cost of an average shipment over a high capacity highway is about 70 percent lower than over single lane roads and that the reduction in transport costs is greater the more transportation sensitive an industry is. Their results suggest

[19] It should be noted that we are not conducting a simulation exercise but directly interpreting the estimate we obtain for the elasticity of exports by road with respect to road upgrading on the EWH. The former requires a model and structural estimation of the model's deep parameters.

that $1 investment in road infrastructure generates a 10-year discounted stream of additional trade flows between USD 0.7- USD 2 billion**.** The baseline estimate reported in their study implies that the upgrading of the entire EWH corridor would generate additional export revenues of USD 776 million. This estimate is almost half of the estimate we obtain for Georgia. It is worth noting that our estimates for Georgia are not directly comparable to those reported by Coşar and Demir (2016) because of different identification and estimation strategies employed in the two studies. Nevertheless, we can think of the estimated effects of large-scale road infrastructure investments reported in the two studies as lower and upper bounds: upgrading the entire EWH is estimated to generate additional export revenues between USD776 million and USD1,466 million.

1.6 Spillover Effects to Neighboring Countries: The Case of Azerbaijan

36. In this section, we investigate whether improvements in the EWH have had positive spillovers over neighboring countries. We focus on Azerbaijan as routes from Azerbaijan through Georgia often lie in the East-West direction. It is not the case, for instance, for Armenia. In the case of Armenia, most of the traffic through Georgia follows the North-South Corridor rather than the EWH.

37. Our conjecture is that Georgia's investment in the EWH should have generated potential cost reductions for shipping Azerbaijani goods to some destinations but not others. In particular, only those destinations with a land connection through the EWH were affected by the investments. Therefore, improvements in the EWH over the 2006-2015 period constituted an exogenous shock to Azerbaijani exports, which created two groups of destinations: control and treated. The control group consists of destination countries for Azerbaijani exports, for which there is no land connection via the EWH in Georgia. Countries in the treated group, on the other hand, have land connections to Azerbaijan through the EWH.[20] To illustrate, the land route between Azerbaijan to Turkey passes through the EWH while the route between Azerbaijan to Iran does not. Therefore, exports of Azerbaijan of a given product destined for Turkey should have benefited from lower transport costs due to the improvements in the EWH while exports destined for Iran should not. For each treated route, we only consider related road improvements finished in the respective year, thus the variable of interest $lnLength_{dt}$ is a destination(d)-year(t) specific variable. We obtain detailed data on Azerbaijani exports at the 6-digit HS product and destination country level for the 2005-2015 period from UN Comtrade.

38. Results are reported in Table 8. In the first column, the dependent variable is the annual change in the value of Azerbaijani exports at the product-destination level. The coefficient of interest is not statistically significant, suggesting that the upgrading of roads on the EWH did not have an effect on the exports of Azerbaijan to destination countries that have land connection via the EWH.

[20] We construct routes using the website https://www.freemaptools.com/how-far-is-it-between.htm

Table 8: Results for Azerbaijani Exports

	ΔlnX_{dpt}	New_{dpt}	$Drop_{dpt}$
$lnLength_t$	0.0558	0.0134***	-0.000220
	(0.0396)	(0.00414)	(0.00782)
N	36931	110884	25787
R2	0.389	0.244	0.539
Regression	OLS	OLS	OLS

Notes: All columns include product-year and destination specific dummies, as well as annual changes in GDP as additional controls. * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at the destination-year level

39. In column 2, we estimate whether the upgrading of the EWH has led to establishment of new trade links for Azerbaijan. To do so, we estimate a Linear Probability Model, where the dependent variable is a binary variable that takes on the value one if exports of a particular flow is positive at time t and zero at time t-1. Results from this estimation suggest Azerbaijan was more likely to establish new trade links with destination countries that benefited from the improvements in the EWH. Nevertheless, we do not find a statistically significant effect on the probability that a trade flow disappears at time t (column 3).

1.7 Trade and Growth

40. Using the estimates obtained from estimating equation (4) and Georgia's national accounting data, we can obtain a back-of-the-envelope estimate for the contribution of the investment program on the country's economic growth through its effect on trade over the 2006-2015 period. The share of exports of goods and services in Georgia's GDP measured in constant Lari was 28.6 percent in 2008 and reached 42.8 percent as of 2014.[21] Over the same period, exports of goods and services made the largest contribution (25 percentage points) to the cumulative GDP growth of 26 percent, implying an elasticity of 3.4.

41. The EWH project could be expected to have generated additional benefits to the Georgian economy, which are difficult to quantify given the lack of available data. The economic geography literature highlights that geography is the foremost determinant of the remoteness of a location, which then determines the cost of accessing other markets. Therefore, a significant fraction of spatial disparity in economic activity can be explained by variations in the cost of accessing to other markets. Given such relationship, improving transport infrastructure to reduce regional disparities in the cost of market access is a powerful tool to reduce regional disparities and poverty in a country. For instance, in a recent study, Allen and Arkolakis (2014) estimate that at least 20 percent of the income variation across the US can be explained by geographic location, and removing the

[21] Using data from the 2016 World Development Indicators.

Interstate Highway System would decrease welfare as much as 1.4 percent. Using detailed sub-national data, one could estimate whether there was a decline in the variation of income across the regions in Georgia over the 2008-2015 period, and whether income and employment in regions closer to the EWH increased relatively more strongly during the same period.

1.8 Limitations of the Modelling Approach

42. Partial equilibrium models, such as the gravity model, usually focus only on one part or sector of the economy, assuming that the impact of that sector on the rest of the economy is either non-existent or small, ignoring interactions with other sectors. A partial equilibrium model also does not take into account the resource constraints of the economy; that to increase production in one sector resources need to be pulled away from other sectors. A partial equilibrium model is most suited for policy analysis when the policy-maker is only interested in sectoral policies, or when the sector under study represents only a small share of total income, or policy changes are likely to change the price in only one market, while prices in other markets will remain constant. In contrast, CGE modeling is an established method for studying economy-wide impacts. In this study the focus has been the impact of the EWH upgrade on exports, and has excluded impacts on economic growth and jobs that could arise from the non-tradeable sector.

43. The main challenge faced by researchers when investigating trade effects of large-scale transport infrastructure investments is endogeneity: countries tend to invest in regions characterized by high productivity and trade potential. Therefore, it is critical to control for any confounding factors and trends so that observed outcomes can only be attributed to the investment project under consideration. Such an empirical strategy is demanding in terms of data. Unfortunately, in the case of the EWH we are constrained by data limitations. Various tests were carried out to examine the robustness of our results.

44. First, our first-differencing specification eliminates any time-invariant demand or supply-related factors as well as product or customs office-specific composition of export flows. Second, we include product and customs office specific trends in the baseline specification, and country-year and product-year dummies in our preferred specification to soak up any confounding time-varying demand and supply-related factors that might have affected Georgia's exports over the 2005-2015 period. Third, we control for secular trends specific to products and customs offices. Finally, we run a falsification (placebo) test to ensure that the results we have obtained from the regression analysis do not capture a spurious correlation. In the falsification test, we use the start year of the EWH projects instead of the finish dates. As expected, the coefficient of interest (γ_1 in equation 4) is estimated to be insignificant in this specification. This result increases our confidence in the results presented in Tables 3 and 4. Finally, in line with the current literature, we find that our results are driven by exports of time-sensitive products. This result is based on a different identifying variation than in equations (4) or (5) and complements our baseline results.

45. Despite various robustness checks, due to the lack of data on the source (within Georgia) and final destination of export flows, our results should be interpreted with caution. One could think of a number of threats to our identification strategy. First, we are not able to control for growth in demand for particular products in a given destination. If fast-growing product-destination exports are cleared at customs offices located on the EWH and transported by road, our results would partly reflect such a composition effect. Second, our variable of interest, length of road upgrading on the EWH, does not properly capture the extent of cost savings on particular segments. One could construct a finer measure (similar to Coşar and Demir (2016)) if data on the source of export flows within Georgia was available.

1.9 Conclusion

46. In this paper, we have investigated whether the upgrading of the EWH to international standards by Georgia have brought economic benefits to the country through expansion of exports. As highlighted extensively in the literature, improving domestic transportation infrastructure and the efficiency of the logistics sector can help countries gain competitiveness in international export markets, which could translate into faster economic growth and higher income. Improvements in the EWH should improve connections to international production networks in the EU and Turkish markets.

47. Our results suggest that (i) a 10 percent increase in the length of upgraded road network predicts a 1.1 percent increase in exports transported by road while no significant effect is estimated for exports on other transport modes (rail, sea, and air); (ii) the resulting increase in exports by road was reflected by a decrease in exports transported by sea; (iii) the effect is statistically and economically significant only for customs offices located along the EWH; (iv) only exports of time-sensitive products responded positively and significantly to improvements in the EWH during the 2006-2015 period; (v) upgrading the entire EWH is estimated to generate additional export revenues between USD 776 million and USD 1,466 million.

48. We have also investigated whether improvements in the EWH have had positive spillovers over neighboring countries. We find that Azerbaijan could establish new trade links with destination countries, with which it has land connection via the EWH over the 2006-2015 period. These results provide evidence that supports the view that investment in domestic transport infrastructure generates positive externalities on other countries. For sustainable provision of such investments, its costs could be shared among countries benefiting from them.

49. We see this report as a first step to quantify the trade-generating effects of the EWH on Georgia and the neighboring countries. Given the importance of international trade as an engine of economic growth and increasing importance of participation of middle-income countries in global value chains, more thorough analysis using more detailed data (e.g. firm level data) would be

extremely useful to understand and quantify the rate of return to such large-scale investment projects.

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Annex 1: Model Description

After a long period of mystery about the reason for the success of the empirical gravity relationship, Anderson and van Wincoop (2003) laid a theoretical foundation for the model by assuming constant elasticity of substitution preferences and differentiated goods by origin. More importantly, they showed that adding only bilateral trade costs would create serious omitted variable bias in the gravity model, but that it can be removed by adding variables that capture "multilateral resistance" (MR) in the equation.

Anderson and van Wincoop (2003) assume a world consisting of N countries and the same number of goods, each differentiated by its country of origin. Each country is populated by individuals with identical preferences for those N goods. Their preferences are represented by a constant-elasticity-of-substitution (CES) utility function. Assuming that Y_j denotes income in country j, individuals in country j maximize utility subject to a budget constraint given income Y_j and goods prices p_i , i = 1,… N . Using the demand functions derived from the consumer's utility maximization problem together with the market clearing conditions, one can obtain the following expression for the volume of trade between countries i and j:

$$X_{ij} = \frac{Y_i Y_j}{Y_W}\left(\frac{t_{ij}}{P_j P_i}\right)^{1-\sigma},$$

where Y_i (Y_j) denotes the income of country i (j), and Y_W denotes the world income; t_{ij} is the level of bilateral trade costs between i and j. Finally, P_j (P_i) is the "multilateral resistance term" which measures trade barriers that country i (j) faces with all its trade partners. These terms are usually absorbed by importer-specific and exporter-specific intercept terms (importer and exporter fixed effects).

The equation above can be estimated by taking the logarithm of both sides and using Ordinary Least Squares (OLS). As noted above, importer and exporter fixed effects are added to the estimating equation to absorb the multilateral resistance terms as omitting them causes biased estimates for the coefficients of interest, in particular that of bilateral distance.

More recently, Santos Silva and Tenreyro (2006) suggested estimating gravity models using Poisson pseudo-maximum-likelihood (PPML). This method has two advantages over OLS. First, as PPML uses the dependent variable in levels rather than in logarithm, it includes zero trade flows in the estimation. Second, in the presence of heteroskedasticity in levels, the expected value of the logarithm of the error terms depends on the explanatory variables, which would result in biased and inconsistent OLS estimates. PPML is now the state of the art in the empirical international trade literature.

In the empirical analysis, we will deviate from the standard modelling of bilateral trade costs by adding a variable that captures the improvements in the quality of road infrastructure along the shortest route between the source and destination countries over time. In the gravity literature, bilateral trade costs are assumed to depend on bilateral distance and various time-invariant factors as follows:

$$t_{ij} = d_{ij}^{\delta} \exp(\alpha_1 Border_{ij} + \alpha_2 CommonLang_{ij} + \alpha_3 RTA_{ij}),$$

where d_{ij} denotes the bilateral distance between countries i and j, and $Border_{ij}$, $CommonLang_{ij}$ and RTA_{ij} are dummy variables which indicate, respectively, whether the country pair ij shares a common land border, has a common language and the countries are members of the same regional trade agreement. Our specification of trade costs mimics the one introduced by Coşar and Demir (2016). In particular, our formulation of bilateral trade costs will be time-variant as it will include a time-varying variable that captures the improvements in the quality of the road infrastructure along the shortest route between the source and destination countries due to the upgrading of the East-West Highway:

$$t_{ijt} = d_{ij}^{\delta_n RSC_{ijt} + \delta_o (1 - RSC_{ijt})} \exp(\alpha_1 Border_{ij} + \alpha_2 CommonLang_{ij} + \alpha_3 RTA_{ij}),$$

where RSC_{ijt} is the share of completed corridor in the total length of the route between the countries ij, and δ_n (δ_o) is the distance elasticity of trade costs on the new high-quality (old low-quality) roads. We can now substitute the time varying trade costs into the gravity model to obtain:

$$X_{ijt} = \frac{Y_{it} Y_{jt}}{Y_{Wt}} \left(\frac{d_{ij}^{\delta_n RSC_{ijt} + \delta_o (1 - RSC_{ijt})} \exp(\alpha_1 Border_{ij} + \alpha_2 CommonLang_{ij} + \alpha_3 RTA_{ij})}{P_{jt} P_{it}} \right)^{1-\sigma},$$

Annex 2: Female Employment across Industries

The literature is salient on whether benefits of trade are distributed equally by gender, or whether trade deepens already existing gender inequality. Providing an answer to such questions in the context of the EWH project is difficult. If detailed data on the distribution of employment by sector and gender was available, we could discuss the potential trade-driven effects of the EWH project on gender inequality. Given the lack of such data for Georgia, we have to rely on the share of female employment by industry in the US. Table A1 presents the share of female employment in some selected US industries in 2015. The figure is high relative to the overall manufacturing in agriculture, food and textile manufacturing, and low in machinery, wood products and transportation equipment. The latter belongs to the group of industries that have benefited more from the upgrading of the EWH (see Table 5). The resulting expansion of those industries could lead to an increase in gender inequality in terms of employment in Georgia. Although it is not possible to reach a conclusion that rests on solid grounds based on such figures, this argument raises concerns about the potential adverse effects of the EWH upgrading project on gender equality.

Table A1: Female Employment Share across US Industries (2015)

Industry	Share of female employment
Agriculture, forestry, fishing, and hunting	46.8
Manufacturing	29.1
Machinery manufacturing	20.8
Computers and electronic products manufacturing	30.7
Electrical equipment and appliances manufacturing	31.3
Transportation equipment manufacturing	24.5
Wood products manufacturing	12.7
Food manufacturing	39.7
Textiles, apparel, and leather manufacturing	53.8

Source: Bureau of Labor Statistics