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Association between Transport Infrastructure and Decentralization in Developing Countries

1. Introduction

Among the key impediments to the economic growth of many developing countries, especially those disadvantaged geographically, are high transport costs. They limit access to resources, capital, and markets; they also reduce the flow of information, ideas, and technology. For example, landlocked countries are isolated from international trade, lack "needed trade linkages" and face "the inland market too small to support a refined division of labor" (Bloom et al. 1998, p. 239). These challenges, however, could be overcome with well-developed infrastructure. Infrastructure generates multiplier effects increasing both supply and demand and is a strong determinant of long-term economic growth, because many investments in that area last for generations (Caledron 2009). Improved and more numerous roads, bridges, canals, railways, ports, and airports connect people and bring them new opportunities, notably better jobs and higher incomes. With rapidly growing populations and rates of urbanization, implementing infrastructure in developing countries is becoming increasingly important.

Nonetheless, developing countries face substantial underinvestment in infrastructure, including transportation: "Although roads are the predominant mode of transport, much of Africa's road network is unpaved, isolating people from basic education, health services, transport corridors, trade hubs, and economic opportunities —particularly in regions with high rainfall." (AfDB 2018, p. 73). Dangerous road conditions lead to a large number of accidents, and Africa's fatality rates are the highest in the world (AfDB 2018). Railroads, ports, and other forms

of infrastructure perform equally poorly (AfDB 2018). Resulting high trade costs lead to a vicious cycle of limited opportunities for growth and scarce funding for future investment in infrastructure.

Thus, the question of how to improve infrastructure in developing countries is of major interest, and one aspect to consider is government decentralization. Whether the policy of decentralization has more advantages than disadvantages has been a topic of a fierce debate in development economics. On the one hand, decentralization may make the state more accountable and more efficient in addressing to the needs of a local population (e.g. Faguet et al. 2014). In the case of infrastructure, familiarity with local conditions, such as geographic ones, translates to better selection and implementation of projects (Bahl et al. 2014). On the other hand, local governments may be captured by the local elites (Bardhan 2002). An argument in favor of central governments is that they may gain from economies of scale and promote high standards across the country (Humplick et al. 1999a). Furthermore, potential efficiency gains may be offset by inadequate financial and human capital at the subnational level (Bahl et al. 2014). Therefore, the overall effect of decentralization is not clear.

Transportation, in turn, seems to have a distinct relationship with decentralization, because it connects different places within and across countries and thus entails externalities. By prioritizing the national transportation network, a central government may favor projects with positive externalities to other parts of the country (Humplick et al. 1999a). In addition, national government's supervision is necessary in cases such as highways or airports, because these types of infrastructure connect the country to its neighbors. Hence, the presence of externalities may outweigh other considerations and mandate the central government. This may weaken the potential association between decentralization and transport infrastructure. Nevertheless, local

governments may still be responsible for infrastructure maintenance and from the provision of local networks. Therefore, the association, even if weak, is likely positive.

The literature on decentralization and transport infrastructure is relatively small, and authors tend to focus either on infrastructure understood more broadly or more narrowly than transportation as a category. Bardhan (2001) posits that decentralization enhances welfare provided that services are financed by user fees, although the author does not differentiate between transport and other categories of infrastructure. Humplick et al. (1999a) study road provision and assert that local governments act more efficiently in areas such as road maintenance, monitoring the quality of construction, and spending decisions, while central governments are better at regulating safety and incorporating network externalities. In addition, empirical evidence shows that the loss in the economies of scale can be outweighed by other efficiency gains, such as better reflecting users' preferences (Humplick et al.1999b). Andres et al. (2014) share the view that local governments supervised by the central government do better at road provision, but the authors also note that efficiency of infrastructure provision may depend on the type of decentralization (deconcentration, delegation, or devolution) and strategic cooperation between governments. According to Kappeler et al.'s (2013) empirical study of European countries, revenue decentralization leads to increased public spending on sub-national infrastructure. Estache and Sinha (1995) reach a similar conclusion in their paper, in which they analyze data from ten developing and ten industrialized countries. They find that decentralization increases the transport infrastructure expenditures on both national as well as local level, and this effect is even more visible in the developing countries than in the industrialized ones. Similarly, Array's (2019) empirical study on Spanish provinces finds that fiscal and administrative

decentralization increases public investment in infrastructure; however, it suggests that the effects may be limited to the short run.

Considering the lack of substantial research in the area, this paper takes the relationship between transport infrastructure and decentralization as its main subject of analysis. Is decentralization associated with improved transport infrastructure provision in developing countries? Although the degree of decentralization certainly changes the ways governments provide goods and services to their citizens, it is not obvious whether a statistically significant association between decentralization and transportation infrastructure provision can be observed across many countries and years. Due to the potentially large role of cross-regional and cross-country externalities, can transport infrastructure be differentiated as a separate class of infrastructure? The goal of this paper is to suggest an answer for these two questions.

In order to accomplish this, I perform cross-sectional-data and panel-data analyses involving simple OLS and fixed-effects models. I use several infrastructure indicators and two different decentralization measures from the World Bank and the International Monetary Fund. After four series of regressions, I conclude that transport infrastructure may be uncorrelated with decentralization on a worldwide scale. Since this conclusion differs for non-transport infrastructure, I argue that the former could be treated as a distinct class of infrastructure for the purpose of studying decentralization.

The rest of this paper is organized as follows. Section 2 describes the dataset and variables. Section 3 lays out the empirical strategy, including the specification, assumptions, and limitations. Section 4 presents the results. Section 5 discusses the findings. Section 6 concludes.

2. Data

The data in this paper come from a variety of sources, mostly from World Bank (WB), the International Monetary Fund (IMF), and the Organisation for Economic Co-operation and Development (OECD). The full dataset includes 129 countries from low-income, lower-middle-income, and upper-middle-income WB categories in the time period 2001-2017. There are six dependent variables and two main independent variables of interest. The numbers of observations, means, standard deviations, and minimum and maximum values of the indicators are summarized in Table 1. A full list of the sources of indicators can be found in Appendix A. Due to a large number of indicators, the overlap among them is limited, and the sample of each regression is different. The number of countries and of years ranges from 7 to 35 and 2 to 17 in panel-data regressions. The number of countries ranges from 25 to 124 in cross-sectional regressions.

Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)
Transport Infrastructure Variables	N	MEAN	SE	MIN	MAX
road accidents per mln inhabitants	156	60,086	60,086	1,180	568,649
railways, goods transported (bln ton-km)	225	172	172	0.00068	2,492
air transport, freight (million ton-km)	407	463	463	0	7,579
overall logistics performance index (1 to 5)	123	2.70	2.70	1.21	3.78
Other Infrastructure Variables					
access to electricity (% of population)	470	85.6	85.6	3.21	100
people using at least basic sanitation services (% of population)	479	75.7	75.7	4.56	100
Decentralization Variables					
Decentralization Index	127	0.021	0.021	0	0.24
share of subnational government expenditures in total expenditures, IMF 2001-2017	371	0.20	0.20	0.0018	0.57
Control Variables – Financial					
GDP per capita, PPP (constant 2011 international $)	475	9,766	9,766	594	31,698
trade (% of GDP)	470	81.4	81.4	0.27	270
foreign direct investment, net outflows (% of GDP)	451	0.88	0.88	-2.89	46.0

Control Variables – Demographic					
total population (mln)	409	38.9	38.9	0.28	1,300
urban population (% of total population)	480	55.4	55.4	9.38	88.0
ethnic fractionalization (0 to 1)	382	0.47	0.47	0.039	0.95
Control Variables – Geographic					
land area (sq. km)	479	1,185	1,185	0.34	16,381
average precipitation in depth (mm per year)	472	1,127	1,127	56	3,240
land area where elevation is < 5 (% of total)	363	2.25	2.25	0	54.6
Control Variables – Political					
regulatory quality (percentile rank)	474	44.0	44.0	0	85.8
rule of law (percentile rank)	474	37.3	37.3	0	83.7

Notes: The total number of countries is 129. The time period is 2001-2017.

The development of transport infrastructure is this paper's outcome of interest. The WB and the OECD provide data on various kinds of infrastructure in both quality and quantity aspects. To measure quality, I use *road accidents* (per 1000 inhabitants) from the OECD. Most observations for this indicator are European countries. To measure the size of railroad networks, I use *railways, goods transported* (million ton-kilometers[1]) from the WB. This variable includes disproportionately few Latin American countries. To measure the quantitative aspect of air transport, I include *air transport, freight* (million ton-kilometers) from the WB. Furthermore, I add an *overall logistics performance index* (from 1 to 5, where a higher number means better performance) from the WB.

Furthermore, I add separate class of infrastructure variables that are not related to transportation. They are used for comparison, in order to establish the potential heterogenous correlations between each class of infrastructure variables and decentralization. Thus, they help answer the question whether the distinctive characteristics of transportation, such as having

[1] "a unit of freight carriage equal to the transportation of one metric ton of freight one kilometer" ("Ton-kilometer." The Merriam-Webster.com Dictionary, Merriam-Webster Inc., https://www.merriam-webster.com/dictionary/ton-kilometer. Accessed 6 December 2019.)

interregional and international externalities, make its association with decentralization differ. The variables are *access to electricity* (% of population) and *people using at least basic sanitation services* (% of population) from the WB Global Development Indicators data.

The main independent variables of interest are measures of decentralization. An ideal measure of decentralization would indicate which government level is responsible for infrastructure planning, building, and maintenance in a given country in a given year. However, none of the indicators available fully meets these expectations. The most precise measure available is the WB Expenditure Assignment from the 2001 Qualitative Decentralization Indicators. There are two problems with this indicator: it does not include a time series and it lacks many observations. Due to its small sample size of 18 countries, it is not suitable for regressions. However, it is included in Appendix B for reference.

My analysis relies on proxy measures of decentralization, which are less precise but include larger samples. One of them is the Decentralization Index (*DI*) developed by Ivanyina and Shah (2013). This aggregate decentralization index incorporates the relative importance and the security of existence of local governments and fiscal, political and administrative indexes based on 2005 data (or earlier in some cases). This measure is useful in my analysis, because it simultaneously takes into account various aspects of decentralization. Therefore, even if not precise, it is likely to capture the influence of local governments on infrastructure provision. However, because the index does not include a time series, it only allows me to perform a cross-sectional analysis. This index encompasses 127 countries, including 26.19% low-income countries, 33.33% lower middle income countries, and 40.48% upper middle income countries. The largest group of countries included are located in Sub-Saharan Africa, which accounts for 36.51% of observations. I have recalculated the index so that it is now expressed within the 0 to 1

range, where 1 represents the value the most decentralized country of my dataset had in the original units.

In order to extend my analysis beyond a single point in time, I use international panel data from the IMF Fiscal Decentralization Dataset (2019). Fiscal decentralization is a narrower measure and may not accurately capture which level of government is responsible for infrastructure planning. However, inasmuch as it shows the expenditure autonomy of local governments, it should still otherwise reflect their role in infrastructure provision. Both indicators denote the share of subnational government expenditures in total expenditures, here converted to a value between 0 and 1. The IMF indicator originally included 60 countries and the period 1990-2017. However, the dataset was heavily unbalanced for the period 1990-2000. In order to obtain more reliable estimations, I have selected the period 2001-2017, which reduced the number of countries to 35. This subset includes just 3.77% observations from low-income countries, 32.61% from upper middle-income countries, and 36.39% from upper middle income countries. In addition, with about 44% of observations from Europe and Central Asia, these regions seems to be over-represented.

This dataset also includes many control variables, which fall into four main categories: financial, political, demographic, and geographic. The financial variables *GDP per capita* (GDP per capita, PPP (constant 2011 international dollars), *trade* (% of GDP), *foreign direct investment, net outflows* (% of GDP), and come from the WB Global Financial Development dataset. The political variables are the percentile ranks (where higher is better) of the *regulatory quality* and *rule of law* from the WB's Worldwide Governance Indicators, developed by Kaufmann, et al. (2010). The demographic variables are *total population* and *urban population* (% of total population), and *ethnic fractionalization* (an index from 0 to 1) from the World

Development Indicators. The geographic variables are *land area* (sq. km) and *average precipitation in depth* (mm per year), and *land area where elevation is below 5 meters* (% of total land area).[2] The *ethnic fractionalization index* (from 0 to 1, where 1 means the highest fractionalization) is from Fearon (2003).

4. Empirical Strategy

The empirical models used in this paper are designed to answer the following two key questions of the paper. Is decentralization associated with improved transport infrastructure provision in developing countries? Compared to non-transportation infrastructure, does transportation infrastructure have a unique relation with decentralization?

A. Specification

In order to answer the questions, I perform a cross sectional-analysis as well as a panel data analysis, depending on the decentralization measure, as discussed in the *Data* section. I propose an ordinary least squares model (1) and a fixed-effects regression model (2):

$$(1)\ y = \alpha + \beta DC + \boldsymbol{\gamma} CTRL + \epsilon$$

$$(2)\ y_{c,t} = \theta + \pi DC_{c,t} + \boldsymbol{\lambda} CTRL_{c,t} + \delta_c + \nu_t + \varepsilon_{c,t}$$

where y denotes the dependent variable of interest, c denotes a country, t denotes a year, α and θ denote constant terms, DC denotes a decentralization variable, $CTRL$ denotes a set of control variables, δ denotes the set of country-fixed effects, ν denotes the set of time-fixed effects, ϵ and ε denote random error terms. The coefficients of interest are α for cross-sectional analysis and π

[2] In order to balance the panel data, I adjusted these two indicators so that the value for every year is the maximum value each country had in the original data.

for panel-data analysis. The OLS regressions have heteroskedasticity-robust standard errors, and the fixed-effects regressions have clustered standard errors.

Compared to model (1), model (2) controls for time-invariant effects, and therefore is less prone to omitted variable bias. Enhanced by the time dimension, the model also takes more observations. However, model (1) may help address two important problems with the data: the fact that the *DI* is time-invariant and the fact that the panel data is unbalanced, as mentioned in the *Data* section. Therefore, I use model (1) for cross-sectional regressions and for the initial panel-data regressions. I use model (2) for the panel-data regressions with fixed effects and control variables. In addition, I create two-year, six-year, and ten-year lag intervals on the decentralization variable, which I use in both models when analyzing the panel data.[3]

B. Assumptions and Caveats

Due to the relative simplicity of the econometric methods and data imperfections, there are some caveats to the empirical analysis. First, the proxy variables employed in my analysis are broad and only indirectly indicate the responsibility for infrastructure provision. I assume that the resulting bias may weaken the measured association between the variables of interest rather than strengthen it. Therefore, this assumption makes my analysis more likely to reject rather than accept the hypothesis that there is a significant correlation between decentralization and transport infrastructure. Second, because of the inconsistency in terms of countries and years examined across the indicators I use, samples differ across regressions. Therefore, the results of the regressions may not be perfectly comparable, which I take into consideration when discussing them. This is especially the case with low-income countries, as their percentage share varies from

[3] Insofar as transport infrastructure projects are rarely implemented in just one year, the response of infrastructure indicators to structural changes is unlikely to be instant.

12 to 28 percent of observations, depending on the indicator. Nonetheless, the primary purpose of this paper is to establish whether there is a statistically significant association between transport infrastructure and decentralization in developing countries, to which the potentially limited comparability across samples is rather not a threat.

In addition, due to limited data availability, there are some missing observations in the dataset, which leaves the regression panel data unbalanced. In order to address that, I have trimmed the variables for which the data was heavily unbalanced: most importantly, I narrowed down the range of the IMF decentralization measure, as discussed in the *Data* section. However, the data for most of the key indicators remains unbalanced to a small degree, with a small number of countries having few observations across the time series, and with most countries missing few observations across the time series. As a result, regressions may suffer from selection bias. For instance, more prosperous countries may both share more data with the international institutions and have better infrastructure. However, the empirical strategy of this paper prefers larger sample sizes to a complete elimination of the potential selection bias.

Moreover, because I cannot preclude reverse causality issues, this paper's goal is to establish the association between decentralization and transport infrastructure rather than an effect of the former on the latter. However, Canavire-Bacarreza et al. (2017) find that infrastructure does not statistically significantly reduce the impact of geographical conditions on decentralization. This suggests that the reverse causality bias may be negligible and is consistent with my intuition that it is decentralization that determines infrastructure provision.

Finally, omitted variable bias is still possible, because a panel-data regression does not control for country-specific time-varying third factors. For example, decentralization may be a part of democratization (the WB 2001), which, in turn, attracts foreign investment in

infrastructure in a given country over time. Conversely, dictatorships may be correlated with government centralization and little foreign investment. Considering these internal validity concerns, the empirical strategy of this paper does not allow for conclusions about causality between infrastructure and decentralization. Most likely, therefore, the relationships found are mere correlations.

5. Results

Table II shows the results from basic OLS estimation on data from a cross-section of countries, whose number varies depending on regression. The significance level is obtained from heteroskedasticity-robust standard errors. Transport infrastructure is represented here by rail and ship freight, and non-transport infrastructure—by access to electricity and sanitation services. The results from regressions on *road accidents* and *overall logistics performance index* are not reported due to too small sample sizes obtained (18 and 25 observations). The results suggest that, if no other factors are taken into account, there is a strong correlation between decentralization broadly understood and infrastructure provision, which is consistent with the notion that the more decentralized a country is, the better at infrastructure provision it is. In addition, the results suggest there is little heterogeneity in the correlations between decentralization and infrastructure, whether infrastructure is related to transport or not. This finding is particularly surprising for air transport, because airlines connect different countries, implying a larger involvement of the central government, and thus smaller agency of decentralization in the improvement of services. However, these preliminary estimations may be biased by some omitted factors.

Table II: Cross-Sectional Regressions (Basic)

VARIABLES	Col. 1 *Rail*	Col. 2 *Air*	Col. 3 *Electricity*	Col. 4 *Sanitation*
Decentralization Index	2,986***	10,103***	290.9***	181.5***
	(1,019)	(1,878)	(71.75)	(66.31)
Observations	51	89	118	124
R-squared	0.149	0.250	0.124	0.058

"*Rail*" stands for *railways, goods transported* (bln ton-km). "*Air*" stands for *air transport, freight* (million ton-km). "*Electricity*" stands for *access to electricity* (% of population). "*Sanitation*" stands for *people using at least basic sanitation services* (% of population). These indicators come from the WB World Development Indicators and enter the regression as means from the time period 2000-2010. The Decentralization Index comes from Ivanyina and Shah (2013) and is based mostly on data from 2005. The number of observations is equal to the number of countries.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Therefore, I control for financial, demographic, geographic, and political factors and report the results in Table III. The results that the association between decentralization and the transport infrastructure variables is not statistically significant. However, electricity and sanitation remain associated with decentralization, which implies a heterogeneity of correlations depending on the class of infrastructure. This is consistent with the perspective that transportation, by generating externalities among regions and countries, falls less often under the provision of subnational governments and thus does not gain potential benefits from decentralization. Nonetheless, such conclusions cannot be drawn based on the regressions provided, not only because of the limitations of this simple specification, but also because of small and variant samples in this series of regressions (in particular, in the one on *Rail*). Moreover, only quantitative aspects of infrastructure are captured in this setup, whereas the correlations may be stronger for qualitative indicators. Finally, *Decentralization Index*, as a broad measure, may more weakly indicate the potential association between the relationship in question than a narrower decentralization measure.

Table III: Cross-Sectional Regressions (Control Variables)

VARIABLES	Col. 1 *Rail*	Col. 2 *Air*	Col. 3 *Electricity*	Col. 4 *Sanitation*
Decentralization Index	-175.1	2,493	237.8***	168.1***
	(1,175)	(2,905)	(62.74)	(60.07)
Observations	25	42	44	46
R-squared	0.868	0.773	0.823	0.805

Control Variables: yes.
"*Rail*" stands for *railways, goods transported* (bln ton-km). "*Air*" stands for *air transport, freight* (million ton-km). "*Electricity*" stands for *access to electricity* (% of population). "*Sanitation*" stands for *people using at least basic sanitation services* (% of population). These indicators come from the WB World Development Indicators and enter the regression as means from the time period 2000-2010. The Decentralization Index comes from Ivanyina and Shah (2013) and is based mostly on data from 2005. The number of observations is equal to the number of countries.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

So as to address these concerns, panel-data estimations from Table IV include more observations (although from fewer countries), the time dimension, two qualitative transport infrastructure indicators (*road accidents* and *overall logistic performance index*), and a narrower measure of decentralization: the fiscal decentralization indicator. These additions come at the expense of comparability between the cross-sectional and the panel-data analyses. Nonetheless, in order to obtain at least a limited understanding of how the analyses compare, I first once more use model (1), this time to run a series of regressions with the IMF Fiscal Decentralization Indicator for 2001-2017 without controlling for third factors.[4]

[4] The regressions with the IMF Fiscal Decentralization Indicator 2005 values, after taking the means of other variables for 2001-2010, had too small sample sizes to be conclusive. However, they are reported in *Appendix C*.

Table IV: Panel-Data Regressions (OLS)

Independent variable: share of subnational government expenditures in total expenditures, IMF 2001-2017

Dependent Variable	Col. 1 L0	Col. 2 L2	Col. 3 L6	Col. 4 L10
road accidents per mln inhabitants	222,538*** (76,591) 145	208,919** (83,773) 120	192,640* (106,202) 70	276,007** (125,882) 32
railways, goods transported (bln ton-km)	1,398*** (295.9) 187	1,585*** (362.2) 146	1,839*** (523.5) 86	2,100** (931.4) 39
air transport, freight (mln ton-km)	1,877*** (323.7) 335	1,867*** (368.5) 273	1,975*** (552.2) 171	1,984** (857.7) 82
overall logistics performance index (1 to 5)	1.027*** (0.235) 123	0.930*** (0.227) 110	1.027*** (0.260) 77	1.079** (0.398) 38
access to electricity (% of population)	10.41** (4.712) 369	6.434 (4.494) 301	-1.796 (4.044) 180	-8.905** (4.456) 87
people using at least basic sanitation services (% of population)	8.661 (6.214) 371	5.966 (6.634) 301	0.720 (7.740) 180	-7.776 (10.08) 87

Fixed effects: no. Control Variables: no.

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

Standard errors reported in parentheses.

Numbers of observations reported below standard errors.

Note: L0, L2, L6, and L10 refer to 0-, 2-, 6-, and 10-year lags in the IMF fiscal decentralization variable. The indicators used as dependent variables come from the OECD and the WB World Development Indicators. The decentralization variable comes from the IMF Fiscal Decentralization Indicators.

An interesting dissimilarity between Table II and Table IV is that in the latter, it is transportation infrastructure rather than non-transportation infrastructure that seems more significant. This is a counterintuitive observation, because the access to electricity and the access to sanitation seem to depend on subnational governments more than airports, railways, or roads. Another important difference is that the correlations are smaller, especially for *air transport, freight.* Because these differences have appeared for the same statistical model, they must result

from the difference in data. A remaining question is whether this is because of a different sample of countries or because of the time dimension.

The lag intervals in Columns 2-4 help understand the role of time. The number of road accidents decreases with the time lag (except for the 10-year lag, which relies on a very small sample size). The transport of goods via trains and planes also increases with the time lag. The *overall logistics performance index* remains roughly the same. This pattern suggests that decentralization may be associated with the improvement in transport infrastructure over time. However, the relationship between decentralization and the access to electricity and sanitation is the opposite: these services seem to deteriorate over time after decentralization. However, these coefficients are less statistically significant than the ones on the transportation indicators. This difference is contrary to findings in Table III, in which electricity and sanitation infrastructure, as opposed rail and air infrastructure, retain statistical significance.

In order to examine these preliminary findings for panel data, it, I use model (2), which controls for time- and country-fixed effects, as well as other financial, demographic, and political factors.[5] Table V presents the results All coefficients on transport variables (except for one) lose significance, and the coefficients on rail and air variables switch to negative signs. This calls into question the correlation between decentralization and transport infrastructure. In turn, the correlation between decentralization and non-transport infrastructure gains both significance and magnitude, although is still not strongly pronounced. This heterogeneity of correlations for transport- and non-transport-related infrastructure is consistent with the findings from the cross-sectional analysis based on Table III. As far as the impact of time is concerned, it is not clear in

[5] The geographic variables and *ethnic fractionalization* are excluded from these regressions because of multicollinearity with country-fixed effects.

this regression series. Most coefficients on all kinds of infrastructure lose magnitude with the increase of the time lag. However, this pattern is not statistically significant enough to draw reliable inferences.

Table V: Panel-Data Regressions (Fixed-Effects)
Independent variable: *share of subnational government expenditures in total expenditures, IMF 2001-2017*

Dependent Variable	Col. 1 L0	Col. 2 L2	Col. 3 L6	Col. 4 L10
road accidents per mln inhabitants	128,561* (65,060) 144	65,705 (82,380) 120	80,835 (58,107) 70	12,396 (20,884) 32
railways, goods transported (bln ton-km)	-642.1 (486.8) 166	-570.9 (454.5) 133	-238.5 (220.9) 78	62.04 (199.0) 37
air transport, freight (mln ton-km)	-3,106 (2,165) 303	-2,019 (1,796) 254	-45.55 (954.4) 163	1,042 (1,024) 80
overall logistics performance index (1 to 5)	0.795 (0.682) 117	0.821 (0.567) 105	0.0867 (0.572) 74	-0.684 (1.064) 37
access to electricity (% of population)	35.37* (17.59) 330	35.56*** (11.17) 277	17.08 (11.12) 171	15.08* (7.360) 85
people using at least basic sanitation services (% of population)	7.557 (6.211) 332	2.777 (3.986) 277	7.785* (3.928) 171	2.888 (2.357) 85

Fixed effects: yes. Control Variables: yes.
*** p<0.01, ** p<0.05, * p<0.1
Standard errors reported in parentheses.
Numbers of observations reported below standard errors.

Note: L0, L2, L6, and L10 refer to 0-, 2-, 6-, and 10-year lags in the IMF fiscal decentralization variable. The number of observations is smaller for larger lags but never reaches fewer than 32 observations. The indicators used as dependent variables come from the OECD and the WB World Development Indicators. The decentralization variable comes from the IMF Fiscal Decentralization Indicators.

6. Conclusion

The goal of this paper was to find out whether there is an association between government decentralization and transport infrastructure in the developing countries and whether this

association is different when transport is compared to other kinds of infrastructure. Due to very few research papers on this topic as well as limited data, it was not an easy task to perform an analysis that would yield unambiguous results. After controlling for financial, demographic, geographic, and political factors, both the cross-sectional analysis using the OLS model and the panel-data analysis using the fixed-effects model indicate that the association between decentralization and infrastructure provision across countries and years may be very weak or even nonexistent. However, the non-transport-related services exhibit some correlation with decentralization in both specifications, which indicates that there may be a heterogeneity of results for transport- and non-transport-related services.

This similarity of findings for the panel and the cross section is noteworthy considering that they differ in terms of indicators and samples. The *Centralization Indicator* from the cross-sectional analysis is an all-encompassing measure for a specific year, while the *share of subnational government expenditures in total expenditures* indicator is a specific measure for almost two decades. The panel data come from a smaller subset of countries and underrepresent lower-income countries, while the cross-sectional data come from a more than three times larger sample and represent income levels more evenly.

There are different possible answers as to why transport infrastructure may be uncorrelated with decentralization on a worldwide scale. Decentralization may have a weak impact on infrastructure or infrastructure may have a weak impact on decentralization. Due to the role of international externalities, transportation infrastructure (unlike other classes of infrastructure) may rarely be under the supervision of local governments, and so the hypothetical impact, regardless of its direction, is not manifested in reality. This interpretation explains why the results for non-transport infrastructure are different. Assuming this, I suggest that, in further

studies on decentralization, transportation infrastructure should be treated separately, as a distinct category of infrastructure, and not as one category together with kinds of infrastructure such as electricity or sanitation. Otherwise, when transport- and non-transport variables are studied together but without distinction, the overall association between decentralization and infrastructure may be weakened by transport variables (as they are often the largest share in infrastructure investment, e.g. in Africa this share is equal to 40%; *African Economic Outlook 2018*, p. 84),.

Nonetheless, the association between decentralization and transport infrastructure provision cannot be excluded, even across countries and years. My research relies on imperfect proxies and limited data; it may suffer from different internal validity issues, such as selection bias, and omitted variable bias. In addition, My analysis does not differentiate among different classes of income for developing countries, which may mask some important underlying patterns. In addition, the time span I chose, 2001-2017, is relatively short and likely covers few decentralization changes as compared to earlier periods. In order to obtain more reliable results, future research could choose a different time period and a narrower group of countries or a single country; for instance, a period of time during which a group of countries was transitioning from dictatorship to democracy. It would be interesting to compare transportation infrastructure provision in the years of Soviet Union's existence and in the years after its dissolution (data permitting). Due to the importance of this topic for the developing countries, there is a need for further research: the improvement of transportation infrastructure is crucial not only for economic growth of developing countries, but also for overall quality of life of its citizens.

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Appendix A—Variable Sources

International Monetary Fund:

Fiscal Decentralization Data
https://data.imf.org/?sk=1C28EBFB-62B3-4B0C-AED3-048EEEBB684F

Organisation for Economic Co-operation and Development:

Transport Indicators
https://data.oecd.org/transport/road-accidents.htm#indicator-chart

World Bank:

Qualitative Decentralization Indicators Dataset
http://www1.worldbank.org/publicsector/decentralization/qualitativeindicators.htm#1

World Development Indicators
http://datatopics.worldbank.org/world-development-indicators/

Including the WB's Research Database on Infrastructure Economic Performance (Estache et al. 2005)
http://documents.worldbank.org/curated/en/823331468328564333/A-research-database-on-infrastructure-economic-performance

Worldwide Governance Indicators
https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators

Worldwide Governance Indicators
https://info.worldbank.org/governance/wgi/

Global Financial Development
https://datacatalog.worldbank.org/dataset/global-financial-development

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Appendix B— Expenditure Assignment Indicator (World Bank, 2001)

		Interurban Highways	Urban Highways	Ports and Navigable Waterways	Airports	Railroads	Urban Transportation	Drinking Water and Sewerage	Waste Collection	Electric Power Supply	Telecommunications	Public Health	Hospitals
Czechia	Amount	C	C				C	L	L	L		C,L	C,L
	Structure	C	C					L	L	L		C,L	C,L
Lithuania	Amount			C	C			L	L				C,I
	Structure			C				L	L				
Argentina	Amount		L	I	C,I			C,I	L	I		C,I	I
	Structure		L	I	C,I			C,I	L	I		C,I	I
Bolivia	Amount	C	L					C,L	L			C	C
	Structure	C,I	L					L	L			L	
Brazil	Amount	C,I	I,L	C,I	C,I,L	C,I	I,L	C,I,L	L	C,I	C	C,I,L	C,I,L
	Structure	C,I	I,L	C,I	C,I,L	C,I	I,L	C,I,L	L	C,I	C	C,I,L	C,I,L
Chile	Amount	C	C	C	C	C	C	C	L		C	L	
	Structure	C	C	C	C	C	C	C,I	L		C,I	L	
Colombia	Amount	C,I	L	C,L	C	C	L	L	L	C,L	C,L	C,I,L	C,I,L
	Structure	C,I	L	C,L	C	C	L	L	L	C	C,L	I,L	C,I,L
Costa Rica	Amount	C	C	C	C	C	C	C	L	C	C	C	C
	Structure	C	C	C	C	C	C	C	L	C	C	C	C
Dominican Republic	Amount	C	C	C	C		C	C	I	C	C	C	C
	Structure	C	C	C	C		C	C	I	C	C	C	C
El Salvador	Amount	C	C	C	C	C	C	C	L	C	C	C	C
	Structure	C	C	C	C	C	C	C	L	C	C	C	C
Ecuador	Amount	C,I	L	C	C	C		C,L	L	C,L	C	C	C
	Structure	C,I	L	C	C	C		C,L	L	C,L	C	C	C
Guatemala	Amount	C	L	C	C	C	C	C,L	L	C	C	C	C
	Structure	C	L	C	C	C	C	C,L	L	C	C	C	C
Honduras	Amount	C	C,L	C	C	C		C	L	C	C	C	C
	Structure	C	C,L	C	C	C		C	L	C	C	C	C
Mexico	Amount	C,I	C,I,L	C,I	C	C	I,L	C,I,L	L	C	C	C	C,I
	Structure	C,I	C,I,L	C,I	C	C	I,L	C,I,L	L	C	C	I	C,I
Panama	Amount	C	C	C	C	C		C	I,L	C	C	C	C
	Structure	C	C	C	C	C		C	I,L	C	C	C	C
Paraguay	Amount	C	L	C	C	C	C	C	L	C	C	C	C
	Structure	C	L	C	C	C	C	C	L	C	C	C	C
Peru	Amount	C	I,L	C	C	C	I,L	C,L	L	C,I		C	C
	Structure	C	I,L	C	C	C	I,L	C,L	L	C,I		I	I
Suriname	Amount	C,I	I	C	C	C	I	C	I	L	L	C	C
	Structure	I	I	I	C,I	I	I,L	L	I,L	I,L	L	C,I,L	C,L
Trinidad and Tobago	Amount	C	C	C	C		C	C	C			C	C
	Structure	L	C	C	C		C	C	C			C	C
Uruguay	Amount	C	I	C	C	C		C,I	I	C	C	C,I	C
	Structure	C	I	C	C	C		C,I	I	C	C	C,I	C
Venezuela	Amount	C,I	I,L	C,I	C,I	C	L	C,I	L	C,I		C,I	C,I
	Structure	C,I	I,L	C,I	C,I	C	L	C,I	L	C,I		C,I	C,I
Pakistan	Amount	C	I					I	L			I	I
	Structure	C	I					I	L			I	I

The table indicates whether the central (C), intermediate (I), or local (L) government, or a combination thereof, is responsible for the amount and the structure of expenditures in each category of infrastructure in a given country. Note: "Amount" indicates which level of government decides the amount, and "Structure" indicates which government defines the structure of the expenditure. Source: The World Bank (2001)

Appendix C—Cross-Sectional Regressions with the IMF Fiscal Decentralization Indicator

Cross-sectional regressions with *share of subnational government expenditures in total expenditures, IMF 2005* as the independent variable.

VARIABLES	(1) *Road Acc.*	(2) *Rail*	(3) *Air*	(4) *Logistics*	(5) *Electricity*	(6) *Sanitation*
Decentralization	110,485	-74.58	147.4	0.811	0.280	-11.00
	(75,047)	(584.2)	(504.4)	(0.613)	(24.50)	(25.28)
Observations	11	17	25	25	25	25
R-squared	0.997	0.590	0.786	0.522	0.559	0.497

Fixed effects: yes Control variables: yes

Robust standard errors in parentheses

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

"*Decentralization*" stands for share of subnational government expenditures in total expenditures, IMF 2001-2017, "*Road Acc*." stands for road accidents per mln inhabitants, "*Rail*" stands for railways, goods transported (bln ton-km), "*Air*" stands for air transport, freight (mln ton-km), "*Logistics*" stands for overall logistics performance index (1 to 5), "*Electricity*" stands for access to electricity (% of population), and "*Sanitation*" stands for people using at least basic sanitation services (% of population).