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DEMOCRACY TO THE ROAD:
THE POLITICAL ECONOMY OF POTHOLES

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"Democracy to the Road: The Political Economy of Potholes"*

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* The views expressed in this paper are those of the author and do not necessarily represent those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. Ted Crone, Loretta Mester and Jose Tavares provided useful comments and suggestions. All remaining errors are the responsibility of the author. Comments on this version of the paper are welcome.
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Abstract

Are dictatorships more prone to build and maintain roads? This paper identifies a puzzling fact: countries that are more democratic tend to have roads in worse conditions than less democratic countries. Using lagged values of a democracy index to instrument for democracy in 1980 yields higher estimates of the magnitude of the association between democracy and bad roads. Instruments based on climate, population, and education yield similar results. The evidence points to a negative causal relationship from democracy to road quality. I also find that changes to a more democratic government are associated with slower growth of the road network. I advance four non-mutually exclusive hypotheses that can explain the results and find support for one of them: dictatorships prefer a better highway network ready for external and internal military intervention.

JEL codes: E62, H54, O17, R42

Keywords: Democracy, infrastructures, political economy

In 1924 a dictator inaugurated the first modern motorway in the world. The Milan-Varese motorway, which was completed under Benito Mussolini's regime, took drivers along 85 Km. Between 1924 and 1939, Mussolini had overseen the creation of 500 Km of Italian *autostrade*, a major expansion of Europe's incipient motorway system.[1] Adolf Hitler was soon to follow *Il Duce's* lead with the development of Germany's 2,100 Km *autobahn* system.[2] Two of the most terrible regimes in history seemed singularly concerned about road quality. Are dictators especially prone to the building and maintaining of highways?

The answer to this question is important in understanding contemporary public investment in developing countries. Consider the case of highway provision in Central America. Costa Rica is by far the richest country in that region. With a modern welfare state and a dynamic democracy, it is widely regarded as one of the most developed countries in Latin America. Why is it that Costa Rica's roads are so bad compared to those of its neighbors?[3] The most common explanation by Costa Rican officials is that budget pressures associated with redistribution make it difficult to assign resources to infrastructures.[4] Are officials trying to justify their relatively poor performance or are there explanations rooted in the political economy of highway provision?

[1] Hutchinson's Encyclopedia (2002).
[2] The *autobahn* system had been started during the Weimar republic, although the nazi regime fostered its fast expansion. See Oster (1996).
[3] Castro and Gavarrete (1999) use the World Economic Forum Methodology to study the efficiency of several aspects of Central American economies. Costa Rica came the last of five Central American countries in all transportation infrastructure categories: roads, railway system, air transportation, and ports. The World Economic Forum rankings are based on subjective responses from entrepreneurs. According to national surveys undertaken by CLACDS-INCAE (a prominent research institution in the region), in 1996 the percentage of roads in bad conditions was 30 percent in Guatemala, 45 percent in El Salvador, 30 percent in Honduras, 73 percent in Nicaragua, and 55 percent in Costa Rica (Saiz, 1998). Only in much poorer and war-torn Nicaragua was the share of roads in poor conditions greater than in Costa Rica in 1996.
[4] Personal communication with officials at the Costa Rican Public Finance and Transportation Ministries.

This paper sheds some light on these questions. I use data on quality of roads for a sample of developing countries and find that, indeed, democratic countries tend to have roads in worse conditions all over the world. This finding holds after controlling for several variables that differ between democracies and dictatorial regimes. The result is robust to instrumenting the values for a democracy index in 1980 with lagged values of the same democracy variable, and to instrumenting with other variables such as climate and percentage of population who are illiterate. Democratic countries tend to be much richer than dictatorial nations, and the country sample for this exercise is tilted toward less developed nations. I account for the hypothetical existence of heterogeneous treatment effects by stratifying the sample into four income quartiles. Similar qualitative results arise within income quartiles. The paper also shows that changes to a more democratic type of government are associated with slower growth of the highway system. The share of total capital devoted to transportation infrastructure may also be smaller in more democratic governments. In all cases the association between democracy and transportation infrastructure is very robust.

Four theories are advanced to explain these surprising results. First, dictatorial governments may be more prone to spend on "white elephant" road projects. Thus, road quality may be higher than optimal in dictatorial regimes. Second, democracies care more about redistribution, so they give higher priority to welfare-related consumption expenditures. Third, dictatorships may have preferences toward maintaining a good road network ready for internal and external military intervention. Finally, electoral competition may generate a higher discount rate among elected officials, which may push them to give priority to new construction over maintenance.

The paper expands the literature on the political economy of democracy. Most previous studies have studied the "black box" or general impact of democracy on the economy, finding positive impacts on welfare and redistribution (Sen, 1999; Rodrik, 2002). Rodrik (2002) argues that democracies yield long-run growth rates that are more predictable, produce greater short-term stability, and handle adverse shocks much better. Rivera-Batiz (2002) finds that democracy is a statistically significant variable affecting total factor productivity. He finds that this effect is mediated through the higher quality of governance in democracies. The literature has found a null overall association of democracy with economic growth (Tavares and Warcziag, 2000, and references therein). This paper looks at one important aspect inside the black box of the impact of democracy on economic outcomes (namely public investment in highways) and complements previous literature on the political economy of investment. Alesina and Perotti (1996) find that political instability reduces investment; more closely related to this paper, Tavares and Warcziag (2000) find a negative association between democracy and investment. How do political institutions affect public investment?

Methodology, Data and Results

The paper is interested in estimating the treatment effect of democracy on road quality. The main specification is the equation:

(1) $$P_i = \gamma \cdot Dem_i + X_i\beta + \varepsilon_i$$

Where P_i is the share of paved roads in poor condition in country *i*, Dem_i is an index of democracy, and X_i a vector of other country-specific variables.

I obtain the dependent variable on road quality from Canning (1996). The quality variable is available for a sample of developing countries (see Data Appendix).[5] The source for the democracy index is the Gastil index of political rights: the index is published yearly and takes seven discrete values. I use a transformation in Barro (1996) where the values of the index are bound between zero (less democratic) and one (more democratic).[6] In 1980, for example, the indicator took value zero in Somalia, 0.5 in Morocco and one in Costa Rica.

Other country specific data are obtained from Barro and Lee (1995), Summers and Heston (1995), the World Income Inequality Database from the United Nations Development Program, Harvard CID, and other sources. More information on the data sources and units is in the Data Appendix.

Table 1 presents the results of the general regressions. In all the regressions the dependent variable is the share of paved roads in bad condition in 1984,[7] the year for which the data are available.[8] The independent variable of interest is the democracy index in 1980. The four-year lag structure minimizes the Akaike criterion[9] and allows the impact of durable investments to show up after the typical duration of a democratic legislature. The basic regression (column 1) includes the logs of country area and income as additional explanatory variables for the quality of roads. The democracy index in 1980 is a significant predictor of poor road quality in 1980. Going from a total dictatorship

[5] There are 75 countries with data on road quality. Of these I cannot match two of them to data on the democracy index.
[6] I have to thank Jose Tavares for the data. The correlation of the index of political rights, which I use here, with the related Gastil index of civil rights is close to 0.95.
[7] Unpaved roads are not always a control variable of governments, as they can be old pathways and local or private highways.
[8] The data are available for 1988 for only a subset of 36 African countries.

(index 0) to a total democracy (index 1) is associated with a 14 percent increase in the share of roads in poor condition. Since more democratic nations are generally richer I try to avoid the democracy indicator capturing non-linear effects of income by including the square of log income in column 2. The democracy effect goes up, and this is consistent with the fact that democracies are richer and that the share of paved roads in bad condition is smaller in richer countries.

It is well known that road deterioration is a function of climatic variables (International Study of Highway Development and Management Tools, 1995). And at the same time there is a remarkably high negative correlation (-0.469) between the log of average country temperature and the democracy index. This negative association between temperature and democracy persists after controlling for other variables: the coefficient of log temperature on the democracy index has a t-statistic of -2.96 in a regression that controls for log income, log area, and log population. The log of precipitation has a t-statistic of 2 in the same regression. Thus colder and rainy countries tend to be more democratic. I control for the effects of climate on road quality in two ways. In column 3 I include dummies for 5 climate groups. I obtain the groups by standardizing the temperature and precipitation variables and conducting a *kmeans* cluster analysis.[10] In column 4 I just control for log temperature and precipitation. Column 5 controls for the average mean elevation of the country: road maintenance costs are higher in mountainous

[9] I run the regression in column 1 with specifications with 0 to 10 lags in the democracy index and choose the one that minimizes the Akaike criterion. Results are similar irrespective of the lag specification.

[10] I conduct a kmeans cluster partition using Euclidean distances on the space of the two standardized variables.

terrain. None of the geographic control variables is significant in the specifications and the coefficient on democracy remains unchanged.[11]

To allow for other regional omitted variables I also include three dummies for sub-Saharan Africa, Latin America, and East Asia. Barro and Sala-i-Martin (1995) argue that for these regions "previous researchers[12] have observed that growth rates are surprisingly low or high," which might point to possible idiosyncrasies in the regions' political or economic systems. The results (column 6) suggest that the democracy effect on road quality is not driven by such regional particularities.

Column 7 controls for the impact of productivity, proxied by past (1965-1980) long run growth of GDP per capita, which could be correlated with both democracy and road quality. Results are robust to the inclusion of the economic growth variable, which is a significant predictor of road quality.

Alesina and Perotti (1996) have shown that a country's political instability reduces investment. Is the democracy index capturing the effects of external or internal regime instability on the investment on durable public goods? Columns 8 and 9 include the fraction of time that the country spent in wars during the 1965-1980 period and the Barro-Lee measure of average political instability during the 1980-84 period. The results yield similar estimates of the coefficient on the democracy index.[13]

[11] In unreported regressions I also control for three other geographic variables: the percentage of population living within 100km from the coast or navigable river, the typical density experienced by an individual, and the percentage area in geographical tropics. Results are very robust.
[12] See also Barro (1991).
[13] The implicit view in the inclusion of the variable is that democracy in 1980 may be associated with posterior instability. The causation line between political stability and democracy could be reversed. In a complementary regression I add a pre-1980 political instability index and obtain similar results.

Columns 10 and 11 control for the possible decreasing marginal productivity in road maintenance. If democracies serve more people or provide more extensive access the results may be a mechanical product of decreasing returns (i.e. it may be that most roads are of the same quality and it is only the marginal difficult-to-build extensions that are necessarily worse in democracies). Controlling for the log of population and the log of paved road length does not substantially affect the results. Conditional on the same population size and highway network length, democracies provide lower quality over the road network.[14]

Similarly, we should control for a possible vintage effect. Countries that developed earlier may tend to be more democratic and may also have older stocks of highways. This spurious association could explain the statistical relationship between democracy and poor road quality. I control for some of this effect by the inclusion of road length in column 11. The length of the highway system seems to follow an error correction model (Canning, 1995). It is thus possible that countries that developed earlier and are relatively *overinvested* in roads rationally decide to depreciate *part* of the stock. But the vintage effects may also entail a higher cost of maintenance everywhere on the optimal road network. To control for this early development problem, I include the log of GDP per capita in 1960 (column 12). Early development does not account for the impact of democracy on roads.

Democracy is not a randomized treatment assignment. However, reverse causation in this exercise seems difficult a priori: the quality of the roads seems an implausible

[14] Randolph, Bogetic and Hefley (1996) suggest that the urbanization rate, the labor force participation rate and the size of the foreign sector are also amongst the most important predictors for investment in

determinant of a country's political rights.[15] The real potential problem with the interpretation of γ is the existence of omitted variables that are correlated with both the democracy index in 1980 and road quality in 1984. Table 2 presents 2SLS instrumental variables estimation of equation (1). I try to find variables that are correlated with the democracy index in 1980 but plausibly orthogonal to road conditions in 1984. In column 1 the instruments are past values of the democracy index (1972 to 1975): these should be exogenous to variables affecting road quality nine or more years later. Column 2 uses the log of average temperature and precipitation, log of population, the percentage of people with no schooling in 1980 and the average schooling years in 1980 as instruments for the democracy index in 1980.[16] Results in Table 1 are consistent with these exclusion restrictions. In both specifications the estimated democracy effect is higher, but so are the estimated standard errors.[17] Tables 1 and 2 provide the same qualitative results, and I cannot reject that the quantitative results are similar.[18]

How generalizable are the results to the full distribution of world countries? The data are only available for a set of relatively low-income countries. In fact, the correlation between the democracy index and the log of income is about 0.6 in the overall world

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infrastructure in developing countries. Unreported specifications of the model used these variables without much change in the quantitative or statistical significance of the democracy index.

[15] Alesina, Ozler, Roubini and Swagel (1996) find no contemporary causal link between low economic growth (a more plausible economic determinant of democracy) and the propensity to government changes.

[16] Barro (1999), shows that population and education levels are good predictors of the democracy index. Other variables proposed by Barro (1999) – GDP, urbanization rates and oil-producing country dummy- are not plausibly exogenous to road quality.

[17] This is consistent with the fact that the democracy index in any given year is a noisy indicator of actual democracy: this fact may bias the estimates in Table 1 downward.

[18] In Appendix Table A.3 I present the results from a Heckman-type treatment effects selection model. I create a dummy variable for democracy that takes value 1 if the democracy index is greater than 0.5 (recall that the index takes values from 0 to 1). The table presents the results of the maximum likelihood estimation of the selection into democracy treatment (column 2), and the treatment effect (column 1). The specification allows for covariance between the random terms in both equations.

sample. If the democracy "treatment effect" on road quality is heterogeneous and contingent on income, the results in the regressions may not tell us much about the general impact of democracy on road quality. The model with heterogeneous treatment effects becomes:

$$P_i = \gamma_i \cdot Dem_i + X_i\beta + \varepsilon_i \quad (2)$$

As the main concern is about heterogeneous treatment effects with respect to income, I use a simple stratification technique (Rosenbaum, 1995): I divide the sample into four income quartiles and estimate a separate democracy impact for each quartile (Table 3). The results are imprecise (each quartile has only 17 observations), but they are very robust: democracy is associated with lower road quality *within each income quartile.* The specification in Table 3 also helps us see that the results in Table 1 are not driven by *outlier* observations. [19]

Do the results in the previous tables indicate that democracies tend to have overall lower investments in roads? Clearly, that also depends on the length of the road network. Column 1 in Table 4 answers the question: do democracies provide more extensive highway systems? For comparability, I limit the sample to those countries for which I have information on road quality, and control for log income, log area, long-run economic growth, political instability (the *usual suspects* in terms of statistical significance in the previous regressions), plus log of population and the climate group dummies. The results are inconclusive. A total democracy (democracy index=1) has a paved road system about 40% longer than a total dictatorship (democracy index=0),

although the result is not significant. The problem with the interpretation of this result is that while quality is a stationary variable that depends on a control variable (maintenance), road length is basically a unit root series that integrates past additions to the stock. If democracies tend to have longer histories as industrialized countries they may have stocked up longer road networks. Thus, for example, Mussolini's *autostrade* could wrongly be attributed to the contemporaneous Italian democratic system. Recent changes in road length are indeed a control variable of democratic governments and a stationary series.

In Table 5 I consider the eight-year change in the length of paved roads from 1980 to 1988 (the long difference on the full length of the series). I use eight-year differences of the variables in Table 1 as controls, except for those variables that are fixed for each country (the fixed variables are area, climatic variables, fraction time at war between 1960-1980, income in 1960, and 1965-80 income growth). As road construction follows an error adjustment process, I also include the log of initial road length (1980). Since planning, budgeting and building new roads is not instantaneous, changes in democracy and the other variables are unlikely to affect road length contemporaneously. Thus I use lagged eight-year changes of the independent variables.[20] I implement the Akaike criterion to select the optimal lag structure, which is, again, four years. Table 5 shows how a 0-1 change in the democracy indicator from 1976 to 1984 is associated with a decrease of about 25% in the growth of the road network from 1980 to 1988. Since the

[19] In fact, the results are similar in different quantiles of the dependent variable. Quantile regression of specifications similar to those in Table 1 yield coefficients of the democracy index equal to 0.17 (0.33 quantile), 0.181 (median) and 0.182 (quantile 0.66).

change in the democracy index between two years is bound to be relatively noisy, column 2 uses the more stable Barro-Lee five year average values of the political and civil rights indexes (80-84, 75-79 and 70-74) as instruments for the 76-80 change in democracy. The negative association between increased democracy and a deceleration in new road investment holds in the IV specification (column 2).

Consistent with lower quality and decreased investment in new roads, democratic government policies seem to be less complementary with transportation capital investment. In Table 4, column 2, the democracy index is associated with a lower share of total capital per worker in transportation infrastructure, although there are a reduced number of observations and the result is not significant at the conventional levels.

4 Hypotheses

The paper so far has shown how democracy is associated with lower road quality. Changes toward a more democratic government are associated with a deceleration in new road construction. Here I posit several explanations of the political economy of this fact, and conduct simple tests that reinforce one of them. The results have to be taken with caution because of the small samples that I can muster.

First it may be that dictatorial governments have a preference for "white elephant" projects with lower social returns. It may be that roads are more conspicuous – a good highway network could be used as an indicator of government competency for foreign observers and a source of international prestige for dictatorships. For example, according

[20] The Barro-Lee Database only offers five-year stability indexes, so I take the difference between the index in the period 1980-84 and the period 1975-79.

to Oster (1996) "Hitler had grasped how popularly and effectively motorway construction could be sold as a means of propaganda." Under this scenario, dictatorships chose a road quality level above the optimal one. Highway spending may also be government expenditure category where corruption and cronyism are facilitated. A suitable example is the association between Nicaragua's Anastasio Somoza's government preference for roads and public works built with concrete from the Somoza family factories. As Barro (1996) argues, "democratic institutions provide a check on governmental power and thereby limit the potential of public officials to amass personal wealth." Unfortunately, corruption indexes are only widely available for recent periods, and I can only match them to 1984 road quality data for 19 countries.[21] But I can use the observations without road data in 1984 to see whether dictatorships tend to be associated with more corruption. After controlling for income, corruption and the democracy index are effectively orthogonal. It is thus unlikely that corruption accounts for the impact of democracy on roads. With the data available, I cannot test for the use of roads as a source of prestige or means of propaganda for dictatorships.

Second, democracies have preferences for redistributive expenditures (Rodrik, 2002; Sen, 1999). Alesina and Rodrik (1992) and Persson and Tabellini (1994) demonstrate that more inequality implies more redistribution through capital taxation and thus lower investment in democratic countries. These authors do not find any relationship between inequality and investment in dictatorships. In a democratic regime the median voter may prefer redistributive expenditures to highway maintenance (a type of public capital

[21] I use the corruption perception index from Transparency International (average from 1980 to 1985). The index is available for only 54 countries.

investment). If this is true, democracies should maintain better road networks when poverty or inequality are less of a problem, even if they have general preferences for redistribution. In contrast, dictatorships should be relatively insensitive to poverty levels. To instrumentalize this idea, I interact the democracy index with the share of population that is illiterate. Since the contemporaneous value of this indicator is bound to be endogenous to democracy (i.e. democracy reduces contemporary illiteracy), I use its 1960 historical level. The evidence is not consistent with the hypothesis for investments in highway quality (Table 6, column 1). Democracies with higher historical illiteracy levels tend to have *better* roads, but the correlation is not significant.[22]

Third, military governments may choose to invest in a well-maintained road system that facilitates the transportation of troops ready for internal repression and external intervention. If this is true, military spending and road maintenance are relatively more complementary the more military-oriented the government. Therefore we should also see that more militaristic democracies maintain relatively better road systems. Take, for example, the development of the United States Interstate Highway system. A retired general (President Eisenhower) oversaw the development of the transcontinental superhighway system. As a participant in the U.S. army's first transcontinental motor convoy from Washington D.C. to San Francisco in 1919 and an admirer of Germany's *autobahnen,* Eisenhower was well aware of the strategic advantages of an integrated and well-maintained highway system.[23] The military importance of the U.S. highway system was explicitly acknowledged by its official name - "National System of Interstate and

[22] I conducted similar regressions with the earliest historical values of the country's Gini coefficient: the results were similar. Democratic countries with higher Gini coefficients (more inequality) tend to have better roads on average, but the association is not statistically significant.

Defense Highways." Do more militaristic democracies maintain better roads? In Table 6, column 2, I interact the democracy index with military spending as a share of GDP during the 1975-1979 period. The effect of the democracy index on poor road quality is significantly smaller for democratic governments with higher military buildups. The result is consistent with the idea of relative complementarity between military expenditures and highway maintenance.[24]

Fourth, democratic governments may choose to under-maintain roads as an inconspicuous way to transfer public debt to future governments (Alesina and Tabellini, 1990). Gwilliam and Shalizi (1999) argue that "current political pressures or the electoral cycle may result in myopic decisions (…); road deterioration reveals its symptoms late. Expenditures on timely maintenance do not yield such obvious improvements in system performance as do expenditures over new investment." Consider for instance "the Bruning government of Weimar Germany who hoped to tackle motorway construction as a measure to create jobs. […]. But the continual changes of government, elections and dissolutions of the Reichstag in the moribund Weimar Republic meant that the plans could not be translated into action" (Oster, 1996). The national socialist party opposed the plans for the development of the motorway system during the Weimar Republic that "were branded a capitalist bourgeois waste of money for the benefit of only a few motorists" (*op. Cit.*). But such plans were swiftly and aggressively pursued under Hitler's dictatorial grip.

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[23] Weingroff (1996).

[24] Note that including total military spending allows for a general crowding out effect of such spending categories on other government outlays. The relevant parameter for the current discussion is the interaction between military spending and democracy.

Alesina and Tabellini (1990) argue that "the equilibrium level of government debt is larger (…) the more likely [it] is that the current government will not be elected." Similar results might be expected for the lack of road maintenance in democratic countries. I apply this idea by interacting the 1980 democracy dummy with the 75-79 political instability index. Democratic governments in more unstable countries should discount more the future and spend less in road maintenance. Actually (Table 6, column 3), a more unstable democracy is associated with higher road quality, although this association is not significant.

Conclusions

This paper analyzes the relationship between democracy and road quality. I find that more democratic governments tend to have road systems in worse conditions. Changes towards a more democratic system are associated with deceleration in the construction of new highways. The results seem consistent with a preference towards projects that are of the "white elephant" type or that enhance the image of dictatorial regimes. But I find evidence consistent with the view that military governments may choose to invest in a well-maintained road system that facilitates the transportation of troops ready for internal repression and external intervention.

References

Alesina, A., and R.Perotti (1996). "Income Distribution, Political Instability and Investment." *European Economic Review* 40(6): 1203-1228.

Alesina, A., and D.Rodrik (1992). "Distribution, Political Conflict, and Economic Growth: A Simple Theory and Some Empirical Evidence." In Cukierman, A., Z.Hercowitz, and L.Leiderman, eds. "Political Economy, Growth, and Business Cycles." Cambridge, MA: The MIT Press.

Alesina, A., and G.Tabellini (1990). "A Positive Theory of Fiscal deficits and Government Debt in a Democracy." *Review of Economic Studies*, March 1990.

Alesina, A., Ozler, S., Roubini, N., and P. Swagel (1996). "Political Instability and Economic Growth." *Journal of Economic Growth* 1 (2).

Barro, R. (1991). "Economic Growth in a Cross-Section of Countries." *The Quarterly Journal of Economics*, 106, 2: 407-433.

Barro, R. (1996). "Democracy and Growth." *Journal of Economic Growth,* 1(1).

Barro, R. (1999). "Determinants of Democracy." *Journal of Political Economy,* 107(6).

Canning, D. (1998). "A Database of World Stocks of Infrastructure: 1950-1995." *The World Bank Economic Review*, vol. 12: pp 529-548.

Castro, L.M., and E.Gavarrete (2000). "Competitividad en Centroamerica." *CLACDS-INCAE Working Paper* #1405.

Gwilliam K. and Z.Shalizi (1999). "Road Funds, User Charges and Taxes." *The World Bank Observer*, vol.14, no.2, pp.159-185.

Hutchinson Encyclopedia (2002). "Motorway." Available online at http://www.tiscali.co.uk/reference/encyclopaedia/hutchinson/

International Study of Highway Development and Management Tools (1995). "Modeling Road User Effects in HDM-4." The Asian Development Bank.

Oster, U. (1996). "The Autobahn Myth." *History Today*, November 1996.

Persson, T., and G.Tabellini (1994). "Is Inequality Harmful to Growth?" *American Economic Review*, vol.84, no.3: pp600-621.

Randolph, S., Bogetic, Z., and D.Heffley (1996). "Determinants of Public Expenditure on Infrastructure: Transportation and Communication." *World Bank Policy Research Working Paper* 1661.

Rivera-Batiz, F.L. (2002). "Democracy, Governance and Economic Growth: Theory and Evidence." MIMEO: Columbia University.

Rosenbaum, P.R. (1995). "Observational Studies." New York: Springer-Verlag.

Rodrik, D. (1999). "Democracies Pay Higher Wages." *The Quarterly Journal of Economics*, vol.CXIV, n.3.

Rodrik, D. (2002). "Institutions for High-Quality Growth: What They Are and How to Acquire Them." *NBER Working Paper Series* #7540.

Saiz, A. (1998). "Financing Infrastructures in Central America." MIMEO – Harvard Institute for International Development.

Sen, A.K. (1999). "Development as Freedom." London: Anchor Books.

Tavares, J., and Warcziag (2002). "How Democracy Affects Growth." *European Economic Review 45: 1341-1378.*

Weingroff, R.F. (1996). "Creating the Interstate System." *Public Roads*, Summer 1996, vol.60 n.1.

TABLE 1

Democracy to the Road

	Share Paved Roads in Poor Condition in 1984											
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Democracy Index (1980)	**0.147**	**0.193**	**0.193**	**0.188**	**0.194**	**0.174**	**0.176**	**0.171**	**0.176**	**0.166**	**0.183**	**0.192**
	(0.069)**	(0.074)**	(0.074)**	(0.073)**	(0.074)**	(0.076)**	(0.067)**	(0.069)**	(0.065)***	(0.071)**	(0.078)**	(0.079)**
Log Land Area	0.027	0.027	0.027	0.025	0.027	0.026	0.021	0.019	0.02	0.014	0.015	0.019
	(0.011)**	(0.011)**	(0.012)**	(0.011)**	(0.014)*	(0.016)	(0.015)	(0.015)	(0.015)	(0.018)	(0.019)	(0.019)
Log 1984 per Capita Income	-0.068	-1.105	-1.075	-1.08	-1.019	-1.078	-1.112	-0.973	-1.042	-1.051	-1.445	-1.645
	(0.031)**	(0.626)*	(0.636)*	(0.631)*	(0.634)	(0.649)	(0.715)	(0.667)	(0.648)	(0.665)	(0.587)**	(0.589)***
Log 1984 per Capita Income Squared		0.07	0.069	0.069	0.064	0.066	0.075	0.066	0.071	0.072	0.102	0.118
		(0.042)*	(0.043)	(0.042)	(0.043)	(0.043)	(0.049)	(0.046)	(0.045)	(0.046)	(0.041)**	(0.041)***
Log Average Temperature				0.047	0.051	0.072	0.062	0.066	0.077	0.078	0.095	0.107
				(0.070)	(0.078)	(0.077)	(0.102)	(0.105)	(0.099)	(0.102)	(0.105)	(0.110)
Log Average Precipitation				-0.018	-0.018	-0.011	-0.019	-0.015	-0.019	-0.02	-0.03	-0.035
				(0.018)	(0.018)	(0.021)	(0.017)	(0.017)	(0.019)	(0.018)	(0.026)	(0.027)
Log Mean Elevation					-0.007	-0.009	0.011	0.011	0.011	0.011	0.017	0.016
					(0.021)	(0.022)	(0.024)	(0.024)	(0.024)	(0.024)	(0.026)	(0.026)
Log(GDPcap 1980)-Log(GDPcap 1965)							-0.187	-0.183	-0.175	-0.179	-0.195	-0.21
							(0.074)**	(0.075)**	(0.075)**	(0.075)**	(0.078)**	(0.083)**
Fraction of time in war (65-80)								0.076	0.022	0.022	0.002	-0.033
								(0.113)	(0.101)	(0.103)	(0.095)	(0.088)
Political inestability index 1980-84									0.21	0.208	0.217	0.279
									(0.115)*	(0.116)*	(0.111)*	(0.108)**
Log 1984 Population										0.009	0.034	0.031
										(0.018)	(0.032)	(0.033)
Log 1984 Paved Road Lenght											-0.028	-0.027
											(0.034)	(0.034)
Log 1960 per Capita Income												-0.039
												(0.068)
Constant	0.361	4.122	3.973	4.018	3.824	4.146	3.942	3.398	3.572	3.602	4.826	5.686
	(0.223)	(2.269)*	(2.289)*	(2.240)*	(2.241)*	(2.345)*	(2.412)	(2.232)	(2.176)	(2.225)	(2.015)**	(2.026)***
Climate Dummies	no	no	yes	no	no	no	no	no	no	no	no	no
Geographic Dummies	no	no	no	no	yes	no	no	no	no	no	no	no
Observations	73	73	73	73	71	71	68	67	67	67	59	58
R-squared	0.14	0.21	0.22	0.22	0.23	0.27	0.31	0.32	0.35	0.35	0.41	0.43

Heteroskedastic-consistent (White-robust) standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 2

Instrumental Variables: 2SLS estimates

	Share Paved Roads in Poor Condition in 1984	
	(1)	**(2)**
Instrumented† Democracy Index (1980)	**0.221** (0.105)**	**0.325** (0.189)*
Log Land Area	0.029 (0.013)**	0.027 (0.015)*
Log 1984 per Capita Income	-0.028 (0.035)	-0.043 (0.053)
Log(GDPcap 1980)-Log(GDPcap 1965)	-0.182 (0.076)**	-0.134 (0.084)
Political instability index 1980-84	0.225 (0.121)*	0.151 (0.134)
Constant	0.038 (0.273)	0.124 (0.349)
Observations	68	56
R-squared	0.28	0.12

Heteroskedastic-consistent (White-robust) standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Equation (1) uses the democracy indexes in 1972,1973,1974 and 1975 as instruments for the democracy index in 1980. Equation (2) uses log of average temperature, log of average precipitation, log of population, the percentage of population with no schooling in 1980, and average schooling years in the total population in 1980 as instruments for the 1980 democracy index.

TABLE 3

Heterogeneous Treatment Effects

	Share Paved Roads in Poor Condition in 1984
First Income Quartile * Democracy	**0.409**
	(0.429)
Second Income Quartile * Democracy	**0.151**
	(0.118)
Third Income Quartile * Democracy	**0.164**
	(0.140)
Fourth Income Quartile * Democracy	**0.267**
	(0.099)***
Log Land Area	0.025
	(0.012)**
Log(GDPcap 1980)-Log(GDPcap 1965)	-0.216
	(0.085)**
Political instability index 1980-84	0.242
	(0.129)*
Constant	-0.118
	(0.159)
Income Quartile Dummies	yes
Observations	68
R-squared	0.33

Heteroskedastic-consistent (White-robust) standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 4

Democracy and the Extent of the Transportation System

	Log 1984 Paved Road Length	Transportation Equipment as a Share of Capital (1984)
	(1)	**(2)**
Democracy Index (1980)	**0.475**	**-4.172**
	(0.297)	(3.744)
Log 1984 per Capita Income	0.918	1.634
	(0.134)***	(1.255)
Log Land Area	0.081	0.627
	(0.080)	(1.705)
Log 1985 Population	0.835	-1.34
	(0.086)***	(1.489)
Log(GDPcap 1980)-Log(GDPcap 1965)	0.073	2.265
	-0.344	(4.993)
Political instability index 1980-84	-0.906	-5.469
	(0.384)**	(5.074)
Constant	-7.299	-0.061
	(1.187)***	(13.703)
Climate Dummies	*yes*	*yes*
Observations	60	31
R-squared	0.87	0.21

Heteroskedastic-consistent (White-robust) standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 5

Changes in Democracy and Highway Length

	Log(paved roads 1988)-Log(paved roads 1980)	
	(1)	**(2)**
	OLS	IV
Democracy Index Difference 1984-1976	-0.237	-0.251
	(0.108)**	(0.121)**
Log(GDPcap 1984)-Log(GDPcap 1976)	0.562	0.561
	(0.128)***	(0.127)***
Log(Pop 84)-Log(Pop 76)	-0.134	-0.152
	(0.700)	(0.693)
Change in Political Stability Index 84/80-79/75	-0.147	-0.153
	(0.160)	(0.158)
Log Paved Roads in 1980	-0.046	-0.046
	(0.019)**	(0.019)**
Constant	0.708	0.714
	(0.268)**	(0.266)**
Observations	53	53
R-squared	0.35	0.35

Heteroskedastic-consistent (White-robust) standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Equation (2) uses the Barro-Lee 5-year averages (70-74,75-79,80-84) of the political and civil rights indexes as instruments for the change in the democracy index from 1976 to 1980.

TABLE 6

Testing Three Hypotheses

	Share Paved Roads in Poor Condition in 1984		
	(1)	**(2)**	**(3)**
Democracy Index (1980)	**0.293**	**0.313**	**0.204**
	(0.244)	(0.100)***	(0.091)**
Democracy 1980 * Share Illiterate in 1960	**-0.307**		
	(0.380)		
Share Illiterate in 1960	0.126		
	(0.200)		
Democracy Index * Share Military Expenditure 1975-79		**-6.218**	
		(2.549)**	
Share Military Expenditure 1975-79		2.111	
		(0.781)***	
Instability * Democracy Index			**-0.356**
			(0.573)
Political Instability 1979-1980			0.337
			(0.228)
Log Land Area	0.018	0.029	0.02
	-0.015	(0.013)**	(0.012)
Log 1984 per Capita Income	-0.012	-0.032	-0.022
	(0.055)	(0.035)	(0.031)
Log(GDPcap 1980)-Log(GDPcap 1965)	-0.177	-0.181	-0.176
	(0.097)*	(0.078)**	(0.076)**
Constant	0.054	0.06	0.113
	(0.534)	(0.286)	(0.255)
Observations	49	66	68
R-squared	0.19	0.3	0.32

Heteroskedastic-consistent (White-robust) standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix TABLE 1

Descriptive Statistics

Variable	*N*	*Mean*	*Std. Dev.*	*Min*	*Max*
Share Paved Roads in Poor Condition in 1984	74	**0.25**	0.17	0.00	0.96
Democracy Index (1980)	73	**0.37**	0.30	0.00	1.00
1984 per Capita Income (1985 U.S. $)	73	**1,869.41**	1,596.60	310.00	8,162.00
Land Area (sq. Km)	73	**817,900.90**	1,532,967.00	2,230.00	9,326,410.00
Average Temperature (Degrees Celsius)	74	**22.30**	5.35	9.20	31.10
Average Precipitation (mm per sq.m.)	74	**1,170.39**	786.26	19.70	3,869.00
Log(GDPcap 1980)-Log(GDPcap 1965)	68	**0.30**	0.32	-0.34	1.09
Fraction of time in war (65-80)	69	**0.10**	0.21	0.00	1.00
Political inestability index 1980-84	72	**0.11**	0.16	0.00	0.93
1985 Population (thousands)	73	**43,812.14**	148,599.50	381.00	1,036,803.00
1984 Paved Road Length (Km.)	65	**23,163.40**	94,749.77	300.00	758,236.00
1988 Paved Road Length (Km.)	61	**29,115.98**	114,473.40	340.00	884,842.00
1960 per Capita Income (1985 U.S. $)	67	**828.16**	647.64	208.00	3,271.00
Democracy Index (1976)	73	**0.27**	0.28	0.00	1.00
Political inestability index 1975-79	71	**0.13**	0.18	0.00	0.93
Share of GDP in Military Expenditure 1975-79	68	**0.03**	0.04	0.00	0.27
Share Illiterate in 1960	50	**0.60**	0.25	0.12	0.99

Appendix TABLE 2

First Stage for 2SLS

	Democracy Index (1980)			
	(1)	**(2)**	**(3)**	**(4)**
Democracy Index (1975)	0.465	0.378		
	(0.252)*	-0.303		
Democracy Index (1974)	2.255	2.25		
	(1.126)**	(1.233)*		
Democracy Index (1973)	-2.211	-2.199		
	(1.043)**	(1.107)*		
Democracy Index (1972)	0.203	0.169		
	(0.136)	(0.149)		
Log Land Area		-0.027		-0.08
		(0.020)		(0.032)**
Log 1984 per Capita Income		0.069		0.163
		(0.054)		(0.083)*
Log(GDPcap 1980)-Log(GDPcap 1965)		-0.05		-0.105
		(0.114)		(0.141)
Political inestability index 1980-84		-0.185		-0.204
		(0.188)		(0.235)
Log Average Temperature			0.159	0.134
			(0.162)	(0.173)
Log Average Precipitation			-0.051	-0.063
			(0.050)	(0.051)
Log 1984 Population			0.004	0.066
			(0.026)	(0.034)*
Share Illiterate in 1980			-0.008	-0.007
			(0.003)**	(0.003)**
Average Schooling Years in 1980			-0.061	-0.089
			(0.053)	(0.053)
Constant	0.157	0.062	0.827	0.301
	(0.040)***	(0.432)	(0.732)	(1.083)
Observations	73	68	58	56
R-squared	0.45	0.49	0.2	0.34
F-statistic	13.73	6.95	2.56	2.64

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix TABLE 3

"Treatment Effects" Selection Model

	Roads in Poor Condition in 1984	Democracy Dummy
	(1)	**(2)**
Democracy Dummy Variable Indicator	**0.271** (0.127)**	
Log Land Area	0.034 (0.016)**	-0.395 (0.159)**
Log 1984 per Capita Income	-0.048 (0.046)	0.796 (0.402)**
Log(GDPcap 1980)-Log(GDPcap 1965)	-0.159 (0.089)*	-0.799 (0.720)
Political instability index 1980-84	0.205 (0.111)*	
Democracy Index (1975)		1.493 (1.287)
Democracy Index (1972)		0.228 (0.492)
Log 1985 Population		0.343 (0.144)**
Log Average Temperature		0.05 (0.614)
Log Average Precipitation		-0.248 (0.127)*
Constant	0.117 (0.329)	-3.331 (4.356)
Observations	68	68

Heteroskedastic-consistent (White-robust) standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Equation (1) is the main (treatment effect) equation. Equation (2) is the selection (into treatment) equation.

Data Appendix

Variable	Source	Description
Share Paved roads in bad condition	Canning (1995)	
Democracy Index	Freedom House (1972-1990)	The transformation in the paper follows Barro (1996) and takes on seven discrete values. From 0 (less democracy) to 1 (more democracy).
Land Area	CIA, World Fact Book 2001	Size of land, square Km.
Per capita income (several years)	Penn Tables, v.5.6.a	Real GDP per capita in constant dollars (Chain index), expressed in international prices, base 1985).
Average Temperature	www.worldcimate.com	Average temperature (degrees Celsius) in capital city or other available main city.
Average Precipitation	www.worldcimate.com	Average precipitation (milliliters per square meter) in capital city or other available main city.
Fraction of time in war (65-80)	Barro and Lee (1995)	The fraction of time over 1960-85 involved in *external* war.
Political Instability Index	Barro and Lee (1995)	The index is based on the number of assassinations and revolutions per year, averaged over 5-year periods.
Population (several years)	Penn Tables, v.5.6.a	
Paved Road Length (1984, 1988)	Canning (1995)	Paved roads are concrete or bitumen-surfaced roads.
Geography Dummies: South East Asia Latin America sub-Saharan Africa	Barro and Lee (1995)	
Percentage Population with no schooling (1980)	Barro and Lee (1995)	
Average Schooling Years in the Total Population (1980)	Barro and Lee (1995)	
Political Rights Index (5 year averages, several periods)	Barro and Lee (1995)	It is an average of the Gastil Index of Political Rights over 5 years. Goes from 1 (more political rights) to 7 (less political rights).
Civil Rights Index (5 year averages, several periods)	Barro and Lee (1995)	It is an average of the Gastil Index of Civil Rights over 5

		years. Goes from 1 (more civil rights) to 7 (less civil rights).
Mean Elevation	Harvard CID – Geography Datasets (Compiled by John L. Gallup, Andrew D. Mellinger, and Jeffrey D. Sachs)	Mean elevation (meters above sea level)
Ratio of Population within 100km of coast	Harvard CID – Geography Datasets	Ratio of population within 100km of ice-free coast or navigable river to total population
Typical Density	Harvard CID – Geography Datasets	Typical population density experienced by an individual (persons/km^2)
Percentage area in tropics	Harvard CID – Geography Datasets	
Urbanization Rate (1980)	World Development Indicators (WDI) World Bank (2002)	Percentage of population living outside of rural areas.
Size of the foreign sector	Constructed from data in Barro and Lee (1995)	Defined as the sum of imports and exports over total GDP.
Labor Force Participation rate	Labor force: WDI Population: Penn Tables, v.5.6.a	Defined as labor force over population.
Share of military spending over GDP (5 year averages)	Barro and Lee (1995)	Ratio of nominal government expenditure on defense to nominal GDP.
Gini Index	World Income Inequality Database –United nations Development Program	Earliest available value of the Gini index
Corruption Index 1980-85	Transparency International http://www.gwdg.de/~uwvw/icr.htm	The index is based on surveys that ask for perceptions about corruption. It takes values from 0 (most corrupt) to 10 (less corrupt).

List of countries with data on road quality (1984)

Barro-Lee Country Code	Country	Percentage Roads in Bad Condition
DZA	Algeria	28
ARG	Argentina	44
BGD	Bangladesh	45
BEN	Benin	6
BOL	Bolivia	31
BWA	Botswana	2
BRA	Brazil	28
BFA	Burkina Faso	20
BDI	Burundi	5
CMR	Cameroon	10
CAF	Central African Republic	29
TCD	Chad	96
CHL	Chile	11
CHN	China	20
COL	Colombia	21
COM	Comoros	20
COG	Congo	16
CRI	Costa Rica	49
CIV	Cote d'Ivoire	7
CYP	Cyprus	24
DOM	Dominican Republic	38
ECU	Ecuador	28
EGY	Egypt	28
ETH	Ethiopia	33
GMB	Gambia	23
GHA	Ghana	61
GTM	Guatemala	43
GIN	Guinea	14
GNB	Guinea-Bissau	33
HTI	Haiti	0
HND	Honduras	7
IND	India	35
IDN	Indonesia	40
JAM	Jamaica	17
KEN	Kenya	16
KOR	Korea, Rep.	5
LSO	Lesotho	40
LBR	Liberia	2
MDG	Madagascar	50
MWI	Malawi	15
MLI	Mali	24
MRT	Mauritania	40
MEX	Mexico	5
MAR	Morocco	36

MMR	Myanmar	50
NPL	Nepal	25
NER	Niger	10
NGA	Nigeria	23
OMN	Oman	14
PAK	Pakistan	32
PAN	Panama	10
PNG	Papua New Guinea	21
PRY	Paraguay	5
PER	Peru	52
PHL	Philippines	15
PRT	Portugal	20
ROM	Romania	10
RWA	Rwanda	0
SEN	Senegal	13
SLE	Sierra Leone	35
SOM	Somalia	20
LKA	Sri Lanka	50
SDN	Sudan	30
SWZ	Swaziland	25
TZA	Tanzania	28
THA	Thailand	20
TGO	Togo	36
TUN	Tunisia	9
UGA	Uganda	31
URY	Uruguay	15
YUG	Yugoslavia	29
ZAR	Zaire	63
ZMB	Zambia	30
ZWE	Zimbabwe	5