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Road Infrastructure and Enterprise Development in Ethiopia

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Abstract

As a landlocked country with largely non-navigable rivers and literally no railway systems, road transport plays a critical role for the performance of the Ethiopian economy. A large scale public investment program, known as the Road Sector Development Program (RSDP), was implemented in Ethiopia over the period 1997-2010. In this paper we investigate whether the improvement in road infrastructure resulting from the RSDP has affected the patterns of entry of new manufacturing firms and the firm size of new entrants. Combining GIS based panel data on the road accessibility of towns with a unique panel of Ethiopian manufacturing firms for the period 1996-2009, we report econometric results indicating that better road access significantly increases a town's attractiveness for manufacturing firms. While towns with initially large number of firms continue to attract more firms, there is an underlying tendency toward convergence in the distribution of manufacturing firms, reducing the degree of geographic concentration. The results also indicate that firms entering isolated markets start with relatively smaller size as compared to entrants into well connected markets in terms of road infrastructure. We conclude that the improvements in the road infrastructure have had a favourable impact on the size and structure of the manufacturing sector in Ethiopia.

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1. Introduction

Poor infrastructure and high transport costs are often identified as a key constraint for industrial development in low-income countries (e.g. Bloom and Sachs, 1998). As noted by Collier (2000), manufacturing firms are intensive users of infrastructure services, so if such services are poor quality or high cost manufacturing will be at a comparative disadvantage. As a result, economies with poor infrastructure will record a low share of manufacturing production in GDP. Tybout (2000) argues that one of the reasons why the industrial landscape of low-income countries is dominated by small and micro enterprises is that the market for manufactured goods is small and fragmented due to poor infrastructure. In such an environment, firms start and stay small simply because they target highly segmented small product markets.

These arguments, predicting links between infrastructure and the size and structure of manufacturing, appear to be consistent with the facts observed for Sub-Saharan Africa: the infrastructure is under-developed, and the region's industrial sector is small and heavily populated by micro and small firms. However, over the last decade, there have been considerable improvements in road infrastructure across many African countries. One such case is Ethiopia, where a large scale public investment program, known as the Road Sector Development Program (RSDP), has been implemented over the period 1997-2010. Ethiopia is strongly dependent on road infrastructure for its freight and public transport services. The country has been landlocked since the secession of Eritrea in 1993 and most of Ethiopia's international trade has since been channelled through the smaller and more expensive port of Djibouti. There are practically no railways except for the rundown single-track connecting Addis Ababa and Djibouti that began service in 1901, and only a few of the rivers are navigable due to the country's mountainous terrain. This makes Ethiopia an interesting case study.

In this paper we investigate whether the improvement in road infrastructure resulting from the RSDP has affected the rates of entry of new manufacturing firms, and the firm size of new entrants in Ethiopia. To this end we combine GIS based panel data tracking the changes in the road accessibility of towns resulting from the RSDP with a panel of Ethiopian manufacturing firms for the period 1996-2009. Our study is the first of its kind to test empirically whether, as is commonly assumed in the policy discussion, manufacturing activity responds to changes in infrastructure quality in Africa.

The econometric results indicate that better road access significantly increases a town's attractiveness for manufacturing firms: the empirical relationship between infrastructure improvements and entry rates is positive, statistically significant, and robust to treating the placement of roads as endogenous in the regression analysis. The results further indicate that while towns with initially large number of firms continue to attract more firms, there is an underlying tendency toward convergence in the distribution of manufacturing firms, reducing the degree of geographical concentration. The study also shows that firms entering isolated markets start with relatively smaller size as compared to entrants into well connected markets in terms of road infrastructure.

The paper is organized as follows. Section 2 reviews the literature on location choice analysis. Section 3 discusses the policy process as well as the criteria for road placement in Ethiopia. Section 4 highlights the GIS based data on road accessibility, the panel data on manufacturing firms as well as some descriptive statistics. Section 5 addresses the first research question on firms' location choices. It does so in two parts: the first part presents results based on cross-sectional analyses while the second part presents results based on dynamic panel data estimation. Section 6 answers the second research question on the number of start-ups and average size of entrants. Conclusions and some policy discussion are offered in Section 7.

2. Theory and Methods of Location Choice Analysis

Public investment on transport infrastructure is arguably the least controversial of the roles of government in economic growth as it is expected to complement private investment. Since the manufacturing sector has extensive forward and backward linkages with other sectors and within itself, one would expect manufacturing firms to experience the most direct and maximum effects of improvement in transport infrastructure. Researchers who analyze firm level response to physical infrastructure mainly focused on two outcome variables – the location choices of new establishments and the productivity of incumbent firms. The underlying assumption regardless of outcome variables is that better road infrastructure (the most studied type of infrastructure) would increase the expected profits of enterprises.

There is some difference though among researchers in terms of the weights attached to different mechanisms through which road networks boost profitability. Some of the literature on economic geography such as Krugman's (1991) core-periphery model gives more weight to agglomeration benefits which are reinforced by reduction in transport costs. In other words, with better road connectivity most firms would prefer locating in a few economic hubs while supplying the rest of the market through efficient transport networks. This would allow firms not only to stay closer to bigger markets but also to benefit from agglomeration effects such as specialized inputs, broader market for skilled workers, and better access to information and technology. According to this literature, reduction in transport costs would increase the degree of concentration of economic activities while improving productivity.

The literature on urban economics, on the other hand, focuses on the impact of road infrastructure on the attractiveness for entrepreneurs of urban centres other than provincial capitals (Mills, 1967; Helpman, 19998). While major urban centers offer bigger markets and agglomeration advantages, the cost of living is typically higher in such cities leading to higher prices for land and labor. With a decline in transport costs, new firms may therefore want to take advantage of relatively cheaper factor inputs in peripheral towns while shipping their products to larger markets. Since most start-ups are relatively small concerns supplying standardized products, choosing low cost manufacturing locations could boost their chances of survival during the initial few years when the exit hazard is typically higher. For such firms the agglomeration benefits could be secondary to the expected profitability from locating in less crowded production sites. According to this literature, better road infrastructure would lead to productivity growth and geographic diffusion of economic activities.

Since reduction in transport costs could change the balance between the attractiveness of established economic centers (large cities) and peripheries, determining its effect on firms' location choices becomes an empirical question. There is a sizable empirical literature on industrial location choice focusing particularly on advanced economies. Arauzo et al. (2010) provides a recent review of the empirical approaches and the main findings of existing studies on the location choices of entrants. One of the widely used methodological approaches is to study location choices from the perspective of the entrepreneur and assess which geographic attributes increase the probability of selecting a particular site. Such studies rely on discrete choice models (multinomial logit or nested logit models) that allow both firm and location characteristics to be represented in the choice model. The other major approach is to use the number of start-ups in a district or town as an outcome variable and examine the location characteristics that drive its variation. The preferred methodology in the latter case is count data models such as the Poisson estimator. A number of studies on industrial location choice have found a positive and statistically significant effect of transport infrastructure on the average number of entrants in developed countries. Evidence from the US using count data models is provided in Smith and Florida (1994) and List (2001) while Arauzo and Viladecans (2009), Holl (2004a) and Arauzo (2005) provide supportive evidence from Spain. Similar results are reported in Cieslik (2005) and Holl (2004b) for Poland and Portugal, respectively.

The marginal returns to public investment on infrastructure projects are presumably larger in developing countries relative to developed countries given their low stock of infrastructural capital. However, the micro-level evidence on the role of infrastructure in developing countries is quite limited coming almost entirely from a handful of emerging economies. Rothenberg (2011) uses discrete choice models on firm level data from Indonesia to show that highways had a significant effect on the location choice of new firms. Cheng and Stough (2006) and Wu (1999) use count data models to examine the location choices of FDI firms in China.[1] Datta (2011) evaluates the impact of upgrading Indian highways and finds significant reduction in the stock of intermediate inputs for firms located in treatment cities relative to the control group. How indicative these findings are for the role infrastructure in the developing world at large is yet to be seen.

While a number of reports and cross-country studies underscore the severity of the infrastructural constraints in Sub-Saharan Africa, much less is known about its impact on the location choices and performance of firms in the region. Based on a cross-country analysis, Limão and Venables (2001)

[1] While Hansen (1987) examines location characteristics to understand the geographic distribution of industrial activity in Brazil, he did not take into account road accessibility of sites. Binswanger and Khandker (1993) estimate the response of aggregate private investment and aggregate output in rural India using district level data on road networks.

ascribe a large part of Africa's low trade volume to its poor infrastructure while Buys, Deichmann and Wheeler (2010) provide simulation results suggesting large gains in intra-regional trade among Sub-Saharan African countries as a result of upgrading continental road networks. Jedwab and Moradi (2011) provide historical evidence that railway lines in the early 20th century contributed to the boom in cocoa production in Ghana which in turn fueled urbanization. Naude and Matthee (2007) find that the bulk of manufactured exports in South Africa is produced within 100km of ports suggesting very high domestic transport costs although this does not necessarily mean that this geographic pattern would be different had transport costs were lower. Escribano, Guash and Pena (2009) provide cross-country analysis on the joint effects of a set of infrastructure indictors on aggregate productivity based on firm level data from 26 African counties. They find heterogeneous effects for different groups of countries.

At the micro-level, evidence from African countries mainly shows the role of infrastructure on rural households. Dercon et al. (2008) show that rural households in Ethiopia with access to all weather road to the nearest town have higher consumption expenditures while Renkow et al. (2004) find that transaction costs in rural Kenya increase with remoteness of villages constraining farmers' market participation. McPherson (1995) analyzes location factors that influence the survival probability of micro and small enterprises in four southern African countries. He finds that MSEs located along the road and close to commercial centers have better chances of survival; factors which could draw more entrants to such locations although he did not directly address this topic. No other study that we are aware of seems to analyze the relationship between public investment on infrastructure and the location choices of firms in Sub-Saharan Africa.

As indicated in Escribano et al. (2009), Ethiopia is one of a few African countries where poor infrastructure is perceived by firms as a major constraint for their performance. As already indicated, this paper examines the response of Ethiopian manufacturing firms to the Road Sector Development Program that was implemented during 1997-2010. We assess industrial location choice using both the total number of firms in a town as well as the number of new firms. For the latter we resort to versions of the Poisson model as it allows us to gauge whether road infrastructure is part of the location characteristics that attract potential entrepreneurs. Given the relatively small size of most start-ups in our sample and the potentially large search cost entailed by an exhaustive comparison of alternative locations, we would expect entrepreneurs to make limited comparison of potential locations in neighbouring towns. This assumption is reinforced by the ethno-linguistic diversity of Ethiopia which could exclude certain locations from the choice set of some entrepreneurs. Such features of our sample are inconsistent with the assumption of independence of irrelevant alternatives that is central to discrete choice models such as the multinomial logit model.

While we analyze the location choices of new manufacturing establishments at the town level, as most studies in this literature do, we also extend the analysis by examining the extent to which improvements in road infrastructure affect the total number of manufacturing firms in a town as well as the size of start-up firms. The justification for this extension is straightforward. From the perspective of policy makers as well as entrepreneurs, entry into a market is a small, albeit critical, aspect of enterprise development. Towns that attract new firms may not necessarily witness a significant increase in the total number of firms if exit rates are very high. Existing studies suggest that overcoming entry barriers is relatively less daunting as compared to surviving the market (Geroski, 1995). The key issue is whether entrants stand a good chance of survival – which could influence their location decisions. Analyzing the change in the total number of firms in a town is therefore at least as relevant as examining the number of entrants. In fact the theoretical foundation of empirical models of location choice asserts that such decisions are made on the basis of expected profits which in turn affect the exit hazard (Strotmann, 2007). Similarly, we expect better road infrastructure to lead to an increase in the average firm size at entry. If transport costs are high, most entrants would be sited in large urban centers. However, because other firms make similar choices including larger ones, the intensity of competition in central locations would force entrants to start small. Similarly, manufacturing firms that open up in smaller distant markets would be constrained to start small and perhaps remain small if transport costs are very high (Tybout, 2000). Improvement in transport networks would broaden the potential market for entrants, regardless of their location choices, inducing them to start at a relatively larger size than would be otherwise.

3. Road Placement

The current Ethiopian government made the road sector one of its priority areas and implemented three Road Sector Development Programs (RSDPs) during the period 1997-2010. The total cost of the RSDP during the 14 years was about US$ 4.12 Billion financed partly by various donors including the World Bank, European Union, ADB, NDF, BADEA, OFID, Governments of Japan, Germany, U.K., and Ireland. The first RSDP run from 1997-2001 and the second one from 2002-2007. The total road network expanded from 26,550 km in 1997 to 46,812 km in 2007 while the fraction of roads in good and serviceable conditions increased from 22% to 54% (ERA[2], 2009). Among the major activities of the RSDP include 17 projects to rehabilitate major trunk roads, 26 upgrading projects of trunk roads, upgrading of 32 link roads (roads that link trunk roads) and construction of 73 link roads. This is undoubtedly the largest infrastructure development program in the country's history and probably one of the largest in the region. Table 1 below shows the improvements in road infrastructure as a result of the RSDP.

Before we examine the responses of manufacturing firms to improved road networks, we will highlight the process by which the government assigns road projects across the country. This is very important because identifying the impact of better road networks on manufacturing firms will depend crucially on the extent to which the effects of road placement can be isolate from the impact of the road networks themselves. This difficulty arises because of the expected overlap in the information set used by government to assign roads with the information set used by firms to choose factory locations.

As shown in Appendix-A the Ethiopian Road Authority applies five criteria for the preliminary selection of new road projects that are proposed by regional states. As would be expected, priority in road placement is given to areas with high economic potential and surplus food production. ERA also takes into account population distribution as well as regional equity in economic development. Road projects that pass the preliminary selection will go through feasibility studies which would help ERA refine its selection of projects and the proposed budget. Once the five-year plan is approved, the number and type of road projects remains intact except for minor adjustments to accommodate extremely important unanticipated road projects. The five-year RSDP is implemented through annual action plans.

[2] Ethiopian Road Authority (ERA, 2009): RSDP Performance: 12 Years Later.

ERA follows a slightly different criteria for the assignment of road upgrading projects. More weight is given for existing roads with high traffic densities and better connectivity with other road networks both of which are strongly correlated with economic potentials and market size.

Despite having a set of criteria for road placement, it is not clear what specific variables ERA uses to operationalize them. For instance, it is not clear how exactly economic potentials of different geographic locations are assessed or how regional inequality in economic development is evaluated. There is also lack of clarity about the process and criteria by which regional states prioritize their road projects for submission to ERA. It seems that the above mentioned criteria serve as broad guidelines rather than strict rules for road placement.

4. Data and Descriptive Analysis

4.1. Data

The 1st RSDP was implemented during 1997-2001 focusing mainly on rehabilitation and upgrading of existing major trunk roads. It is during the 2nd and 3rd RSDPs that construction of new road projects accounted for the lion's share of the road budget. We use alternative indicators of road networks based on the so-called accessibility analysis. This method captures improvements in travel time as well as increase in areas accessible as a result of the RSDP. The accessibility analysis relies on Geographic Information System (GIS) using specifically the "Network Analysis" tools of GIS such as Service Coverage and O-D (Origin-Destination) matrix. We believe these are better indicators of improvements in transport services than other widely used proxies such as total spending on road projects or the stock of infrastructural capital.

The major source of data is ERA's 2011 report on the 14 years of RSDP implementation which provides the list of roads rehabilitated, upgraded or newly constructed between 1997 and 2010. Since ERA's report doesn't contain the completion period for some of the projects, other documents were consulted for detailed information on project specific physical accomplishment and budget disbursement. This allowed us to construct time series data on road accessibility at the town level.

After collecting the project level data, a GIS table is constructed featuring the beginning and completion period for upgrading, rehabilitation and new construction over the period 1996 to 2008. Roads were also identified by their pavement type and condition such as asphalt roads or gravel roads to estimate improvements in travel time. Changes in road accessibility for a given location as a result of the RSDP is calculated using conversion factors indicated in Table B1 in Appendix B. The conversion factors provide the estimated speed of travel on different pavement types and road condition.

Based on the above assumption, travel time in each segment of the roads have been calculated for every other year starting from 1996, i.e. 1996, 1998, 2000, 2004, 2006 and 2008 G.C. This is a pragmatic approach to economize on time and budget taking into account the fact that annual changes in road conditions are relatively small.

Service Coverage Analysis

Improvements in travel time and distance were calculated using the expected travel speed on each pavement type taking into account changes both in the number of roads as well as conditions of roads. This was done by using GIS to overlay road projects with the location coordinates of towns. Using travel time as unit of analysis, the total travel time is estimated for 106 towns using all roads around each town in our sample. The list of towns was taken from the 2007 census of manufacturing firms carried out by the Ethiopian statistical office. The GIS analysis takes a 60 minutes cutoff to observe the change in travel time from the nodes (i.e. towns) to neighboring areas using all roads that serve a town. Two alternative measurements emerge from this exercise. The first one captures the total distance traveled during a 60 minute drive from a node while the second one captures the areas accessible during those 60 minutes of drive. The latter uses a buffer zone (area of influence) of 5km on both sides of the road. Figure 1 compares the total area accessible during a one hour travel from Addis Ababa in 1996 and 2008.

Origin-Destination Matrix

Origin-Destination (OD) matrix is another GIS tool to determine the impact of road projects on travel time. The service coverage analysis discussed above only captures the impact of road projects in the vicinity of the selected nodes. This approach ignores the effect on enterprises of other road project connecting a node with major centers of economic activity. Such improvements can be observed by constructing an OD matrix relative to selected economic centers.

The OD-matrix was constructed using 15 regional capital cities and other urban centers that are considered to be key market centers, as major economic destinations. The origins are the selected economic nodes (towns) from the 2007 census of manufacturing. A cut-off time for the OD analysis is 10hrs to limit the size of the matrix. The destinations relevant to a town for constructing the OD matrix are decided based on a 10hr travel time threshold at the beginning of the study period. The list of destination cities is indicated in Table B2 in the Appendix.

4.2. Descriptive Statistics

Table 2 shows how public investment on the Road Sector Development Program translates into improvements in road networks as captured by actual gains in speed of travel as well as more road connections for the towns in our sample. Column 1 shows the increase in average area that can be accessed during a one hour drive from a given town in the sample. The average town has experienced an increase of about 260 km^2 in neighbouring areas that are made accessible over the 12 years of the RSDP. Column 2 shows the increase in the total distance that can be travelled on average during a 60 minute drive from a given town in the sample. The average town in the sample has gained additional 46km/hr in 2009 as compared to 1996. Similarly, Column 3 shows that the average travel time to major economic destination from the towns in our sample has declined by nearly 5 hours per year on average during the same period.

Table 2 reveals that indicators of road accessibility show very little, if any, improvement in road networks during the first few years of the RSDP. In fact it is only in 1999, more than halfway into the first RSDP, that noticeable changes in road accessibility started to emerge. This is mainly because of the fact that only a few road projects were launched at the beginning of the RSDP and partly because most of those projects were upgrading and rehabilitation of existing roads. The other reason is that road projects normally take several years to complete. We will use this observation to identify initial conditions against which we analyse subsequent improvements in road conditions and their expected impact on firms' location choices. Part of our empirical analysis therefore considers the period 1996-1998 as the initial period during which road networks have not changed although strictly speaking 1996 is the only pre-RSDP period for which we have data both on roads and manufacturing firms.

It is interesting to note that while road accessibility improved significantly since 1999, the variation across towns has also increased during the same period leading to more inequality. The last two columns of Table 3 show that there has been significant improvements in road accessibility during 1999-2009 as compared to the initial period of 1996-1998. In the meantime, both the standard deviation as well as the coefficient of variation of the indicators of road accessibility have increased in between these two sub-periods (except for the OD measure) showing that variation in road conditions across towns has increased during the RSDP. This observation remains valid even when we divide the period since 1999 into shorter sub-periods of three year intervals. It is this variation in road networks that we want to exploit in capturing the response of manufacturing firms.

Data from the Central Statistical Agency (CSA) of Ethiopia show that the total number of manufacturing firms that employ at least 10 workers increased from about 617 in 1996 to 1713 in 2009 with annual average growth rate of about 7.8%. Figure 2 shows the evolution in the share of the top five towns starting with the 1996 distribution of manufacturing firms. These are Addis Ababa (65.5%), Dire Dawa (4.1%), Bahir Dar (2.6), Hawassa (2.4%) and Nazreth (2.1%). The importance of the capital city in manufacturing has declined from 65.5% in 1996 to 42% in 2009 while the share of the top five locations dropped from 76% to 55%. While these towns continue to host the majority of manufacturing firms in Ethiopia, it is quite clear that most of the recent increase in the number of manufacturing firms has taken place in previously less important towns.

5. Road Accessibility and Firm Location

The declining share of the top five towns in manufacturing shows that there has been a significant change in the distribution of manufacturing firms in Ethiopia. In this section we examine the role of improved road networks on the changing geographic distribution of manufacturing firms. This would have been a straightforward task had variation in road infrastructure been exogenous or road projects were assigned randomly across towns. However, the non-random placement of roads across locations as discussed above makes identification of the impact of road infrastructure quite difficult. Road placement as discussed above is likely to be driven by the desire to exploit untapped economic potentials or to benefit from favourable initial conditions that could maximize returns to pubic investment on roads. Interest groups such as business associations may also use their economic clout to demand for better road access. Such factors that influence road placement could also lure potential entrepreneurs to open businesses in a particular location making it difficult to isolate the impact of better road networks from the effect of road placement or factors that drive road placement.

5.1. Cross-sectional Analysis

We use regression analysis with alternative approaches to control for the endogeneity of road assignment[3]. The basic model to investigate the impact of road accessibility is expressed as:

$$\ln(N)_i = \beta_0 + \beta_1 RN_i + u_i \qquad (1)$$

Where $\ln(N)_i$ is the logarithm of the total number of manufacturing firms in town *i*, RN_i is a measure

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[3] One solution to this problem would be to identify a control group of towns which did not benefit from the RSDP and compare their performance with respect to treatment towns using the difference-in-difference estimator. This approach can be strengthened by using matching estimators which allows a better comparison of outcome variables between otherwise similar towns except for participation in the RSDP. Apart from the assumption that unobservables that drive road placement are time-invariant, the diff-in-diff estimator requires the condition that road projects have a highly localized impact on outcome variables. This assumption is particularly untenable in the Ethiopian RSDP because the program comprises mainly of Federal roads that connect fairly large and far apart geographic locations which are very likely to have a broader impact on the equilibrium(long-run) distribution of firms across towns. This implies contamination of the control group due to the spillover effect of Federal roads which leads to unreliable estimation of the average of effect of treatment on the treated. Moreover, the DID approach would not allow us to capture marginal effects of the improvement in road access for towns participating in the RSDP.

of road accessibility of town i, β_1 is a slope parameter to be estimated and u_i is town specific error term. If the criteria for road placement are entirely observable and a subset of these variables are also used by firms to choose locations, they could be included directly in an extended version of equation (1) as:

$$\ln(N)_i = \beta_0 + \beta_1 RN_i + \sum_j \alpha_j PL_j + u_i \qquad (2)$$

Where PL_j is the *jth* determinant of road placement to a particular location.

If PL_j are observables that explain a substantial part of road assignment and if we assume further that the unexplained portion of road placement is white noise, then β_1 captures the increase in the number of manufacturing firms in a town due to better road accessibility.

Assuming ERA strongly adheres to its road assignment criteria, our first approach is to control for those criteria as far as data permit. However, ERA's criteria are broadly defined making it rather difficult to measure them accurately. Nonetheless, since agriculture is the main stay of the Ethiopian economy, we proxy the agricultural potential of a location by a dummy variable indicating whether the woreda in which a town is located is at least food self-sufficient. Information on food self-sufficiency is obtained from the Productive Safety-Nets Program (PSNP) which has been implemented since 2005 by the Ethiopian Government and a consortium of donors. The main objective of the PSNP is "… to provide transfers to the food insecure population in chronically food insecure woredas (districts) in a way that prevents asset depletion at the household level and creates assets at the community level" (Government of Ethiopia, 2004). Woredas participating in the PSNP are therefore considered to be of low agricultural potential.

The other proxy for economic potential is the average number of manufacturing firms in a town during 1996 to 1998. We believe this variable captures initial conditions (including physical and institutional infrastructure) that propagate agglomeration benefits. Such initial conditions would sustain the attractiveness of historical centers of manufacturing for potential entrants while serving as indicator of economic potential for road placement. The choice of the period 1996-1998 is based on the fact that our indicators of road accessibility in Table 2 show practically no change until 1999 although the RSDP started in 1997.

Since population is one of the criteria for road placement, we use woreda level population in 2007. Firms are also likely to use population as a proxy for market size in choosing locations. In addition to these variables, there could be unobserved woreda and regional fixed effects that influence road placement. We account for such unobserved effects through woreda and region dummy variables. In Appendix I we report results of reduced form regression of road networks during 1999-2009 on the above mentioned factors. The results show that while our proxies for economic potential and population play a statistically significant role, most of the variation in road accessibility is captured by woreda and region fixed effects with the woreda fixed effect playing the most dominant role.

Results

We begin by estimating equation (2) using OLS where the dependent variable is the logarithm of the average number of manufacturing firms in a town during the period 1999-2009. The explanatory variables are the logarithm of the average number for firms during 1996-1998 (ln(N_9698)), the logarithm of woreda level population in 2007(ln(woreda_pop)) , and an indicator variable for food surplus and food self-sufficient areas (Food Surplus) that takes the value 1 for woredas that did not participate in the PSNP and zero for woredas participating in the PSNP. The policy variable is the average road accessibility of a town during the period 1999-2009. Road accessibility is measured in terms of area accessible (ln(acc_9909)) and travel distance (ln(trvd_9909)), as well as the first difference in travel time to major economic destinations. The model also includes regional dummy variables[4].

Tables 4 to 6 present the results of the OLS estimator. Table 4 provides the results using area accessible

[4] Woreda fixed effects are not controlled for because the data is cross-sectional and the number of towns is nearly equal to the number of woredas. This is because the majority of the Woredas in our sample have only one town with manufacturing firms which is unsurprising given the low degree of urbanization and industrialization in Ethiopia (only 15% of the population leaves in urban areas).

as a measure of road accessibility of towns. We proceed by adding variables sequentially as a robustness check. Column 1 includes only the road accessibility variable and comparison with the coefficients of ln(acc_9909) in subsequent columns shows that excluding proxies for road placement from the regression model overstates the correlation between the number of firms in a town and its road accessibility. The size of the coefficient on road accessibility declines by more than half once we control for economic potential in columns 2 and 3. The goodness of fit also increased by more than five folds when economic potential is accounted for. Treating road infrastructure as exogenous for micro-level analysis is therefore not supported by the data.

The results indicate that after controlling for initial number of manufacturing firms as well as other proxies for economic potential, towns with better road accessibility have a significantly larger number of manufacturing firms. This finding indicates to an increase in the number of entrants as well as survival of incumbent firm in connection with improvement in road networks. In Column 4 we expand the model by including region fixed effects. While this does not lead to a noticeable increase in the R-square, it does increase the size and significance of the coefficient on road accessibility. This could be the result of unobserved region specific effects that are unattractive for manufacturing activities which are somehow mitigated by better road infrastructure. These could include access to financial intermediaries and electricity which tend to improve with road accessibility.

The coefficient on the initial number of manufacturing firms is positive and highly significant indicating agglomeration effects that sustain the attractiveness of towns with a history of relatively intensive manufacturing activities. While the coefficient is less than one in all the specifications, it is not statistically distinguishable from the hypothesis of a proportionate increase in the number of firms across town during 1999-2009 with respect to their average number of firms during 1996-1998. Nonetheless, the actual decline in the fraction of firms in the top five towns (see Figure 2) implies that the agglomeration effect plays a relatively small role in the overall distribution of manufacturing firms. The other proxies for economic potential, i.e., population and agricultural potential do not seem to drive firms' location choices (and survival) in Ethiopia probably because of the strong correlation of these variables with region fixed effects.

The results from Tables 5 and 6 are qualitatively similar to that of Table 4. Table 5 shows that increasing the travel distance per hour of drive from a town increases significantly the average number of firms after controlling for economic potential and region fixed effects. In Table 6 we use the change in travel time rather than the average travel time to major economic destinations since 1999. This is because travel time to other economic hubs such as regional capital cities could be very long even for towns with initially large number of manufacturing firms such as Addis Ababa. We also did not take the log of this difference simply because the change in travel time is negative over time. Columns 1-4 of Table 6 are similar to that of Tables 4 and 5. That is, the results reveal an upward bias of the effect of reduction in travel time if we don't take into account factors that affect road placement, and that controlling for region fixed effects increases the size and significance of the coefficient on road accessibility. It is worth noticing that reducing travel time to major economic destinations increases the number of firms while the physical distance remains the same. Columns 5 and 6 of Table 6 provide results from a slightly different specification where we include travel time to major economic destinations together with the other two indicators of road accessibility, i.e., area accessible and travel distance. The results indicate that firms give more weight to roads that pass through a town as compared road projects that do not necessarily pass through the town but improve its connectivity with other commercial centres. This could be partly because firm owners have less information about roads that are further away from a town or they are less capable of using this information on their expected profitability.

5.2. Dynamic Panel Data Approach

While the results discussed in section 5.1. suggest that the number of firms increases with the road accessibility of a town, the estimation method is unlikely to adequately separate the effect of road placement from that of road connectivity. This is partly because of the incompleteness of the proxies for road placement that we used and partly due to the inadequacy of the proxies in representing the underlying variables. One should therefore be wary of unobserved factors that influence road placement while at the same time affecting firms' location choices. One reliable way of dealing with this problem is to use instrumental variables approach to obtain exogenous variation in road access. This requires instruments that do not affect the number of firms in a town except through the allocation of roads. None of our proxies for ERA's criteria for road placement satisfy this requirement for a valid instrument. However, since we have a sufficiently long panel data of towns with their corresponding number of manufacturing firms and indicators of road accessibility, the system GMM estimator proposed by Bludell and Bond (1998) would be suitable to capture the effect of improved road infrastructure. This method generates internal instruments whose validity can be tested empirically. Unlike the cross-sectional analysis in section 5.1., the panel GMM estimator will also allow us to control for time fixed effects. The latter would allow us to account for the faster pace at which the Ethiopian economy has been growing particularly since 2001 that could lead to an increase in the number of manufacturing firms across all towns.

Our estimation model using town level panel data can be expressed as :

$$\ln(N)_{it} = \beta_0 \ln(N)_{it-1} + \beta_1 RN_{it} + v_t + e_i + u_{it} \qquad (3)$$

First differencing equation 3 removes location specific factors that affect both firms' and government's decisions to invest in a particular geographic location. These include not only economic potentials that are time invariant but also initial conditions that make certain locations more attractive for entrepreneurs. The variables which were included in our previous model to account for prioritizing road projects such as initial number of firms, agricultural potential, level of population as well as woreda and region dummy variables will be differenced out from the model when using the GMM estimator.

While first differencing equation 3 removes the bias arising from location specific fixed effects, it introduces endogeneity problem as the lagged dependent variable will be correlated with the first difference of the composite error term. This problem will be addressed by using internal instruments generated by the system GMM estimator that include the lagged levels of endogenous variables for the equation in first differences and the lagged differences of the variables for the equation in levels.

Tables 7 presents the results of the system GMM estimator. For each specification we test the validity of the instruments using the Sargan overidentification test. The p-value of the Sargan test is too high to reject the null of a vector of instruments that are not correlated with the error term of the equation in first difference. We also report the Arellano-Bond test for first- and second-order autocorrelation in the time varying town specific error term. The test statistics show that there is a AR(1) process in the first difference equation but no AR(2) process. These standard tests indicated that the system GMM estimator is valid to estimate the effect of road infrastructure on firms' location choices. The results tables also report robust standard errors that are clustered at the town level.

The lagged dependent variable shows a positive and statistically significant coefficient showing a strong persistence in the annual number of firms in a town. The size of the coefficient ranges between 0.75 to 0.79 indicating that there might be agglomeration effects that make towns with historically larger fraction of firms, like Addis Ababa, Dire Dawa , and Bahir Dar continue to provide agglomeration advantages. It is noticeable that the agglomeration effect becomes less precise in the model where road access is measured in terms of travel time to major economic centres.

After controlling for time and location fixed effects, improved road access increases significantly the number of manufacturing firms in a town. A road project that increases travel distance from a town by 10% would increase the number of firms by 3.6%. Similarly, a 10% increase in the land area accessible within an hour of travel from a town would increase the number of firms by about 4%. The other measure of road access is the travel time to major economic centres which could change as a result of road projects further away from the immediate neighbourhood of a town. While the coefficient has the expected negative sign it is not statistically significant. This effect is weaker than the OLS estimates which indicate that the attractiveness of a town for manufacturers depends primarily on its own road networks while also benefiting from the connection with other important centres of economic activity such as regional capital cities or key regional markets.

We also estimated the model using the panel fixed effects estimator that takes into account only within town variation in road accessibility ignoring its variation across towns. As shown in Table 8, the coefficients from the fixed effects estimator on travel distance and area accessible for one hour of drive from a town are very close to that of the system GMM estimator discussed above. This suggests that once the time-invariant location effects are controlled for, there are no unobserved correlations between firms' decision to invest in a town and government's decision to assign a road project to that town. The travel time to major economic centers has now a highly significant effect on the average number firms in a town. Since physical distance to major economic centres from a town is obviously a fixed effect, it is unlikely that roads assigned outside the immediate neighbourhood of a town would be endogenous to firms' decision to locate in that same town. In that sense, travel time to major economic destinations is the least endogenous of the three measures of road access we used. If so, the internal instruments used in the system GMM estimator are less relevant for this variable and the fixed effects estimator is perhaps the best approach to capture its effect on the average number of firms in a town.

6. Number and Size of Start-ups

The discussion in section 5 examines the change in town level total number of firms which combines the effect of both firm survival and entry. In this section we focus only on entrants. Our variable of interest is the average number of start-ups in a town conditional on location specific factors including road accessibility. As discussed in section 2, researchers use either discrete choice models or count data models. We prefer the latter class of estimators and use specifically the Negative Binomial estimator which does not rely on the assumption of equality of mean and dispersion of entrants across towns like in the Poisson regression. Since a number of towns in our sample have zero entrants at a given point in time, we deploy the zero inflated negative binomial estimator. The negative binomial models take into account town fixed effects which minimize the endogeneity of road infrastructure.

The other important hypothesis that we want to test in this section is whether road accessibility of towns increases the average size at which firms enter a market. If demand for manufactures is small and the existing markets are fragmented due to inadequate infrastructure, then firms will start small because of the confined scope of the market. As the scope of the market broadens due to better road access, potential entrants would start at a relatively larger size as compared to entrants to a town with poor road connectivity. Similarly, if both agglomeration effects and transport costs are high, large cities would host most of the entrants but the average start-up size would be smaller in comparison with a situation where agglomeration effects are high but transport costs are lower.

We use OLS to estimate the average size of start-ups. We consider a firm to be an entrant if it appears for the first time in the CSA census of manufacturing firms. As in the previous sections, a reliable test of this hypothesis would require addressing the endogeneity of road placement. To that effect the model includes proxies for economic potentials as indicated in equation(2). Similarly we add time fixed effects to account for macroeconomic factors such as faster GDP growth and access to credit which could increase entry size across towns. We also allow for region fixed effects that not only control for unobserved economic potentials but also ability to negotiate for more road projects at the federal level. While it can be argued that these variables may not resolve the endogeneity problem, the results from the cross-section analysis in section 5.1 which is more susceptible to the endogeneity problem have been consistent with the results from the instrumental variables approach in section 5.2. We believe this applies to our analysis of average entry size although we cannot test it using panel data approach as entry is a onetime event.

The results of the negative binomial estimation are reported in Table 9. After controlling for initial number of firms and other indicators of economic potential, towns with better road accessibility have larger number of entrants. While the coefficients on area accessible and travel distance are positive and significant , the coefficients on the level and first difference of travel time to major economic destination are not significant. While connectivity to economic hubs matters for other firm decisions, it does not seem to matter for number of start-ups. It is worth to notice that initial number of manufacturing firms has a positive and significant effect on the number of new firms in a town. However, the coefficient is significantly less than one suggesting that an increasing number of start-ups are located in towns previously less important as centers of manufacturing. Agricultural potential also seems to matter; towns located in food surplus or food self-sufficient woredas are more likely to attract manufacturing start-ups than those in food deficit woredas.

Table 10 show the results on the average size of entrants and its association with road accessibility of towns using the OLS estimator. It shows that the average size of entrants increases with the areas accessible and distance travelled during a one hour drive from a town. Similarly, reducing the travel time to major economic destinations raises the average size of new firms in a town significantly. This indicates that business size is constrained by the size of the market and that road accessibility tends to reduce this constraint. The importance of market size is also corroborated by the positive and highly significant coefficient on the log of woreda level population although population does not affect the number of entrants.

The increase in start-up size as a result of improved road networks is likely to contribute to firm survival. Previous studies from developed and developing countries show that firm exit rate declines with initial firm size. However, the level of significance and size of the coefficients, particularly on area accessible (acc) and travel distance (trvd)**,** and the overall R^2 of the model indicate that the effects of road accessibility on entry size are relatively modest and that there is a lot we need to know about the determinants of firm size at entry.

In Table 11 we present results of the same regression analysis as in Table 10 with further control on the initial number manufacturing firms. This reduces the sample size as the average number of firms is calculated over the period 1996-1998 which means we are looking entry size after 1999. The results are quite similar to that of Table 10. It is quite interesting to see that firms entering a town with initially large number of firms begin with a size that is relatively smaller than start-ups entering a less crowded market.

7. Conclusion

Ethiopia has experienced the largest boost in road infrastructure in its history since the second half of the 1990s. This paper examines the response to this public investment program of manufacturing firms in terms of location choice as well start-up size. It combines census based firm level panel data from the Ethiopian manufacturing sector and GIS based town level panel data on road accessibility. The response variables we examined include the total number of firms, the number of entrants as well as the size (in terms of number of workers) of start-ups in a town. The main challenge of answering these important questions is addressing the endogeneity of road placement which might be driven by a common set of variables, some of which are unobservables, that firms use to choose their location and start-up size. Using alternative approaches to control for this problem of unobserved effects, the paper shows that better road accessibility increases a towns desirability for manufacturing firms. Improvement in road networks also increase the average size of entrant firms by broadening the scope of the market they supply. Average firm entry also increases in towns with initially low number of manufacturing firms suggesting the competitive pressure in relatively crowded markets. By increasing the accessibility of formerly isolated towns, the RSDP has started to increase both the number of firms in such towns as well as the average size of new firms. This suggests that the public investment on roads is not only expanding the size of the manufacturing sector, it is improving the distribution of manufacturers across towns.

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Figure 1 juxtaposes the change in area accessible during a one hour travel from Addis Ababa in 1996 and 2008.

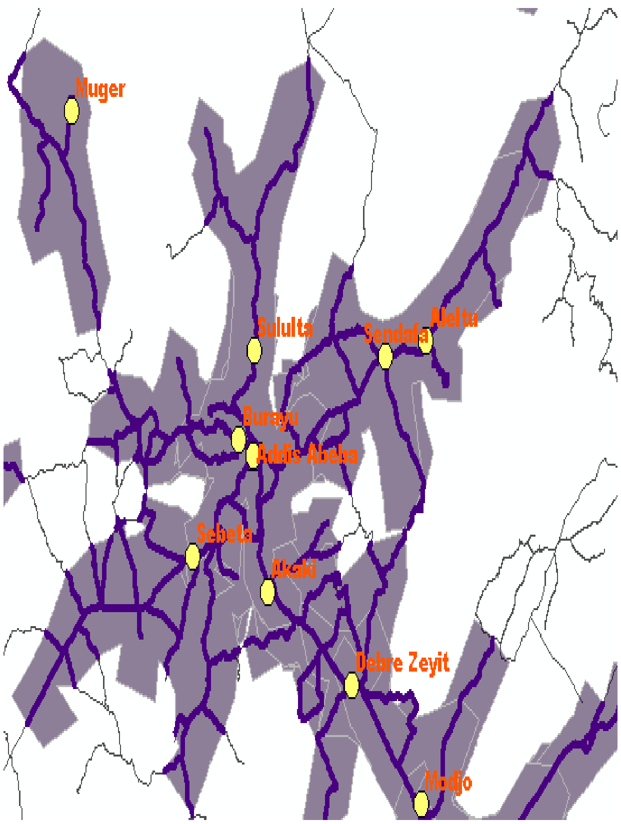

Figure 1a: Area accessible during a 1hr Drive from Addis Ababa in 1996

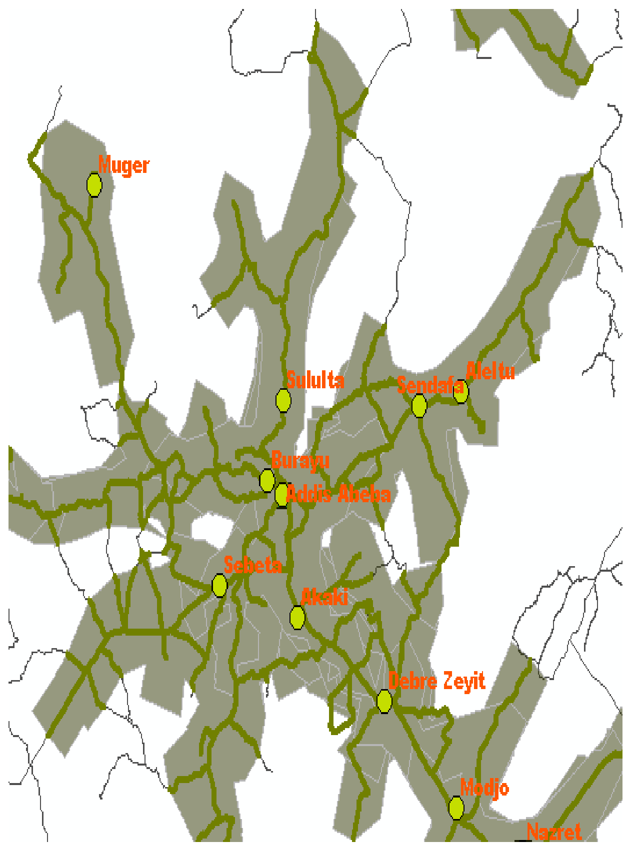

Figure 1b: Area accessible during a 1hr Drive from Addis Ababa in 2008

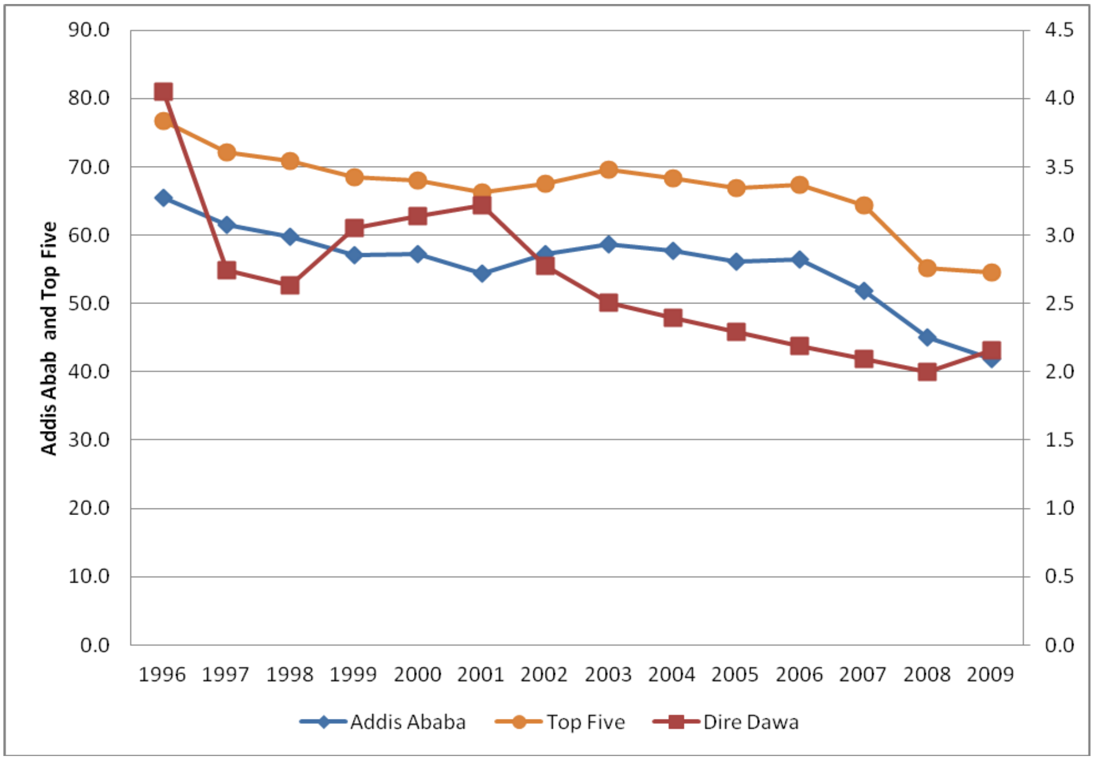

Figure 2: The Share of the Top Five Towns in Manufacturing Firms

Table 1: Improvements in Road Infrastructure

Indicator	1997	2009
Proportion of asphalt roads in good condition	17%	70%
Proportion of gravel roads in good condition	25%	54%
Proportion of rural roads in good condition	21%	50%
Proportion of total road network in good condition	22%	54%
Road Density/ 1000 sq. km	24.1km	42.6km
Road Density/ 1000 Population	0.46km	0.57km
Road Density/ 1000 sq. km (including community roads)	24km	120.5km
Proportion of area more than 5km from all weather road	79%	65.3%
Average distance to all weather road	21.4km	11.8km

Source: Table 8, ERA (2009)

Table 2: Trends in Road Accessibility (Annual Mean)

Year	Area Accessible (Km2)	Travel Distance (Km)	Travel Time to Major Destinations (hours)
1996	1098.2	210.6	379.9
1997	1100.9	210.9	379.8
1998	1103.7	211.2	379.7
1999	1108.5	211.8	378.5
2000	1113.3	212.5	377.3
2001	1139.7	216.3	369.4
2002	1166.2	220.1	361.4
2003	1181.2	222.3	359.7
2004	1196.1	224.4	358.0
2005	1235.3	230.4	350.9
2006	1274.6	236.4	343.9
2007	1317.7	246.4	334.7
2008	1360.9	256.4	325.5
2009	1360.9	256.4	325.5

Source: Authors' computation based on ERA data

Table 3: Average Change in Road Accessibility (town level)

	1996-98			1999-2009			Mean Difference	
	Mean	Std-Deviation	Coefficient of Variation	Mean	Std-Deviation	Coefficient of Variation	Difference	t-test (p-value)
ACC	1100.9	497.7	0.4521	1223.1	631.6	0.5164	122.189	0.0024
TRVD	210.9	119.3	0.5656	230.3	138.0	0.5994	19.4229	0.0297
TTOD	379.8	110.8	0.2916	353.2	107.6	0.3046	-26.6045	0.0003

Source: Authors' computation

Note: ACC stands for area accessible from a town, TRVD stands for travel distance from a town and TTOD stands for travel time from origin to destination.

Table 4: OLS Estimates: Dependent variable log number of Firms (Town Level) - Area Accessible as Measure of Road Accessibility

	1	2	3	4
ln(acc_9909)	1.0417	0.4709	0.4795	0.7699
	(0.3456)***	(0.2501)*	(0.2719)*	(0.2840)***
ln(N_9698)		0.9279	0.9474	0.8810
		(0.0701)***	(0.0867)***	(0.1061)***
Food Surplus			-0.0796	0.2197
			(0.3010)	(0.3198)
ln(woreda_pop)			-0.0825	0.0555
			(0.1360)	(0.1571)
Region Dummies	No	No	No	Yes
Constant	-6.3902	-2.7589	-1.8195	-4.6934
	(2.4285)**	(1.7722)	(2.5053)	(2.6266)*
R^2	0.13	0.67	0.66	0.70
N	88	79	73	73

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Robust standard errors in parenthesis

Table 5: OLS Estimates: Dependent variable log number of Firms (Town Level) – Travel Distance as Measure of Road Accessibility

1				
ln(trvd_9909)	0.8909	0.3743	0.3867	0.6251
	(0.2756)***	(0.2091)*	(0.2296)*	(0.2437)**
ln(N_9698)		0.9229	0.9425	0.8775
		(0.0730)***	(0.0889)***	(0.1088)***
Food Surplus			-0.0896	0.2091
			(0.2941)	(0.3164)
ln(woreda_pop)			-0.0847	0.0465
			(0.1393)	(0.1612)
Region Dummies	No	No	No	Yes
Constant	-3.8030	-1.4318	-0.4643	-2.5367
	(1.4634)**	(1.1192)	(2.0259)	(2.2548)
R^2	0.14	0.66	0.66	0.70
N	88	79	73	73

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Robust Standard errors in parenthesis

Table 6: OLS Estimates: Dependent variable log number of Firms (Town Level) – Average Travel Time to Major Economic Destinations as Measure of Road Accessibility

	1	2	3	4	5	6
Δttod_9909	-0.2364	-0.0707	-0.0735	-0.1130	-0.0735	-0.0811
	(0.0467)**	(0.0417)*	(0.0430)*	(0.0466)**	(0.0455)	(0.0467)*
ln(N_9698)		0.8933	0.9168	0.8546	0.8046	0.7924
		(0.0845)***	(0.1013)***	(0.1285)***	(0.1238)***	(0.1269)***
Food Surplus			-0.1069	0.1891	0.2214	0.2137
			(0.2889)	(0.2993)	(0.3081)	(0.3051)
ln(woreda_pop)			-0.1001	-0.0052	0.0319	0.0227
			(0.1526)	(0.1734)	(0.1500)	(0.1551)
Ln(acc_9909)					0.6217	
					(0.2838)**	
Ln(trvd_9909)						0.4995
						(0.2469)**
Region-Dummies	No	No	No	Yes	Yes	Yes
Constant	-0.2906	0.2069	1.4187	0.7817	-3.5127	-1.7273
	(0.2620)	(0.2337)	(1.7776)	(1.9259)	(2.4546)	(2.1395)
R^2	0.25	0.66	0.66	0.68	0.71	0.70
N	84	76	70	70	70	70

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Robust standard errors in parenthesis

Table 7: System GMM Estimates: Dependent Variable log number of firms (town level)

	Travel Distance	Area Accessible	Travel Time to Major Destinations	Change in Travel Time to major Destin
$Ln(N)_{it-1}$	0.7524 (0.0641)***	0.7490 (0.0702)***	0.7939 (0.4096)*	0.8225 (0.0512)***
$ln(trvd)_{it}$	0.3559 (0.1596)**			
$ln(acc)_{it}$		0.4076 (0.2064)**		
$ln(ttod)_{it}$			-0.1492 (0.7765)	
$\Delta ttod_{it}$				-0.0039 (0.0018)**
Year Dummy	Yes	Yes	Yes	Yes
Constant	-1.4383 (0.7849)*	-2.4017 (1.3722)*	1.2521 (4.8258)	0.3392 (0.0752)***
Observations	1170	1170	1118	1118
Number of Towns	90	90	86	86
Sargan statistic and p-value	81.498 (0.207)	82.004 (0.196)	77.436(0.734)	76.499(0.398)
AR1	0.000	0.000	0.000	0.000
AR2	0.405	0.410	0.374	0.392

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Standard errors in parentheses

Table 8: Panel Fixed Effects Estimates: Dependent variable log number of firms

	1	2	3
ln(trvd)	0.3482 (0.1583)**		
ln(acc)		0.3128 (0.1585)**	
ln(ttod)			-0.5350 (0.1875)***
Year	0.0566 (0.0039)***	0.0567 (0.0040)***	0.0522 (0.0043)***
Constant	-113.9330 (7.3647)***	-114.3942 (7.4274)***	-100.1152 (9.4076)***
Observations	1260	1260	1204
Number of towns	90	90	86
R-squared	0.23	0.23	0.23

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.
Standard errors in parentheses

Table 9: Determinants of Number of Entrants: Zero Inflated Negative Binomial Estimation

	(1)	(2)	(3)	(4)
ln(acc)	0.6295 (0.1511)***			
ln(trvd)		0.6692 (0.1683)***		
ln(ttod)			-0.2694 (0.2299)	
$\Delta ttod_{it}$				0.0095 (0.0073)
ln(N_9698)	0.6568 (0.0721)***	0.6426 (0.0719)***	0.6882 (0.0773)***	0.6142 (0.0799)***
Ln(woreda_pop)	-0.1463 (0.1180)	-0.1543 (0.1194)	-0.0419 (0.1190)	-0.0110 (0.1192)
Food Surplus	0.7041 (0.2558)***	0.7475 (0.2584)***	0.8330 (0.2574)***	0.9274 (0.2496)***
Constant	-4.7102 (1.4515)***	-3.6600 (1.3356)***	-0.2792 (1.7805)	-18.2178 (1.2927)***
Observations	1038	1038	996	924

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.
Robust standard errors in parentheses

Table 10: Average Size of Entrant Firms (log number of workers)

	(1)	(2)	(3)
ln(acc)	0.1457 (0.0787)*		
ln(trvd)		0.1329 (0.0769)*	
ln(ttod)			-0.2258 (0.0968)**
ln(woreda_pop)	0.1261 (0.0407)***	0.1294 (0.0410)***	0.1868 (0.0394)***
Food Surplus	-0.3383 (0.1566)**	-0.3172 (0.1578)**	-0.3089 (0.1562)**
Year Dummy	Yes	Yes	Yes
Region Dummy	Yes	Yes	Yes
Constant	1.1465 (0.5802)**	1.4299 (0.4980)***	1.9396 (0.7102)***
Observations	2016	2016	1979
R-squared	0.05	0.05	0.05

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Robust standard errors in parentheses

Table 11: Average Size of Entrant Firms (log number of workers)

	(1)	(2)	(3)
ln(acc)	0.1535 (0.0767)**		
ln(trvd)		0.1664 (0.0823)**	
ln(ttod)			-0.1850 (0.1113)*
ln(N_9698)	-0.0622 (0.0310)**	-0.0619 (0.0309)**	-0.0464 (0.0330)
ln(woreda_pop)	0.1915 (0.0614)***	0.1879 (0.0615)***	0.2402 (0.0552)***
Food Surplus	-0.1517 (0.1494)	-0.1233 (0.1497)	-0.1390 (0.1475)
Year Dummy	Yes	Yes	Yes
Region Dummy	Yes	Yes	Yes
Constant	-0.4512 (0.6393)	-0.2015 (0.6156)	1.8734 (0.9359)**
Observations	1630	1630	1597
R-squared	0.05	0.05	0.05

Note: *, **, *** represent statistical significance at the 10%, 5% and 1% level of significance.

Robust standard errors in parentheses

Appendix A: Road Assignment Process

The Ethiopian Road Authority uses the following five criteria during the preliminary selection of new road projects.

i) Roads providing access to areas with economic development potential (20%)

ii) Roads leading to areas with surplus food and cash crop production (20%)

iii) Roads that link existing major roads (20%)

iv) Roads providing access to large and isolated population centers (30%)

v) Roads that bring balanced development amongst the regions in the country and that provide access to emerging regions (10%)

This shows that economic potentials account for about 40% of the weights for new road placement while another 40% weight is given primarily to social equity concerns (criteria iv and v) that could redress existing inequality in road accessibility. ERA uses different inputs to determine the weight for each criterion. The planning department of ERA undertakes the so-called Transport Poverty Observatory on a regular basis which include “corridor analysis” and “network studies”. Weights for the above mentioned criteria are determined by a committee on the basis of these studies and additional information provides by regional states and government ministries.

Proposals for new roads come mainly from regional states. Each regional state submits its proposal to ERA with its own prioritization and justification. Some government ministries also put forward proposals for new roads. For instance, the Federal Ministry of Mines and Energy requested for a new road following the discovery of potash in Dallol area. ERA evaluates all the proposals against the five selection criteria. The next step is to see how many new roads can be funded given the budget envelop. By aligning road projects with the budget envelop, ERA will present the proposal to the Federal Ministry of Construction and Urban Development. The approved proposal will be presented to the Prime Minister as well as other relevant ministries. Such meetings involve the Governor of National Bank of Ethiopia and the Federal Ministry of Finance and Economic Development (MoFED) administers the federal budget). At this level the overall framework/criteria and fund will be approved. Specific roads are to be selected by ERA based on the agreed framework.

Following the above mentioned preliminary selection process, all selected roads will go through a feasibility study based on which a final project selection will be made. The estimated budget at preliminary level will be adjusted after the feasibility studies. The final budget is determined when the road design is completed by engineers. Once this is done the budget will be submitted to the Ministry of Finance and Economic Development (MoFED). Because of the priority given to the road sector, MoFED often approves the budget with only minor adjustments. For instance for the 2011/12 fiscal year ERA asked for Birr 17 billion and got Birr 15.4 billion.

Upgrading projects also go through a similar process. Most of the proposals for road upgrading come from regional states. The preliminary selection and prioritization of road upgrading projects by ERA is slightly different from that of new roads. The criteria and their respective weights are as follows:

i) Roads with high traffic density - 30%
ii) Roads with better network connectivity -20%
iii) Roads that are in poor condition - 20%
iv) Roads that link import/export and regional integration corridors - 20%
v) Roads connecting investment routs (potential areas) - 10%

The reason why roads with high traffic are given priority for upgrading is that traffic flows that go beyond the designed capacity could cause severe damage to the road at which level routine maintenance may not be economical.

Despite having a set of criteria for road placement, it is not clear what specific measures ERA uses to operationalize them. For instance, it is not clear how exactly economic potentials of different geographic locations are assessed or how regional inequality is evaluated. There is lack of clarity also about the process and criteria by which regional states prioritize their road projects for submission to ERA. From our discussion with ERA, it seems that the above mentioned criteria serve as broad guidelines rather than strict rules for road placement.

Appendix B:

Table B1: Expected Improvement in Speed of Travel

Pavement Type and Condition	Average Travel Speed	
	Before Rehabilitation/upgrading	After Rehabilitation/upgrading
Asphalt Roads	50km/hr	70km/hr
Federal Gravel Road	35km/hr	45km/hr
Regional Gravel Road	25km/hr	35km/hr
Earth Surfaced Roads	20km/hr	35km/hr
Federal Gravel or regional rural roads to Asphalt Roads	25km/hr to 35km/hr	70km/hr

Source: ERA

Table B2: Regional Capitals and other Urban Centers as Destination for O-D matrix

ID	NAME	POINT_X	POINT_Y
1	Addis Abeba	472656.04	998453.60
2	Arba Minch	338197.89	664536.16
3	Asosa	10524.93	1115450.18
4	Awasa	441088.20	779102.38
5	Bahir Dar	324514.77	1281398.44
6	Dessie	568955.98	1229367.46
7	Dire Dawa	814860.19	1063118.29
8	Gambela	12264.77	913864.40
9	Harer	842893.99	1030414.93
10	Jigjiga	917315.59	1035495.53
11	Jima	260937.87	848508.63
12	Mekele	551884.95	1492540.45
13	Nazret	528918.44	943849.55
14	Nekemte	230291.32	1005545.02
15	Semera	717990.30	1300962.68

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