Roads and Jobs in Ethiopia*

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Abstract

We look at how improving road infrastructures can affect jobs and structural transformation in the context of a low-income, weakly industrialised country. We present a novel geocoded dataset covering the universe of Ethiopian roads that have been built or rehabilitated under the Road Sector Developing Programme (RSDP). We match this information with individual data (from both census and national labour surveys), and identify the effects of an increase in market potential due to improvements in roads on the creation, quality and sectoral distribution of jobs over the period 1994-2013. Our results show that improving roads affect the overall size of the workforce and brings significant changes in its composition. Specifically, we find evidence of a positive impact of roads on typical metrics related to structural transformation. This happens through a reduction of agricultural workers and an increase of workers in the services sector, but not in manufacturing. The latter experiences a relative increase in the share of informal work. Finally, we identify some of the potential mechanisms that can help explaining our findings.

Keywords: structural transformation; transport infrastructure; roads; Ethiopia
JEL Classification: L16; O18; O55; R4

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Introduction

Transport infrastructures matter for economic development. Greater transport connectivity can improve the life of individuals, widening their work and educational opportunities and fostering transition to more productive activities. In addition, improving domestic transport infrastructures can relax some of the key constraints that affect the private sector in many low-income countries, by allowing firms to better connect to local and international markets, improve efficiency and providing better jobs. Understanding whether policies supporting the construction of transport infrastructures can affect jobs in low-income countries is therefore of high policy relevance. Yet, partially due to limited availability of time series data on transport infrastructures in low-income countries, this topic remains relatively under-investigated in the academic literature.

In this paper we look at the effects of developments in road infrastructures on the number and quality of jobs in Ethiopia.

We take advantage of the collection of very granular information on a recent large scale programme, the Road Sector Development Programme (RSDP). The RSDP started in 1997 with the aim of improving connectivity across the country through rehabilitation of existing roads and the construction of new ones[1]. In the space of just a decade improvements due to the RSDP have been remarkable. Road density rose up from 24.1 when the programme started to 44.4 per 1000 sq. km in 2010 (when an evaluation of the first three rounds of the programme was completed, Ethiopian Road Authority, 2011). Over the same period, the proportion of the total road network in good condition passed from 22% to 56%. More specifically, in this paper we use geolocalized information on the Ethiopian road network, for which we track road-segment specific improvements recorded under the RSDP. We match information on the road network with information at the level of individuals taken from the 1994 Population Census and the Ethiopian National Labour (NLF) Survey, a representative survey of Ethiopian workers, available for the years 1999, 2005 and 2013. We use the district (or woreda, the third level administrative units in Ethiopia) as unit of analysis. To better explore how transport infrastructures affect labor demand, we further combine road data with additional information on the activity of (manufacturing and services) firms.

The case of Ethiopia is particularly relevant for our purposes. Industrialization and structural transformation are at the core of the Ethiopian national development strategies. Beginning with the agricultural development led industrialization (ADLI) strategy in 1995, and following with the most recent growth and transformation plans (I and II), a large emphasis has been attributed to structural transformation (Schmidt et al., 2018). This policy agenda focused on the development of some targeted industries (those with the higher linkages to the agricultural sector), but it also more generally promoted diversification into high productive activities, entrepreneurship and supported the rise of investments, especially from abroad. Improving connectivity both within country (rural-urban and urban-urban) and with the external markets is a related effort

[1] Note that roads represent the exclusive means of transport in Ethiopia over the period covered in our analysis. The railway, connecting Addis to Dijibuti, was in fact restablished in 2017.

that comes along the pursuit of structural transformations and economic upgrading (Ali, 2019).[2] Existing evidence from Ethiopia shows in fact how high transport costs have so far represented high barriers to market integration (Atkin and Donaldson, 2015; Gunning et al., 2018) and labor supply (Franklin, 2018).

We study the impact of road infrastructures using a market potential indicator. Grounded on the work by Harris (1954) and theoretically founded in gravity adaptations of the new economic geography (NEG) model, a measure of market potential allows to account for the direct and indirect effects of roads investments that took place all over the country under the RSDP. We expect that improvements in market potential will have implications on the number and quality of jobs in Ethiopia.[3] However, the sign of these effects is theoretically ambiguous (Asher and Novosad, 2018; Baum-Snow et al., 2018). Especially for countries at earlier stages of development (and high transport costs to start with), improvements in market potential shape the distribution of economic activities, with central locations initially growing faster compared to more peripheral ones (Brulhart et al., 2019). Changes in market potential alter the economic environment for both firms and workers.[4] Better roads can affect firms in various ways. Improvements in road infrastructures reduce firms' transport costs, increasing market opportunities while lowering the costs of sourcing inputs. This can trigger private sector development through more entry, higher performance, and ultimately generate an increase in labour demand. However, better roads also increase competitive pressures faced by firms with potentially opposite implications on labor demand. On the supply side, roads can contribute to push workers out of agriculture (Asher and Novosad, 2018), which is still the prevalent sector in the country. This happens primarily through improvements in farms' productivity (due, for instance, to greater access to new and imported inputs). Recent evidence provides support to the link between improvements in connectivity under the RSDP and increases in agricultural productivity (Adamopoulus, 2018). Also, lower transport costs reduce constraints to migration choices (Morten and Oliveira, 2017). According to a report of the recently established Ethiopian jobs commission (Jobs Creation Commission Ethiopia, 2019), recent increases in migration (mostly rural-urban) do exert a huge pressure on urban labour markets, with likely consequences on wages, unemployment and the size of the informal sector. Understanding how labour demand and supply interact in the Ethiopian context and what are the effects on the size and composition of local employment is therefore an empirical question that we try to analyze in the paper.

A key issue for our analysis is that the high costs and potentially large benefits of investment in road infrastructures might imply a correlation between the placement of new roads and both the economic and political characteristics of each district. Note that an advantage of using a market potential approach, compared for instance to measures of local road density, is that its value

[2] The recent efforts to develop industrial parks in the country is consistent with the idea that both employment creation in non-agricultural sectors and structural transformation is indeed dependent on a reliable network of infrastructures.

[3] Following Gollin and Rogerson (2014), in developing countries it is hard to undertake structural transformation without improving first transport costs.

[4] There is indeed evidence showing that improvements in within-country market potential are linked with more trade, income, and population (for instance, Storeygard, 2016; Eberhard-Ruiz and Moradi, 2019; Chiovelli et al., 2019; Alder, 2019). For the case of Ethiopia, Fiorini et al. (2019) show that improvements in market access due to the RSDP are a necessary condition for firms to experience productivity gains from trade liberalization.

is influenced by improvements recorded elsewhere in the country. This should, in turn, reduce some of the common concerns related to endogenous road placement (Donaldson and Hornbeck, 2016). Our identification strategy relies on exploiting the time series dimension of improvements in roads within each district, running a panel regression that includes granular district fixed effects together with region-time fixed effects. To further minimize endogeneity concerns we add an appropriate battery of controls varying at the time-district level that allow to isolate changes in market potential which are orthogonal to investments in local road infrastructure. In addition, we exploit the fact that market potential in a district is determined by changes not only in nearby districts' road segments but also in any other part of the national road network. Therefore, by controlling for improvements to roads within the district we restrict the variation in the market potential measure to reflect improvements in the road network which are arguably exogenous to other district's characteristics. Note that this is also, to the best of our knowledge, the strategy adopted to tackle the endogeneity of market potential by most of the papers using similar measures than ours in a panel setting (see for instance Donaldson and Hornbeck, 2016; Storeygard, 2016; Storeygard and Jedwab, 2018).[5]

Our results show that there is a link between improvements in connectivity, jobs and their composition in the context of Ethiopia. We find that improvements in market potential contribute to the creation of jobs. An improvement from the 25^{th} to the 75^{th}-percentile of the distribution of market potential in our estimation sample would imply for an average district an increase of about 19.6% in the number of jobs, which corresponds on average to roughly 8.6 thousand additional persons employed. In addition, we find evidence of improvements in roads to be associated with changes in the sectoral composition of the workforce within the same district. This happens through a reduction of agricultural workers and an increase of workers in the services sector, but not in manufacturing. We show therefore that improvements in roads seem to contribute to set up a pattern of structural transformation without manufacturing, which is consistent with findings of other studies looking at the dynamics of structural transformation in the African continent (Hjort and Poulsen, 2019; Hohmann, 2018; Rodrik, 2016). By investigating the effects of road infrastructures at a disaggregated sectoral level, we show that the increasing share of services employment that can be attributed to improvements in roads is mostly accounted for by low value added activities, including private household services and retail trade.

Next, we shed light on the effects of infrastructural reforms on informal jobs across sectors. To do this, we exploit information available from the NLF surveys (but not from the 1994 census) covering both the formal and informal nature of the organizations in which workers are employed and the self-employment status of workers. Overall, we do not find a strong evidence of an increase in informal jobs. A notable exception is the manufacturing sector, for which we show relative increases in the share of informal jobs following improvements in market potential.[6]

Moreover, we extend our analysis and make two additional points. First, we identify some

[5] Most of the papers that have so far instrumented for road improvements or market access have done so by adopting time invariant instruments, including for instance planned or historic routes, or the geophysical conditions of the terrain (Redding and Turner, 2015)

[6] To some extent, this looks consistent with experimental evidence provided by Blattman and Dercon (2017), who showed how Ethiopian workers in the manufacturing sector do not reveal clear preferences for a formal against informal nature of jobs (and even seem more prone to the latter should capital constraints being eased).

gender specific patterns. Evidence on the relative increase of workers in services is significant for women but not for men, a result that confirms some previous evidence on the gender specific benefits of improvements in transports (e.g. Lei et al., 2019). Second, we show also evidence of an increase in working age population with higher education (diploma and higher degrees) in districts where investments in road infrastructure determined higher market potential. This finding supports the result of higher returns to schooling in well connected locations (as in Adukia et al., forthcoming, for the case of India). Importantly, our results remain qualitatively robust to alternative definitions of the variables of interest as well as to different cuts in the data.

Finally, we investigate some of the potential economic mechanisms that can help rationalizing our results. Following the existing literature, it can be argued that the effects of road infrastructures on jobs are driven by reduced costs of internal migration on the one hand (Morten and Oliveira, 2017) and by increased economic activities on the other (Hjort and Poulsen, 2019).[7] We show that increases in market potential through improved roads are indeed correlated with higher domestic migration to urban areas. Moreover, we find support for the hypothesis that the effects of roads on jobs are also driven by an increase in the demand for workers in districts with better market potential. Using data on both formal and informal manufacturing firms, we find that the response of (both formal and informal) manufacturing firms includes improvements in productivity, as well as a relative increase in the number of non-production workers, as well as in their wages. Given that this employment category includes high-skilled workers, we interpret this finding as explaining how individuals in locations with higher market potential are most likely to invest in education, in view of more rewarding job opportunities in the future. Firms operating in the trade related services (i.e. wholesalers and retailers), on the other hand, experience an increase in the number of jobs but a reduction in their productivity.

Our work speaks to different strands of the literature. First, it contributes to a growing body of evidence employing detailed micro data to investigate the drivers and patterns of job creation and structural transformation in developing countries. Some recent works by Bustos et al. (2016, 2017) focus on push factors, and show how technological shocks affecting agricultural productivity have driven structural changes in Brazil. Erten and Leight (2019) and Hohmann (2018) look at pull factors, including openness to trade and exogenous changes in international prices of natural resources to explain changes in the composition of the workforce in China and several other developing countries. Most related to the content of this paper are the works by Hjort and Poulsen (2019); Asher and Novosad (2018); Adukia et al. (forthcoming). These authors look at how connection to infrastructures can affect structural transformation. Hjort and Poulsen (2019) relate the connection to fast internet cables along the coasts of some African countries to an increase in jobs opportunities. Similarly to our findings, they show that this effect is likely to be driven by the rise of a more dynamic private sector in treated locations. Asher and Novosad (2018) and Adukia et al. (forthcoming) exploit rich information on the construction of roads in rural villages in India. They offer a more nuanced set of results. Investments in roads do stimulate reallocation of workers out of agriculture and higher investments in education, but

[7] An additional mechanism has to do with improvements in connectivity leading to agricultural productivity. This channel has been already explored by Adamopoulus (2018) using comparable data for Ethiopia and therefore is not directly addressed in our study.

do not increase significantly local economic activities in treated areas. Differently from their work, our paper captures not only the construction of new roads, but also improvements (e.g. rehabilitation, expansions) occurring to all types of roads. In addition, while they focus on rural India our work lookss at both rural and urban areas in Ethiopia.

Second, by exploring the relation between roads and informal employment we add to the study of the causes of informality in developing countries. For instance, the trade literature has some contrasting findings about the potential drivers of informal activities following liberalization episodes (McMillan and McCaig, 2019; McCaig and Pavcnik, 2018; Dix-Carneiro and Kovak, 2017). We contribute to this body of research by arguing that informal jobs can also react to changes in the costs of trading domestically. More specifically, we show that especially in the manufacturing sector higher competition following improvements in market potential can push firms and workers to more informal jobs.

Third, we contribute more generally to a growing literature looking at the effects of transport infrastructures on several dimensions of local economic development in low-income countries (see, for instance, Redding and Turner, 2015; Berg et al., 2017, for a review of the recent evidence). Donaldson (2018) and Storeygard (2016) among others demonstrate high returns to infrastructural investments in several developing countries. Jedwab and Moradi (2016), Baum-Snow et al. (2018) and Storeygard and Jedwab (2018) show that infrastructures have persistent effects on urbanization and the distribution of economic activities across space. Other works point to second order advantages related to, for instance, removing costs of migration (Bryan and Morten, 2018), which are especially important for rural areas (Asher and Novosad, 2018; Adam et al., 2018).

Last, there is a small but growing literature looking at the consequences of infrastructural investments in Ethiopia, especially under the RSDP. Shiferaw et al. (2015) and Fiorini et al. (2019) find some evidence on the benefits of RSDP on business dynamics and firms' productivity, respectively. Importantly, and consistent with our overall story, a recent work of Adamopoulus (2018) provides evidence supporting the link between improvements in connectivity under the RSDP and increases in agricultural productivity using a panel of Ethiopian woreda over the period 1996-2014.[8] None of this work looks specifically at the capacity of roads to generate jobs. Closer to the spirit of our work is the one by Moneke (2019). He looks at the effects of infrastructural investments (in roads and electrification) on structural transformation and welfare in Ethiopia. Similarly to our work, he finds that roads investments promote structural transformation out of the agriculture and towards services but not in manufacturing. Rather, the analysis by Moneke (2019) shows that manufacturing jobs are supported by investments in roads in those areas of the countries that received as well investments in electrification.

The remaining of the paper is organized as follows. Section 1 presents the main data employed in the paper. Section 2 describes the identification strategy, while Section 3 introduces the core results on the effects of road connectivity on structural transformation. Section 5 offers an empirical investigation of the mechanisms driving our findings. Section 6 concludes.

[8] Also Iimi et al. (2017) report some evidence on the effects of improved infrastructures on agricultural productivity in Ethiopia. The focus of their work is on railways and not on roads.

1 Data

1.1 Individuals

Individual level data are obtained after merging two sources that provide complementary information. The first is the Ethiopian National Labour Force (NLF) survey. This is a representative survey of both urban and rural areas administered by the Central Statistical Agency (CSA) with the objective of monitoring the economic and social conditions of economically active population. Information provided in the survey includes, among others, the demographic characteristics of the individuals, their education and working conditions. Questions include as well whether previous residence of the interviewed was different from the current one, allowing thus to identify of internal migrants, as well as on the formal or informal nature of the current job of the individuals. We use all the existing waves of the NLF, covering the years 1999, 2005 and 2013.[9]

A limitation of the NLF surveys is that they do not cover the period preceding the start of the RSDP. To address this issue we combine the NLF with the 1994 population census. The 1994 edition of the census has most of the information that is also present in the NLF, including on the working conditions and educational attainments of the individuals. Crucially, the 1994 census provides as well details on the distribution of workers across industrial sectors[10]. Once the two datasets have been cleaned and made homogenous to account for different definitions of the areas over time[11], we have collapsed all the information at the district-year level using sample weights to recover information on the underlying population.

Table 1 shows the distribution of labour shares over the 1994-2013 period, computed at the national level. While jobs are on the rise, there is also some general evidence on the process of structural transformation occurring in the country as economic growth increases. Notably, there is some evidence that workers move away of agriculture in favour of services. Little changes are instead recorded in the manufacturing sector, which is consistent with related evidence pointing to a lack of industrialization in the country[12]. Note that, when we observe the distribution of workers across industries within the service sector, we do not find evidence of any relevant shifts towards neither high value added industries (real estate, business services or finance) nor jobs in the public administration. Rather, we observe some rapid improvements in a few industries,

[9] The NLF surveys are nationally representative. They cover all urban and rural areas of the country, except the non-sedentary areas in the Somali region. The sampling frame to select enumerator areas is provided by the population census (the 1994 census for the 1999 and 2005 NLF and the 2007 census for the 2013 NLF). All the relevant information on the sampling procedures, coverage and full descriptive statistics are available from the survey reports published by the CSA (2014, 2006, 2004).

[10] This is not trivial, since the 2007 census no longer includes this information. Note that while the 1994 census reports most of the relevant questions that are included in all the NLF surveys, it does not ask to the individuals who work if their job is in the formal or in the informal sector.

[11] NLF survey data are not geocoded, but provide identification codes for each location, including region, zone and district. To combine the different waves of data we have used the definition of district (woreda) provided by IPUMS that matches districts using their names when the geographic definition of borders differed between the 1994 and 2007 censuses. Note that the 1994 census does not provide disaggregated information on the woredas belonging to Addis Abeba region, so that woredas in Addis are covered only for the three successive periods. Overall, the sample on which we run our empirical analysis covers on average about 80% of the estimated total population in each wave considered.

[12] Note that this pattern of transformation, known as "premature de-industrialization" (Rodrik, 2016), is common in many developing countries, especially in Africa.

namely trade-related services (which move from 2 to about 5% of total jobs from 1994 to 2013), private services to the households (going up from nearly 0.7 to about 3.4% during the sample period) and the other uncategorized services, which grew up to 6.3% in 2013.

Data show also that, over time, the relative position of women in the labour market has improved (women representing about 46% of total workers in 2013, from 43% in 1994). This relative improvement seems to be driven by an increase in women employment in the services. While men dominate employment in the agricultural sector, women represents a larger share of employment in both manufacturing and the services.

Table 1: Sector composition of employment

Year	Agriculture	Manufacturing	Construction	Services
1994	89.71%	1.78%	0.29%	8.21%
1999	80.68%	4.50%	0.93%	13.90%
2005	83.64%	4.41%	1.28%	10.67%
2013	75.36%	4.17%	1.79%	18.68%

Source: Authors' elaboration on CSA data. *Notes:* All values represent the share of sectoral workers on the total number of employed persons in the specific year. Following the NLF report, a worker is defined as a person who declared at least 1 hour of work during the week preceding the interview. All data have been weighted before collapsing information at the woreda-year level.

The information on the informal sector is only available from the NLF surveys. NLF provides a fairly detailed definition of informal sector employment. An informal worker is so defined if two criteria are met. First, the worker is not employed in the following sectors (all taken by definition as formal): government; government development organization; NGOs and members of cooperative. Second, those that do not fit the previous criterion are considered informal workers if the enterprise for which they work does neither have book of account or license [13]. Following the existing literature (McCaig and Pavcnik, 2018; McMillan and McCaig, 2019), a definition based on the status of the firm in which the worker is employed provides a better account of informality compared to those based on the worker's registration status within formal firms, especially in countries in which the informal sector represents a large share of employment. The data show large discrepancies in the number and share of informal work between 1999 and the remaining years. This because since 2005 the question was asked only to a part of the employed population, excluding persons engaged in subsistence farming and those who work in private households (see, CSA, 2014, 2006). For this reason the focus of our analysis is restricted to informal employment in the modern sectors. Informal jobs have been on the rise in these two sectors, though they represent a declining share of the total. Still, however, almost 50% of manufacturing jobs are in the informal sector. To overcome some of the above mentioned limitations of the informal sector data, we use as well information on self-employment, a proxy that is most commonly used in empirical works on informality. This information is available for all sectors. Self-employment represented 38.6% of total jobs in 2013, about 7 p.p. lower if compared to 1999. The agricultural sector hosts a majority of self-employed persons. Shares of self-employment on the total number of jobs are in line with those reported for the informal sector, confirming the complementarity of the two definitions.

[13] These feature are asked directly to the person being interviewed in separate questions. A worker is defined informal if her response to both questions is negative, and formal otherwise.

1.2 Firms

To dig into more specific mechanisms, in some extensions of the paper we will combine road data with three different datasets on Ethiopian firms.

The first is the annual census of large and medium manufacturing establishments, published by the CSA. Data cover all firms with at least 10 persons engaged and that use electricity in their production process.[14] All firms need to comply with CSA requirements, and the census is therefore reporting information on the universe of more structured and formal firms in the country. The dataset includes detailed information on the characteristics of each establishment that are needed to estimate production functions, as well as detailed information on the size and composition (including by skills and gender) of the workers. Firms belong to the manufacturing sector, and their industry is defined at the 4-digit level according to the ISIC Rev. 3 classification.

The second is the small scale manufacturing industries survey (SSIS). This is a representative survey that covers the small (i.e. those engaging less than 10 persons) and informal firms in the manufacturing sector. Over 95% of the firms surveyed in the different waves of the SSIS do not keep a book of the account (or declare to keep it incomplete). We combine all the existing five waves of the survey (covering the years 2002, 2006, 2008, 2010 and 2014), collapsing the information at the level of the woreda.

As per our data (Table 2), small and informal firms represent the large majority of manufacturing establishments, more than half of total manufacturing employment and about one third of the value added produced in the sector.

Table 2: Share (% of total) of informal manufacturing sector

Year	N firms	Employment	Value added
2006	97.14%	51.42%	38.77%
2008	96.74%	59.64%	31.06%

Source: Authors' elaboration on CSA data. *Notes:* All values represent the share of informal manufacturing firms on the total values. The latter is given by the sum of informal and formal firms' annual totals. Information on the informal firms is calculated using weights. We report the information only for the two years in which both the SSIS and the firm census were run simultaneously. Value added is computed as the total value of production net of production costs.

Unfortunately, there is not an equivalent information for firms in the services sectors. The only information that we could recover on such firms is based on the Ethiopian Distributive Trade Survey (DST), which covers service firms in trade related activities (i.e. retailers and wholesalers). Note that the survey is not representative at the national level, given that it covers only the urban areas of the country[15]. This is a cross-sectional survey, available for the years 2003, 2009 and 2011. Crucially, it includes information on the districts in which these firms are located, as well as other basic information on their activity such as their size, wages, sales and investments.

[14] The number of persons engaged refer to employees as well as working owners. This means that the total number of employees of these firms could also be lower than 10.

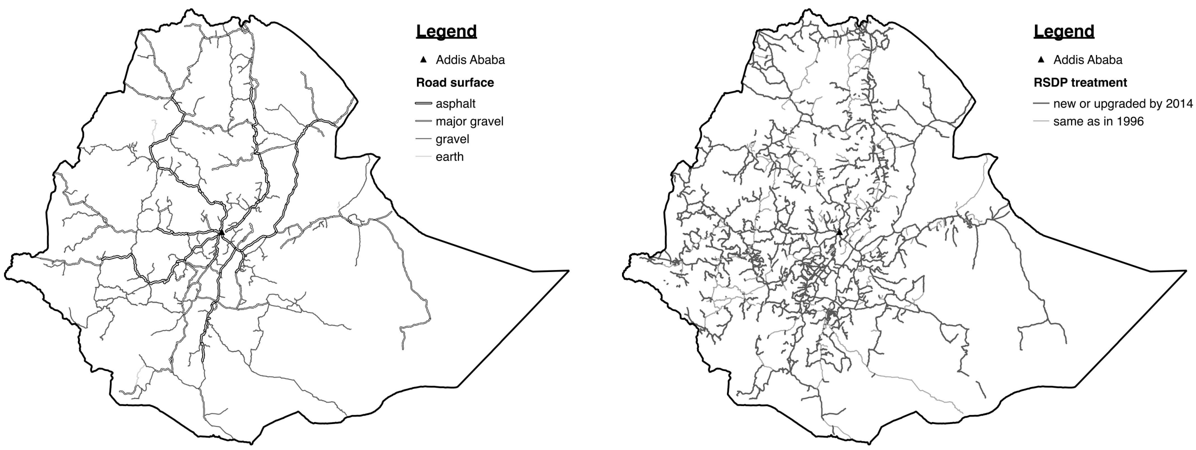
[15] Namely, this corresponds to fifteen major urban centres (regional capitals and other major towns) and 106 other towns

1.3 Roads

The main source of information on Ethiopian road infrastructure is a proprietary geo-spatial database consisting of coded documents by the Ethiopian Road Authority (ERA) reporting on all road construction sites that were opened in the context of the first three phases of the RSDP. The resulting database is a time series of shapefiles of the Ethiopian road network, where for each geo-localized road segment, two main attributes are registered: the type of road surface and the road's condition.[16]

Figure 1a presents the network of federal and regional roads in 1996 by type of surface. Figure 1b shows the network of federal and regional roads in 2014, distinguishing between road segments which existed in 1996 and were not rehabilitated by 2014 (light grey segments on the map) and roads that were either newly constructed or rehabilitated during the first three phases of the RSDP. A visual inspection of the two maps shows a substantial expansion of the road network between 1996 and 2014. Importantly, this expansion does not appear to be geographically concentrated, but spans over different administrative areas across the country. This data on road improvements can be aggregated to compute the average travel speed for each road segment at each point in time. This is done in accordance with the speed matrix proposed by the ERA and reported in Table 3.[17].

Figure 1: Federal roads, regional roads and the RSDP



(a) RSDP roads in 1996 by surface type

(b) New and upgraded RSDP roads from 1996 to 2014

We employ an indicator of market potential á la Harris (1954). This and alternative versions of the market potential indicator have been used in the seminal contribution by Donaldson and Hornbeck (2016) to measure the economic effects of infrastructural developments in the context of a formal structural gravity trade model. In the context of the present paper and similarly to Storeygard (2016), market potential captures the structure of road connections between a geographically defined area and all other markets in the country weighted by the intensity of

[16]There are four types of road surfaces in the data: earth surface, minor gravel (which identifies regional rural roads with a gravel surface), major gravel (federal gravel roads) and asphalt. As for road conditions, the database distinguishes between two categories: not rehabilitated and new or rehabilitated.

[17] The same speed matrix has been used by Shiferaw et al. (2015) and Storeygard and Jedwab (2018).

Table 3: The ERA travel speed matrix

Surface	Condition	
	Not rehabilitated	Rehabilitated or new
Asphalt	50	70
Major gravel	35	50
Minor gravel	25	45
Earth	20	30

Notes: The table reports average travel speed as a function of the surface and condition of the road segment. Speed is measured in kilometers per hour.

their economic activity.

Formally, we define the indicator Roads_{rt} for each district i at time t as follows:

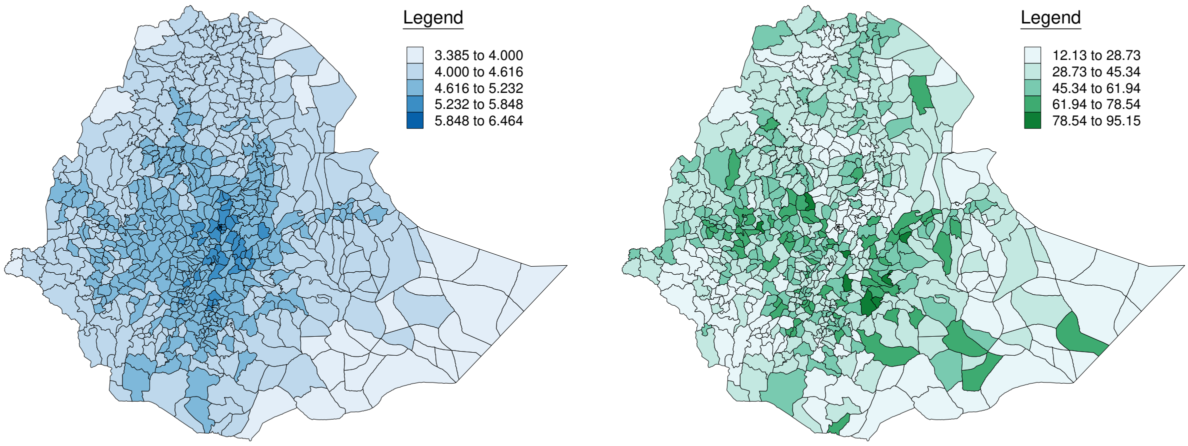
$$\text{Roads}_{it} = \log\Big(\sum_{z \neq i} D_{iz,t}^{-1} L_z\Big)$$

where $D_{iz,t}$ is the minimum distance in hours of travel between district i and district z given the road network in place at t, and L_z is an indicator of the economic activity based on night-light intensity in z provided by NOAA National Geophysical Data Center (2018) over 0.86km^2 grid cells within the district. Note also that we fix the weight at the beginning of the sample period (1996) to exclude potential correlation between changes in destinations' economic activity and our outcomes.[18] Bilateral distances in travel hours are computed applying the Dijkstra algorithm on the whole network of Ethiopian districts connected by federal and regional Ethiopian roads (links). This means that the time variation in Roads_{it} solely reflects the rehabilitation, upgrading and construction of new roads undertaken during the RSDP.

Figure 2a plots the value of the market potential indicator at the beginning of our baseline estimation sample (1996) for all Ethiopian districts. Figure 2b shows the change in market potential between 1996 and 2014 for each woreda, formally $\text{Roads}_{r,2014} - \text{Roads}_{r,1996}$. Focusing on Figure 2a, dark blue woredas near the center of the country close to Addis reveal higher market potential in this area of the country. Light blue districts away from the center indicate lower market potential for these areas. Figure 2b shows a large increase in market potential for less connected districts away from the center, suggesting that they saw improvements in road infrastructure over the time period of our analysis.

[18] While many papers including Donaldson and Hornbeck (2016) use population data in the computation of market potential, we employ night light intensity data as in Storeygard (2016) and Chiovelli et al. (2019). This is particularly appropriate given our interest in supply-side economic activity. Note that other works (e.g. Alder, 2019) use a market potential computed with beginning of sample weights as an IV for the market potential using time varying night light density weights.

Figure 2: Market potential: starting point and change by woreda



(a) $\text{Roads}_{r,1996}$ (b) $\text{Roads}_{r,2014} - \text{Roads}_{r,1996}$

2 Empirical Model

The objective of our empirical analysis is to link improvements in connectivity, which we measure through market potential, to outcomes related to the labour market at the district level in Ethiopia. Our baseline specification is the following:

$$y_{it} = \beta_1 \text{ Roads}_{it} + \beta_2 \text{ X}_{it} + \theta_i + \phi_{rt} + \epsilon_{it} \tag{2.1}$$

where y measures one of the outcomes that we can track for each Ethiopian district i over time t. The term Roads_{it} is market potential, which also vary across district i and over time t. Each specification includes district and region-time fixed effects. District fixed effects θ_i are important to control for all the time invariant characteristics of the district (e.g. geophysical ones, such as soil quality and elevation) that can affect the decision to invest in roads. Region specific time trends ϕ_{rt} account for common shocks (e.g. policies) that can cofound the relations between the outcomes and the treatment. Standard errors are clustered at the level of the district. X_{it} includes some controls that vary over time at the level of the district. One is the nighttime light intensity, which is a commonly adopted proxy for the level of economic activity at the sub-national level.[19] We also account for the intensity of conflicts, measured as the number of conflict occurring in each district on a yearly basis.[20] Last, we include total population, whose information is calculated directly using weights from census and NLF data.

Our estimation sample is based on 1,573 observations covering 506 different woredas. Taken together, these observations account for over 80% of total population and total jobs in the country. Table 4 below reports descriptive statistics of our outcomes of interest and the main

[19] Data is provided by NOAA National Geophysical Data Center (2018) over 0.86km^2 grid cells within the area corresponding to the districts. Following Eberhard-Ruiz and Moradi (2019), we use scores from raw satellite images, instead of processed images with stable nightlights, as more reliable proxies of economic activity in small and medium African towns.

[20] Data is provided by Aiddata geoquery, and originally sourced from ACLED Conflict Events.

controls.

Table 4: Summary statistics

Variable	mean	sd	min	max	obs
Jobs (log)	10.92	.7870	5.567	12.76	1,573
Agr. share	.8052	.2092	0	1	1,573
Manuf. share	.0365	.0561	0	.6123	1,573
Const. share	.0111	.0272	0	.3143	1,573
Services share	.1449	.1654	0	.9855	1,573
Informal manuf.	.0211	.0399	0	.3729	1,573
Informal constr.	.0029	.0112	0	.2514	1,573
Informal services	.0502	.0788	0	.7826	1,573
Roads	4.846	.4027	3.418	6.575	1,573
Local roads	12.03	5.225	0	16.57	1,573
NTL (log)	1.475	.3481	1.098	4.158	1,573
Conflict	.0415	.4565	0	9.832	1,573
Population (log)	11.47	.7335	6.347	13.99	1,573

2.1 Identification

A potential threat to identification in our empirical setting is the endogeneity of our key variable of interest. Note that, by construction, changes in market potential can be due to road investments occurring in other districts. This means that our specification is not only identified by changes occurring in district i. Some robustness checks are nevertheless needed to exclude issues related to omitted variable bias or to reverse causality (i.e. decisions on which investments in roads are to prioritise may be anticipated by the characteristics of the district). It is in fact possible that investments in road improvements were allocated systematically across districts in a way that introduces non random treatment with respect to our outcomes of interest. Indeed, the improvement of the road network across districts may be driven by the spatial distribution of economic activities. For instance, geographic areas with a relatively larger (smaller) agricultural or services sector might be systematically more successful in attracting infrastructural investment. Hence, in a first exercise, we try to exclude the potential concern of an anticipation effect by running the following regressions

$$\Delta \text{ Roads}_i = \beta_1 \ X_i + \phi_i + \epsilon_i \tag{2.2}$$

in which the dependent variable is the change in the coefficient of market potential calculated between 1996 (i.e., 1 year before the beginning of the RSDP) and 2013 and X is a vector of initial characteristics district i. This includes our main outcomes, i.e. initial employment, as well as the shares of agriculture, manufacturing and services on total jobs. Initial characteristics are computed using information included in the 1994 census. Results of this preliminary exercise, reported in Table A.1 in the Appendix, show that there is no evidence of a initial conditions driving subsequent investments in the road sector.

Literature on the effects of transport infrastructures has proposed some solutions to address endogeneity[21] (for a review of the methods adopted see Redding and Turner, 2015). In the rest of the paper, we rely on the identification strategy originally proposed by Donaldson and Hornbeck (2016) and adopted in various guises also by other papers using market potential as their measure of infrastructural improvements (including, for instance, Storeygard and Jedwab, 2018). More precisely, we exploit the fact that variation in each district's market potential is determined by improvements to the whole road network in the country. In this way we can partial out the changes in local roads, which are the key source of the endogeneity concerns. We capture the district level infrastructural developments through a weighted sum of the distance covered by each road segment within the district area, with weights equal to the speed allowed by the type of surface and the roads condition.

3 Results - Roads and Jobs

Our analysis links improvements in the road sector, measured through the market potential approach, with a set of measures accounting for changes in the size and composition of the workforce over time. In the next sub-sections we provide a set of results looking respectively at the effect of market potential on jobs, structural transformation, and informality.

3.1 Jobs

We start by introducing a set of results linking market potential to jobs in Ethiopian districts. The first column of Table 5 report a cross-sectional comparison across districts with different levels of treatment, including region-year fixed effects and the district specific controls. It shows that districts with higher levels of market potential have larger employment rates compared to others. Next, we ask whether this finding survives to our more demanding identification strategy. Table 5 reports the same results after controlling for district specific effects, region time trends and time varying controls at the district level. In the last column we also add a measure of local improvements in connectivity, which is essential to correctly identify the effects of market potential on the outcomes, as discussed in Section 2. So, we account specifically for within district changes over time in market potential which can be attributed to the improvements in the quality of roads. There is a difference in both the size and the precision of the estimated coefficient, which can be attributed to the inclusion of the local improvements in connectivitity. The larger point estimate (as well as the gains in precision) reported in column (3) might therefore reflect the omitted variable bias of the estimates in column (2)[22].

The results are not only statistically, but also economically relevant. An improvement allowing a district to move from the 25^{th} to the 75^{th}-percentile of the distribution of market potential in our estimation sample would imply an increase of about 19.24% in the total number of jobs in that district, which corresponds on average to roughly 8.6 thousand additional jobs.

[21] Yet, most of the solutions based on the use of IV strategies ground on the construciton of time invariant instruments, such as the placement of planned or historic roads, which we cannot replicate in this paper.

[22] Note that another common source of bias is due to measurement error of market potential. Without an instrument, we can do little on that however.

Table 5: Roads and jobs

Jobs:	Cross-Section	Main (no local roads)	Main
	(1)	(2)	(3)
Roads	0.0516**	0.111	0.166**
	(0.0243)	(0.0778)	(0.0829)
Constant	-0.558***	-1.300***	-1.498***
	(0.161)	(0.467)	(0.475)
Observations	1,573	1,573	1,573
R-squared	0.936	0.961	0.962
Controls	YES	YES	YES
District FE	NO	YES	YES
Region Year FE	YES	YES	YES

Notes: The dependent variable in all regressions measures the log number of jobs in each district. The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population. In column 3 we add a measure of local roads improvements, as described in Section 2.1 Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.2 Sectoral Composition of Jobs

In this section, we present results linking market potential to the composition of the workforce across broadly defined sectors. Table 6 reports the results. We find that there seem to be a role for improvements in market potential on the typical outcomes of a process of structural transformation. There is evidence of a reduction in the share of agricultural workers that is due to improvements in connectivity. This seems to happen mostly in favour of the services sector, rather than the manufacturing. A pattern like this is not uncommon in low income countries. It rather echoes existing evidence on the direction of structural change, including on Ethiopia, that see a reallocation of workers out of agriculture in favour of services. We add that changes in market potential due to road investments do play a role in driving workers out of agriculture, and in attracting them in the services. Also in this case, the relation is economically relevant. Taking again an improvement from the 25^{th} to the 75^{th} percentile of market potential, this would imply (a) a reduction of about 14 percentage points (p.p.) down from their sample average (80.52%) in the share of agricultural workers; and (b) an increase of about 2 p.p. from their sample average (14.5%) in the share of workers employed in the services.

Note that, as such, we cannot derive any clear implications in terms of growth potential of the interested districts. Due to the heterogeneous nature of services, we do not know whether this improvement is driven by the rise of high- or low-productive activities. While one should expect that workers move from low to high productivity industries, this is not to be given for granted, especially in the African context. For instance, Barrett et al. (2017) argue that typically episodes of structural transformation in the continent have brought workers into low-productive services in urban areas. This is, in turn, consistent with the evidence on the emergence of consumption cities (Gollin et al., 2016) and premature de-industrialisation (Rodrik, 2016).

Hence, a related question that we ask to the data is which specific activities are mostly affected by roads, with respect to those included within the services[23]. Table A.2 in the Appendix provides

[23] We have run this analysis only within services, as there is more cross industry variation compared to the manufacturing sector. The latter represents about 4% of employed persons, and none of the industries within

Table 6: Roads and the composition of jobs

Employment:	Agriculture	Manufacturing	Construction	Services
	(1)	(2)	(3)	(4)
Roads	-0.149**	0.0134	0.00884	0.118*
	(0.0715)	(0.0203)	(0.0102)	(0.0604)
Constant	0.768*	-0.0694	-0.126**	0.453
	(0.414)	(0.153)	(0.0533)	(0.351)
Observations	1,573	1,573	1,573	1,573
R-squared	0.675	0.512	0.558	0.651
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the share of agricultural workers on total (Agriculture); the share of manufacturing workers on total (Manufacturing); the share of construction workers on total (Construction); the share of services workers on total (Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1 Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

a summary of our results by collating information from several regressions run at the (2-digit) industry level. Within services, improvements in market potential mainly bring higher shares of workers in low productive activities, including the provision of personal services and retail trade. We also find significant increases in the financial services.

3.3 Informality

In this Section we look at another important dimension related to the sectoral composition of jobs in Ethiopia by exploring the link between market potential and informality. Remember that information on informality is only available from the NLF surveys, so the time coverage of this specific part of the analysis is limited to the 1999-2013 period. Also, data based on the informal nature of the organizations in which workers are based is most reliable for the modern sectors. So, in what follows we report our estimates covering manufacturing and services sectors' share of informality on the total number of jobs. Results are reported in Table 7, and show some evidence of an increase in the share of informal jobs on the total as far as the manufacturing sector is concerned.

Due to the difficulties to properly define the informal sectors across the board, and also to provide a definition that is consistent across different contexts, as in McMillan and McCaig (2019) we also focus on self-employment as a proxy for informality. This time the data cover all sectos, and allow as well to give a broad indicator of the share of informal (self-employed) workers over the total. Results, presented in Table A.3 in the Appendix, are fully consistent with the previous ones as far as the manufacturing and service sectors are concerned. Moreover, they show that there is no effect of roads on the overall share of informal workers over the period considered.

that go over 1%. On this respect, it has to be noted that our analysis covers a period during which industrial parks (such as the one of Hawasa) had not yet started their activities.

Table 7: Roads and informality

Informal Jobs:	Manufacturing	Construction	Services
	(1)	(2)	(3)
Roads	0.0352*	0.00289	-0.0418
	(0.0196)	(0.00537)	(0.0448)
Constant	-0.325***	-0.0686*	0.693***
	(0.113)	(0.0351)	(0.255)
Observations	1,086	1,086	1,086
R-squared	0.497	0.490	0.622
Controls	YES	YES	YES
District FE	YES	YES	YES
Region Year FE	YES	YES	YES

Notes: The dependent variables measure, respectively, the share of informal workers in manufacturing on total jobs (Manufacturing); the share of informal workers in construction on total jobs (Construction); the share of informal workers in services on total jobs(Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1 Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4 Extensions and Robustness

In this Section, we provide some additional analysis that serves us to the double purpose of adding additional dimensions of heterogeneity to our main set of results and to test their robustness. Thus, in the first part of this section we extend our results in two main directions. First, we disaggregate information on workers across their gender to check for heterogeneous responses to improvements in market potential. Second, we use educational attainments as an additional outcome, to check whether incentives to invest in education are affected by roads. The rest of the section presents a number of different set of robustness checks, based on different definitions of the variables of interest and to some cuts to the data.

4.1 Gender

In this Section, we check for potential heterogeneous responses to improvements in connectivity by disaggregating our main results according to the gender of respondents. Results, reported in Table A.4 in the Appendix show that the patterns described in the previous Section get mostly confirmed even after disaggregating our outcomes among men and women. The effect of an improvement of market potential is particularly pronounced for women as compared to men in the case of the total number of jobs (column 1). A major result of this exercise is, however, the one showing that increases in services jobs due to improvements in connectivity are different from zero only for the group of women. This is an important finding, which is also consistent with the evidence reported in Table A.2, in which we showed that household services, generally performed by women, are among those that drive the overall increase in the share of service related jobs. Evidence from developing countries shows that women face larger frictions in the labour market compared to men, and are disproportionally affected by infrastructural bottlenecks. Improving connectivity can reduce some of these constraints, allowing to save time to spend in unpaid activities, reduce discriminations, and by looking for opportunities beyond their local communities (Lei et al., 2019).

4.2 Education

Table A.6 reports results linking improvements in market potential to a number of indicators catching education related outcomes. Educational indicators cover information on the highest grade completed[24]. Note that despite data on educational attainments were originally collected for each person aged 5 years and above, we follow the same approach adopted by the CSA in their NLF reports (CSA, 2014) and calculate the information for all the individuals older than 10. Over time the number of individuals with some levels of education has been growing consistently. Still, only a very small fraction of individuals report levels of education higher than the primary school (grades 1 to 8). Overall, improvements in connectivity have an effect on both educational enrollment and attainments. And this is true especially as far as higher levels of schooling are concerned. Individuals living in districts that improve their connectivity over time are likely to invest more in education, possibly in anticipation of more remunerative positions. These findings suggest evidence of higher returns on education in better connected places, and are consistent with a recent work by Adukia et al. (forthcoming), linking investments in roads to educational outcomes in rural India.

4.3 Robustness checks

In this Section we introduce a number of additional tests we made in order to check for the robustness of our main findings.

First, we use different definitions of the proxy for local roads that we have introduced to strengthen our identification strategy, as discussed in Section 2.1. Including local roads allows us to isolate changes in market potential that are orthogonal to changes in each district's own roads. Our main definition of local roads, the total (weighted) length of all roads within the borders of the district may not necessarily identify investments that are developed far away. To account for this we augment our baseline specification to account as well for improvements in road lengths for buffers of 10 to 50 km (either one after each other and all together) from the border of each district. The estimated coefficient of market access does not get affected, and it remains economic and statistically significant (Table A.8).

Second, results may be affected by the way in which we construct the market potential variable measuring roads. We use an alternative measure of market access that draws upon the model-based formula derived in Donaldson and Hornbeck (2016) and applied to the East African context by Eberhard-Ruiz and Moradi (2019) (henceforth ERM). Using the night-light intensity variable L and bilateral travel times D, the model-based formula of market access for district i can be written as $\sum_{z \neq i} L_z / \exp\{\sigma D_{iz,t}\}$, where σ is a distance decay parameter and captures the non-linear impact of distance on trade. We follow the parametrization in ERM where σ is the product of trade elasticity - fixed at 8.4 - and the average per unit cost of transporting a good for one hour

[24] Data on the educational indicators are reported in Table A.5 in the Appendix.

over the road network relative to the good's overall value. The value of this latter parameter has been estimated by ERM at 0.005 using monthly petrol prices for seven Ugandan cities. We plug the resulting value (0.042) of the distance decay parameter σ in the market access formula, take the log. Results, reported in Table A.9 in the Appendix, show that coefficients remain consistent, though there is no significant effect of the model base proxy for market access on jobs (column 1).

Third, we drop potential growth hubs from the sample. This approach follows Faber (2014) and Storeygard and Jedwab (2018) and is motivated by the fact that growth in hubs might have driven the placement of road construction. We first drop the woreda included into the Addis special administrative division (six in total). Next, we also exclude the districts where regional capitals are located[25]. Finally, we run our analysis excluding all the districts belonging to the Tigray region, which host the majority of the Tigrayan ethnic group that has been in political power until 2018. This test is motivated by political economy type of argument according to which co-ethnicity can drive public investments choices (Burgess et al., 2015). Results, summarized in Table A.10 in the Appendix, show that our main findings hold to all the different cuts to the data, with the coefficients of interest generally getting smaller in terms of magnitudes, but still statistically significant.

Fourth, we check whether the possible presence of spatial correlation in the residuals can affect the results. To do this, we run our model again by introducing a spatial HAC correction of standard errors based on Conley method using the code by Hsiang et al. (2011). We impose no constraints on the temporal decay to the weights and test the robustness of our specification to different lengths of the radius (respectively, from 100 to 500km) for the spatial kernel. Standard errors gets generally smaller approaching higher distances (especially in the specifications on the services), and there are no changes to the substance of our results.[26]

5 Mechanisms

Our main results point to a nexus between improved market potential with an increase in the number of jobs, a process of structural transformation towards services (especially for women) and a relative surge of informality in the manufacturing. In this Section we try to reconcile all these pieces of evidence by dealing with some of the potential mechanisms underling these relations. There are several ways through which improvements in market potential can support changes in the size and composition of the labour force. Directly, by lowering transport costs and therefore reducing some of the typical frictions that characterise the labour market in developing countries. And indirectly, by levelling the playing field increasing economic opportunities, as well as competition, in the treated locations.

[25]The capital of the Oromia region has been moved to Addis in 2005. Still, for the purpose of this exercise we used the old capital, Adema. As in the case of Addis, we also included all the districts (2 in total) belonging to the special administrative zone of Dire Dawa

[26]Results of these specifications are not included for reasons of space, but are available upon request to the authors.

5.1 Internal migration

First, we ask whether improvements in connectivity, driving down transportation costs, have also a direct effect on the cost of moving people. While this is intuitive, there is very little evidence supporting this relation empirically. An exception is the recent work by Morten and Oliveira (2017), who show how improvements in roads in Brazil had large effects on abating migration costs. We check whether improvements in roads are conducive to more migration in treated districts. Information available in both census and NLF data allow to track for changes in the place of residence of people before the interview. An individual is classified as a migrant in the year of the survey if her birthplace is different from the place where she currently lives.[27] Note that for this exercise we can only track migrants at the destination and not at the origin, as information on the former is only available at a highly disaggregated geographic area (the zone). We focus on migration towards urban areas only. Results are reported in Table A.7 of Appendix. Overall, they confirm that locations with higher levels of infrastructures are likely to host a larger number of migrants. Results are statistically significant only in a specification focussing on across districts comparison, which is consistent with the data showing that a large share of migrants is directed towards a few areas (especially to Addis and, to a lesser extent, towards the regional capitals).

5.2 Economic opportunities

In this sub-section we provide some evidence supporting a demand mechanism. To do this we match our road data with firm level data covering the manufacturing sector and the trade services. The census of manufacturing firms collects information on several indicators, including the location of firms[28]. Our data cover the 1998-2009 period, thus ending a few years earlier than our main analysis, but it has the advantage of providing a firm specific panel setting. We use these data to explore if improvements market potential in the location in which a firm is based have an impact on the dynamism of private sector and on several dimensions of firms' performance. In all regressions we control for firm and region-time fixed effects. Results are presented in Table A.11 in the Appendix. First, after collapsing the data at the location-year level, we show whether there is any significant effect on firms dynamics. We find that improving infrastructure has no effect on firms' entry, but is particularly relevant to attract foreign firms. The latter is an important finding since it is demonstrated that foreign investors normally generate more qualified jobs, pay higher salaries and create more linkages with local firms (including in the services sector).[29] Moving to the firm specific changes, we show that firms in locations that have improved their market potential have experienced gains in several dimensions, including some suggesting upgrading (e.g. by increasing their productivity). We also find evidence of

[27] The NLF considers (return) migrants also individuals who were born in the survey town and has returned to that town after having resided in another place.

[28] Note that information on the location of manufacturing firms is slightly more precise that the one we use in the paper, so we have computed our market potential at the level of the (urban) town, rather than at the district level.

[29] Looking at the local impact of FDI in Ethiopia, a recent work by Abebe et al. (2019) provides sound evidence that the entry o FDI generate high spillovers on domestic firms and workers

a compositional shift towards non-production workers, whose real per capita wages are also positively affected by an increase in market potential.

Next, we try to replicate the previous set of results using data on the informal manufacturing firms. This is an important part of the story, since as far as the manufacturing is concerned, these firms represent the large majority, as well as a (slight) majority of the sector's employment (see Table 2). The possibility of replicating exactly the same analysis is constrained by the lack of a panel dimension of the SSIS data. Thus, we run our analysis using district and region-year fixed effects to get a sense of how aggregate and average firm indicators have changed over time within the same district under differential changes in market potential. Results, reported in Table A.12 in the Appendix, resemble those of the formal firms. Thus, they seem to confirm that improvements in market potential affect informal firms productivity, a shift towards non-production workers and an increase of their wages.

Last, we try to replicate some of the previous analysis on the basis of information available from the survey of trade services firms. Note that the information provided by this survey is much more limited compared to those on manufacturing firms. In addition to cover only a part of the services firms, the survey is not representative of rural areas, and provides only limited information on firms' accounts. This being said, we show that firms in districts experiencing improvements in market potential do experience increases in their average size, have no effects on wages, and see a reduction in their levels of labour productivity. In spite of data limitations, this is still helpful to interpret some of our key findings as they seem to point out an increase in employment in low value added service activities (consistent with findings reported in Table A.13) and a reduction in average productivity that could be due to increased competition in the sector that can be attributed to higher market potential.

6 Conclusions

In this paper we have analysed the consequences of an improvement of market potential on the size and composition of jobs in Ethiopian districts. We have taken advantage of novel geocoded information covering the universe of Ethiopian roads, which we combined with individual information from population census and nationally representative labour force surveys. Our results provide a mixed picture. We show that districts that have experienced increases in market potential due to road improvements have generally recorded an increase in the number of jobs, as well as a process of structural transformation characterized by a reduction of the share of agricultural workers in favour of services. We do not find evidence of improvements in market potential leading to more jobs in the manufacturing sector. Rather, we show that within manufacturing roads lead to a (slight) compositional shift towards the informal sector. We show also that such changes are most likely to benefit women rather than men, and that roads lead to a potential upgrading of the labour force through higher investments in education. We motivate our results by showing that higher economic activity induced by road investments stimulates both the demand from firms, through increases in productivity, and supply from workers, who are more likely to migrate towards areas with higher market potential in the country.

All in all, our results show that investments in roads under the RSDP can support the process of jobs creation and structural transformation since they can contribute to reduce some of the typical frictions affecting the labour market in Ethiopia, while spurring demand. Yet, the lack of incidence of roads on the manufacturing is disappointing, especially in view of the country's high political focus on industrialization. Having said that, it is important to highlight that our analysis does not cover the most recent years, when most of the industrial parks (e.g. the one established in Hawassa) have started their activities at scale and for which it is well know infrastructural investments are key. Further research is therefore needed to investigate this further, and to gain a better understand on the dynamics through which the nexus between market potential and industrialization in low-income countries happens.

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Appendix

Table A.1: Endogeneity of Roads

Dep. Var.: Delta Roads	Total	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
	-0.0124	0.0617	-0.191	-0.0748
	(0.0147)	(0.0600)	(0.221)	(0.0776)
Constant	0.491***	0.301***	0.361***	0.363***
	(0.159)	(0.0554)	(0.00756)	(0.00870)
Observations	363	363	363	363
R-squared	0.176	0.176	0.175	0.176
Region FE	YES	YES	YES	YES

Notes: The dependent variable measures changes in market potential between 2013 and 1996. The independent variables are baseline levels of the (log of) jobs (Total); the share of agriculture on total jobs (Agriculture);the share of manufacturing on total jobs (Manufacturing); the share of services on total jobs (Services) Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Sectoral results

Sectors	Coefficient	Standard error
utilities	0.00801	(0.00855)
wholesale	-0.0384***	(0.0142)
retail	0.0434**	(0.0184)
hotels & restaurants	-0.00282	(0.0155)
transport	0.00208	(0.00321)
financial	0.00342*	(0.00190)
estate	-4.80e-05	(0.000722)
public admin	0.00600	(0.00550)
education	0.000447	(0.00588)
health	-0.00556	(0.00676)
other services	0.0673**	(0.0287)
private hh services	0.0382**	(0.0191)
n.c. services	0.000426	(0.000309)

Notes: The coefficients and standard errors reported are derived from individual regressions using the share of individuals employed in each sub-sector on total jobs. Industries are classified according to the ISIC classification. Some harmonization using concordance tables has been made necessary given that different waves of data reported sectors classified according to different revisions of the ISIC codes (3, 3.1 and 4). The number of observations is 1573 for all the specifications. All regressions include a full set of controls, district fixed effects and region-year fixed effects. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Roads and self-employment

Informal Jobs:	Total	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
Roads	-0.0667	-0.0814	0.0311*	-0.0213
	(0.0694)	(0.0669)	(0.0162)	(0.0494)
Constant	0.789**	0.549	-0.220**	0.600**
	(0.387)	(0.382)	(0.0854)	(0.272)
Observations	1,086	1,086	1,086	1,086
R-squared	0.556	0.600	0.497	0.574
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the share of self-employed workers on total jobs (Total); the share of informal workers in agriculture on total jobs (Agriculture);the share of self-employed workers in the manufacturing on total jobs (Manufacturing); the share of self-employed workers in services on total jobs(Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1 Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Employment and gender

Employment:	Total	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
Panel A: females				
Roads	0.256*	-0.0743	0.00389	0.0869*
	(0.144)	(0.0456)	(0.0149)	(0.0414)
Constant	-2.768***	0.355	-0.0632	0.175
	(0.842)	(0.260)	(0.0900)	(0.231)
Observations	1,573	1,573	1,573	1,573
R-squared	0.898	0.598	0.449	0.612
Panel B: males				
Roads	0.124	-0.0744	0.00953	0.0316
	(0.0759)	(0.0485)	(0.0120)	(0.0260)
Constant	-2.110***	0.413	-0.00620	0.278*
	(0.423)	(0.276)	(0.106)	(0.156)
Observations	1,573	1,573	1,573	1,573
R-squared	0.972	0.649	0.577	0.653
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the log number of employed persons (Total); the share of agricultural workers on total (Agriculture); the share of manufacturing workers on total (Manufacturing); the share of services workers on total (Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Educational attainments

Year	Grade 1-8	Grade 9-12	Diploma	Degree
1994	15.95%	3.91%	0.17%	0.10%
1999	22.83%	3.91%	0.31%	0.11%
2005	31.86%	4.40%	0.50%	0.15%
2013	46.74%	7.19%	1.89%	1.04%

Source: Authors' elaboration on CSA data. *Notes:* All values represent the share of individuals with different levels of education on the total number of individuals aged 10 and above. This is to keep consistency with the NLF reports. All data have been weighted before collapsing information at the woreda-year level.

Table A.6: Roads and education

VARIABLES	Grade 1-8	Grade 9-12	Diploma	Degree
	(1)	(2)	(3)	(4)
Roads	0.00392	0.00934	0.0127**	0.00985**
	(0.00978)	(0.00569)	(0.00596)	(0.00413)
Constant	-0.0105	0.0214	-0.0525	-0.0511*
	(0.0510)	(0.0366)	(0.0377)	(0.0277)
Observations	1,573	1,573	1,573	1,573
R-squared	0.662	0.800	0.618	0.643
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the share of individuals with completed grades 1-8 (Grade 1-8), 9-12 (Grade 9-12), diploma (Diploma) and degree (Degree) on the total number of individuals aged 10 and above. The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Internal migration

VARIABLES	Urban migration	Urban migration
	(1)	(2)
Roads	0.0110**	0.0177
	(0.00436)	(0.0159)
Constant	-0.0282	-0.0488
	(0.0491)	(0.0761)
Observations	1,573	1,573
R-squared	0.285	0.609
Controls	YES	YES
District FE	NO	YES
Region Year FE	YES	YES

Notes: The dependent variable measure, the share of migrants on the total population in the urban areas of the district. The main control (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8: Robustness: Additional local roads

Employment:	Jobs	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
Roads	0.148*	-0.156**	0.0115	0.131**
	(0.0849)	(0.0739)	(0.0215)	(0.0622)
Constant	-1.404***	0.797*	-0.0576	0.395
	(0.478)	(0.425)	(0.158)	(0.358)
Observations	1,573	1,573	1,573	1,573
R-squared	0.962	0.675	0.512	0.652
Controls	YES	YES	YES	YES
Local roads outside border	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the log number of jobs (Jobs); the share of agricultural workers on total (Agriculture); the share of manufacturing workers on total (Manufacturing); the share of services workers on total (Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. All equations include measures proxying local roads improvements happening outside the border of the district (at 10, 20, 30, 40 and 50 km). Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: Robustness: Market Access

Employment:	Jobs	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
Market Access	0.0528	-0.231***	-0.00617	0.220***
	(0.105)	(0.0883)	(0.0217)	(0.0754)
Constant	-1.052	1.621***	0.0380	-0.472
	(0.769)	(0.620)	(0.183)	(0.537)
Observations	1,573	1,573	1,573	1,573
R-squared	0.961	0.675	0.511	0.652
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the log number of jobs (Jobs); the share of agricultural workers on total (Agriculture); the share of manufacturing workers on total (Manufacturing); the share of services workers on total (Services). The regressor of interest (Market Access) measures the log of market access computed according to the approach of Eberhard-Ruiz and Moradi (2019). Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Robustness: Cuts to the data

Employment:	Jobs	Agriculture	Manufacturing	Services
	(1)	(2)	(3)	(4)
Panel A: Excluding Addis				
Roads	0.165**	-0.149**	0.0136	0.118*
	(0.0828)	(0.0714)	(0.0203)	(0.0602)
Constant	-1.469***	0.809*	-0.0315	0.381
	(0.488)	(0.418)	(0.151)	(0.350)
Observations	1,547	1,547	1,547	1,547
R-squared	0.961	0.576	0.456	0.575
Panel B: Excluding Regional Capitals				
Roads	0.159*	-0.141**	0.0122	0.112*
	(0.0832)	(0.0712)	(0.0202)	(0.0599)
Constant	-1.239**	0.882**	-0.0834	0.358
	(0.505)	(0.437)	(0.149)	(0.368)
Observations	1,518	1,518	1,518	1,518
R-squared	0.961	0.550	0.455	0.555
Panel C: Excluding Tigray				
Roads	0.150*	-0.148**	0.0149	0.120*
	(0.0839)	(0.0728)	(0.0210)	(0.0614)
Constant	-1.383***	0.773*	-0.0742	0.431
	(0.488)	(0.427)	(0.161)	(0.360)
Observations	1,445	1,445	1,445	1,445
R-squared	0.963	0.687	0.517	0.665
Controls	YES	YES	YES	YES
District FE	YES	YES	YES	YES
Region Year FE	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the log number of employed persons (Total); the share of agricultural workers on total (Agriculture); the share of manufacturing workers on total (Manufacturing); the share of services workers on total (Services). The regressor of interest (Roads) measures the log of market potential. Controls include the log of nighttime light density, the log number of conflicts, the log of total population and a measure of local roads improvements, as described in Section 2.1. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.11: Manufacturing firms

VARIABLES	Entry	Foreign_entry	Productivity	Empl	Non production emp	Wage	Wage non-prod	Wage prod.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Roads	0.00775	0.00266*	0.160***	0.0166	0.0565*	0.00948	0.0806*	0.00832
	(0.0155)	(0.00155)	(0.0577)	(0.0318)	(0.0333)	(0.0329)	(0.0453)	(0.0299)
Constant	-0.321	0.0914	10.28***	4.064***	-1.954***	7.806***	7.749***	7.460***
	(0.559)	(0.0595)	(1.041)	(0.510)	(0.537)	(0.497)	(0.729)	(0.491)
Observations	604	604	8,478	10,130	8,758	10,120	9,198	9,566
R-squared	0.537	0.406	0.697	0.906	0.632	0.790	0.737	0.686
Firm FE	NO	NO	YES	YES	YES	YES	YES	YES
TOWN FE	YES	YES	NO	NO	NO	NO	NO	NO
Region_Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, the entry rate, measured as the share of new firms at t on the total number of firms at $t-1$ in each town (Entry); the entry rate of foreign owned firms (Foreign_entry); firms' labour productivity, measured as value added on employment (Productivity); firms' (log of) total employment (Empl); Firms' share of non-production workers (Non-prod workers); the (log of) per capita wages for all employees (Wage), and for production (Wage prod.) and non-production workers (Wage non-prod.). The main control (Roads) measures the log of market potential. Standard errors are clustered at the town level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.12: Informal manufacturing firms

VARIABLES	Empl	Productivity	Non production empl	Wage	Wage prod	Wage non-prod
	(1)	(2)	(3)	(4)	(5)	(6)
Roads	-0.341	0.471**	0.0222	-0.0242	0.0858	5.777*
	(0.213)	(0.205)	(0.0347)	(1.390)	(0.414)	(3.160)
Constant	0.210	-0.0601	-0.184	1.717	6.146***	-19.73
	(1.065)	(1.029)	(0.172)	(7.092)	(2.079)	(14.09)
Observations	10,604	10,069	10,604	7,417	5,600	970
R-squared	0.345	0.707	0.143	0.292	0.333	0.334
District FE	YES	YES	YES	YES	YES	YES
Region_Year FE	YES	YES	YES	YES	YES	YES

Notes: The dependent variables measure, respectively, firms' (log of) total employment (Empl); firms' labour productivity, measured as value added on employment (Productivity); Firms' share of non-production workers (Non-prod workers); the (log of) per capita wages for all employees (Wage), and for production (Wage prod.) and non-production workers (Wage non-prod.). The main control (Roads) measures the log of market potential. All the regressions include firm specific controls (the age, total size and the status of importer and exporter) as well as a measure of local roads' improvements. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.13: Trade Services

VARIABLES	Employment	Wages	Productivity
	(1)	(2)	(3)
Roads	2.021**	-1.640	-11.81***
	(0.798)	(9.705)	(3.545)
Constant	-9.081**	81.08*	70.04***
	(4.097)	(45.78)	(17.94)
Observations	10,582	3,609	10,490
R-squared	0.134	0.311	0.360
District FE	YES	YES	YES
Region_Year FE	YES	YES	YES

Notes: The dependent variables measure, respectively, the (log) number of employees (Employment); the (log of) wage per capita (Wage); the (log of) sales of employees (Productivity), all computed at the firm level. All variables have been deflated using the GDP deflator from the IMF. The main control (Roads) measures the log of market potential. All the regressions include as well a measure of local roads' improvements. Standard errors are clustered at the district level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.