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【要旨】

This paper examines the impact of a rural road improvement project on schooling decisions and youth employment in Morocco. Paved rural roads are expected to reduce travel time and costs, allowing additional school choices and increasing the motivation for youth to enter higher education in response to higher returns. On the other hand, immediate earnings opportunities created by new connections may encourage youth to seek paid employment. Thus, the impact of rural road improvement on schooling and youth employment warrants empirical investigation. We employ a difference-in-differences estimation using a household-level dataset with a five-year interval collected under a quasi-experimental setting. First, we do not observe any positive effect on primary school completion for either sex, but we find a positive and significant effect on secondary school attainment or above only for females. Moreover, the higher educational attainment of females is associated with a lower proportion of early marriage. Second, we do not observe any significant effects on self-employment for either sex, but we find a positive and significant effect on wage employment only for males, which is pronounced among the better educated. Our findings reveal sharp gendered differences in the impact of the rural road improvement project, with increased motivation toward better education for females and paid work for males.

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The Gendered Impact of Rural Road Improvement on Schooling Decisions and Youth Employment in Morocco

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Abstract

This paper examines the impact of a rural road improvement project on schooling decisions and youth employment in Morocco. Paved rural roads are expected to reduce travel time and costs, allowing additional school choices and increasing the motivation for youth to enter higher education in response to higher returns. On the other hand, immediate earnings opportunities created by new connections may encourage youth to seek paid employment. Thus, the impact of rural road improvement on schooling and youth employment warrants empirical investigation. We employ a difference-in-differences estimation using a household-level dataset with a five-year interval collected under a quasi-experimental setting. First, we do not observe any positive effect on primary school completion for either sex, but we find a positive and significant effect on secondary school attainment or above only for females. Moreover, the higher educational attainment of females is associated with a lower proportion of early marriage. Second, we do not observe any significant effects on self-employment for either sex, but we find a positive and significant effect on wage employment only for males, which is pronounced among the better educated. Our findings reveal sharp gendered differences in the impact of the rural road improvement project, with increased motivation toward better education for females and paid work for males.

Keywords: rural road improvement, schooling outcomes, youth employment, market integration, Morocco, gender.

JEL Classification Codes: I25, O18, J24.

1. Introduction

Access to transportation infrastructure is essential for daily life in both developed and developing countries, serving as a driving force for economic development. However, for many people, access to transportation infrastructure remains very disappointing, particularly in developing countries. Rural Access Index (RAI) rankings indicate that transport access continues to pose serious policy challenges for poorer countries.[1] Access to transportation infrastructure in rural areas is particularly impaired in the African continent, where the majority of smallholder farmers suffer from limited connections with outside markets, and many poorer people endure limited access to social services.

This study examines the impact of a rural road improvement project on schooling outcomes and youth employment in Morocco. Despite substantive efforts being made over the past several decades, there have been calls for the upgrading of rural roads in Morocco. Limited access to road infrastructure impedes economic opportunities and social services provision in rural areas. Moreover, the country suffers from lower educational enrollment, particularly in post-primary education for girls in rural areas. This can be partly attributed to poor road infrastructure (JICA, 2011). Under these circumstances, rural road improvement is expected to favorably affect both schooling and work decisions among youth.

However, the impact of rural roads improvement on schooling outcomes and youth employment is *a priori* indeterminate and calls for empirical investigation (Adukia et al., 2020). The improvement of road transportation is expected to reduce travel time and costs as well as expand the availability of transport options. As a result,

[1] https://rai.azavea.com/

access to improved roads may increase students' school choices, which is critical for decisions to advance beyond primary school education. Moreover, people living in rural areas may gain access to outside markets and enjoy new employment opportunities. New connections to markets may encourage educational attainment if they increase financial returns from education. If this is the case, households will be motivated to invest more in human capital to seek higher educational attainment.

On the other hand, integration with outside markets through new connections may activate local economic development and create new jobs in rural areas. Renewed rural roads may create new wage employment opportunities by transforming agricultural production and creating small businesses. Further, renewed rural roads may create new employment opportunities through access to outside markets. Hence, the transformation of regional economic activities may lead to new immediate employment opportunities in rural areas. As opportunity costs for schooling are higher than before, youth may choose to take an earlier exit from school to obtain a paid job. If this is the case, road improvements may crowd out educational investment in rural areas.

In comparison to the large volume of literature on new connections to international markets, the impacts of domestic market integration have been studied less.[2] Among the limited available literature, some studies have found that better accessibility has a positive effect on education outcomes in terms of increasing school attendance, greater school choices and school completion rates in Morocco (Levy et al., 1996), Vietnam (Mu & van de Walle, 2007), Nigeria (Porter (1997)) and India (Mukherjee, 2012). Moreover, Khandker et al. (2009) and Khandker and Koolwal

[2] For example, schooling increase and child labor reduction were mitigated in areas with employment concentrated in industries losing tariff protection in India (Edmonds et al., 2010). Districts with lower costs of learning English benefited more from globalization in India (Shastry, 2012).

(2011) showed that small-scale road construction is associated with a higher school enrollment in Bangladesh. On the other hand, other studies found no significant effect in Ghana (Hine et al., 1983)) and in Vietnam (Cuong, 2011).[3]

Recently, Aggarwal (2018) used district-level data in India to show that rural roads enhance school enrollment for younger children, while teenagers are motivated to drop out of school and join the labor force as urban markets become accessible. Adukia et al. (2020) found children are more likely to stay in school longer and perform better on standardized exams in India. They argue that a standard human capital investment model supports their finding: school enrolment increases most when nearby labor markets offer high returns to education.

A central concern for empirical analysis is the crowding out of higher education: the trade-off for individuals between long-run investment in human capital and immediate economic opportunities. In order to interrogate this concern, this study utilizes a unique data set collected under a quasi-experimental setting during the 2010s in Morocco. The data consists of a panel sample of households that gained access to all-weather roads through a road improvement project and households that remained inaccessible to paved roads. We employ a difference-in-differences estimation to explore the impact of rural road improvement on schooling outcomes and youth employment during the period.

We attempt to contribute to the literature in three ways. First, we provide evidence on the impact of rural road improvement in a country where gender disparities in educational and economic opportunities are large. In Morocco, females face greater restrictions on opportunities to attain higher education or employment than males. Thus,

[3] See Hine et al. (2016) for a systematic survey on the impact of rural road extension.

we focus on the difference in the impact of rural road improvement between young females and males, which may shed light on the gendered impacts of infrastructure on beneficiaries. Second, we examine the impact of community road improvement in rural areas, an area that has been largely neglected in the literature, in contrast to many studies on the impact of highways and their feeder roads. This study focuses on residential roads dispersed over rural areas, including the coastal and mountainous areas that are relevant to decisions on schooling and employment for youth. Third, we utilize rich household-level data to provide new evidence on the impact of rural road improvement, allowing us to identify the impact after controlling for heterogeneity of households. Our dataset contains rich information on the characteristics of individuals, households, and villages, and the negligible attrition rate enhances the precision of our estimates.

Our empirical results show that road improvement has a positive and significant impact on youth, which differs between males and females. For young females, access to paved roads encouraged them to advance to secondary school or above. Higher educational attainment is also associated with a decline in early marriage, suggesting that improved road access has eased commuting to secondary schools or above and led young females to postpone marriage. In contrast, for young males, rural road improvement did not motivate them to pursue better education. Instead, young males exploited new employment opportunities to enjoy a significantly higher chance of finding wage employment and the impact is larger for better-educated males. In summary, we show the heterogeneous impact of road access improvement across gender, reflecting the difference in return on education between females and males.

This article is comprised of the following sections. The next section describes the

target project and the research design. Section 3 explains the data set and Section 4 describes our empirical strategy. Section 5 shows the estimation results and Section 6 provides those using alternative analyses. We discuss the findings in Section 7. The final section summarizes our main findings and offers some considerations for future research.

2. The project and research design

With a population of 37 million in 2020, Morocco is located in the west of the Maghreb region of North Africa that looks toward both the Mediterranean Sea and the Atlantic Ocean. The transportation sector occupies a substantial portion of economic activities in the country, accounting for 6% of its total GDP, creating 10% of urban employment and contributing to 15% of national tax revenue (JICA, 2011). However, until recently, there was a substantial gap in transportation activities between urban and rural areas. At the beginning of the 2010s, more than 80% of major roads in the country, such as highways and national/state roads, were paved, and road transportation conveyed 90% of intercity land passengers and 75% of inter-city land freight (JICA, 2019). In contrast, the development of rural road infrastructure was slow: only 62% of prefectural roads were paved in 2009, and only 54% of the rural population enjoyed access to road infrastructure (JICA 2011).[4]

The large economic disparity between urban and rural areas has been a major challenge for Morocco, where the latest rural poverty headcount ratio is 36.8% against

[4] At the beginning of the 2010s, the public roads in Morocco consisted of highways (1.6%), national roads (18.3%), state roads (17.6%) and prefectural roads (62.5%). In addition to public roads, "not-classified roads" concentrated in rural areas play an important role in rural transportation (JICA, 2011). Accessibility to rural roads is defined as the proportion of the rural population who live in "douars" (villages) of at least 50 households located within one kilometer from an all-weather road.

6.4% for urban areas in 2019 (Observatoire National du Développement Humain, 2021). For decades, the government has placed a top priority on reducing disparities between urban and rural areas, a goal repeatedly stated in the country's five-year economic development plans. The government acknowledged that the limited access to road infrastructure was an impediment to economic opportunities and social services provision in rural areas and that rural economic activities can be activated through rural road improvement and better access to transportation services for remote populations (JICA, 2011).

Under these circumstances, the government launched the National Rural Roads Plan (Plan National des Routes Rurales: PNRR) I in 1995 and improved rural roads by 11,200 kilometers to increase rural road accessibility to 50% in 2005. Subsequently, the government began to implement the National Rural Roads Plan II in 2005, aiming to improve 15,500 kilometers of rural roads to ensure that 80% of the rural population had access to the paved road network by 2012.

In addition to economic indicators, urban-rural inequality is predominant among social indicators and prominently observed in school attainment. In Morocco, compulsory education starts at the official age of 6 and covers both primary (age 6 to 11) and junior secondary education (age 12 to 14). This is followed by senior secondary (age 15 to 17) and tertiary education (age 18 and over). The enrolment rate for primary education has gradually increased from 93.2% in 2011 to 99.5% in 2019.[5] The enrolment rate for secondary education also increased from 53.8% in 2011 to 66.2% in 2019.

[5] The data is available from UNESCO Institute of Statistics (http://uis.unesco.org/country/MA). During the same period, the gross enrolment ratio increased from 110.7 in 2011 to 114.76 in 2019 with a higher ratio for boys. The gross enrolment ratio for secondary education was 66.5% in 2011, which increased to 81.2% in 2019 and the rate was consistently higher for boys.

However, there is a large discrepancy in school enrolment by region. Among primary-school-age children, 4% of rural children were not enrolled, compared to 1% in urban areas, and the exclusion rate in rural children was higher for girls (UNICEF, 2014). Among children in the junior-secondary-school age, 16% were not in primary or secondary school, and the exclusion rate exceeded 30% for rural children. Moreover, 11% of rural children in this age group were working, contrasting to only 1% for children living in urban areas.

Furthermore, the educational disparity by gender among rural youth is large, especially in secondary education. Girls comprise 78% of children excluded from junior secondary education in rural areas. According to the High Planning Commission (Haut-Commisariat au Plan), in 2016, 14.8% of rural women aged 15 – 24 years old were illiterate against 7.2% for the rural men in the same age range. Furthermore, the proportion of NEET (Not in Education, Employment, or Training) among rural women of 15 – 24 years old was 44%, almost four times that of men. Young rural women tend to marry earlier; the average age of first marriage is 25.5 years old for women and 29.5 years old for men (LANDINFO 2017).

Given this harsh reality, the Japan International Cooperation Agency (JICA) has supported rural road improvement initiatives in the National Rural Roads Plan II through two concessional loans ("Rural Road Improvement Project" I and II), expecting to improve the living standards of the rural population and stimulate the rural economy by ensuring access to road infrastructure.[6] The Rural Road Improvement Project II, the target of this study, financed the improvement of rural roads (530km in total) in 5

[6] The Rural Road Improvement Project I financed the construction of 67 sections in 9 provinces with a total length of approximately 835km between 2008 and 2015. The program of the National Rural Roads Plan II was financed by the World Bank, African Development Bank, European Investment Bank, French Development Agency, and JICA.

provinces (Al Hauze, Chefchaouen, Essaouira, Safi, and Settat). The project paves 30 sections of rural unpaved roads (on average 17.7km per section) and widens the roads to allow two-way traffic so that more than 163,000 people in rural areas can gain access to an all-weather road (JICA 2011). The construction work commenced at different times depending on the section. The first work started in 2012 and the last in 2014. The construction period also varies, and the final construction work related to this study was completed in June 2016. The population started to use each road once construction work was completed.

3. Data description

In the Rural Road Improvement Project II, 30 of the target (treatment) roads to be constructed or rehabilitated were selected as follows. First, the provincial offices of "Direction des Routes" (Roads Directorate within the Ministry of Equipment, Transport, Logistics and Water) in each of five provinces prepared a priority list of potential roads to be constructed. The selection criteria included the size of the population covered by each road as well as the number of markets, schools, and health facilities along roads and connectivity to existing road networks (JICA, 2019). The list was scrutinized by communal and provincial governments and the Ministry assemblies to accommodate local needs and preferences. The participation of local authorities was crucial to ensure the sustainability of the roads since communes are responsible for the maintenance of roads after construction.

The target (treatment) roads for data collection were drawn from this list by JICA, considering the preparedness of the construction plan, coverage of other donors, and the necessity of land acquisition and/or resettlements. Seventeen treatment roads were

identified for the survey. Then, comparison (control) roads that were not improved were selected. The "Direction des Routes" in each province listed several roads that were most similar to the target roads based on the same criteria considered in the selection process of the target roads. Among these listed roads, the candidates for comparison roads were further identified by the evaluation team. Finally, 18control roads were identified.

The baseline survey was conducted from September to November 2011 before the first construction work started. The end-line survey was implemented from March to June 2017, 2 – 5 years after the completion of construction.[7] The primary sampling unit (PSU) was "douar," a cluster of houses (small villages) in a rural area. Hereafter, we use "village" for "douar." The catchment area of each road, which is defined as an area within a one-kilometer distance on both sides from each road, is used in the sampling of villages, following the national definition of rural road accessibility. A village is regarded as located within a road's catchment area if at least a part of a village is within one kilometer from the road. For each road, five located villages were randomly selected in the catchment area and all villages were sampled if the number of villages in the catchment area was less than five. In each village, 10 households were randomly selected.

Both household and village surveys were conducted at the baseline and end-line surveys. The household survey collected a variety of socio-economic variables of households and individuals, including demographic characteristics, access to facilities, economic activities, education, health, household assets, and consumption. The village survey collected information on basic village characteristics, availability of transport

[7] It was impossible to conduct the end-line survey between September and November, as done in the baseline survey, for logistical reasons.

services and infrastructure. At the end-line survey, the same households and villages were surveyed again to construct panel data.

For both baseline and end-line surveys, the number of villages in the treatment road areas was 76 from 27 communes, with 70 from 21 communes in the control road areas. The number of households in the treatment group was 760 in the baseline survey, which reduced to 748 at the end-line survey. The number of households in the control group was 694 in the baseline survey, which reduced to 669 in the end-line survey. The attrition rate is surprisingly negligible given the five-year interval, 1.6% for the treatment group and 3.6% for the control group. The number of individuals in the treatment group was 4,710 in the baseline survey, which increased to 4,974 in the end-line survey and the number of individuals in the control group was 4,271 in the baseline survey, which increased to 4,404 at the end-line survey. The sample of individuals includes those who migrated out from original villages but were recovered by the phone survey.

We can define the treatment and control group more precisely using the actual distance from the road based on the coordinates (longitude and latitude) of each sample household. Since some households in the sample were accessible from both treatment and control roads and we are interested in the impact of treatment roads, we regrouped households into treatment and control groups using two definitions. First, we define the households as belonging to the treatment group if a household is located within 2 kilometers from a treatment road and the households in the control group if a household is located within 2 kilometers from a control road and (at least 2 kilometers) away from a treatment road. Second, we define the households as being in the treatment group if a household is located within 5 kilometers from a treatment road and the households in

the control group if the household is located within 5 kilometers from a control road and (at least 5 kilometers) away from a treatment road. The thresholds are arbitrary but we succeed in splitting the households into treatment and control groups through the balance test (see Table 1 below). We also confirm that the main results do not depend on the choice of the threshold. We perform the analyses based on these two definitions below.

Table 1 provides a balance test of the outcome variables at the baseline before the intervention of the project to compare the variables used in the estimation between the treatment and control groups. We employ different age groups for different outcomes since the age group that is supposed to be most affected depends on outcomes. First, we see the balance of the schooling outcomes at the time of the baseline survey. School attendance for girls aged 7 to 18 is 59% for the treatment group and 54% for the control group when setting the threshold as 2 kilometers and that for boys is 69% for the treatment and 70% for the control groups. The differences of those variables between treatment and control groups are not statistically significant. The figures are comparable when we take the other threshold as 5 kilometers and we do not see any statistical difference between treatment and control groups.

Further, we take two forms of educational attainment outcomes. The proportion of primary school completion for girls aged 13 to 18 is 41% for both the treatment and control groups, and that for boys aged 13 to 18 is 61% for the treatment group and 66% for the control group when the threshold is 2 kilometers. The proportion of having ever attained secondary school or above for females aged 13 to 25 is 14% for the treatment group and 10% for the control group, while that for young males aged 13 to 25 is 36% for the treatment group and 31% for the control group. The difference of those variables

is not statistically significant between treatment and control groups, which is also the case when the threshold is 5 kilometers.

Turning to labor market outcomes, the proportion of the self-employed for young females aged 13 to 25 is 2% for the treatment group and 1% for the control group while that for males in the same age range is 42% for the treatment group and 37% for the control group when the threshold is 2 kilometers. The proportion of the wage employment for females aged 13 to 25 is less than 1% for both groups, while that for young males in the same age group is 33% for the treatment group and 43% for the control group. In both cases, the proportion of young females with work is very small across the country, which is particularly the case for work outside the home. The proportion of the wage employment of males is statistically different when the threshold is 5 kilometers, but the proportion is higher for the control group than the treatment group.

Lastly, the proportion of being married for young females aged 14 to 25 is 40% for the treatment group and 38% for the control group while that for males in the same age range is 8% for the treatment group and 11% for the control group when the threshold is 2 kilometers.[8] The difference of those variables is not statistically significant between treatment and control groups, which is also the case when the threshold is 5 kilometers.

Moreover, we performed a balance test for underlying characteristics of the sampled households and villages at the baseline survey (Appendix 1 and 2). The average age among the youth is statistically different between the treatment and control

[8] While the minimum marital age is 18 for both sexes, child marriage is prevalent in the country corresponding to 11% of the total number of marriages in 2013 which is considered to be underreported (LANDINFO 2017).

group, but the difference in the magnitude is marginal (less than one year difference). While the proportion of male head/spouse and female spouse is slightly different between the treatment and control groups, the average ages of the male head/spouse and female spouse are not statistically different between the treatment and control groups regardless of the threshold. Education attainment of the female spouse does not differ, whereas that of the male head/spouse differs in some categories, but we control these differences in the regression analyses below. We do not see any significant difference in household characteristics (household size, the ratio of dependents to household size, holding of agricultural lands, agricultural land, assets, consumption, and Palmer Drought Severity Index (PDSI)[9] or village characteristics (population, average agricultural land per household, and so on) except marginally statistical differences in population in the case of the threshold of 2 kilometers.

In sum, we confirm that there was no statistically significant difference in outcome variables except the wage employment of males in the case of the threshold of 5 kilometers between the treatment and control groups. Regarding the covariates, household and village characteristics at the baseline are reasonably balanced, while some individual characteristics differ between the treatment and control groups that we control in the regression analyses below.

4. Empirical strategy

[9] Palmer Drought Severity Index (PDSI) shows the level of drought of a location based on the data of precipitation, temperature, and water balance information. This variable at the household level is included in the balance test to capture the climate impact for their agricultural production. We use the 1/24 degree gridded (approximately 4km X 4km) raster image of monthly PDSI retrieved from https://www.climatologylab.org/terraclimate.html. We construct the household level PDSI index by assigning each household the value of PDSI of the cell it is located (12-month average before the survey month).

This study employs a difference-in-differences (DID) approach to estimate the impact of the project. The central assumption for the DID methodology to be valid is the "parallel trend." We assume that any change between baseline and end-line surveys without the intervention caused by unobserved characteristics is common between the treatment and control groups. We confirmed the observed characteristics were not biased at the baseline survey, showing that people in both groups lived in similar circumstances before the project started.

We examine the impact of the rural road improvement project on the outcome variables by using pooled panel data of the individuals belonging to a specific age group (corresponding to each outcome variable) at each round of the survey. The basic specification is as follows:

$$Y_{ijt} = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot S_j + \beta_3 \cdot (S_j * t) + \epsilon_{ijt} \quad (1)$$

where: i refers to an individual, j points to a village, and t is time ($t = 0$ for baseline and $t = 1$ for end-line). Y_{ijt} is the dependent variable and takes several forms. The first three are related to schooling outcomes and the latter two are employment outcomes. All of them are binary. For educational outcomes, Y_{ijt} is a binary variable (a) to take 1 if a youth attends school and 0 otherwise, (b) to take 1 if a youth completed primary education and 0 otherwise, and (c) to take 1 if a youth has ever attained secondary or above education and 0 otherwise. For labor outcomes, Y_{ijt} is a binary variable to take the value of 1 if a youth is self-employed and 0 otherwise, and to take the value of 1 if a youth is employed with wages and 0 otherwise. We also take marital status to take 1 if married and 0 otherwise as the dependent variable.

Turning to the right-hand side variables, S_j is a binary variable that takes the value

1 for the treatment group and 0 for the control group. β_0 to β_3 are the parameters to be estimated. β_3 is the parameter of our interest and measures the impact of the project on the outcomes. ϵ_{ijt} is an iid error term. We employ an ordinary least squared (OLS) estimation to obtain the coefficients. Since the dependent variables are binary, our specification is a linear probability model (LPM).

The parallel trend assumption in the DID methodology may be violated if changes in covariates are not common between the treatment and control groups. Thus, we also employ an empirical model with some covariates. The covariates take four forms: X_{1ijt} comprises age cohort dummies (individual characteristics) and X_{2ij} is a vector to include the characteristics of male heads/spouses and female spouses as well as a set of household characteristics such as household size, ratio of dependents to household size and holding of agricultural land. PDSI (12-month average before the survey month) is also included to capture labor environmental conditions for labor market outcomes. Moreover, we include X_{jt}, a vector containing a set of time variant village *j*'s characteristics. Lastly, μ_j is a dummy variable to indicate village-level fixed effect to capture village j's time invariant characteristics. By adding those covariates, we write another version of our empirical model:

$$Y_{ijt} = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot S_j + \beta_3 \cdot (S_j * t) + X_{1ijt}\gamma_1 + X_{2ijt}\gamma_2 + X_{jt}\gamma_3 + \mu_j + \epsilon_{ijt} \quad (2)$$

where the notations are the same as in (1) except that γ_1 to γ_3 are vectors of the parameters to be estimated.

All the regression models in the following section control for the covariates at the

individual, household, and village level as well as with village-level fixed effects. All standard errors are clustered at the village level.

5. Empirical results

Table 2 reports the estimation results on primary and secondary school attendance for youth aged 7 to 18. The parameter of interest is the coefficient on the interaction term between the treatment group dummy and the year 2017 (end-line) dummy. Columns (A) and (B) report the results for girls. The coefficient on the interaction term is positive but not significant in Column (A), but it is positive and significant in Column (B), suggesting that the rural road development project enhances school attendance significantly for girls. The coefficient on the interaction terms is positive but not significant for boys, as reported in Columns (C) and (D). These results indicate that road improvement might encourage school attendance for girls but not for boys in the age group.

Table 3 shows the estimation results of primary school completion for youth aged 13 to 25. The coefficient on the interaction term of the interest is not significant for girls regardless of the threshold of the treatment group (2 or 5 kilometers). This is also the case for boys. The coefficient on the interaction term is not significant for boys either. These results reveal that road improvement did not stimulate primary school completion for either girls or boys. Those results are natural because most primary schools that students attend are located near each household and most students do not use road transportation to commute to their schools. We note that the coefficient of the year dummy for girls is largely positive and statistically significant at the one percent level,

reflecting a series of government policy measures to promote girls' education.[10]

Table 4 shows the estimation results of having ever attained secondary school education or above for youth aged 13 to 25. The coefficient on the interaction term of interest is positive and significant for girls. The coefficient is 0.104 in Column (A), showing that the rural road development project increased the probability of having ever attained secondary education or above by 10%. The positive coefficient is comparable at 0.079 (7.9%) if we take a threshold of 5 kilometers to reach treatment roads (Column (B)). In contrast, the corresponding coefficient for boys is positive but much smaller and imprecisely estimated, indicating the rural road improvement did not increase the probability of ever attaining secondary education or above of males. The coefficient of the year dummy for girls is positive and significant, for the same reason ascribed to Table 3.

We find that the rural road improvement encouraged youth to pursue substantially better educational attainment by around 10% only for girls but not for boys, (given that males' education attainment was much higher than females at the baseline survey. The clear gender gap in the impact of road improvement on completion of higher schools may reflect the lower completion rate of higher schools for young females; the proportion of secondary school or above attainment for girls is about 10 – 14% at the baseline. While most primary schools are located within walking distance of their houses, and road improvement is less relevant to primary school attendance, most students need road transportation to commute to secondary schools or above. Thus,

[10] In 2006, the government enacted the "National Strategy for Gender Equality," providing a practical approach to the reduction of gender disparities in all sectors and seeking to promote girls' education and women's rights to counter the multiple inequalities they experience. Subsequent to this strategy, a new program, the "National Strategy for Equity and Equality," was adopted for the period 2012 – 2016. It includes equal access to education as one of eight pivotal areas (Boutieri, 2016).

rural road improvement reduces the travel time and costs of commuting to school and provides a wider range of options for transportation, which contributes to the higher rate of completion in higher education.

In contrast, we do not see any positive impact on schooling outcomes for young males, partly because the completion rate of higher education was higher than that of girls, and there was less room for them to increase. In the aspect of school attainment, rural road improvement did not benefit young females and males evenly, and it might be tempting to conclude that the road project did not alter the behavior of young males. However, the little impact on schooling does not mean that paved roads did not affect young males.

Now, we turn to labor market outcomes for youth. Table 5 reports the estimation results of the impact on self-employment. For young females, the coefficient on the interaction term between the treatment group dummy and the end-line year dummy is insignificant. Similarly, for young males, the coefficient is not significant. These results indicate that rural road improvement did not stimulate self-employed work in rural areas for either females or males.

Table 6 shows the estimation results of the impact on wage employment. The upper part finds that the coefficient on the interaction term is small and insignificant for young females. In contrast, the coefficient is positive and statistically significant for young males. Column (E) shows that rural road improvement increased wage employment by 11.7%. The point estimate is similar at 11.3% in Column (D). These results demonstrate that rural road improvement increased paid jobs for young males, but the positive impact is not found for young females.

6. Further analyses

We turn to further analyses.[11] First, we considered the distance from each household to a paved (treatment) road since the impact of access to paved roads may depend on the location of each household. We utilized geographical data on the location of households and paved roads to measure the distance and included an interaction term among the treatment group dummy, the end-line survey dummy and distance to road from the household in the treatment group. We confirmed that our estimation results are not largely altered and that the impact is less affected by the distance to the paved roads in the treatment group.

Second, we incorporated the duration in service of each treatment road since the time of completing construction differs between roads (one to three years). We included interaction terms among the treatment group dummy, the end-line survey dummy, and each of the three-year dummies of completion of a treatment road (year=2014, 2015, or 2016). For female educational attainment for secondary high school or above, the magnitude of the coefficients of the three interaction terms is comparable, and only the interaction term including the year 2015 dummy is statistically significant. For male wage employment, all the interaction terms are positive, with the year 2014 dummy the largest in magnitude and statistically significant, implying that earlier completion of the road benefits potential wage earners more in later periods.

Third, we adjusted the threshold to distinguish between the treatment and control groups other than two and five kilometers (i.e., 3 kilometers and 4 kilometers) and confirmed that the main results are unchanged.

Finally, we estimated the main specifications of education and employment by

[11] All the results in this section are available upon request from the authors.

applying the seemingly unrelated regressions (SUR) because the decisions on undertaking education or engaging in work are likely to be jointly determined. We confirm that the main results are robust to this joint estimation.

7. Discussion

Our findings uncover a sharp gendered impact resulting from the rural road improvement project, motivating higher education for females and paid work for males. Adukia et al. (2020) find that road construction did not have positive effects on primary school children but significantly increased middle school enrollment in India for both girls and boys.[12] While the insignificant effect of road improvement on primary school children with fewer labor market opportunities is common in the literature, the effect on secondary schooling among young males is noteworthy because we do not find any positive impact from the improved rural road on males having ever attained some secondary education or above.

In the case of rural Morocco, young males are more likely to get a paid job easily, thanks to the improvement of the road. However, this does not necessarily mean a trade-off between a higher level of schooling and immediate employment opportunities. To investigate this aspect, we estimate the main specification on the wage employment regression focusing on the young male sample age 16 to 25, splitting them into their levels of educational attainment (primary or some secondary or above). The lower part of Table 6 shows that the coefficient on the interaction term of interest is not statistically significant for male youth with primary education but only positive and

[12] Adukia et al. (2020) also found that school performance improved, but we do not examine this due to a lack of performance data.

significant for males with some secondary school or above if the threshold is 5 kilometers. Even in the case of the threshold of 2 kilometers, the coefficient is positive and the magnitude is similar to the threshold of 5 kilometers. Hence, the improved rural roads encourage relatively more educated males to find wage employment opportunities.[13] We confirmed that the most popular occupation types that young males are engaged in for wage employment require proficiency in Arabic or French (i.e., construction and manufacturing workers, and employees repairing cars or motorbikes), while most of the individuals in the sample speak the local Amazigh language as their mother tongue. This may explain why rural road improvement is effective for the wage employment of better educated young males.

Compared to males, under conservative social norms related to Muslim traditions, young females are restricted from entering the labor market outside of their households. We find that young females are more motivated to complete higher (secondary or above) education following the rural road improvement, which reduces travel time and costs of commuting to school and provides a wider range of options for transport. At the same time, we find suggestive evidence that early marriage among young females decreased in the treatment group. Table 7 shows the impact of improved rural roads on the probability of marriage among young females, which includes those who had migrated out at the end-line survey.[14] We use the same specification as our main specification (2), replacing the dependent variable with a binary to take 1 if married and 0 otherwise. The coefficients on the interaction term of interest in columns (A) and (B)

[13] This "complementarity" between schooling and roads is consistent with the case of rural Indonesia (Yamauchi et al., 2011).

[14] Marriage involves separation from the original household, especially for females in Morocco. The end-line data includes the data from the phone tracking survey for individuals who have separated from the original household to track individuals who have separated from their households.

are negative and statistically significant. Hence, the higher educational attainment of young females might coincide with the decrease in early marriage. The coefficient is not significant for boys. Assaad and Krafft (2015) show that assortative mating in terms of education is likely to be at work in the marriage market in Morocco: there is a clear pattern of trade-offs between women's education and later marriages for higher educated men. Such underlying mechanisms could be at work in the marriage market to explain our findings.

8. Conclusion

This paper examines the impact of a rural road improvement project on schooling decisions and youth employment in Morocco. We find contrasting results between young females and males. First, we find a positive and significant effect on secondary school attainment or above only for females. Higher educational attainment is associated with a lower proportion of early marriages. Second, we observe a positive and significant effect on wage employment only for males. Our findings reveal a sharp gender difference in the impact of the rural road improvement project, which motivates better education for females and paid work for males.

Our results show that the impact of an infrastructure improvement project may be heterogeneous between young females and males. Thus, we argue that not only the total impact but also the gendered impact should be considered for policymaking. The contrasting impact revealed in this study was made possible by rich longitudinal household-level data. Future research should address the impact of infrastructure using micro-level data to reveal heterogeneous effects across different beneficiaries with different characteristics, which are not limited to gender. Such efforts are essential to

understand the gradation of the total impact that the previous literature has largely neglected by identifying the full range of beneficiaries and exploring whether road infrastructure has contributed to reducing inequality and poverty.

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Table 1 Balance test of outcome variables

	Treatment (within 2km)			*Treatment (within 5km)*		
	Treatment groups	***Control groups***	***Diff.*** (A)-(B)	***Treatment groups***	***Control groups***	***Diff.*** (D)-(E)
	(A)	(B)	(C)	(D)	(E)	(F)
School attendance (=1)						
Girls aged 7 to 18	**n=311**	**n=203**		**n=393**	**n=255**	
	0.595	0.542	0.053	0.598	0.565	0.033
Boys aged 7 to 18	**n=338**	**n=222**		**n=439**	**n=253**	
	0.692	0.703	-0.010	0.699	0.684	0.016
Primary completion (=1)						
Girls aged 13 to 18	**n=141**	**n=98**		**n=184**	**n=124**	
	0.411	0.408	0.003	0.435	0.411	0.023
Boys aged 13 to 18	**n=174**	**n=111**		**n=220**	**n=127**	
	0.609	0.658	-0.048	0.591	0.646	-0.055
Some secondary or above (=1)						
Females aged 13 to 25	**n=360**	**n=228**		**n=494**	**n=265**	
	0.139	0.101	0.038	0.154	0.132	0.022
Males aged 13 to 25	**n=408**	**n=229**		**n=532**	**n=250**	
	0.360	0.306	0.055	0.346	0.332	0.014
Self-employment (=1)						
Females aged 16 to 25	**n=294**	**n=175**		**n=404**	**n=204**	
	0.017	0.006	0.011	0.012	0.010	0.003
Males aged 16 to 25	**n=316**	**n=163**		**n=417**	**n=176**	
	0.418	0.368	0.050	0.451	0.398	0.053
Wage employment (=1)						
Females aged 16 to 25	**n=294**	**n=175**		**n=404**	**n=204**	
	0.007	0.006	0.001	0.007	0.010	-0.002
Males aged 16 to 25	**n=316**	**n=163**		**n=417**	**n=176**	
	0.335	0.429	-0.094	0.317	0.415	-0.098**
Marriage (=1)						
Females aged 14 to 25	**n=341**	**n=212**		**n=468**	**n=246**	
	0.396	0.377	0.019	0.385	0.346	0.039
Males aged 14 to 25	**n=372**	**n=210**		**n=488**	**n=231**	
	0.078	0.114	-0.036	0.084	0.091	-0.007

Note: Fisher's exact test results are shown: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 2 Impact on school attendance

Dependent variable: School attendance (=1)	Female youths aged 7 to 18		Male youths aged 7 to 18	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	0.048	0.094*	0.062	0.046
	(0.056)	(0.049)	(0.061)	(0.053)
Year 2017 (=1)	0.042	0.003	-0.082	-0.076
	(0.047)	(0.042)	(0.051)	(0.048)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.416	0.391	0.401	0.390
No. of observations	1042	1291	1080	1340

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 3 Impact on primary school completion

Dependent variable: Primary completion (=1)	Female youths aged 13 to 25		Male youths aged 13 to 25	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	-0.001	0.053	-0.041	-0.028
	(0.090)	(0.084)	(0.124)	(0.106)
Year 2017 (=1)	0.305***	0.250***	0.174	0.172*
	(0.063)	(0.065)	(0.107)	(0.098)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.378	0.372	0.306	0.313
No. of observations	488	620	544	676

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 4 Impact on secondary school or above attainment

Dependent variable: Some secondary or above (=1)	**Female youths aged 13 to 25**		**Male youths aged 13 to 25**	
	Treatment (within 2km)	**Treatment (within 5km)**	**Treatment (within 2km)**	**Treatment (within 5km)**
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	0.104**	0.079*	0.020	0.023
	(0.045)	(0.041)	(0.062)	(0.057)
Year 2017 (=1)	0.083***	0.084***	0.054	0.049
	(0.029)	(0.027)	(0.055)	(0.052)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.299	0.321	0.254	0.272
No. of observations	1063	1355	1203	1471

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 5 Impact on self-employment

Dependent variable: Self-employment (=1)	Female youths aged 13 to 25		Male youths aged 13 to 25	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	-0.001	0.006	-0.012	0.016
	(0.014)	(0.015)	(0.064)	(0.065)
Year 2017 (=1)	0.028	0.021	-0.259*	-0.266**
	(0.037)	(0.031)	(0.138)	(0.131)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.147	0.142	0.278	0.257
No. of observations	969	1246	983	1204

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 6 Impact on wage employment

(1) All youth aged 16 to 25

Dependent variable: Wage employment (=1)	Female youths aged 16 to 25		Male youths aged 16 to 25	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	0.007	0.003	0.117*	0.113*
	(0.012)	(0.010)	(0.063)	(0.063)
Year 2017 (=1)	0.009	-0.009	-0.185	-0.144
	(0.010)	(0.017)	(0.123)	(0.121)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.173	0.148	0.334	0.316
No. of observations	969	1246	983	1204

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

(2) Young males aged 16 to 25 by educational level

Dependent variable: Wage employment (=1)	Male youths aged 16 to 25 (primary education)		Male youths aged 16 to 25 (some secondary)	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	0.098	0.121	0.162	0.180*
	(0.075)	(0.077)	(0.115)	(0.108)
Year 2017 (=1)	-0.371**	-0.294*	-0.039	-0.151
	(0.175)	(0.175)	(0.187)	(0.185)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.415	0.410	0.407	0.389
No. of observations	644	787	339	417

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 7 Impact on marriage

Dependent variable: Marriage (=1)	Female youths aged 14 to 25		Male youths aged 14 to 25	
	Treatment (within 2km)	Treatment (within 5km)	Treatment (within 2km)	Treatment (within 5km)
	(A)	(B)	(C)	(G)
Treatment and year dummy variables				
Treatment * Year 2017 (=1)	-0.104*	-0.082*	-0.063	-0.048
	(0.053)	(0.044)	(0.043)	(0.042)
Year 2017 (=1)	0.023	0.020	0.071*	0.056
	(0.040)	(0.037)	(0.037)	(0.037)
Age cohort fixed effects	Yes	Yes	Yes	Yes
Male head/spouse characteristics	Yes	Yes	Yes	Yes
Female spouse characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Village characteristics	Yes	Yes	Yes	Yes
Village fixed effects	Yes	Yes	Yes	Yes
R sq.	0.422	0.417	0.196	0.185
No. of observations	1140	1456	1167	1430

Note: Village-level cluster-adjusted standard errors are in parentheses: * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Appendix 1 Balance test (threshold= 2 kilometers)

	Treatment (2km)			
	Treatment groups	Control groups	Difference	
			(A)-(B)	S.E.
	(A)	(B)	(C)	(D)
Individual characteristics (aged 7 to 25)	**n=1102**	**n=673**		
Female (=1)	0.481	0.495	-0.014	(0.024)
Age	16.3	15.8	0.47*	(0.26)
Male head/spouse characteristics	**n=447**	**n=263**		
Present (=1)	0.982	0.953	0.030**	(0.013)
Age	54.7	53.9	0.86	(1.13)
No education (=1)	0.738	0.821	-0.083**	(0.033)
Primary education (=1)	0.148	0.122	0.026	(0.027)
Secondary education or above (=1)	0.060	0.034	0.026	(0.017)
Islamic studies (=1)	0.054	0.023	0.031**	(0.016)
Female spouse characteristics	**n=422**	**n=267**		
Present (=1)	0.927	0.967	-0.040**	(0.018)
Age	45.2	44.3	0.87	(1.01)
No education (=1)	0.950	0.951	-0.001	(0.017)
Primary education (=1)	0.040	0.041	-0.001	(0.015)
Secondary education or above (=1)	0.009	0.007	0.002	(0.007)
Household characteristics	**n=455**	**n=276**		
Household size	6.36	6.33	0.03	(0.233)
Ratio of dependents to household size	0.336	0.352	-0.016	(0.016)
Agricultural land (ha)	3.32	3.54	-0.23	(0.55)
Household assets (thousand MAD)	20.7	14.6	6.09	(5.30)
Annual consumption per capita (thousand MAD)	6.07	6.40	-0.33	(0.38)
Palmer Drought Severity Index (PDSI)	2.64	2.59	0.06	(0.08)
Village characteristics	**n=48**	**n=29**		
Population	439	320	119.0*	(62.1)
Average agricultural land per household (ha)	3.38	3.58	-0.194	(0.865)
Average assets per household (thousand MAD)	20.8	15.0	5.85	(6.30)
Distance to permanent market (km)	19.5	19.8	-0.33	(4.88)
Distance to periodic market (km)	11.8	13.1	-1.30	(4.69)
Distance to trade center (km)	28.6	20.1	8.5	(6.88)

Note: *t*-test or Fisher's exact test results are shown (for binary variables, Fisher's exact tests also support the results); * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Monthly consumption per capita is adjusted by using adult equivalence scales. Assets per household include the value of productive and durable assets. 1USD was worth approximately 9MAD in 2011.

Appendix 2 Balance test (threshold= 5 kilometers)

	Treatment (5km)			
	Treatment groups	Control groups	Difference	
			(A)-(B)	S.E.
	(A)	(B)	(C)	(D)
Individual characteristics (aged 7 to 25)	**n=1454**	**n=772**		
Female (=1)	0.483	0.513	-0.029	(0.022)
Age	16.4	15.6	0.83***	(0.24)
Male head/spouse characteristics	**n=592**	**n=300**		
Present (=1)	0.979	0.952	0.026**	(0.012)
Age	54.2	53.9	0.30	(1.02)
No education (=1)	0.730	0.830	-0.100***	(0.030)
Primary education (=1)	0.145	0.120	0.025	(0.024)
Secondary education or above (=1)	0.061	0.023	0.037**	(0.015)
Islamic studies (=1)	0.064	0.027	0.038**	(0.016)
Female spouse characteristics	**n=560**	**n=306**		
Present (=1)	0.926	0.971	-0.046***	(0.016)
Age	44.8	44.5	0.40	(0.92)
No education (=1)	0.948	0.951	-0.003	(0.016)
Primary education (=1)	0.041	0.039	0.002	(0.014)
Secondary education or above (=1)	0.011	0.010	0.001	(0.007)
Household characteristics	**n=605**	**n=315**		
Household size	6.23	6.27	-0.040	(0.206)
Ratio of dependents to household size	0.328	0.349	-0.022	(0.015)
Agricultural land (ha)	3.31	4.03	-0.73	(0.55)
Household assets (thousand MAD)	20.7	14.3	6.40	(4.62)
Annual consumption per capita (thousand MAD)	6.31	6.23	0.08	(0.38)
Palmer Drought Severity Index (PDSI)	2.64	2.72	-0.08	(0.07)
Village characteristics	**n=62**	**n=34**		
Population	441	374	66.7	(57.4)
Average agricultural land per household (ha)	3.29	3.97	-0.679	(0.780)
Average assets per household (thousand MAD)	20.7	14.3	6.38	(5.47)
Distance to permanent market (km)	20.1	21.8	-1.67	(4.52)
Distance to periodic market (km)	12.5	14.5	-2.01	(4.05)
Distance to trade center (km)	31.7	23.1	8.6	(7.23)

Note: *t*-test or Fisher's exact test results are shown (for binary variables, Fisher's exact tests also support the results); * Significant at 10%, ** Significant at 5%, *** Significant at 1%.
Monthly consumption per capita is adjusted by using adult equivalence scales. Assets per household include the value of productive and durable assets. 1USD was worth approximately 9MAD in 2011.