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The ABCs of the Role of Public Transport in Women's Economic Empowerment

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Abstract

There is increasing recognition that deficiencies in the public transport system impact men and women differently. While transport systems have been shown to play a significant role in women's participation in the labor force globally, this topic has been little explored in the Middle East and North Africa. This paper examines the effect of the spatial accessibility, availability, and safety of public transportation on women's labor market outcomes in three capital cities in the Middle East and North Africa—Amman in Jordan, Beirut in Lebanon, and Cairo in the Arab Republic of Egypt. The analysis uses three types of data collected for each city in 2022, namely, household mobility surveys, transit network data, and built environment audits. The paper investigates how the spatial accessibility of jobs in each city, the availability of public transportation close to residential locations, and the safety of public transit stops affect the labor force participation of women and their likelihood of employment. The main findings are that: (a) accessibility, availability, and safety appear to impact women's labor force participation differentially in each city, and these impacts also vary by income level; and (b) although accessibility, availability, and safety appear to impact women's labor force participation, they have overall little impact on women's employment probability. The paper takes these two findings to imply that: (a) a one-size-fits-all-women solution is not appropriate when designing public transport systems; and (b) although public transport plays a critical role in improving women's access to employment opportunities, complementary actions are needed to translate these gains into gainful employment.

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The ABCs of the Role of Public Transport in Women's Economic Empowerment[1]

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1. Introduction

Fostering women's economic empowerment is central to realizing women's rights and gender equality. Moreover, gender inequalities impede economic growth and stall efforts to eradicate poverty. Gender gaps in the labor market can induce GDP per capita losses as high as 27% in the Middle East and North Africa (MNA) (Cuberes & Teignier, 2016). Only 19 percent of women in the MNA region participate in the labor force (World Bank, 2021) and when compared to other regions, MNA exhibits the highest gender gaps in labor force participation (LFP) as well as the lowest female LFP in absolute terms. In the MNA region, women generate 18 percent of the GDP – compared to 37 percent worldwide. A higher level of female LFP could lead to a higher GDP as well as improvements in gender equity and women's empowerment. Curiously, evidence suggests that low female LFP rates in MNA are not linked to differentials in education; female and male literacy rates are close to parity in many MNA countries and some even exhibit 'reverse' gender gaps in tertiary education, with female students outnumbering male (Minster et al., 2022).

Much evidence has been brought to bear in both developed and developing countries to demonstrate how gender inequities in transport access create worse employment outcomes for women than for men, even within the same household (see for instance, Dobbs, 2007; Ajibola, 2015; Seedhouse et al., 2016; Cook & Butz, 2018). Women's and men's experiences with transport systems differ significantly, across all aspects of travel experience – this includes availability, affordability, spatial accessibility, safety, and acceptability (Dominguez Gonzalez et al., 2020). When adverse characteristics in transport systems are not well considered in planning, design, and operations, they especially affect women's and girls' mobility and employment. The International Labor Organization (ILO, 2017) estimates that in developing countries, limited access to and safety of transportation is the single greatest obstacle to women's participation in the labor market: it reduces their participation probability by as much as 16.5 percentage points. While transport systems have been shown to play a significant role in women's participation in the labor force globally, this topic has been little explored in the MNA region and is a key knowledge gap filled through this work (Alam et al., 2022).

Is a well-functioning[5] public transport system necessary for enhancing women's economic empowerment? On its own, is a well-functioning public transport system sufficient to significantly increase women's economic activity? Public transport can shape how, when and

[5] Reliable, frequent, fast, comfortable, accessible, convenient, affordable and safe.

where women travel. Unreliable and infrequent public transport systems impose a disproportionately higher burden on women than on men, affecting their access to economic opportunities and basic services (Borker, 2022). This paper examines the effect of several aspects of the public transport network on women's labor market outcomes in three metropolitan areas: Amman in Jordan, Beirut in Lebanon and Cairo in the Arab Republic of Egypt. In particular, we investigate how the accessibility of jobs throughout each city, the availability of public transportation close to residential locations, and the safety around public transit stops affect the labor force participation of women and their likelihood of employment.[6] By doing so, we shed light on whether improving public transport systems is a necessary or a sufficient condition for enhancing women's economic empowerment.

To examine these relationships, we rely on three types of data collected in 2022. First, we have mapped the transit network of each city, including timetables and frequencies to be able to construct the measures of accessibility and availability. Second, we have conducted built environment audits to assess the safety around public transportation stops. Finally, we conducted household surveys in these metropolitan areas, in which 5,912 working-age women and men were interviewed and information on their socio-economic characteristics, mobility choices and labor market outcomes were collected.[7] Most of the literature that assesses the impact of improving the transport system on economic outcomes in developing country contexts, relies on one type of dataset. In contrast, we triangulate three different types of datasets to assess how public transport systems influence women's economic choices.

The transit network and built environment audits are used to construct indices for three important facets of the public transport system—accessibility, availability, and safety. Accessibility refers to the spatial accessibility of job opportunities throughout the city, it is measured by estimating the percentage of jobs reachable under 60 minutes using public transport (and walking). Availability refers to the ease with which public transport can be found, measured by the spatial proximity of transit stops to residential locations (factoring in the frequency of service at each stop). In this manner, it measures the availability of public transit close to where people live. Finally, safety measures the level of "security" around the public transport stops. Security includes both sexual harassment and incidence of crimes. This is used

[6] For the employment probabilities we also include men in the analysis to investigate whether there are heterogeneities by gender in the effect of various aspects of transport. For labor force participation this is not possible due to the high participation rates of men.

[7] This means that our analysis only includes people living within the limits of the metropolitan region, and therefore not potential commuters who live outside each region.

to construct a broad measure neighborhood-level safety close to residential locations. All these aspects of public transport matter for both men and women but may matter differently. For instance, the availability of transport could matter more for women if they face time poverty constraints[8] or if they face threats of harassment while walking to public transit stops.[9] Similarly, safety could also matter for men if crime is a key concern.

These spatial measures of public transport are then matched with households' residential locations in order to estimate their effect on labor market outcomes using a linear probability model. We make a novel contribution to the literature by assessing whether different facets of the public transport system differentially influence women's labor market outcomes across cities.

Our main first main finding relates to women's labor force participation. We find that in each of the three cities, women's labor force participation is differently influenced/constrained by the three spatial measures of public transport (accessibility, availability, and safety), and these constraints differ by income level. Thus one-size-fits-all-women type of solutions are not appropriate. In Amman, safety appears to be the most important constraint that women face, while spatial accessibility to jobs is more important for women hailing from low-income households. In Beirut, there is some evidence that spatial accessibility matters for women hailing from low-income households. In Cairo, both accessibility and availability of public transport appear to play a strong role in determining women's labor force participation.

Our second main finding relates to women's likelihood of being employed. We find that while accessibility, availability and safety appear to impact (to varying degrees) women's likelihood of looking for a job, they appear to have overall little impact on women's employment probability. This is consistent with the idea that while public transport plays a critical role in improving women's access to employment opportunities, making them more likely to actively look for jobs, complementary actions are needed to translate this active participation by women in the labor force to gainful employment. Instead, we find that better accessibility increases men's likelihood to be employed in Amman, and safety at public transport stops appears to have some impact on men's likelihood of being employed in Cairo.

[8] Time poverty constraints can be related to the care of children or elderly family members or other household responsibilities.

[9] For instance, in Amman, a recent survey showed that most occurrences of harassment of women in public transportation happened in the street while walking from or to transit stops (Aloul et al., 2018).

Taken together, our two main findings demonstrate that improving public transport is necessary for enhancing women's participation in the economic sphere. However, improving public transport alone is not sufficient enhance women's economic empowerment. Along with improving the accessibility, availability, and safety of public transport, policy measures that address the work environment, social, and household constraints may be needed. The supply and demand factors that may impact women's probability of finding employment are elaborated in the concluding section.

Our analysis also finds that the spatial accessibility of jobs via public transport (and walking) is low in all three metropolises. This points to the need for prioritizing public transport through integrated corridor management, or the creation of/improvements to mass transit (like BRTs or metro). It also highlights the need for improving existing land regulations to foster dense, diverse and well-designed urban development.

This paper contributes to two main strands of the literature. First, it provides evidence on the links between gender and mobility using a novel approach. Studies from both developed and developing countries show that gender plays a critical role in mobility (Blumenberg, 2004; Anand & Tiwari, 2006; Lucas & Porter, 2016; Dominguez Gonzalez et al., 2020). However, in the MNA region, the relationship between different aspects of transport barriers and their disproportionate impact on vulnerable populations is poorly understood (see Minster et al., 2022, for a literature review on the existing evidence on the gendered economic impacts of mobility in the MNA region and the identified gaps in the literature).

Second, it contributes to the literature on the transport-related determinants of labor market outcomes. The interactions between access and employment are complex and have been the subject of debate in economics, transportation planning and other disciplines for over half a century (see Kain, 1992; Fan, 2012; and Bastiaanssen et al., 2022; for evidence on developed economies and Boisjoly et al., 2017; Picarelli et al., 2017; Alam et al., 2021; and Field & Vyborny, 2022 for evidence on developing and emerging economies). Recently, a meta-analysis of the evidence on the effect of transport on employment highlights that the evidence has so far mainly focused on the United States and generally on one of these four types of indicators: private vehicle ownership, public transport access, commute times or job accessibility levels (Bastiaanssen et al., 2020). We complement these in two ways (a) we provide evidence on several public transport measures simultaneously (accessibility,

availability, and safety); (b) we provide evidence on the MNA region which has been understudied so far.[10]

The rest of the paper is structured as followed. Section 2 presents the data. Section 3 presents the methodology, including both the construction of measures of accessibility, availability, and safety, as well as the empirical model. Section 4 presents and discusses the results. Section 5 concludes.

2. Data

This section presents the type of data that have been collected to study the effect of the public transportation network in Amman, Beirut, and Cairo on the labor market outcomes of the population, and in particular women. Three types of data have been collected: the transit network of each city, the built environment audits to assess the safety of public transportation stops, and household surveys. For all three types of data, we restrict the analysis to the metropolitan areas (therefore do not include potential commuters living outside of these borders).[11]

2.1. Transit network data and built environment audits

Transit network mapping and built environment audits were conducted between May and November 2022 for Beirut and Amman. The transport network map for Cairo was collected as part of the Cairo Mobility Assessment and Public Transport Improvement study which was completed in May 2022. The build environment audits for Cairo were collected in November 2022.

In each city, all fixed route-based public transport modes were surveyed for the transit network mapping.[12] The mapping of the public transit system, started with the collection of official routes (and related) information available from government entities. Known gaps within these official records were filled through desk research. Finally, a team of enumerators were deployed to map the actual routes (and capture other attributes like frequency, fares, etc.) using a mobile based application. The building blocks of the field work were public transit stations. Enumerators then conducted station surveys to identify all routes departing from a specific

[10] In the MNA region social and cultural norms might lead to different results than what had been observed in developed countries

[11] Note that metropolitan areas include both the city municipality and its surrounding important areas.

[12] Route-based public transport modes are defined as modes whose routes have a fixed origin and destination, as well as travel through key defined landmarks along the route.

station. This served to build a complete list of routes for the city to determine the full extent of the transit network. The routes were then travelled in both directions to map them. If more stations were discovered through this process, then they were also included in the mapping process using the procedure described above.

Figure 1 illustrates the public transport network for each city. In Amman, the public transport consists of buses, coasters and services (owner-operated shared taxis running on fixed routes). In Beirut, the network consists of buses and microbuses (service and taxis are not included as these operate almost door to door).[13] And in Cairo, it consists of buses, microbuses, and metro.[14] These data not only allow to see the routes of the transit network, but also includes information about frequencies and timetables that will be used in the construction of various indicators (see section 3.1).

Built environment audits were conducted at selected locations to objectively assess the environment in which people are taking public transport. These were performed for 50 public transport locations in each of the three cities using the methodology developed by Safetipin to assess site safety (Safetipin, 2021). The audit locations were stratified based on geography, stop type, public transport modes available and time of day (peak, off-peak and nighttime).

To assess the built environment of a location, the location is rated along seven objective parameters to assess the perception of safety at this public transit stop. The seven parameters are summarized in Table 1, and the locations of the audits are illustrated in Figure 2.

[13] Details relating to services and taxis can be found in the forthcoming Lebanon Public Transport Diagnostic.
[14] The full list of transport modes covered in Egypt include 10 different options.

Figure 1: Maps of the transit network in Amman, Beirut and Cairo

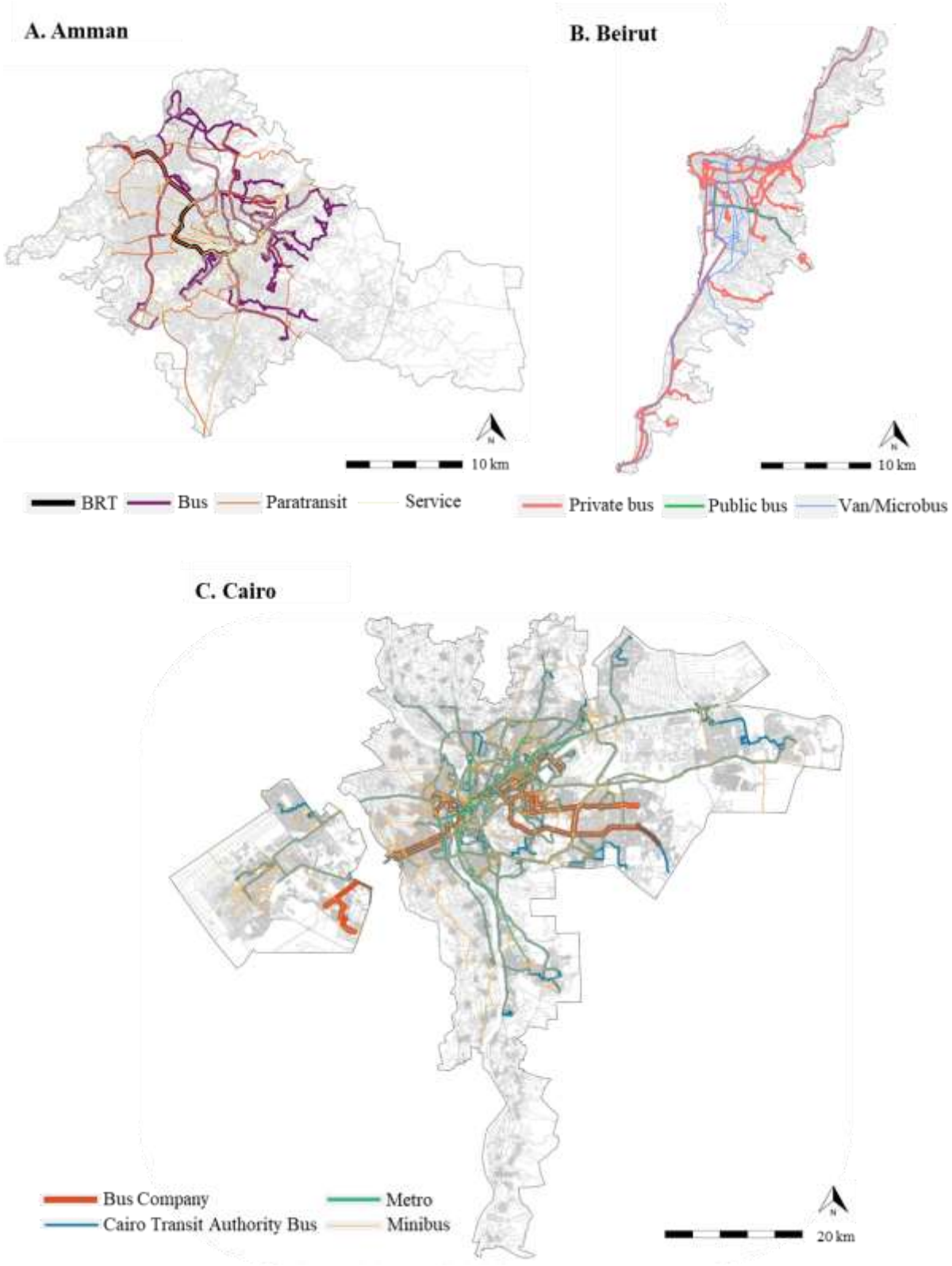


Figure 2: Locations of household surveys and built environment audits in Amman, Beirut and Cairo

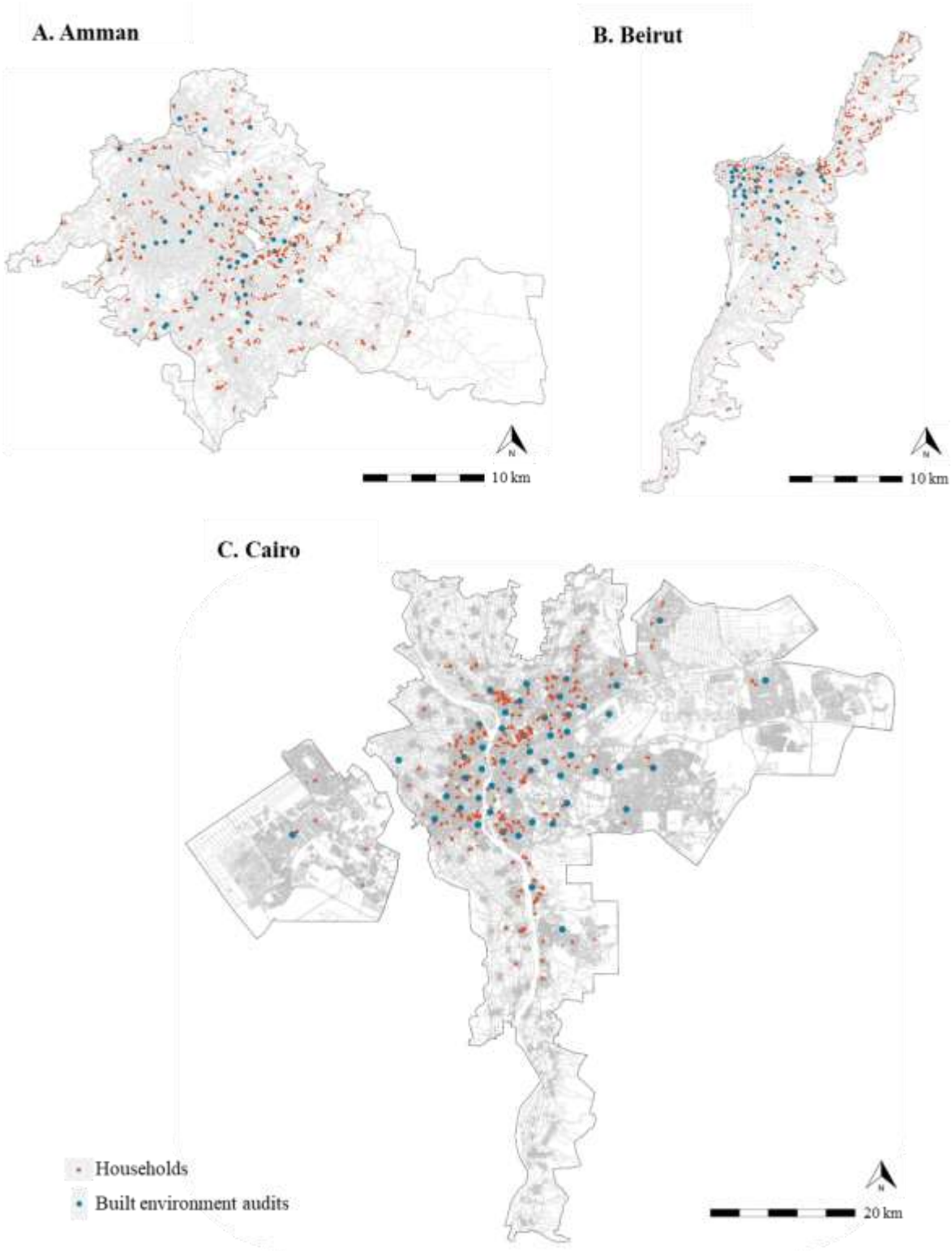


Table 1: Parameters used in the built environment audits

	Parameter	Description	Lowest Value	Highest Value
1	**Lighting**	Availability of lighting infrastructure (surveyed at nighttime)	None	Bright
2	**Walking path**	Presence of sidewalks	None	Good
3	**Openness**	Ability to see and move in all direction	Not open	Completely open
4	**Visibility**	Presence of vendors, shops, building entrances, windows and balconies from where you can be seen	Out of sight of others	Completely visible
5	**Security**	Presence of police or security guards	None	High
6	**People**	Number of people around you	Deserted	Crowded
7	**Gender usage**	Presence of women near you	None	Majority of women

Note: Each parameter was assigned a score between 0 (lowest value) and 3 (higher value), therefore allowing for two additional intermediate scores (1 and 2). These scores will then be rescaled and combined to create an overall safety index between 0 and 100% (see section 3.1.c)..

2.2. Household survey

a. Design and sampling methodology

The household surveys in all three cities were conducted from May to September 2022.[15] The surveys include socio-economic and demographic characteristics, transport mode choices, as well as employment choices. The original sample included 6,088 households, of which 176 were excluded because of data quality and missing information. The final sample of 5,912 households consists of working age women and men (working age is defined as between 18 and 50 years old). In Amman, the sample includes 1,995 households (998 men and 997 women); in Beirut: 2,000 households (1,000 men and 1,000 women); and in Cairo: 1,917 households (953 men and 964 women).[16] Figure 2 presents the location of surveyed households in the city.

The sampling of the households was done to be geographically representative by selecting locations proportionally to population density and building density. Among selected

[15] In Amman: from July to September 2022; in Beirut: from June to August 2022; in Cairo: from May to June 2022.

[16] Note that the sample size does not need to be proportional to the underlying population sizes. Therefore, although the cities have overall different size populations, our samples are similar in size.

households, we randomized the gender of the respondent.[17] To select the respondent and because we are interested in the working population, we first asked whether there is someone currently working, if not, someone who was previously working, and finally, someone who could potentially be working someday. This along with our sampling age restrictions mean in practice that we oversample the working population and the population in the labor force because we need a large enough sample of people in the labor force (especially among women) to be able to study the effect of public transport on labor market outcomes.

b. Description of households surveyed

Table 2 presents the characteristics of households surveyed in each city. On average, households are slightly larger in Amman, with a mean of 4.9 people compared to 3.9 in Beirut and 4.2 in Cairo. The share of households with people over 60 years old is similar in Amman and Beirut (22% to 23%) but much smaller in Cairo (8%). In every city, the majority of households own their home, but home ownership is larger in Cairo (72%) than Amman (67%) and Beirut (57%). Similarly, the housing tenure tends to be higher in Cairo, with 70% of the population that has lived in their house for 10 years or more (40% since birth) and only 2% for less than one year; in Beirut, 66% of households have been in their house for 10 years or more (34% since birth) and 3% for less than one year; and in Amman, households tend to have a lower housing tenure with 47% living in the same house for more than 10 years (19% since birth) and 7% for less than one year. Finally, the average (median) monthly income in our sample is at 572.9 (524) Jordanian dinars in Amman, 7,878,707 (7,500,000) Lebanese lira in Beirut and 4,627 (4,419) Egyptian pounds in Cairo.[18]

Table 2: Household characteristics, by city

	Share of households (%)		
	Greater Amman	**Greater Beirut**	**Greater Cairo**
Number of people in the household			
1	2.6	3.8	0.0
2	7.0	11.1	7.1
3	12.7	22.4	18.4
4	21.8	33.1	34.5
5	21.8	18.6	28.7
6	15.9	7.4	9.4
7 or more	18.3	3.6	1.9

[17] One working age man or working age woman was selected from each household for surveying.

[18] Averages are computed only among people who accepted to answer to this question. In Amman, 10% and 5% of the sample respectively did not know the answer or refused to answer; the same figures are at 0% and 0.2% for Beirut, and 9% and 7% in Cairo. Household income was collected in 9 categories per city. We assign the following average income to the highest categories: Amman: more than 1,850 JD = average of 2,000 JD; Beirut: more than 7,500,000 LL = average of 10,000,000 LL, and Cairo: more than 16,000. = 17,000 EGP. This is just for illustration purposes in the description of the sample and does not affect our empirical analysis.

Share of households with people over 60 years old			
	22.4	22.9	7.9
Share of households who own their home			
	56.6	66.8	72.1
Housing tenure at current residence			
Less than 12 months	7.2	3.3	1.9
1 - 2 years	9.8	6.6	4.4
3 - 5 years	19.6	13.2	10.4
6 - 10 years	16.9	11.0	13.1
More than 10 years	27.7	32.2	30.3
Since birth	18.8	33.7	39.9
Average monthly household income			
	572.9 JD	7,878,707 LL	4,627.0 EGP
Total observations	1,995	2,000	1,917

Notes: Figures are share of households within city. The education category "Technical secondary or post-secondary" corresponds to Vocational training and 2 years diploma in Amman, to the Technical institute in Beirut and to technical secondary and Post-secondary school in Cairo. JD: Jordanian Dinars, LL: Lebanese Lira, EGP: Egyptian Pounds.

Table 3 presents the respondent characteristics by gender and city. The average age is slightly higher in Beirut (35 years old) than in Amman and Cairo (both 33 years old). In particular, the share of households between 45 and 50 years old is higher in Beirut than the two other cities. The age distributions for men and women are fairly similar, except in Amman, where men tend to be slightly younger than women in our sample. In terms of marital status, in our sample women are more likely than men in the same city to be married or engaged, with these shares being at between 55% and 66% depending on the city. For men on the other hand, these figures are between 46% and 59%, with fewer married individuals in Beirut compared to the other cities. Similarly, the share of individuals with young children (under ten years old) is also lower in Beirut compared to Cairo or Amman. Men and women have similar levels of education in Amman and Cairo, while women have a slightly higher education than men in Beirut.[19] Finally, in terms of occupation, in each city, the majority of men are working while the majority of women are not. In Amman, the share of men who are working (employed or self-employed) is at 77.5% while at 35% for women; in Beirut, these shares are respectively at 60% and 20% and in Cairo they are at 79% and 40%. The share of respondents who are unemployed but looking for work is the highest in Beirut, it is also similar across gender (31% of both men and women), while it is higher for women than men in both Amman and Cairo (21% of women and 9% of men in Amman, and 25% of women and 13% of men in Cairo). Overall, this means that in our sample the labor force participation rate (which includes both working people and those looking for work) is: (i) in Amman: at 87% for men and 56% for women; (ii) in Beirut: 91% for men

[19] More precisely, the median education for both men and women in Amman is general secondary school; in Beirut it is general secondary school for men and technical secondary and post-secondary for women; and in Cairo for both men and women, it is technical secondary and post-secondary.

and 51% for women, and (iii) in Cairo: 93% for men and 65% for women. The latest data from the International Labor Organization (ILO, 2020) showed that the labor force participation rate was, respectively for men and women, in Jordan at 66% and 16%, in Lebanon at 78% and 34% and in Egypt at 70% and 15%. While a strict comparison cannot be made between our data and the ILO labor force participation rates because they do not cover the same kind of sample,[20] this suggests an oversampling of both men and women working or looking for work in our sample. As this study focuses on the links between transportation and women's labor market participation, it is key to be able to have a large enough sample of women participating in the labor market and this oversampling was thus a desired feature of our sampling design.

Table 3: Respondent characteristics (percent of total), by gender and city

	Greater Amman		Greater Beirut		Greater Cairo	
Category	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Age group						
18-24	29.6	16.3	23.3	20.3	27.8	26.6
25-29	18.1	20.1	15.5	15.1	16.9	17.0
30-34	13.1	16.2	13.5	11.7	12.7	12.4
35-39	11.1	15.3	10.2	11.0	16.1	15.8
40-44	10.9	12.9	11.7	11.2	13.0	13.4
45-50	17.1	19.1	25.8	30.7	13.5	14.8
Marital Status						
Engaged or Married	50.4	66.2	45.8	54.8	58.6	64.6
Single (or separated, divorced, or widowed)	49.6	33.8	54.2	45.2	41.4	35.4
Share with children under 10 years old	36.2	45.6	24.9	24.4	44.8	43.4
Education						
Less than primary school	1.5	1.5	2.6	1.8	2.2	4.8
Primary school	5.5	5.4	8.9	5.4	1.9	2.8
Middle school	11.3	12.9	21.6	19.0	4.3	6.0
General secondary school	36.1	33.1	21.8	20.8	7.2	8.5
Technical secondary or post-secondary	12.8	13.9	11.6	8.6	46.3	36.0
University bachelor	30.7	31.0	29.4	41.1	37.8	40.6
University master or higher	2.1	2.1	4.1	3.3	0.3	1.3
Occupation						
Working (employed or self-employed)	77.5	34.9	60.0	20.0	79.3	40.4
Unemployed, looking for a job	9.4	21.3	30.5	30.7	13.1	24.8
Not working, not looking for a job	13.1	43.8	9.5	49.3	7.6	34.9
Observations	998	997	1000	1000	953	964

Notes: Figures are percent of respondents within gender and city.

[20] First, the ILO data are averages for the whole country while our data only focus on the capital cities. Second, the ILO age range covers people from 15 to 64 years old while we restrict our analysis to 18 to 50 years old, which is likely to increase the labor force participation. Finally, the ILO data are from 2020 for Jordan and Egypt and 2019 for Lebanon while our sample was collected in 2022.

3. Methodology

This section first presents the method used to construct indicators for measuring accessibility, availability and safety of the public transport network (these are the facets of the public transport system that are of interest to us). It then presents the empirical model used to estimate the effect of the constructed transport measures on labor market outcomes.

3.1. Measuring accessibility, availability and safety of the public transport network

In this section, we present the definitions for each measure used to capture different aspects of the public transport system as well as the data sources and the methodology used to compute them. It also provides descriptive statistics and maps of the transport measures for each of the three cities. Details for each of the indicators can be found in Annex A.

a. Measuring accessibility

Accessibility focuses on measuring the spatial accessibility of job opportunities throughout the city using either public transport or walking. For each residential location, we compute the percentage of total jobs that are accessible within 60 minutes during peak hours (8am to 9am).[21] The measure of accessibility combines the time taken to walk to a public transport stop, time spent in the public transport vehicle, and the time needed to walk to a job opportunity.

Three sources of data are used to measure accessibility for each household in our sample. First, we use a layer of the street composition for each city. All street grid data is taken from OpenStreetMap. For the three cities, there are no pedestrian restrictions, meaning all streets and links in the network are considered accessible to pedestrians. A pedestrian walking speed of 3.6km/h is used, and the threshold of 20 minutes is used as the maximum walking time *per leg* of the trip when public transport is being used. Second, we use the public transit network that has been collected. The collected frequency of departure, and speeds by which the public transport vehicles travel on the route are used for the analysis (see 2.1. for details and maps about this data). Third, we use the distribution of employment in each city. We base it on Barzin et al. (2022), which estimates the relative density of employment across the metropolitan area using a machine learning method and remote sensing data.

[21] A given destination will be considered to be reachable from a residential location if it can be reached in under 60 minutes during at least 50% of the departures within the 8:00 to 9:00 am window.

Figure 3 presents the maps of the spatial accessibility of job opportunities in Amman, Beirut, and Cairo. In our sample, in Amman, households have on average access to 27% of total jobs within 60 minutes using public transportation and walking. In Beirut, the same figure is at 21% and in Cairo (a larger city), it is at 16%. These accessibility levels are lower than many cities in developing countries where such analysis has been done. Peralta-Quiros et al. (2019) perform a benchmarking of 11 cities in Africa, according to this benchmarking, all three cities can be classified as worst performers in connecting people with employment opportunities.[22]

b. Measuring availability

Availability focuses on the availability of public transport close to the residential locations. In practice, we look at the proximity to transit stops factored by the frequency of service. This indicator is used to assess the density of service within immediate reach of the household, but without considering the destinations of the transit.

The same street grid data and transit network data that was used for measuring accessibility is also used to measure availability. For each household, we compute the number of public transport 'runs', that is the number of vehicle departures at all stops available within a 10 minute walking time over the course of an hour. The number of runs is normalized to create an index between 0 and 100%.[23] A value of 100% means that public transport is highly available within 10-minute walking distance from an hour while a value of 0 means that no public transport is available within a 10-minute walking distance of a household.

Figure 4 presents the maps of the availability of public transport in Amman, Beirut, and Cairo. In Amman, for our sample of households, the average value of the index is 41%. In Beirut, the same figure is at 29%, and Cairo it is at 52%.

[22] Benchmarking data is only available for Africa.

[23] To normalize, we divide the number of runs by 60 and truncate the values equal to or over 1 to be equal to 100%. This means that we have an index of an average number of bus reachable each minute between 8 am and 9 am, at a maximum distance of 10-minute walk, with the maximum being 1 bus per minute (in this case the index equals 100%).

Figure 3: Maps of accessibility of public transport for Amman, Beirut and Cairo

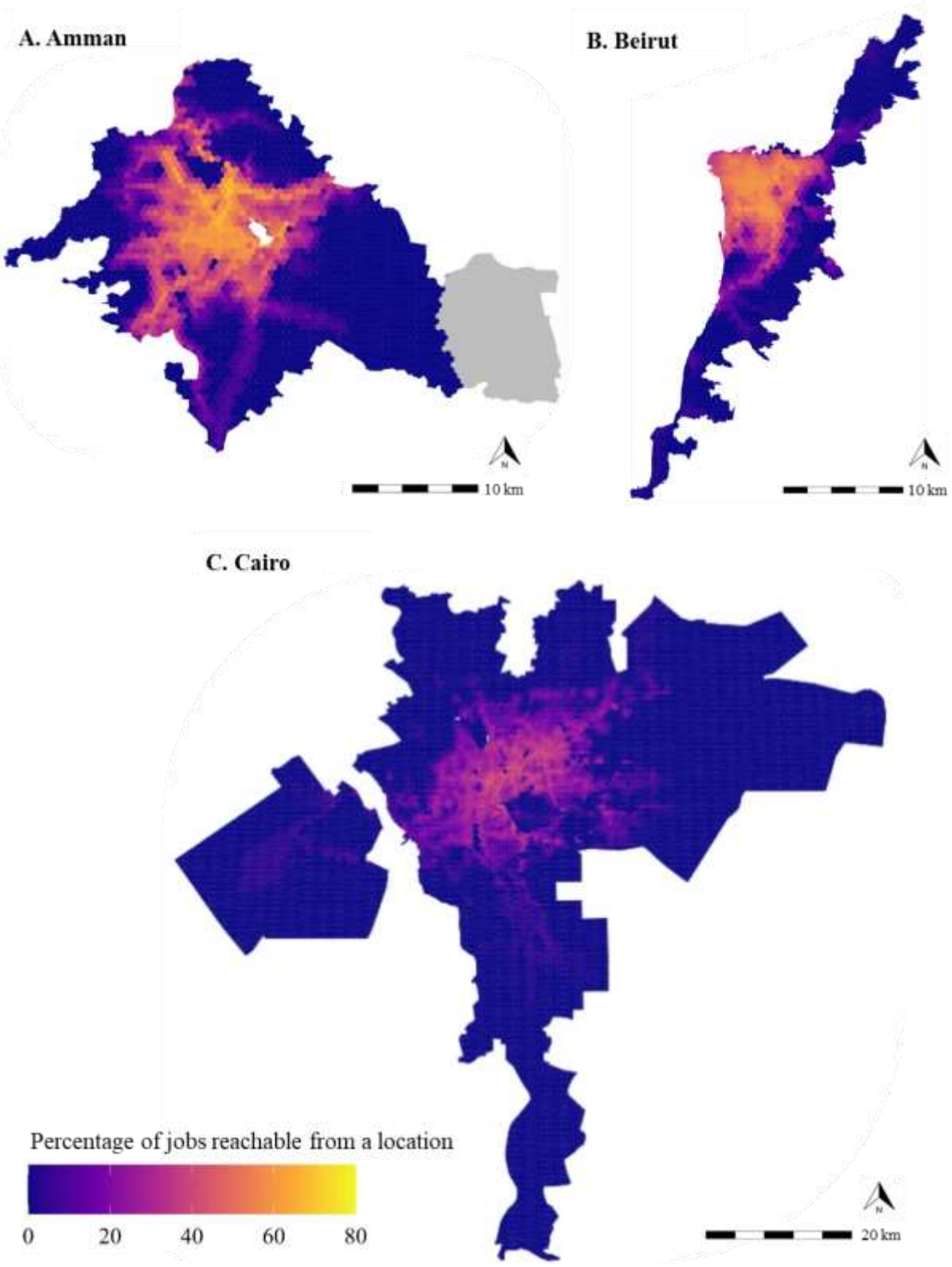
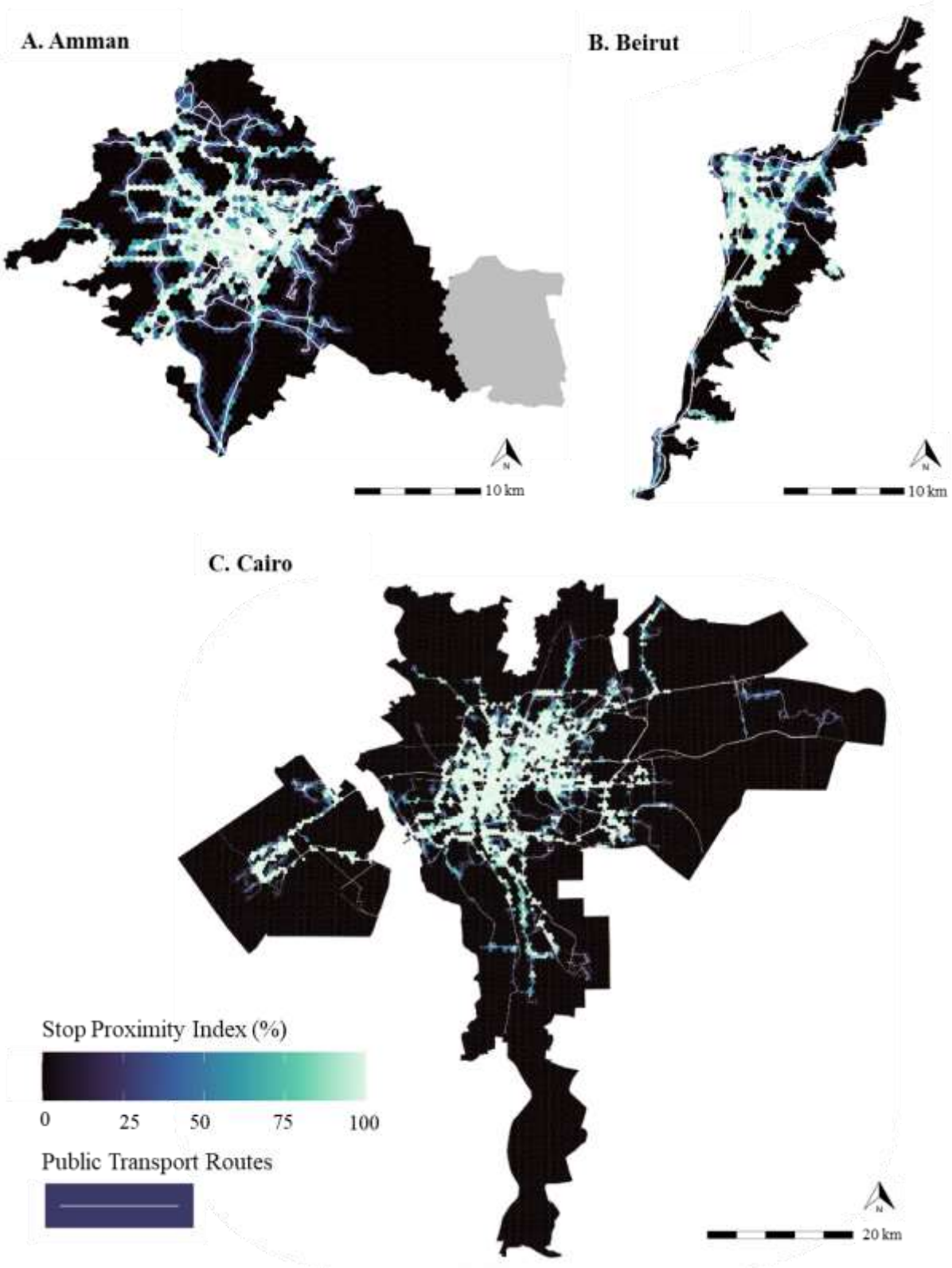


Figure 4: Maps of availability of public transport for Amman, Beirut and Cairo



c. Measuring safety

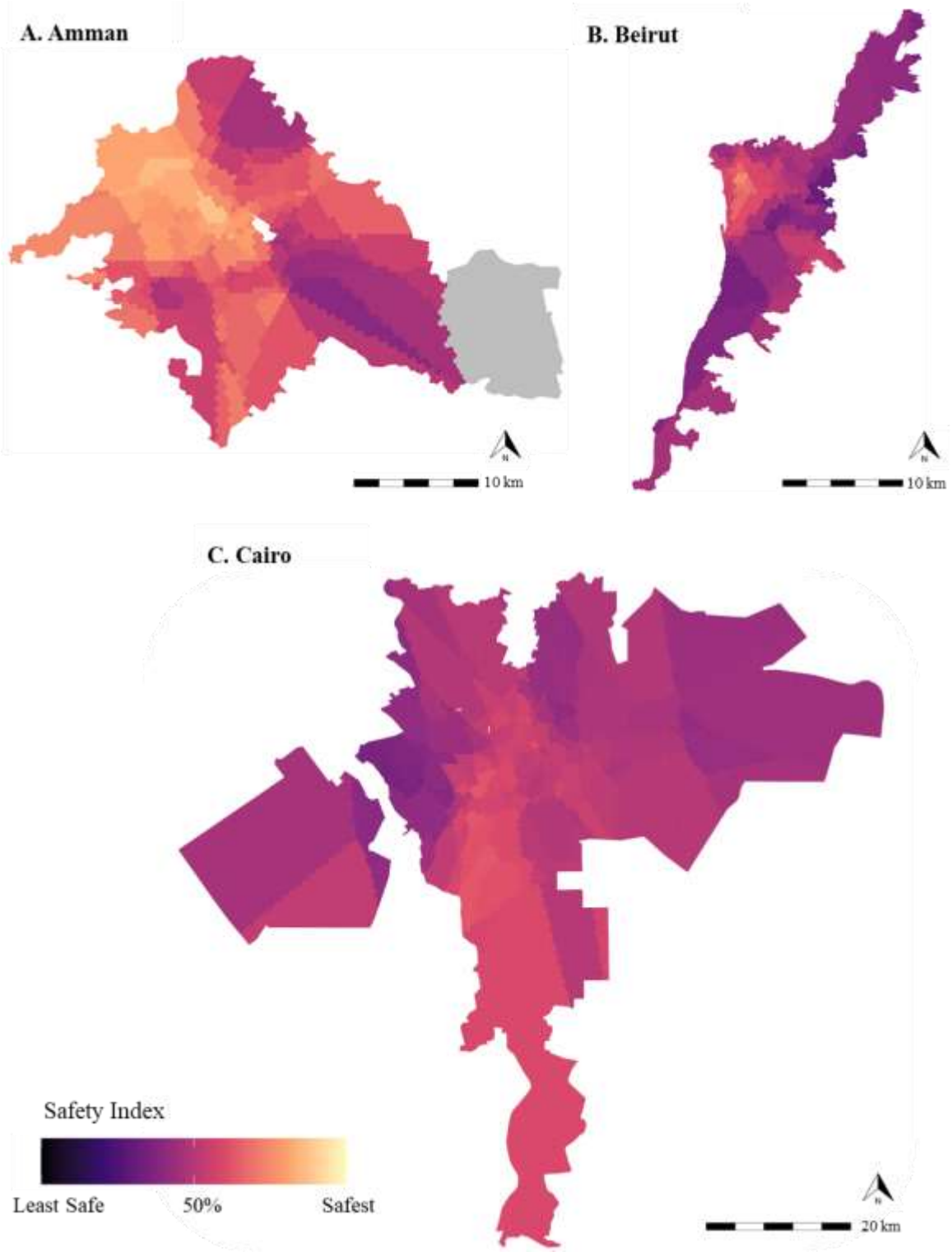
Safety focuses on the safety of the built environment at the public transit stops. It measures the level of "security" around the public transport stops. Security includes both sexual harassment and incidence of crimes. In practice, safety is measured using the built environment audits conducted in each city. Each public transit stop is assessed based on seven objective parameters (availability of lighting, walking path and security, the openness and visibility of the station, the crowdedness of the station and the presence of women – see section 2.1 for more details). Each of these parameters is assessed on a 4-item scale, and we compute a general index of safety for each station by averaging the score of these 7 parameters. The final indicator provides an index of safety with values from 0 (worse) to 100% (best). In order to pair each household with a measure of safety in their neighborhood, we assign to each household location the average index of safety of the three closest audited stations. This measure should be interpreted as a broader neighborhood level measure of safety around each household.

Figure 5 presents the maps of the safety of the built environment at public transit stops in Amman, Beirut, and Cairo. In our sample, in Amman, households have on average a safety index score of 65%. In Beirut, the same figure is at 45%, and in Cairo, it is at 52%.

d. Relationship between accessibility and availability

While the measures of accessibility and availability are distinct, they are also interlinked. The measure of accessibility covers the full journey taken by an individual to reach a job—time spent walking to the public transport stop and waiting for the public transport vehicle, time spent in the public transport vehicle and/or transiting between two or more public transport vehicles, and lastly walking to the job. In contrast, the measure of availability encompasses only on the first leg of the journey, i.e., walking to the public transport stop and waiting for the public transport vehicle. Thus, availability measures one of the elements that determines accessibility. Empirically distinguishing between accessibility and availability is important from a policy perspective. If the empirical results show that availability matters but accessibility does not, then the placement of public transport stops needs to be improved. If instead, the empirical results show that accessibility matters but availability does not, then the routing of public transport to provide access to a higher share of jobs needs to be improved. To remove this linkage and to be able to estimate the independent impact of job accessibility and availability separately, we regress accessibility on availability interacted with city fixed effects and use residual error as a measure of accessibility. By doing this, we not only reduce the correlation between accessibility and availability but also create conceptually cleaner measures for these two aspects.[24]

Figure 5: Map of safety in Amman, Beirut and Cairo



[24] In order to ensure the robustness of the results, we will also present the estimations where we exclude the measure of availability (and thus only estimate the effect of accessibility and safety, see section 4.4).

3.2. Empirical model

The goal of the empirical model is to assess whether spatial accessibility, availability, and safety of the public transport network affect the labor market outcomes of women, and whether there are differential effects of these transport measures by gender. To do so, we present two different models to account for different types of labor market outcomes: labor force participation and likelihood of having a job (employment probability).

Both labor force participation rate and employment probability are important labor market outcomes. The spatial accessibility, availability and safety of the public transport network might affect the decision to participate in the labor market (i.e., either having a job, or being unemployed but looking for a job) versus not looking for a job. In this case, we will restrict the analysis to women. This is because, much fewer working-age men are likely to be out of the labor force,[25] and including them in the analysis to understand the likelihood of participating in the labor force would not be very informative because most of them are participating in the labor force.

Second, the spatial accessibility, availability and safety of the public transport network might also affect the likelihood of being employed. In this case we will expand our analysis to both men and women. This will allow us to study both whether transport affect employment probabilities among women, and whether the effects are different by gender. The remainder of this section will explain in more detail the empirical model for each of these two outcome variables.

a. Labor force participation

The first model studies how these transport measures (accessibility, availability, and safety) affect the labor force participation of women. In order to examine the effect of transport on women's likelihood of participating in the labor force, we estimate a linear probability model akin to the one applied in Alam et al. (2021):[26]

$$LFP_{ijdc} = \beta_0 + \boldsymbol{\beta_1 T_{jdc}} + \boldsymbol{\beta_2 T_{jdc}} * \boldsymbol{City_c} + \boldsymbol{\beta_3 X_{ijdc}} + \boldsymbol{\beta_4 Y_{jcd}} + \delta_d + \varepsilon_{ijdc} \qquad (1)$$

LFP_{ijdc} is a dummy variable that takes the value of 1 if woman *i* in household *j* in district *d* in city *c* is in the labor force and 0 otherwise. $\boldsymbol{T_{jdc}}$ are the three transport measures (accessibility, availability and safety), measured at the household residential location. To account for potential

[25] In our sample, only 10% of men are not in the labor force, but for the large majority of them (8.5% of all men), it is not for staying at-home but rather because they are still students.
[26] As a robustness check, a probit model was estimated, the results are similar to the linear probability model.

differences across cities, we also include an interaction between the transport measures and the city-dummies ($\boldsymbol{T_{jdc} * City_c}$). $\boldsymbol{X_{ijdc}}$ are the individual characteristics of each woman and include age, educational attainment, marital status, and whether the woman has at least one child under the age of ten years old. $\boldsymbol{Y_{jdc}}$ are the household characteristics that include household size, house ownership, and whether there are members over 60 years old. The inclusion of both individual and household characteristics allows to account for many factors identified by the literature as affecting women's decision to participate in the labor market (see for instance Klasen & Pieters, 2015). Finally, in order to account for any characteristics at the neighborhood-level, we include district fixed effects (δ_d).[27] Notably, the city and district fixed effects account for the infrastructure provision in each city, and in each district, the industrial characteristics, the presence of policies towards women, and every type of transport policies at the city- and district-level such as the provision of different modes, the pricing structure or the availability of subsidies.

A large literature in urban economics has shown that residential location choices in cities result from trade-offs including factors such access to amenities, distance to jobs, housing quality and housing supply (Brueckner et al., 1999; Gobillon et al., 2007; Rosenthal, 2014; Picarelli et al., 2017). Higher income households may thus decide to locate in neighborhoods with better infrastructure and higher access to jobs. This would cause the transportation measures to be endogenous to our model of labor force participation. The inclusion of district fixed-effects is a first step to address the endogeneity as it accounts for all characteristics at the district-level, such as average income levels and average infrastructure levels. However, in order to ensure robustness of our results, we will apply two types of sampling restrictions to our dataset.

First, we will restrict our sample to reduce the problem of residential choice and thus reverse causality. A person's decision on where to live may be influenced by the location of jobs (some people may be jointly deciding where to live and where to work) and availability of public transport. On the one hand, people who are willing to work might decide to live in areas where public transport stops are close by, where it is safe to walk to public transport, or where public transport vehicles can quickly reach job centers. In this case, we will observe a positive relationship between our measures of availability, acceptability and safety and a person's likelihood of being active in the labor force or employed. On the other hand, a person who is employed may be able purchase a private vehicle in which case they may choose to live in more

[27] In each city, districts are defined as the admin level 2 boundaries.

suburban areas where public transport is not readily available. In this case we will observe a negative relationship between our measures of availability, acceptability and safety and a person's likelihood of being active in the labor force or employed. In both situations we will not be able to ascertain whether the availability, accessibility, and safety of public transportation plays a causal role in a person's economic empowerment. To address such concerns, we adopt two different sample restrictions. (a) we restrict our sample only to women who have been living in the same house since birth[28] (Alam et al., 2021); (b) we instead restrict our analysis only to women who lived in the same house since birth and women who moved to their current house because of marriage. Both these restrictions (while reducing the sample size) are considered to be more robust to endogeneity than the baseline regression.

Second, we will restrict the analysis to the lower-income households in our sample.[29] As we expect public transport to have a higher importance for people in the lower-income groups (Guzman & Hessel, 2022), this sample restriction is interesting from a conceptual perspective. It also has the advantage of being more robust because it removes some of the endogeneity due to income.[30]

b. Probability of employment

In a second step, we look at the effect of spatial accessibility, availability and safety of public transportation on the employment probability of both women and men. To do so, we estimate a model similar as the one for labor force participation (equation 1) with the significant difference being that we include gender interactions in order to look at the differential effects of transport by gender.

In practice, we estimate the following linear-probability model:[31]

$$\begin{aligned} Empl_{ijdc} = \beta_0 \quad &+ \quad \boldsymbol{\beta_{1a} T_{jdc} + \beta_{2a} T_{jdc} * City_c + \beta_{3a} X_{ijdc} + \beta_{4a} Y_{jdc}} \\ &+ \quad \boldsymbol{G_{ijdc} *} \quad \boldsymbol{(\beta_{1b} T_{jdc} + \beta_{2b} T_{jdc} * City_c + \beta_{3b} \widetilde{X}_{ijdc} + \beta_{4b} \widetilde{Y}_{jdc})} \quad + \delta_d + \varepsilon_{ijdc} \end{aligned} \tag{2}$$

Where $Empl_{ijdc}$ is a dummy variable that is equal to 1 if individual *i* in household *j* in district *d* in city *c* currently has a job (both employed or self-employed) and 0 otherwise (both looking for a job or out of the labor force participation). As for equation (1), $\boldsymbol{T_{jdc}}$ are the three transport measures (accessibility, availability and safety), $\boldsymbol{T_{jdc} * City_c}$ is an interaction term between

[28] This heavily weighs the sample towards single women.
[29] The lower-income group is defined for each city as the bottom-half of the income distribution within our sample.
[30] Note that because of reverse causality, we cannot control for household income in the baseline empirical model.
[31] As a robustness check, a probit model was estimated, the results are similar to the linear probability model.

each transport measure and each city indicator to account for differential effects by city. $\boldsymbol{X_{ijdc}}$ and $\boldsymbol{Y_{jdc}}$ are respectively the individual characteristics and household characteristics. The main difference with equation (1) comes from the interaction with $\boldsymbol{G_{ijdc}}$ which is the gender of the individual *i*. There is an interaction term between gender and transport measures to account for differential effects of transportation by gender, as well as a triple interaction term between gender, transportation and cities to account for the differential effect of transportation by gender to differ over city. A subset of the control variables from the individual characteristics and household characteristics are also interacted with the gender of the respondent ($\widetilde{\boldsymbol{X}}_{\boldsymbol{ijdc}}$ and $\widetilde{\boldsymbol{Y}}_{\boldsymbol{jdc}}$) - namely the marital status, whether the individual has at least one child under ten years old, and whether there is someone in the household over 60 years old – to account for the fact that all these variables could have a differential effect for men and women on their likelihood of employment. District fixed effects (δ_d) are still used in all regressions and therefore, all characteristics, including policies, at the city or district level, are accounted for in this model

As for the model of labor force participation, we will compute several sample restrictions. First, we will restrict the sample either (i) to individuals who have been living in the same house since birth or (ii) to those who have been living in the same house since birth and those who have moved to their current house because of marriage. Second, we will also restrict the sample to only the lower-income households and run the same models.

4. Results

In this section, we will start by describing the travel patterns among the working respondents in our sample. We then illustrate the correlation between these travel patterns and the three measures of the public transport network that we have constructed. Finally, we present the results of the empirical model that measures the effect of transportation on labor market outcomes.

4.1. Description of travel patterns

Since we are interested in the effect of transportation on labor market outcomes, we will start by presenting the commuting patterns from home to work for people who are currently working.

Table 4 presents the dominant mode of transportation used by people to commute from home to work and reveals how different the travel patterns are across Amman, Beirut, and Cairo.[32]

First, a sizeable share of people commuting from home to work in all three cities only use walking as a transportation mode. This share is larger for women than men in both Beirut and Cairo (respectively 19% of men versus 24% of women, and 24% of men versus 30% of women), while there are fewer women using only walking than men in Amman (25% of men versus 18% of women).

Second, in terms of public transportation, there are stark differences by city. Both men and women in Cairo tend to use much more public transportation than in either Amman or Beirut. In each city, taxi, call cabs, or equivalent are more frequently a dominant mode of transportation for women than for men. Private buses provided by employers are not very developed in Beirut, while they represent up to 10.6% of commuting women in Amman. The use of cars for commuting is much more developed in Amman and Beirut than in Cairo.

Table 4: Dominant mode used for commuting from home to work, by city and gender (percent of total)

	Amman		Beirut		Cairo	
	Men	Women	Men	Women	Men	Women
Walking	24.9	17.8	19.3	24.1	23.9	29.6
Bicycle	0	0	2.9	1.0	0.3	0
Bus/Minibus	3.9	3.8	7.8	7.9	3.0	5.1
Microbus	7.5	5.8	1.9	2.6	31.2	31.0
Metro	-	-	-	-	9.3	10.8
Train	-	-	-	-	0.4	0
Taxi, Call Cabs or equivalent*	10.4	12.7	4.1	7.3	6.7	10.5
Private bus (School/ Work/…)	3.0	10.6	0.2	0.5	3.3	3.6
Own motorcycle	0.9	0.3	15.2	1.0	6.7	0.4
Someone else's motorcycle	0.1	0	1.5	1.0	0	0
Own car	42.8	39.7	44.0	50.8	13.8	5.1
Someone else's car	5.6	9.2	3.2	3.7	0.1	2.2
Other	0.7	0	0	0	1.2	1.8
Observations	694	292	587	191	734	302

Notes: * In Amman, services (shared white-taxi with fixed routes) are included in the category Taxi, Call Cabs or equivalent, but are included in the public transport network. Figures are percent of respondents within gender and city. This table includes only respondents who work outside of home (the total is in the row "Observations"). The dominant mode is defined as the motorized mode on which the respondent spends most of their usual work commute, bicycle if no other motorized mode is used, and walking if it is the only mode used. Bicycles include other two-wheeler non-motorized vehicles. Motorcycles include other two- or three-

[32] The survey asks for all modes of transportation used during the commuting trip. The dominant mode is defined as the motorized mode on which the respondent spends most of their usual work commute, as bicycle if no other motorized mode is used, and as walking if it was the only mode of transport reported. Where there was more than one potential dominant commute mode (rare occurrences), precedence was given to larger modes (specifically precedence will be given in the following order: metro – bus/minibus – microbus – taxi – own car – someone else's car – motorcycle – someone else's motorcycle).

wheeler motorized vehicles. Cars include all type of four-wheeler motorized vehicles. Microbuses also include Coasters in Amman, vans in Beirut, Tomnaya in Cairo. Train and Metro are only available in Cairo.

Table 5 now presents the distribution of commuting time by city and gender for all modes of transport (both public and private). A sizeable share of commuters spends 20 minutes or less for a one-way trip from home to work (note that the sample only includes households residing inside the metropolitan area). On average, commuters in Beirut have shorter trips but with similar time for men and women, while in Amman and Cairo, women tend to have somewhat shorter commuting trips than men. Comparing the accessibility to jobs by public transport only (presented earlier) to the observed commuting times accounting for all modes of transport (presented here) show that private modes of transport offer a clear time advantage when getting to and from work.

Table 5: Commuting time (including all modes of transport), by city and gender (percent of total)

	Amman		Beirut		Cairo	
	Men	Women	Men	Women	Men	Women
Less than 10 min.	21.2	14.4	20.4	16.8	22.4	24.5
10 - 20 min.	26.8	28.1	40.4	34.6	24.1	28.5
20 - 30 min.	15.9	24	21.3	29.3	18.7	17.3
30 - 45 min.	19.9	23.3	14.3	16.2	19	17
45 - 60 min.	5.3	5.5	2.4	3.1	8.7	6.1
60 - 90 min.	7.1	4.1	1.2	0	6.4	5.8
More than 90 min.	3.8	0.7	0	0	0.7	0.7
Average (in minutes)	26 min.	23 min.	17 min.	18 min.	25 min.	23 min.
Observations	693	292	587	191	669	277

Finally, Table 6 presents the share of total respondents with private vehicle ownership and driving licenses (it does not restrict the sample to those who commute from home to work). The differences across cities that we have observed in Table 4 in terms of use of private cars for commuting, is also reflected here. In Amman, 66% of households own a car. In Beirut, vehicle ownership is very high with 72% of households owning a car. On the contrary, in Cairo, vehicle ownership is very low, with only 16% of households owning a car. This is also reflected in the share of people with a driving license. This difference is consistent with the finding that as cities become larger and denser, more people rely on public transport to get to places (thus reducing vehicle ownership). In every city, the share of men with a driving license is higher than the share of women.

Table 6: Vehicle ownership, driving license and use of public transportation

Share of households who:	**Amman**	**Beirut**	**Cairo**

own a bicycle		0.5		4.5		2.1
own a motorcycle		0.5		15.6		9.4
own a car		66.3		72.3		15.5
Share of respondents who:	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
have a driving license	68.9	41.7	81.9	55.3	23.5	5.7
Observations	998	997	1000	1000	894	917

Notes: Figures are percent of respondents within gender and city. Bicycles include other two-wheeler non-motorized vehicles. Motorcycles include other two- or three-wheeler motorized vehicles. Cars include all type of four-wheeler motorized vehicles. Driving license include any type of driving license.

4.2. Correlation between travel patterns and accessibility, availability and safety of the public transport network

In this section, we present the correlations between the dominant modes of transportation (as presented in Table 4) used by the respondents who work, and the three measures of the quality of public transport described previously at their residential locations. The complete correlation table is presented in Annex B. that the correlation analysis confirms that, on average, the respondents located in areas with better accessibility, availability and safety of the public transport network are more likely to use public transportation and to walk, and less likely to use private buses (provided by the employer) or private vehicles

While these correlations are informative, they do not account for any confounding factors (such as socio-economic characteristics of the respondents), and do not look at the labor market outcomes of the individuals. This is precisely what we will address in the next section.

4.3. Role of transportation in labor market outcomes

In this section we present the results of the two econometric models described above. The first measures the effect of the characteristics of the public transport network (its accessibility, availability and safety) close to women's residential locations on their likelihood of participating in the labor market, with interaction terms between transport and cities to account for potential heterogeneities of the effect of transport across cities. The second model measures the effect of the same characteristics of the public transport network close to individuals' residential locations on their likelihood of being employed (or self-employed). In this model, we include both women and men and add interaction terms between gender, transport variables and cities. Since both models include interaction effects, in this section we present the marginal effects estimated for the three transport measures by city (and gender for the second model).

Table 7 and Table 8 present the marginal effects of each transportation measures for each city for both labor market outcomes – respectively labor force participation and employment. The results for both labor force participation and employment are presented at the same time in

order to provide a complete interpretation of the effect of transport on both labor market outcomes for each city. The underlying regression results for these marginal effects are presented respectively in Annex C and Annex D. In each table, the first three columns (1a – 3a) present the result without any income restriction, while columns (1b – 3b) restrict the sample to the lower-income group. Within each of these groups, the first column (a) includes the entire sample, while columns; (b) restricts the sample only to those women who lived in the same house since birth or who moved because of marriage; and columns (c) further restricts the sample only to individuals who lived in the same house since birth. As the results for the entire sample (presented in columns (a)) suffer from endogeneity, these are presented (for completeness) but not discussed below.

Since the regression exploring the drivers of labor force participation only include women, we present marginal effects by city. And since the regression exploring the drivers of employment includes both men and women, we present marginal effects by city and gender for employment probabilities. In both instances, a positive and significant coefficient means that improving the transport measure appears to improve the labor market outcome of interest. For example, a positive coefficient for accessibility in Amman means that improving accessibility of public transport in Amman appears to increase a woman's likelihood of actively looking for a job or being employed. In contrast a negative and significant coefficient means that improving the transport measure appears to worsen/diminish the labor market outcome of interest.

Different transport measures explain women's labor force participation and men and women's likelihood of being employed across the different cities. This highlights that different transport constraints are binding for women's access to economic opportunities in different situations and there is no clear single transport constraint that explains women's low labor force participation and employment in the three cities that we study.

Table 7: Marginal effect of public transport characteristics on women's labor force participation, by city.

	No income restriction			**Lower-income group**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Accessibility						
Amman	0.096	0.142	0.255	0.370**	0.445	1.225*
	(0.12)	(0.20)	(0.33)	(0.16)	(0.31)	(0.64)
Beirut	-0.015	0.074	0.14	-0.111	0.088	0.737*
	(0.15)	(0.18)	(0.30)	(0.21)	(0.28)	(0.40)
Cairo	0.627	0.973*	1.755**	1.244**	1.558**	2.740**
	(0.42)	(0.50)	(0.85)	(0.53)	(0.61)	(1.17)

Availability						
Amman	0.037	-0.017	-0.173	0.117**	0.063	-0.061
	(0.04)	(0.08)	(0.13)	(0.06)	(0.10)	(0.19)
Beirut	0.064	0.039	0.148	-0.008	-0.033	0.263
	(0.05)	(0.07)	(0.13)	(0.08)	(0.10)	(0.18)
Cairo	0.006	0.018	0.149*	0.038	0.038	0.205*
	(0.05)	(0.06)	(0.09)	(0.05)	(0.06)	(0.12)
Safety						
Amman	-0.047	0.154	0.945**	-0.024	0.08	0.824
	(0.16)	(0.25)	(0.42)	(0.21)	(0.34)	(0.63)
Beirut	-0.488*	-0.367	-0.607	-0.790**	-0.734	-1.539
	(0.28)	(0.37)	(0.63)	(0.40)	(0.51)	(0.97)
Cairo	-0.761	-0.634	-0.448	-0.473	-0.544	-0.161
	(0.69)	(0.73)	(1.25)	(0.81)	(0.86)	(1.54)
N	2961	1732	670	1701	999	345
R^2	0.174	0.182	0.214	0.201	0.220	0.280
Adj. R^2	0.148	0.139	0.102	0.159	0.153	0.096

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations.

Table 8: Marginal effect of public transport characteristics on employment probabilities, by city and gender.

	No income restriction			**Lower-income group**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Accessibility						
Amman - Men	0.480***	0.466**	0.424*	0.505***	0.521**	0.601*
	(0.10)	(0.19)	(0.23)	(0.13)	(0.25)	(0.35)
Amman - Women	-0.166	-0.368**	-0.276	-0.094	-0.315	-0.161
	(0.11)	(0.18)	(0.38)	(0.14)	(0.23)	(0.52)
Beirut - Men	0.149	0.096	0.208	0.033	-0.198	-0.517
	(0.13)	(0.16)	(0.23)	(0.21)	(0.30)	(0.38)
Beirut - Women	0.076	0.007	0.175	0.079	0.203	0.319
	(0.12)	(0.15)	(0.22)	(0.15)	(0.21)	(0.32)
Cairo - Men	-0.092	-0.322	-0.416	-0.161	-0.226	-0.273
	(0.28)	(0.32)	(0.46)	(0.33)	(0.37)	(0.55)
Cairo - Women	-0.141	-0.238	-0.101	0.01	-0.035	0.087
	(0.31)	(0.35)	(0.51)	(0.37)	(0.41)	(0.60)
Availability						
Amman - Men	0.127***	0.153***	0.145*	0.109**	0.109	0.086
	(0.03)	(0.06)	(0.08)	(0.04)	(0.08)	(0.11)
Amman - Women	-0.099***	0.01	-0.041	-0.026	0.132	0.163
	(0.04)	(0.07)	(0.12)	(0.04)	(0.09)	(0.17)
Beirut - Men	0.015	-0.036	0.02	-0.05	-0.062	0.017
	(0.05)	(0.07)	(0.08)	(0.09)	(0.12)	(0.15)
Beirut - Women	0.012	0.003	0.063	0.007	0.031	0.094
	(0.04)	(0.05)	(0.09)	(0.06)	(0.07)	(0.13)
Cairo - Men	-0.023	-0.045	-0.05	-0.007	-0.026	-0.043
	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.06)
Cairo - Women	-0.012	-0.024	0.095	0.008	-0.012	0.102
	(0.04)	(0.05)	(0.07)	(0.05)	(0.05)	(0.08)

Safety						
Amman - Men	-0.359***	-0.395*	-0.478*	-0.355**	-0.374	-0.526
	(0.12)	(0.21)	(0.26)	(0.15)	(0.29)	(0.39)
Amman - Women	-0.254*	-0.067	0.473	-0.510***	-0.341	-0.323
	(0.15)	(0.24)	(0.45)	(0.19)	(0.31)	(0.65)
Beirut - Men	-0.083	0.331	0.668	0.084	0.568	0.873
	(0.28)	(0.38)	(0.46)	(0.46)	(0.65)	(0.74)
Beirut - Women	-0.038	0.119	-0.215	-0.446	-0.264	-0.314
	(0.23)	(0.31)	(0.56)	(0.29)	(0.43)	(0.89)
Cairo - Men	0.445	0.594	0.529	0.799	1.077*	1.07
	(0.45)	(0.49)	(0.63)	(0.51)	(0.55)	(0.78)
Cairo - Women	0.389	0.764	0.716	0.221	0.751	0.45
	(0.49)	(0.53)	(0.71)	(0.57)	(0.61)	(0.89)
N	5912	3404	1810	3242	1886	929
R2	0.293	0.309	0.272	0.359	0.378	0.354
Adj. R2	0.28	0.287	0.228	0.338	0.343	0.284

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations.

In Amman, safety at public transport stops appears to be a strong predictor for women's likelihood to participate in the labor force. For the sample of women living at home since birth,[33] a one percentage point increase in the safety at a public transport stop increases the chance of a woman actively looking for a job by 0.95 percentage points. This is in line with the findings reported by Aloul et al., (2018) suggesting that harassment is a significant concern for women in transportation, and that the main locations of harassment are in the street or waiting for the public transport at the transit stops.

While safety appears to matter for the sample of all women living in the same home since birth, when we restrict the sample to women who hail from the low-income group, the relationship with safety disappears and instead accessibility becomes a strong predictor for women's likelihood of labor force participation. For low-income households, a one percentage point increase in accessibility increases women's likelihood of actively looking for a job by 1.23 percentage points. This is consistent with the explanation that women in need will brave unsafe conditions to access jobs which imposes a negative externality on them. Availability of public transport options in close proximity to the residential location does not appear to impact women's labor force participation.

While the accessibility and safety play a role in determining women's labor force participation, they appear to have overall little impact on women's employment probability. This is consistent with the idea that while public transport plays a critical role in improving women's access to

[33] Our most robust and restrictive sample (this is also the sample of women who are on average younger and more likely to be single).

employment opportunities, making them more likely to actively look for jobs, complementary actions are needed to translate this active participation by women in the labor force to gainful employment.

In contrast to women, spatial accessibility appears to play a strong and significant role in the employment probabilities among men in Amman. This impact is presented along all sampling restrictions that we use to test the robustness of our results.[34] The results for safety would suggest that the safety of transit stops would negatively affect men's employment probability in Amman, but only at the 10% level. Since this could reflect some income effect, the restriction to lower-income individual is particularly important, and the effects are not robust to the restriction to the lower-income group.

In Beirut, it appears that public transport overall has a limited impact on women's labor force participation and men and women's likelihood of being employed. However, we do find some evidence that women from low-income households are more likely to participate in the labor force when public transport provides better accessibility to jobs spatially. For low-income households, a one percentage point increase in accessibility increases women's likelihood of actively looking for a job by 0.74 percentage points. Several factors can explain the reason why public transport does not appear to be playing a strong role in women's choice to look for work and the probability of finding employment. For nearly three years, Lebanon has been assailed by the most devastating, multi-pronged crisis in its modern history. These crises have severely depressed the Lebanese economy and impacted available employment opportunities. Given these massive disruptions, public transport may play only a small role in determining women's labor force participation and women and men's likelihood of being employed.

In Cairo, both accessibility and availability of public transport appears to play a strong role in determining women's labor force participation.[35] A one percentage point increase in the share of jobs accessible by public transport within 60 minutes leads to a 0.97 to 2.74 percentage point increase in women's likelihood to actively look for a job. This impact is stronger when the

[34] Results of table 8, column 2a suggest that accessibility for women may decrease their employment probability, but this is not robust to the sample restriction to women living in their house since birth (table, 8, column 3a). Since this second sample includes more single women, the negative effect for women in Amman can be interpreted as being concentrated among married women and therefore suggesting an intra-household decision of married couples. In other words, among married couples living in areas with better spatial accessibility of jobs, there could be a decision among spouses for men to work (potentially accessing better jobs) and women to stay at home. Since we do not observe men and women in the same households, this should be validated by further research.

[35] Econometrically, we are only able to assess binding constraints vis-à-vis labor market outcomes. This does not imply that non-binding constraints do not matter. For example, women could be braving or coping with unsafe conditions to access jobs in Cairo which imposes a negative externality on them.

sample is restricted to women hailing from low-income households. Improving availability of public transport also increases the likelihood of women participating in the labor force for the sample of women living at their present locations since birth (with and without the additional restriction to low-income households). A one percentage point increase in the availability of public transport within a 10-minute walking distance increases the chance of a woman actively looking for a job by 0.15 to 0.21 percentage points.

As in Amman, in Cairo, while transport has a strong importance for the labor force participation of women, it does not translate in a higher employment probability. Moreover, contrarily to the effects in Amman, the quality of public transport, including the spatial accessibility of jobs, does not affect men either in Cairo. However, improved safety appears to increase the likelihood of men being employed. As our measure of safety includes aspects related to the incidence of crimes such as the availability of light or openness, it is not surprising that it should also matter for men. However, these are not robust across specifications.

Finally, the underlying regression results in Annex C are also interesting to see the effect of the control variables on women's labor force participation. They show that more educated women and single women are more likely to participate in the labor force. This is valid for both the entire sample and the lower-income sample. Having people over 60 years old in the household or having a smaller household size increase the labor force participation of women on average, but these effects are no longer significant when we restrict the analysis to the lower-income women.

Similarly, the regression results presented in Annex D allow to see the effect of the individuals' and households' characteristics on their employment likelihood. They show that age increases people's probability of employment. The marital status, the presence of young children or people over 60 years impacts differently men and women – namely, being single decreases employment probabilities among men but increases it among women and having young children or people over 60 years in the household increases only men's employment probability, not women's (for people over 60 years old, the effect is not significant when we look only at the lower-income group). Finally, people in larger households have a lower employment probability.

4.4. Robustness checks

In order to ensure the robustness of our empirical analysis, we conduct two additional tests. First, we test the robustness of our results by using city specific regressions instead of a pooled

regression. While we are interested in the marginal effects of transportation measures in each individual city, we have performed all regressions on pooled data. This is done to ensure a large enough sample size and power, particularly for the regressions with sample restrictions made to ensure more robustness against endogeneity. However, in order to ensure the robustness of our results, we have conducted the same analyses separately for each city and the results lead to the same conclusions.

Second, we exclude our measure of availability of public transport from our empirical specification to test the robustness of the results for accessibility and safety. As mentioned in section 3.1, the measures of availability and accessibility are closely linked. To address this, in the baseline, we have regressed accessibility on availability interacted with city fixed effects and use the residual error as a measure of accessibility. This allowed us to estimate the effects of availability and accessibility separately, which is important from a policy perspective. Here, we propose an alternative specification to ensure the validity of our results. We estimate the same sets of regressions as the baseline but excluding the measure of availability, thus only testing for the impact of accessibility of jobs and safety at public transport stops.[36] The results for these specifications both for labor force participation and employment are presented in Annex E. Both sets of results confirm that our conclusions for the effects of accessibility and safety are robust to the new specifications with one exception, for women hailing from low-income households, the coefficient for accessibility is no longer significant.

5. Conclusion

The findings of this paper suggest that deficiencies in the public transport system pose an important barrier to women's likelihood of participating in the work force. However, there are important differences over cities in terms of the aspects of the public transport system that constrain women's labor force participation. In Amman, overall, safety of transport is an important predictor of the labor force participation of women but for women hailing from low-income households, the spatial accessibility of jobs is the most important factor. In Beirut, increasing the accessibility of public transportation has only a weak impact on women's labor force participation. This is likely because many other structural constraints to the Lebanese economy are hampering women's likelihood of participating in the labor force. In Cairo, spatial accessibility strongly affects women's labor force participation, and even more among lower-

[36] Note that in this case, the measure of accessibility is the original measure and no longer the residuals obtained from the regression of accessibility on availability interacted with fixed-effects.

income women. The availability of public transport close to where women live also plays an important role in women's labor force participation.

Even though the quality of public transport matters for the labor force participation of women, it has little impact on their employment probability. On the other hand, the spatial accessibility of jobs and availability of public transport options affects the employment of men in Amman. Transport therefore has a differential effect on men and women in Amman. And safety appears to play a role for men's employment probability in Cairo.

The results of this study demonstrate that a public transport system that does not explicitly recognize that men and women face different constraints when using public transport can exacerbate gender inequalities and limit women's access to economic opportunities. Equally importantly, a public transport system that uses a one size-fits-all-women (or -men) approach can exacerbate differences in access to opportunities within women (or men). Thus, improving accessibility, availability, and safety in the usage of public transport systems can play a crucial role in the economic empowerment of women. Which of these constraints are binding for women in a particular context requires careful inquiry (as shown in this work).

The results also demonstrate that improving public transport is necessary for enhancing women's economic activity; however, only improving public transport is not sufficient on its own without addressing other structural, social, and family related barriers. While a good public transport system improves women's participation in the labor force, converting this participation into actual employment depends on a host of supply and demand side factors. These include factors like demographic characteristics, education, and culture. They also include labor policy and labor market characteristics (such as the availability of jobs). Family-friendly workplace-policies such as the existence of day-care centers at –or close to—where people work or where they live, or flexible work arrangements may also be beneficial. Lastly, a business culture that discriminates based on gender and/or segregates based on gender in the labor markets can also be a contributing factor.[37] Thus, along with improving the accessibility, availability, and safety of public transport, policy measures that address work environment, social, and household constraints may be needed.

Accessibility to jobs in all three metropolises remains below that in many cities in developing countries where accessibility indices have been measured. This shows that prioritizing public

[37] It may also arise from a business culture at firms that does not value the contribution of female staff or favors male employment in order to avoid taking on the responsibility to provide maternity-related benefits or the potential for losing the female workers after they get married.

transport is important. All three cities are among the worst performers when connecting people to employment opportunities through public transport. This points to the need for prioritizing public transport through integrated corridor management or the creation of/improvements to mass transit (like BRTs or metro) and better last mile connectivity through paratransit or walking and cycling pathways. It also points to the need for reviewing and revising existing land regulations to allow/stimulate dense, diverse and well-designed urban development.

The results for Amman demonstrate not only the need to improve the accessibility to jobs but also provide a safe environment for women to access public transport. Improving safety requires actions to improve the built environment of public transport stops (public transport stops should be well-lit, open, and visible), but also actions to improve the paths through which people can get to public transport stops (such as walkways and bicycle paths). It also requires a way through which gender-based violence can be reported easily and a swift response to reports.

The results for Cairo demonstrate that along with improving accessibility, it is important to improve the availability of public transport near residential locations. This requires reassessing the placement of public transit stops (potentially increasing their number or modifying their placement to reduce the time taken to get to them) and enhancing the frequency of public transport vehicles.

While this paper shows that a good public transport system is a key enabler of women's labor force participation and converting this participation into employment may require a concerted effort across sectors to address the demand and supply constraints that hamper women's economic activity, it points to many avenues for future research. First, it may be of interest to assess whether certain types of public transit matter more for women than others. For example, mass transit and paratransit may have a different impact on women's mobility. Second, it may be of interest to assess the role that accessibility, availability, and safety of public transit in the joint decision of where to live and where to work. Third, it might be interesting to look at different facets of safety and their impacts on women's labor market choices, for example, safety while in a public transport vehicle instead of at public transport stops. Fourth, it might be interesting to look at the role of transport in determining whether individuals choose to be self-employed or seek formal employment. Fifth, it might be interesting to look at the role of transport not only in employment probabilities but also in the type of employment and job search radius. For example, enhancing the public transport service could improve job prospects for women as they are able to access a larger share of jobs. Lastly, it may be interesting to assess

the role of affordability of public transport as well as road/traffic safety in determining women's economic choices.

6. Bibliography

Ajibola, B. (2015). Constraints Faced by Women Vegetable Farmers in Kwara State, Nigeria and Its Agricultural Practices. *Jordan Journal of Agricultural Sciences 1*, *11*(4), 995–1005.

Alam, M. M., Cropper, M., Herrera Dappe, M., & Suri, P. (2021). *Closing the Gap: Gender, Transport, and Employment in Mumbai* [Working Paper]. World Bank. https://doi.org/10.1596/1813-9450-9569

Alam, M. M., Kurshitashvili, N., Dominguez Gonzalez, K., Gonzalez Carvajal, K., & Baruah, B. (2022). *Is a Mile for One a Mile for All?* World Bank. https://doi.org/10.1596/37354

Aloul, S., Naffa, R., & Mansour, M. (2018). *Gender in public transportation a perspective of women users of public transportation.* SADAQA, Friedrich-Ebert-Stiftung.

Anand, A., & Tiwari, G. (2006). A Gendered Perspective of the Shelter–Transport–Livelihood Link: The Case of Poor Women in Delhi. *Transport Reviews*, *26*(1), 63–80. https://doi.org/10.1080/01441640500175615

Barzin, S., Avner, P., Rentschler, J., & O'Clery, N. (2022). *Where Are All the Jobs ?: A Machine Learning Approach for High Resolution Urban Employment Prediction in Developing Countries* [Working Paper]. World Bank. https://doi.org/10.1596/1813-9450-9979

Bastiaanssen, J., Johnson, D., & Lucas, K. (2020). Does transport help people to gain employment? A systematic review and meta-analysis of the empirical evidence. *Transport Reviews*, *40*(5), 607–628. https://doi.org/10.1080/01441647.2020.1747569

Bastiaanssen, J., Johnson, D., & Lucas, K. (2022). Does better job accessibility help people gain employment? The role of public transport in Great Britain. *Urban Studies*, *59*(2), 301–322. https://doi.org/10.1177/00420980211012635

Blumenberg, E. (2004). En-gendering Effective Planning: Spatial Mismatch, Low-Income Women, and Transportation Policy. *Journal of the American Planning Association*, *70*(3), 269–281. https://doi.org/10.1080/01944360408976378

Boisjoly, G., Moreno-Monroy, A. I., & El-Geneidy, A. (2017). Informality and accessibility to jobs by public transit: Evidence from the São Paulo Metropolitan Region. *Journal of Transport Geography*, *64*, 89–96. https://doi.org/10.1016/j.jtrangeo.2017.08.005

Borker, G. (2022). *Constraints to Women's Use of Public Transport in Developing Countries, Part I*. http://hdl.handle.net/10986/37821

Brueckner, J. K., Thisse, J.-F., & Zenou, Y. (1999). Why is central Paris rich and downtown Detroit poor?: An amenity-based theory. *European Economic Review*, *43*(1), 91–107. https://doi.org/10.1016/S0014-2921(98)00019-1

Cook, N., & Butz, D. (2018). Gendered mobilities in the making: Moving from a pedestrian to vehicular mobility landscape in Shimshal, Pakistan. *Social & Cultural Geography*, *19*(5), 606–625. https://doi.org/10.1080/14649365.2017.1294702

Cuberes, D., & Teignier, M. (2016). Aggregate Effects of Gender Gaps in the Labor Market: A Quantitative Estimate. *Journal of Human Capital*, *10*(1), 1–32. https://doi.org/10.1086/683847

Dijst, M., Jayet, H., & Thomas, I. (2002). Transportation and Urban Performance: Accessibility, Daily Mobility and Location of Households and Facilities. In *Governing Cities on the Move: Functional and Management Perspectives on Transformations of European Urban Infrastructures* (Ashgate).

Dobbs, L. (2007). Stuck in the Slow Lane: Reconceptualizing the Links between Gender, Transport and Employment. *Gender, Work & Organization*, *14*(2), 85–108. https://doi.org/10.1111/j.1468-0432.2007.00334.x

Dominguez Gonzalez, K., Machado, A. L., Bianchi Alves, B., Raffo, V., Guerrero, S., & Portabales, I. (2020). *Does transport help people to gain employment? A systematic review and meta-analysis of the empirical evidence*. World Bank, Washington, DC.

El-Geneidy, A., & Levinson, D. (2006). *Access to Destinations: Development of Accessibility Measures* (No. 2006–16; Access to Destinations Study).

Fan, Y. (2012). The Planners' War against Spatial Mismatch: Lessons Learned and Ways Forward. *Journal of Planning Literature*, *27*(2), 153–169. https://doi.org/10.1177/0885412211431984

Field, E., & Vyborny, K. (2022). *Women's mobility and labor supply. Experimental evidence from Pakistan* (No. 655; ADB Economics Working Paper Series). https://www.adb.org/sites/default/files/publication/792221/ewp-655-womens-mobility-labor-supply-pakistan.pdf

Gobillon, L., Selod, H., & Zenou, Y. (2007). The Mechanisms of Spatial Mismatch. *Urban Studies*, *44*(12), 2401–2427. https://doi.org/10.1080/00420980701540937

Guzman, L. A., & Hessel, P. (2022). The effects of public transport subsidies for lower-income users on public transport use: A quasi-experimental study. *Transport Policy*, *126*, 215–224. https://doi.org/10.1016/j.tranpol.2022.07.016

ILO. (2017). *World Employment and Social Outlook: Trends for women 2017*. ILO. https://www.ilo.org/global/research/global-reports/weso/trends-for-women2017/lang--en/index.htm

ILO. (2020). *Labour force participation rate by sex and age (%)*. ILOSTAT. https://www.ilo.org/shinyapps/bulkexplorer33/?lang=en&segment=indicator&id=EAP_DWAP_SEX_AGE_RT_A&ref_area=JOR

Kain, J. F. (1992). The Spatial Mismatch Hypothesis: Three Decades Later. *Housing Policy Debate*, *3*(2), 371–460. https://doi.org/10.1080/10511482.1992.9521100

Klasen, S., & Pieters, J. (2015). What Explains the Stagnation of Female Labor Force Participation in Urban India? *The World Bank Economic Review*, *29*(3), 449–478. https://doi.org/10.1093/wber/lhv003

Lucas, K., & Porter, G. (2016). Mobilities and livelihoods in urban development contexts: Introduction. *Journal of Transport Geography*, *55*, 129–131. https://doi.org/10.1016/j.jtrangeo.2016.07.007

Minster, C., Ait Bihi Ouali, L., DiDomenico, L., & Alam, M. M. (2022). *Gendered Economic Impacts of Mobility in the MENA Region: A Literature review.* World Bank.

Palacios Santana, M., & El-Geneidy, A. (2022). Cumulative versus Gravity-based Accessibility Measures: Which One to Use? *Findings*. https://findingspress.org/article/32444-cumulative-versus-gravity-based-accessibility-measures-which-one-to-use

Peralta Quiros, T., Kerzhner, T., & Avner, P. (2019). *Exploring Accessibility to Employment Opportunities in African Cities: A First Benchmark* (SSRN Scholarly Paper No. 3434753). https://papers.ssrn.com/abstract=3434753

Picarelli, N., Jaupart, P., Chen, Y., & Moreno-Monroy, A. (2017). *Unequal Commutes. Job Accessibility & Employment in Accra* (C-33401-GHA-1; IGC Working Paper, p. 52).

Rosenthal, S. S. (2014). Are Private Markets and Filtering a Viable Source of Low-Income Housing? Estimates from a "Repeat Income" Model. *American Economic Review*, *104*(2), 687–706. https://doi.org/10.1257/aer.104.2.687

Safetipin. (2021). *Safety Audit Report, Colombo*. https://safetipin.com/wp-content/uploads/2021/06/Safety_audit_report_colombo_Safetipin.pdf

Seedhouse, A., Johnson, R., & Newbery, R. (2016). Potholes and pitfalls: The impact of rural transport on female entrepreneurs in Nigeria. *Journal of Transport Geography*, *54*, 140–147. https://doi.org/10.1016/j.jtrangeo.2016.04.013

World Bank. (2021). *Labor force participation rate, female (% of female population ages 15+) (modeled ILO estimate)—Middle East & North Africa*. The World Bank - Data. https://data.worldbank.org/indicator/SL.TLF.CACT.FE.ZS?locations=ZQ

7. Annexes

A. Details for measuring accessibility, availability and safety of the public transport network

In this annex we provide the technical details for the construction of measures of accessibility, availability, and safety.

a. Measuring accessibility

Definition

Our first measure of the public transport network focuses on measuring the spatial accessibility of job opportunities throughout the city using either public transport or walking. More precisely, for each residential location, we compute the percentage of total jobs[38] that are accessible within 60 minutes during peak hours (8am to 9am). The measure of accessibility combines the shape of the transport network with the distribution of jobs within the city to measure accessibility—combining the time taken to walk to the public transport stop, time spent in the public transport vehicle, and any time needed to walk to a job opportunity. This approach has strong support in the transport and accessibility literature (see Dijst et al., 2002; El-Geneidy & Levinson, 2006; and Palacios Santana & El-Geneidy, 2022 for a theoretical discussion and Peralta Quiros et al., 2019 for an example of practical application).

Data sources

We use various sources of data to construct this index.

First, we use a layer of the street composition for each city. All street grid data is taken from OpenStreetMap. For the three cities, there are no pedestrian restrictions, meaning all streets and links in the network are considered accessible to pedestrians.

Second, we use the public transit network that has been collected. The collected frequency of departure, and speeds by which the vehicles travel on any route are used for the analysis (see 2.1. for details and maps about this data).

Third, we use the distribution of employment in each city. We base it on Barzin et al. (2022), which estimates the relative density of employment across the metropolitan area using a machine learning implementation and data on night lights and sites from open street map to create an estimation of concentration of employment opportunities across a metropolitan area

[38] Out of all the jobs in the region.

based on patterns of economic activity. Therefore, for any area of analysis, the total sum of jobs adds up to 100% instead of representing the actual number of jobs. This has the advantage of being consistent between cities and being specifically geared to estimating informal as well as formal employment where highly localized data is not available or is inadequate.

Methodology

For each residential location, we first compute the total number of locations that are reachable within 60 minutes using only public transportation or walking. For each of these reachable locations, we compute the share of total jobs that are in that location compared to the entire region. By combining the two previous steps, we are able to compute, for each residential location, the percentage of total jobs that are reachable under 60 minutes out of all jobs in the metropolitan area.

The accessibility analysis is not run at a single point in time. It is run multiple times over the course of a given window – in this case, from 8:00 AM to 9:00 AM on a Monday. The analysis tests the travel time 60 times over the window, with each minute used as a possible departure time. Destination locations will then have a different travel time at each minute-break. The proportion of times a given cell falls within the set travel time threshold (60 minutes) is calculated (in this case, using five Monte-Carlo draws per minute), and a frequency threshold is set to 50%.

This analysis requires to rely on a few assumptions that are consistent across cities. First, the walking speed is assumed to be 3.6 km/h. This speed is chosen as representing a moderate, comfortable walking pace in an urban setting. The speed of public transport does not rely on any assumptions as it is built in the transit network data that was collected.

Second, the threshold of 20 minutes is used as the maximum walking time *per leg* of the trip. For example, an entire trip may include a 10-minute walk from home to a bus stop, and then a further 5-minute walk to connect between two buses, and another 15-minute walk to arrive at the final destination of the trip. But each of these walking times are limited to 20 minutes. This restriction is chosen to reflect particularly vulnerable and time constrained mobility. A trip could hypothetically involve walking any distance, and in networks with poor transit coverage, long walking distances may provide substantial added accessibility. However, for the purpose of this analysis focusing on women – whose movements are more time constrained, often physically constrained, and who are more vulnerable in waking long distances – a relatively

short threshold of walking time was chosen to reflect trips that people may make under relatively comfortable conditions, rather than capturing all possible more arduous trips.

Third, the analysis holds walking speeds as constant throughout the day and for all locations. However, public transport operates at given schedules, and for informal systems, average frequencies. Depending on the time of departure from home, a trip to the same location may take a different amount of time if a transport service is running every five minutes or every fifteen minutes. For low frequencies, it may be expected that people will consult a schedule – for instance, for a train running every hour – and thus time their departure from home to meet the service and optimize the length of their trip. But, often in-between situations, such as a bus route that runs every 10 or every 20 minutes, or is simply unscheduled, may be regarded as just-go-and-wait. In practice, however, this will affect the average trip time. On some occasions this trip will be quick – a random departure from home to the bus stop will see a bus arriving a minute later, meaning little waiting, and sometimes it will be long – the bus may be 9 or 19 minutes away, lengthening the trips. This also often changes over the course of the day. To account for this, the accessibility analysis is not run at a single point in time. It is run multiple times over the course of a given window – in this case, from 8:00 am to 9:00 am, to account for peak hour frequencies, speeds and an assumed morning commute. The analysis tests the length of the travel time 60 times over the window, i.e. each minute. Locations that are reached through public transport (but not those using walking only) will then have a different travel time at each iteration. The proportion of times a given destination falls within the set travel time threshold (60 minutes) is calculated, and a frequency threshold is used: 50%. This means that a given destination will be considered to be reachable from a residential location if it can be reached in under 60 minutes during at least 50% of the departures within the 8:00 window to 9:00 am window.

b. Measuring availability

Definition

Our second measure of the public transport network focuses on the availability of public transport close to the residential locations. In practice, we look at the proximity to transit stops factored by the frequency of service. This indicator is used to assess the density of service within immediate reach of the household, but without considering the destinations of the transit.

Data source

The data used for the construction of this indicator include the same street grid data and transit network data as used for the indicator on accessibility.

Methodology

We first compute for each household the number of public transport 'runs', that is the number of vehicle departures at all stops available within a 10 minute walking time over the course of an hour. We use the same 8:00 am to 9:00 am window to be consistent with the accessibility indicator and to account for the peak services during morning commutes. The walking distance are analyzed using the road-grid distance, using 3.6 km/h as walking speed and based on the same network as used for the accessibility analysis. A public transport vehicle that can be stopped continuously, is assumed to stop every 100 meters.

To give an example, a household that is within a 10-minute walk of three different bus stops, which have a bus arriving – to any destination - once an hour, every thirty minutes (i.e. 2 per hour) and every five minutes (i.e. 12 per hour) between 8 am and 9 am will have a value of 1+2+12=15 for this metric.

Once we have this number of runs, we normalize the number to obtain an index between 0 and 100%. In practice, we divide by 60 and truncate the values equal to or over 1 to be equal to 100%. This means that we have an index of an average number of bus reachable each minute between 8 am and 9 am, at a maximum distance of 10-minute walk, with the maximum being 1 bus per minute (all locations that have a higher availability will report an index=100%).

c. Measuring safety

Definition

The third and last indicator of the public transport network looks at a different aspect of transport, that can affect the decision to use public transport – namely the safety of the built environment at the public transit stops. This should be interpreted as a broader neighborhood level measure of safety.

Data source

We rely on the built environment audits conducted in the three cities and described in section 2.1.

Methodology

In each city, we have collected built environment audits for 50 stations throughout the metropolitan area.[39] Each station is assessed based on seven objective parameters (availability of lighting, walking path and security, the openness and visibility of the station, the crowdedness of the station and the presence of women – see section 2.1 for more details). Each of these parameters is assessed on a 4-item scale, and we compute a general index of safety for each station by averaging the score of these 7 parameters. The final indicator provides an index of safety with values from 0 (worse) to 100% (best).

In order to pair each household with a measure of safety in their neighborhood, we assign to each household location the average index of safety of the three closest audited stations.

[39] In Amman, there are a total of 49 station as one was considered as an outlier during the data cleaning phase.

B. Correlation between dominant mode of transport and public transport measures

Table 9: Pairwise correlations between dominant mode of transportation used by commuters and quality of the public transport network

	Amman			Beirut			Cairo		
Dominant mode	**Accessibility**	**Availability**	**Safety**	**Accessibility**	**Availability**	**Safety**	**Accessibility**	**Availability**	**Safety**
Walking or bicycle				0.10**		0.05*			
Bus/Minibus	0.09**	0.09**		0.08*	0.07*		0.07*		
Microbus									
Metro	-	-	-	-	-	-	0.12**		
Train	-	-	-	-	-	-	-0.07*		
Taxi, call cabs or equivalent	0.22**	0.18**	0.08**						
Private bus (work)	-0.14**	-0.08*	-0.13**				-0.07*		-0.09**
Private vehicle	-0.14**	-0.13**		-0.21**	-0.13**	-0.13**			

Notes: *, ** denote significance at the 5 percent and 1 percent respectively. Correlations are printed in the table only if the correlation is significant at least at the 5 percent level. [a] In Amman, services (shared white-taxi with fixed routes) are included in the category Taxi, Call Cabs or equivalent, but are included in the public transport network. The dominant mode is defined as the motorized mode on which the respondent spends most of their usual work commute, bicycle if no other motorized mode is used, and walking if it is the only mode used. Train and Metro are only available in Cairo.

C. Regression results: effect of transportation on women's labor force participation

	No income restriction			Lower-income group		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Amman	-0.55	-0.611	-0.773	-0.467	-0.618	-0.422
	(0.47)	(0.51)	(0.92)	(0.54)	(0.61)	(1.13)
Beirut	-0.468	-0.42	0.035	-0.285	-0.343	0.469
	(0.47)	(0.51)	(0.93)	(0.56)	(0.62)	(1.15)
Accessibility	0.627	0.973*	1.755**	1.244**	1.558**	2.740**
	(0.42)	(0.50)	(0.85)	(0.53)	(0.61)	(1.17)
Amman*Accessibility	-0.531	-0.832	-1.5	-0.874	-1.113	-1.516
	(0.43)	(0.54)	(0.91)	(0.55)	(0.68)	(1.31)
Beirut*Accessibility	-0.642	-0.899*	-1.615*	-1.355**	-1.470**	-2.003
	(0.44)	(0.54)	(0.90)	(0.57)	(0.67)	(1.23)
Availability	0.006	0.018	0.149*	0.038	0.038	0.205*
	(0.05)	(0.06)	(0.09)	(0.05)	(0.06)	(0.12)
Amman*Availability	0.031	-0.035	-0.322**	0.079	0.026	-0.266
	(0.06)	(0.10)	(0.16)	(0.08)	(0.12)	(0.22)
Beirut*Availability	0.059	0.021	-0.001	-0.046	-0.071	0.058
	(0.07)	(0.09)	(0.16)	(0.10)	(0.12)	(0.22)
Safety	-0.761	-0.634	-0.448	-0.473	-0.544	-0.161
	(0.69)	(0.73)	(1.25)	(0.81)	(0.86)	(1.54)
Amman*Safety	0.715	0.788	1.392	0.449	0.623	0.985
	(0.71)	(0.77)	(1.33)	(0.84)	(0.92)	(1.68)
Beirut*Safety	0.274	0.267	-0.159	-0.318	-0.191	-1.379
	(0.74)	(0.82)	(1.41)	(0.90)	(1.00)	(1.82)
Age	0	-0.001	0.009***	-0.001	-0.001	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education (years of)	0.028***	0.025***	0.036***	0.020***	0.017***	0.024**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)
Single (vs. Married)	0.153***	0.152***	0.032	0.151***	0.159***	0.106
	(0.02)	(0.03)	(0.05)	(0.03)	(0.04)	(0.07)
Has children under 10y	0.021	0.014	-0.204**	-0.014	-0.012	-0.217
	(0.02)	(0.03)	(0.09)	(0.03)	(0.04)	(0.13)
People over 60y in household	0.064***	0.065**	0.058	0.031	0.046	0.048
	(0.02)	(0.03)	(0.04)	(0.03)	(0.05)	(0.07)
Home ownership	-0.083***	-0.035	0.036	-0.089***	-0.032	0.103
	(0.02)	(0.03)	(0.06)	(0.03)	(0.04)	(0.08)
Household size	-0.015**	-0.026***	-0.013	-0.008	-0.012	0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Constant	0.714	0.649	0.006	0.703	0.74	-0.037
	(0.46)	(0.49)	(0.89)	(0.52)	(0.56)	(1.08)
N	2961	1732	670	1701	999	345
R^2	0.174	0.182	0.214	0.201	0.22	0.28
Adj. R^2	0.148	0.139	0.102	0.159	0.153	0.096
Fixed-Effects	District	District	District	District	District	District

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations. District-level fixed effects, their coefficients are not presented in the table. Baseline category for city=Cairo.

D. Regression results: effect of transportation on women's and men's employment probabilities

	No income restriction			Lower-income group		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Women	-0.457***	-0.601***	-0.673**	-0.19	-0.372*	-0.293
	(0.15)	(0.18)	(0.28)	(0.18)	(0.21)	(0.36)
Amman	0.437	0.547	0.699	0.615*	0.765*	1.104*
	(0.30)	(0.34)	(0.45)	(0.35)	(0.41)	(0.58)
Beirut	0.162	0.097	0.03	0.114	0.111	0.16
	(0.32)	(0.36)	(0.46)	(0.39)	(0.46)	(0.61)
Women*Amman	-0.066	-0.102	-0.287	-0.263	-0.324	-0.386
	(0.19)	(0.26)	(0.43)	(0.23)	(0.34)	(0.60)
Women*Beirut	-0.095	0.161	0.652	-0.05	0.255	0.382
	(0.21)	(0.27)	(0.41)	(0.28)	(0.37)	(0.60)
Accessibility	-0.092	-0.322	-0.416	-0.161	-0.226	-0.273
	(0.28)	(0.32)	(0.46)	(0.33)	(0.37)	(0.55)
Women*Accessibility	-0.049	0.084	0.315	0.171	0.191	0.36
	(0.23)	(0.25)	(0.37)	(0.28)	(0.30)	(0.44)
Amman*Accessibility	0.572*	0.788**	0.841	0.667*	0.746*	0.873
	(0.29)	(0.38)	(0.52)	(0.35)	(0.45)	(0.66)
Beirut*Accessibility	0.241	0.419	0.624	0.195	0.027	-0.244
	(0.31)	(0.36)	(0.52)	(0.39)	(0.48)	(0.67)
Women*Accessibility*Amman	-0.597**	-0.919***	-1.015*	-0.771**	-1.027**	-1.121
	(0.26)	(0.35)	(0.55)	(0.33)	(0.42)	(0.73)
Women*Accessibility*Beirut	-0.025	-0.174	-0.348	-0.125	0.21	0.477
	(0.27)	(0.31)	(0.45)	(0.35)	(0.43)	(0.61)
Availability	-0.023	-0.045	-0.05	-0.007	-0.026	-0.043
	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.06)
Women*Availability	0.011	0.021	0.146**	0.015	0.014	0.146
	(0.04)	(0.05)	(0.07)	(0.05)	(0.06)	(0.09)
Amman*Availability	0.150***	0.199***	0.195**	0.116**	0.135	0.129
	(0.05)	(0.07)	(0.10)	(0.06)	(0.09)	(0.13)
Beirut*Availability	0.038	0.009	0.07	-0.043	-0.036	0.06
	(0.06)	(0.08)	(0.10)	(0.10)	(0.13)	(0.17)
Women*Availability*Amman	-0.238***	-0.165*	-0.331**	-0.150**	0.009	-0.068
	(0.06)	(0.09)	(0.15)	(0.08)	(0.12)	(0.20)
Women*Availability*Beirut	-0.014	0.018	-0.102	0.043	0.079	-0.069
	(0.07)	(0.09)	(0.13)	(0.11)	(0.15)	(0.21)
Safety	0.445	0.594	0.529	0.799	1.077*	1.07
	(0.45)	(0.49)	(0.63)	(0.51)	(0.55)	(0.78)
Women*Safety	-0.056	0.17	0.186	-0.577*	-0.326	-0.619
	(0.30)	(0.34)	(0.51)	(0.34)	(0.39)	(0.66)
Amman*Safety	-0.804*	-0.989*	-1.008	-1.153**	-1.451**	-1.595*
	(0.47)	(0.53)	(0.69)	(0.53)	(0.63)	(0.87)
Beirut*Safety	-0.528	-0.263	0.138	-0.715	-0.509	-0.196
	(0.53)	(0.62)	(0.78)	(0.68)	(0.85)	(1.08)
Women*Safety*Amman	0.161	0.158	0.765	0.422	0.358	0.823
	(0.35)	(0.45)	(0.71)	(0.41)	(0.56)	(0.98)
Women*Safety*Beirut	0.101	-0.382	-1.069	0.047	-0.506	-0.568
	(0.46)	(0.57)	(0.85)	(0.62)	(0.84)	(1.30)
Age	0.006***	0.005***	0.007***	0.005***	0.004***	0.003

	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education (years of)	0.009***	0.008***	0.004	-0.002	-0.003	-0.007
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Single (vs. Married)	-0.172***	-0.183***	-0.157***	-0.142***	-0.183***	-0.174***
	(0.02)	(0.03)	(0.04)	(0.03)	(0.04)	(0.05)
Women*Single	0.238***	0.205***	0.128**	0.188***	0.173***	0.131*
	(0.03)	(0.04)	(0.06)	(0.04)	(0.05)	(0.08)
Has children under 10y	0.071***	0.102***	0.071*	0.077***	0.086**	0.110**
	(0.02)	(0.03)	(0.04)	(0.03)	(0.04)	(0.05)
Women*children under 10y	-0.014	-0.034	-0.200**	-0.04	-0.019	-0.183*
	(0.03)	(0.04)	(0.08)	(0.04)	(0.05)	(0.11)
People over 60y in household	0.054**	0.064**	0.058*	0.046	0.055	0.072
	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)
Women*People over 60y	0.007	0.019	0.042	0.003	0.022	0.002
	(0.03)	(0.04)	(0.05)	(0.05)	(0.06)	(0.08)
Home ownership	-0.027**	0.008	0.01	-0.040**	0.014	0.054
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)
Household size	-0.019***	-0.028***	-0.024***	-0.019***	-0.019***	-0.022**
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Constant	0.343	0.254	0.118	0.362	0.224	0.054
	(0.29)	(0.32)	(0.41)	(0.33)	(0.36)	(0.51)
N	5912	3404	1810	3242	1886	929
R2	0.293	0.309	0.272	0.359	0.378	0.354
Adj. R2	0.28	0.287	0.228	0.338	0.343	0.284
Fixed-Effects	District	District	District	District	District	District

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations. District-level fixed effects, their coefficients are not presented in the table. Baseline category for city=Cairo.

E. Regression results when excluding availability

Table 10: Marginal effect of public transport characteristics on women's labor force participation by city, excluding availability.

	No income restriction			Lower-income group		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Accessibility						
Amman	0.098	0.047	-0.123	0.338***	0.271	0.300
	(0.09)	(0.16)	(0.29)	(0.12)	(0.24)	(0.43)
Beirut	0.098	0.082	0.261	-0.043	-0.027	0.625*
	(0.11)	(0.14)	(0.24)	(0.16)	(0.21)	(0.36)
Cairo	0.229	0.416	1.328**	0.579	0.694	1.815**
	(0.32)	(0.40)	(0.64)	(0.39)	(0.46)	(0.85)
Safety						
Amman	-0.047	0.169	1.028**	-0.022	0.107	0.898
	(0.16)	(0.25)	(0.43)	(0.21)	(0.34)	(0.65)
Beirut	-0.459	-0.363	-0.506	-0.774*	-0.773	-1.56
	(0.28)	(0.36)	(0.61)	(0.40)	(0.52)	(0.97)
Cairo	-0.603	-0.364	-0.204	-0.241	-0.154	0.215
	(0.68)	(0.72)	(1.21)	(0.81)	(0.84)	(1.53)
N	2961	1732	670	1701	999	345
R^2	0.173	0.180	0.208	0.199	0.214	0.266
Adj. R^2	0.148	0.138	0.100	0.159	0.149	0.088

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations.

Table 11: Marginal effects of public transport characteristics on employment probabilities, by city and gender, excluding availability.

	No income restriction			Lower-income group		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Sample restriction	All	Birth + Marriage	Birth	All	Birth + Marriage	Birth
Accessibility						
Amman - Men	0.406***	0.429***	0.402**	0.381***	0.410**	0.394
	(0.07)	(0.13)	(0.18)	(0.10)	(0.18)	(0.26)
Amman - Women	-0.220***	-0.164	-0.183	-0.078	0.081	0.214
	(0.08)	(0.15)	(0.26)	(0.10)	(0.20)	(0.37)
Beirut - Men	0.07	-0.013	0.095	-0.055	-0.175	-0.192
	(0.09)	(0.12)	(0.16)	(0.16)	(0.21)	(0.27)
Beirut - Women	0.033	-0.012	0.131	0.027	0.121	0.311
	(0.08)	(0.10)	(0.17)	(0.11)	(0.15)	(0.25)
Cairo - Men	-0.124	-0.324	-0.282	-0.099	-0.22	-0.207
	(0.21)	(0.25)	(0.36)	(0.25)	(0.28)	(0.42)
Cairo - Women	-0.129	-0.214	0.289	0.056	-0.060	0.400
	(0.24)	(0.28)	(0.40)	(0.29)	(0.32)	(0.48)
Safety						
Amman - Men	-0.348***	-0.394*	-0.476*	-0.323**	-0.37	-0.508
	(0.12)	(0.21)	(0.26)	(0.15)	(0.29)	(0.39)
Amman - Women	-0.251*	-0.098	0.448	-0.522***	-0.397	-0.377
	(0.15)	(0.24)	(0.43)	(0.18)	(0.31)	(0.63)
Beirut - Men	-0.112	0.286	0.628	0.031	0.585	0.978
	(0.27)	(0.37)	(0.46)	(0.44)	(0.64)	(0.76)
Beirut - Women	-0.049	0.119	-0.219	-0.468	-0.293	-0.366
	(0.23)	(0.31)	(0.54)	(0.29)	(0.43)	(0.90)
Cairo - Men	0.445	0.585	0.401	0.782	1.082**	1.032
	(0.45)	(0.48)	(0.62)	(0.51)	(0.54)	(0.76)
Cairo - Women	0.388	0.754	0.583	0.206	0.757	0.396
	(0.49)	(0.52)	(0.69)	(0.56)	(0.60)	(0.87)
N	5912	3404	1810	3242	1886	929
R2	0.293	0.308	0.271	0.359	0.376	0.350
Adj. R2	0.281	0.288	0.230	0.339	0.343	0.285

Notes: *, **, *** denote significance at the 10 percent, 5 percent and 1 percent levels respectively. Robust standard errors in parentheses. N: number of observations.