

Market Access and Development of the ICT Sector in the West Bank

Chiara Fratto

Elisa Giannone



WORLD BANK GROUP

Middle East and North Africa Region

Office of the Chief Economist

October 2020

Abstract

Despite the popular view that, with the advent of digital technologies, the world has become flat, geography still plays a key role in the economy. COVID-19 has brought even more awareness of this. This paper studies the impact of security measures that have reduced the mobility of people and goods on the industrial composition of the West Bank economy, and, in particular, on the development of the information and communications technology sector. The paper identifies different channels through which changes in market access due to the introduction of mobility restrictions can differentially affect industries. A newly designed survey instrument is used to identify and disentangle these mechanisms separately. This novel data set contains information on more than 500 establishments that are representative of different sectors of the economy,

including information and communications technology, manufacturing, and retail trade. The analysis finds that the mobility restrictions involved a reallocation of resources toward the information and communications technology sector, as the industry was relatively less affected by the restrictions. Yet, the key role of the input-output linkages, strong dependence on local clients and suppliers, and deep interconnectedness of the information and communications technology sector with other domestic industries severely limit the extent to which the sector can benefit from the reduction in opportunity cost. An industrial strategy focusing on the harmonious development of the entire economy is advised, rather than targeting a specific industry in isolation from the rest.

This paper is a product of the Office of the Chief Economist, Middle East and North Africa Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://www.worldbank.org/prwp>. The authors may be contacted at cfratto@imf.org.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Market Access and Development of the ICT Sector in the West Bank

Chiara Fratto^{*} and Elisa Giannone[†]

Keywords: ICT, market access, input-output, mobility restrictions, West Bank
JEL codes: O18, F1, O25, O33, R1

1 Introduction

Despite the popular view that, with the advent of digital technologies, the world has become flat ([Friedman \(2005\)](#)), geography still plays a key role in the economy. We commute every day, and merchandise gets shipped every day. People and goods travel constantly and costs are not trivial. This is true at a large scale for shipments along the global supply chains as well as at a smaller scale for daily commutes of workers. Geography has become even more important in the COVID-19 era, with teleworking, travel restrictions, lockdowns, and the disruption of the global supply chain ([Papanikolaou and Schmidt \(2020\)](#), [Dingel and Neiman \(2020\)](#)).

Some industries are affected by spatial concerns more than others ([Kolko \(2010\)](#)). Distance can be an impediment to access international markets or a protectionist device to nurture local firms ([Krishna and Krueger \(1995\)](#)). So, this begs the question: in a world with scarce resources, would one dollar be better invested towards shortening distances, such

^{*}Chiara Fratto (corresponding author), cfratto@imf.org, International Monetary Fund, 700 19th St NW, Washington, DC 20431.

[†]Elisa Giannone, Pennsylvania State University, State College, PA 16801.

[‡]The authors acknowledge the generous funding of PEDL-CEPR Exploratory Grant and the World Bank. The authors wish to thank all the participants of the 2019 World Bank's workshop on the digital economy in MENA for their valuable feedback, and in particular Daniel Lederman, Christina Wood, Bob Rijkers, and Ana Paula Cusolito. We are grateful to conference and seminar participants for their helpful comments and suggestions, including Fernando Alvarez, Faisal Awartani, Ufuk Akcigit, Chris Blattman, Jonathan Dingel, Richard Hornbeck, Erik Hurst, Rula Kher, Eliana La Ferrara, Omar Omran, Alessandra Voena. We thank Elia Pietro Boe for his excellent research assistance, and Alpha International for Research Polling, and Informatics for its technical assistance. The views expressed in the paper are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management. The views expressed in the paper do not necessarily presented the views of the Palestinian Central Bureau of Statistics.

as building a road, or towards the development of industries that can naturally overcome distance, such as the information and communication technology (ICT) sector? The ICT sector is a promise for a “productivity miracle” (Bloom et al. (2012)). Focusing on goods sold virtually like software development, application development, and website design, the ICT sector is able to absorb the supply of a high skilled labor force in the area while being less susceptible to mobility restrictions. In addition, ICT has an important role in accounting for aggregate productivity (Draca et al. (2006)). However, as much as we think of ICT as being able to overcome physical barriers, the sector is still deeply affected by them. ICT heavily relies on other industries for its inputs, and an important part of the sector is non-tradable, linked to face-to-face interaction with clients, suppliers, and among employees.¹

The West Bank, a territory interspersed with checkpoints and other mobility restrictions, is an almost ideal place to address these questions. Since 2000, mobility restrictions resulted in a dramatic increase in travel times and transportation costs (figure 1). In the meantime, the Palestinian ICT sector has witnessed a significant expansion, partially driven by the outpouring of foreign investment and foreign aid. Palestinian programmers are employed either directly or via outsourcing by Israeli companies. The largest, Mellanox, employs 125 Palestinians in the West Bank and 25 in Gaza. Other Israel-based ICT firms – Cisco, Microsoft, Intel, Sun-Disk – employ Palestinian workers, attracted by the large pool of cheap, high-skilled labor.² The Palestinian ICT sector has focused on the production of intangible products that require high human capital and low physical capital. This is the case, for instance, of Yamsafer, an online booking website and one of the most successful ICT startups in the West Bank. Established in 2011 thanks to venture capital money, it successfully raised \$3.5 million in its second investment round in June 2015. Donors have often seen the Palestinian ICT as the golden goose, the solution to (physical) barriers and obstacles Palestinians face, and the hope to bring the economy into the new century.³ In 2012, the New York Times wrote “Compared with other industries that the anemic West Bank economy might look to develop, the information and communications technology sector has an advantage: it is much less affected by impediments to movement, like the barriers, checkpoints and permit requirements that Israel imposes on the territory in the name of security.”⁴ As recently as June 15, 2020, the World Bank made the same bet, promising to invest \$15 million in the Palestinian sector,⁵ arguing that “the outlook for the Palestinian IT sector is promising if the right actions are taken.”⁶

We investigate how and to what extent the Palestinian ICT sector can overcome the barriers to the movement of people and goods, and how this has affected the industrial

¹In addition, innovation and technology are important determinants themselves of spatial agglomeration (Davis and Dingel (2019)).

²Senor and Singer (2011) describes the role of startups and technological innovation in Israel.

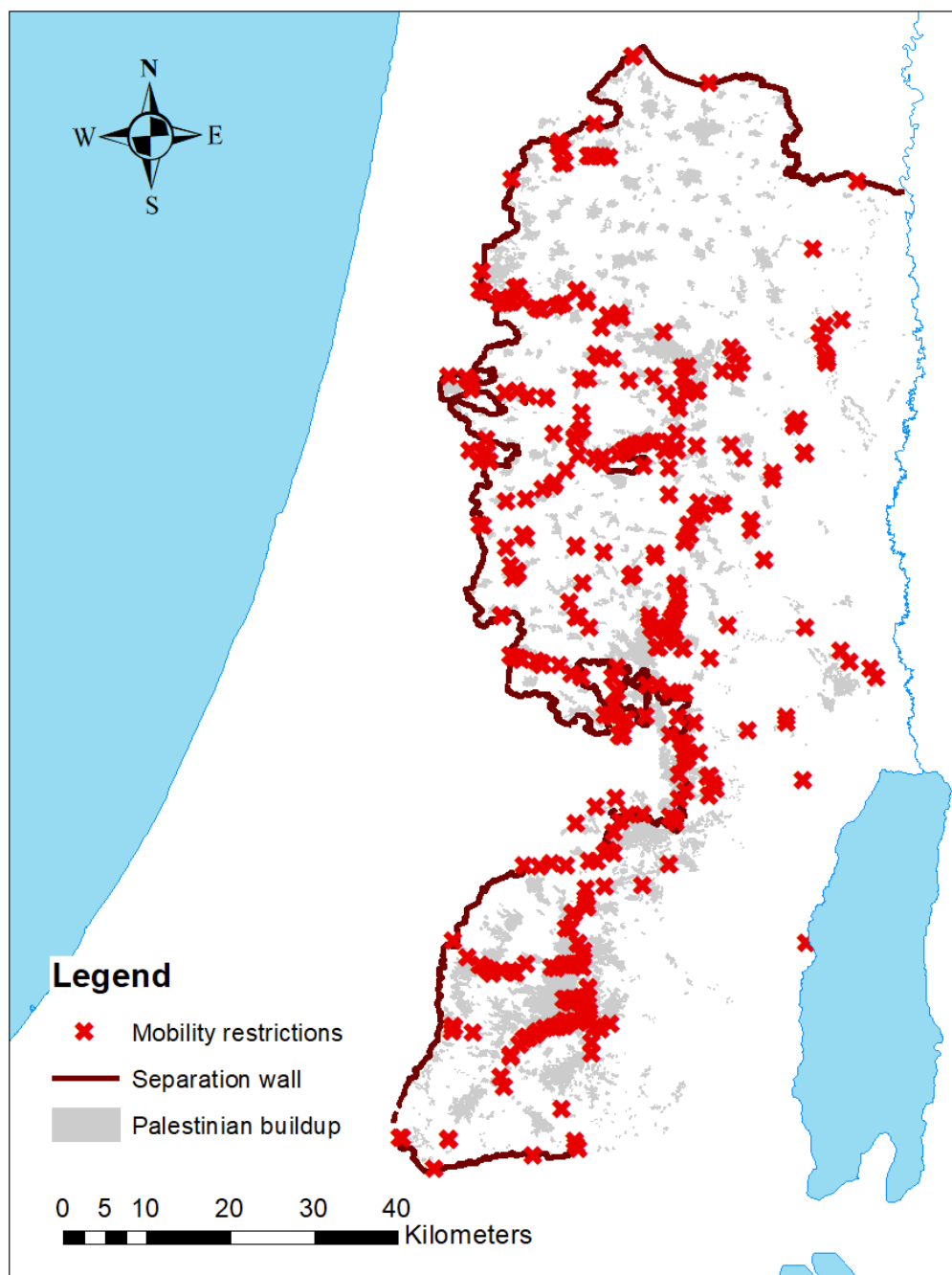
³See The Portland Trust (2013) for an analysis of the IT sector.

⁴New York Times, July 29, 2012. West Bank’s Emerging Silicon Valley Evades Issues of Borders.

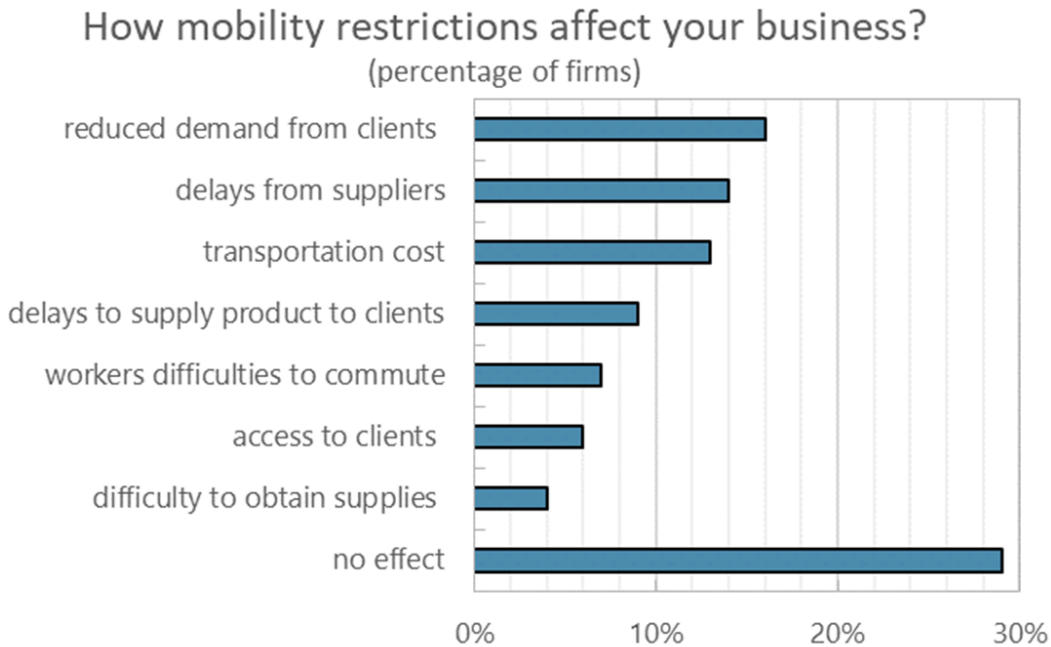
⁵World Bank, Press Release, June 15, 2020

⁶World Bank senior private sector specialist Iulia Cojocaru, according to The Jerusalem post, June 15, 2020.

Figure 1: Mobility Barriers in the West Bank



Notes: Mobility restrictions in 2014. The map displays the position of obstacles (checkpoints, roadblocks, and earthmounds) and the separation wall (constructed sections only).
Source: UNOCHA.



Source: Authors' survey.

composition of the West Bank.⁷ We combine original data collected in the field with state-of-the-art modeling tools. First, we develop a multi-industry model based on [Eaton and Kortum \(2002\)](#) to identify and describe the possible mechanisms that make the ICT sector different from the other sectors. Second, our new data and our newly designed survey instrument instruct the model and allow us to calibrate key parameters. Third, we compare and quantify the different channels in counterfactual experiments.

The survey we designed collects the responses of 533 firms to face-to-face interviews on a variety of topics. Among other questions, we asked owners how mobility restrictions impact their businesses. The answers highlight the relevance of the interactions with clients and suppliers. Transportation costs are only a small part of the impact on firms: 16% of the respondents said that mobility restrictions reduce demands from clients. We have experienced this in the COVID-19 world as well, where for instance people prefer to cook at home rather than eat out. Among the respondents, 14% said they have experienced increased delays from suppliers; 13% said they have increased transportation costs. One-third said they could not discern any effect.

This paper unpacks why market access matters, and points to the key role of input-output

⁷[Etkes and Zimring \(2015\)](#) study the effect of the Gaza blockade. Compared to theirs, this paper has a more granular assessment of industry heterogeneity in the impact of mobility restrictions. [Ihle and Rubin \(2013\)](#) wrote on the effect of mobility restrictions on the price of cucumbers and apples. See [Abrahams \(2015\)](#) for more on the welfare effect of mobility restrictions on workers. [Amodio and Di Maio \(2017\)](#) study the effect of trade restrictions on manufacturing.

linkages (Donaldson and Hornbeck (2016)). Although all industries would benefit from the removal of mobility restrictions, part of the development of the ICT sector is attributable to a reallocation of resources away from manufacturing and retail trade, which are more affected by the mobility restrictions. And yet, the ICT sector still suffers from the introduction of mobility restrictions, impaired by low domestic demand. Most of the ICT firms interviewed do not export abroad, but rather produce for the domestic market. Palestinians spend only 9% of their income in ICT goods and services;⁸ and ICT constitutes only a small fraction of the material inputs used by other industries.⁹ The result is an anemic growth, even in the presence of a favorable shift in the opportunity costs to invest in the industry. Input-output linkages are an extremely important mechanism: in their absence, mobility restrictions have almost no impact on the economy.

No single industry lives in isolation. Industrial policies supporting more competitive sectors increases productivity growth (Aghion et al. (2015)). In these times of automation, policy makers often propose industrial policies and employment protection programs focused on promoting a specific industry. However, the relevance of input-output linkages suggests a scope for designing industrial plans that focus on the harmonious development of all industries, rather than focusing on a single one.¹⁰ Industry-specific projects that do not acknowledge the interconnectedness of the industries are bound to fail. To get the most out of the development of the ICT sector, countries also need to work on improving the overall competitiveness (The World Bank, 2016). The COVID-19 outbreak and the resulting disruption of the global supply chain also point at the importance of the domestic market for the resilience of industries.

Although the paper does not deal with agglomerations, our results speak to the geographical clustering of ICT firms. The industry’s sensitivity to mobility barriers could be a contributing factor to explaining why ICT firms are clustered in or near high-population-density centers, rather than in rural areas. In this sense, the industry might be similar to older industries, such as manufacturing.

The rest of the paper develops as follows. Section 2 describes the institutional background. Section 3 reports the data used for the project, including details from the survey. Section 4 develops the model. Section 5 describes the mechanisms through which changes in market access affect the industrial composition of the economy and how they are linked to the model. Section 6 presents the results from the survey and the calibration. In section 7, we perform a number of counterfactual exercises. In section 8, we describe the role of input-output linkages. Section 9 concludes.

2 Institutional Background

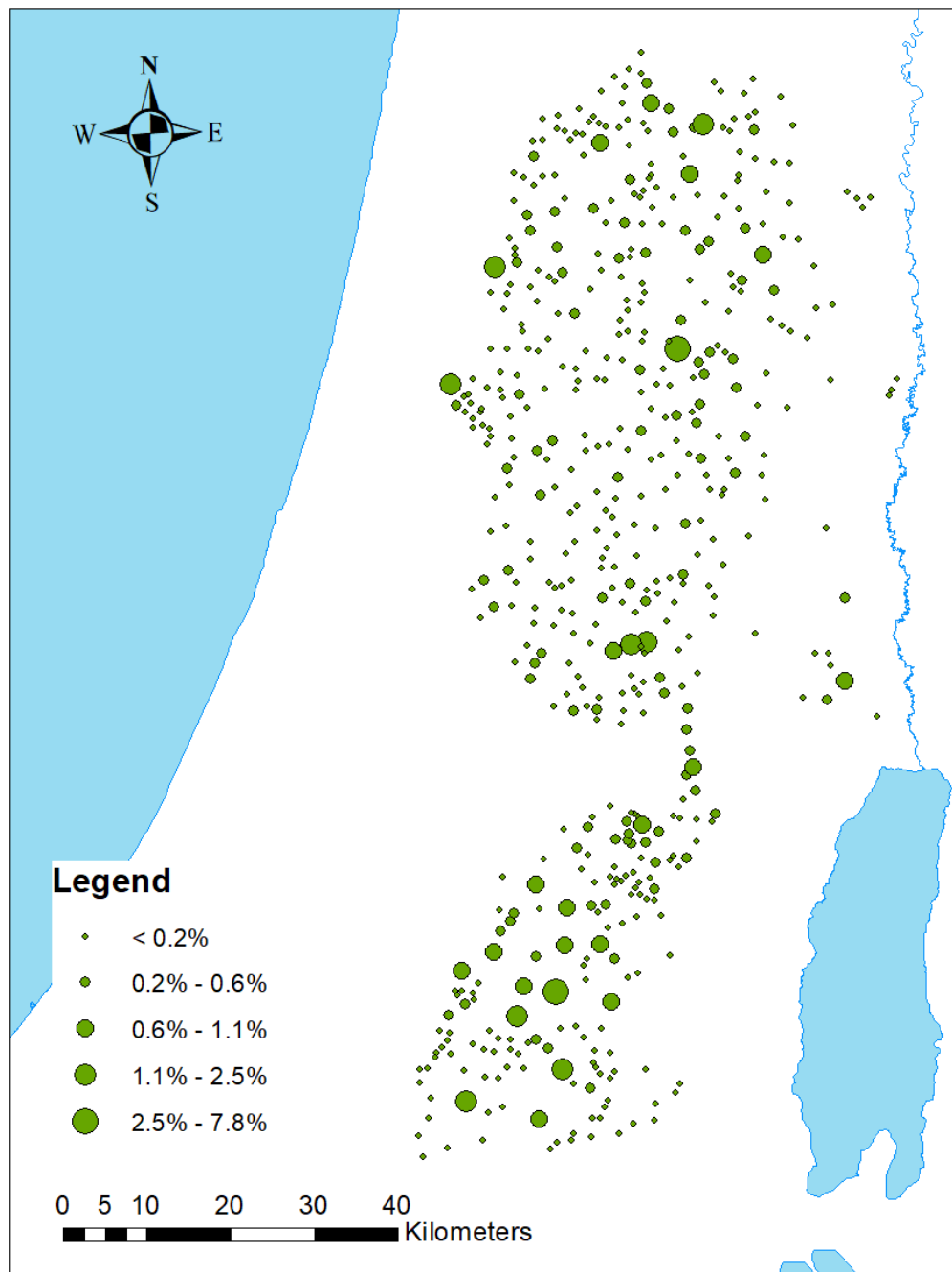
The West Bank is a patch of land of the size of Delaware. It has an area of 5,655 km² (2,183 sq mi). The largest economic sectors are manufacturing, wholesale and retail trade. It is

⁸PCBS data.

⁹With the exception of services.

¹⁰Ellison et al. (2010) point out their key role in explaining firm agglomeration.

Figure 2: Spatial distribution of the Palestinian population



Sources: UNOCHA, PCBS Population Census 2017.

organized in 11 districts: Bethlehem, Hebron, Jenin, Jericho, Jerusalem, Nablus, Qalqiliya, Ramallah and Al-Bireh, Salfit, Tubas, and Tulkarm. While the district capitals host the majority of the population, a large number of built-up areas are evenly distributed in the entire area (figure 2). The population lives along the mountain ridge that covers the eastern part of the territory, while the Jordan Valley, on the west, is less populated and largely under the Israeli control. The West Bank has a population of approximately 2.9 million people as of 2017. The 1949 Armistice Line to the West and the Jordan River to the east mark the borders of the West Bank. The 1949 Armistice Line, also known as the Green Line, is the end result of the 1948 Arab-Israeli war (UNOCHA).

In 2000, a political uprising, known as the Second Intifada, broke out. During the same period, Israel started the establishment of permanent facilities to control the mobility of the Palestinian people. These mobility restrictions, with few changes, are still in effect today. Israel also started the construction of a wall separating the West Bank from Israel. Although sections of the wall are still under construction today, development has significantly slowed since the end of the Intifada.¹¹

The mobility restrictions have two main functions. First, they deter attacks on the Israeli population in the West Bank. According to the United Nations,¹² *“the IDF states that the reason for the closure regime [...] is to reduce attacks on Israelis by Palestinian militants by limiting their ability to move freely by vehicle.”* As a matter of fact, 25% of the obstacles in 2007 were in close proximity to an Israeli settlement or an Israeli military base. Second, mobility restrictions also regulate the traffic flow along the major highways in the West Bank. These restrictions allow the enforcement of roads to create Israeli-limited traffic, and the control of Palestinian IDs and permits within the West Bank.

2.1 What is the ICT sector in the West Bank?

In the last decade, the Palestinian ICT sector has witnessed a large development.¹³ The Palestinian Information Technology Association (PITA) represents the most vibrant part of the sector, and estimates that ICT represents 6% of the Palestinian GDP.¹⁴ According to the PCBS, 4,862 people were employed in the ICT in 2017. Leaders, established in 2004, supports local organizations delivering services on private-sector development, job creation, innovation and entrepreneurship. Since 2011, Sadara Ventures provided early investments to a number of start-ups. The year 2017 saw the termination of the works to build Rawabi, a new city designed with the goal of attracting high tech in the West Bank. In June 2020, the World Bank approved a US\$15 million grant to sustain the Palestinian youth through the ICT sector.¹⁵

While there are almost 1,000 ICT companies, the majority are repairers, retailers, and

¹¹The figure on construction progress is available in the appendix.

¹²UNOCHA (2007)

¹³In this paper, whenever possible, we use a definition based on the “OECD Guide to Measuring the Information Society” (2011). See table 1 for a description of the ICT sector based on such a definition.

¹⁴PITA Newsletter 10, 2020

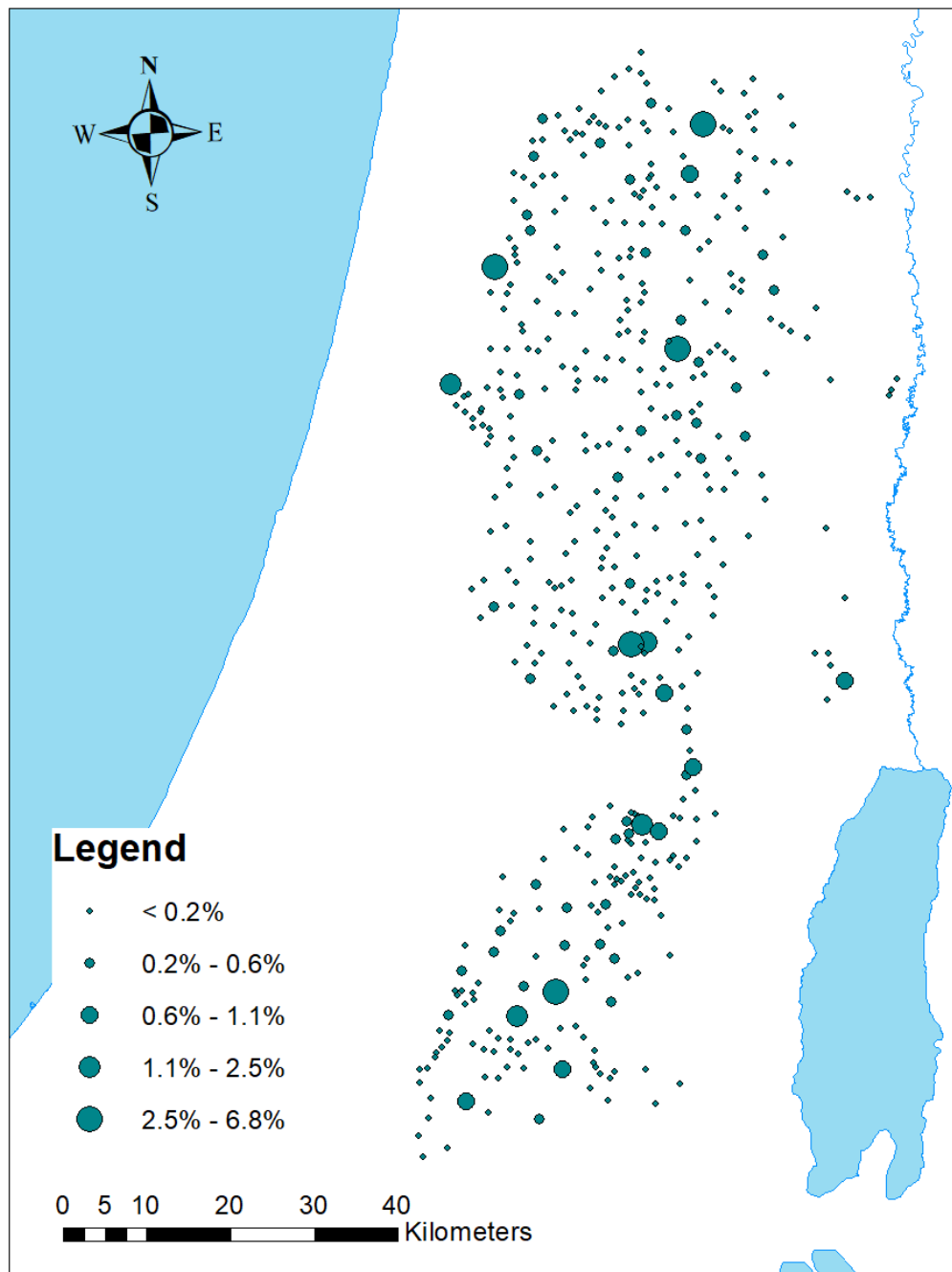
¹⁵World Bank, Press Release, June 15,2020

Internet cafes, small businesses serving local clients. Wireless and wired telecommunication activities employ the largest share of workers, although this sector is highly concentrated. When designing our survey, we paid particular attention to the coverage of businesses other than retailers and repairers. These are businesses operating in computer consultancy, computer programming, data processing, hosting and related activities, lively businesses, often small, at the frontier of technology.

While the spatial distribution of establishments matches the spatial distribution of residents (figures 2 and 3), Palestinian ICT is concentrated in the largest towns (figure 4). Based on the responses to our survey, among the major factors for the location choice of ICT firms are proximity to clients, to the labor force, to suppliers and to funding sources.¹⁶ ICT firms are relatively less concerned about high rents and wages, typical of large towns.

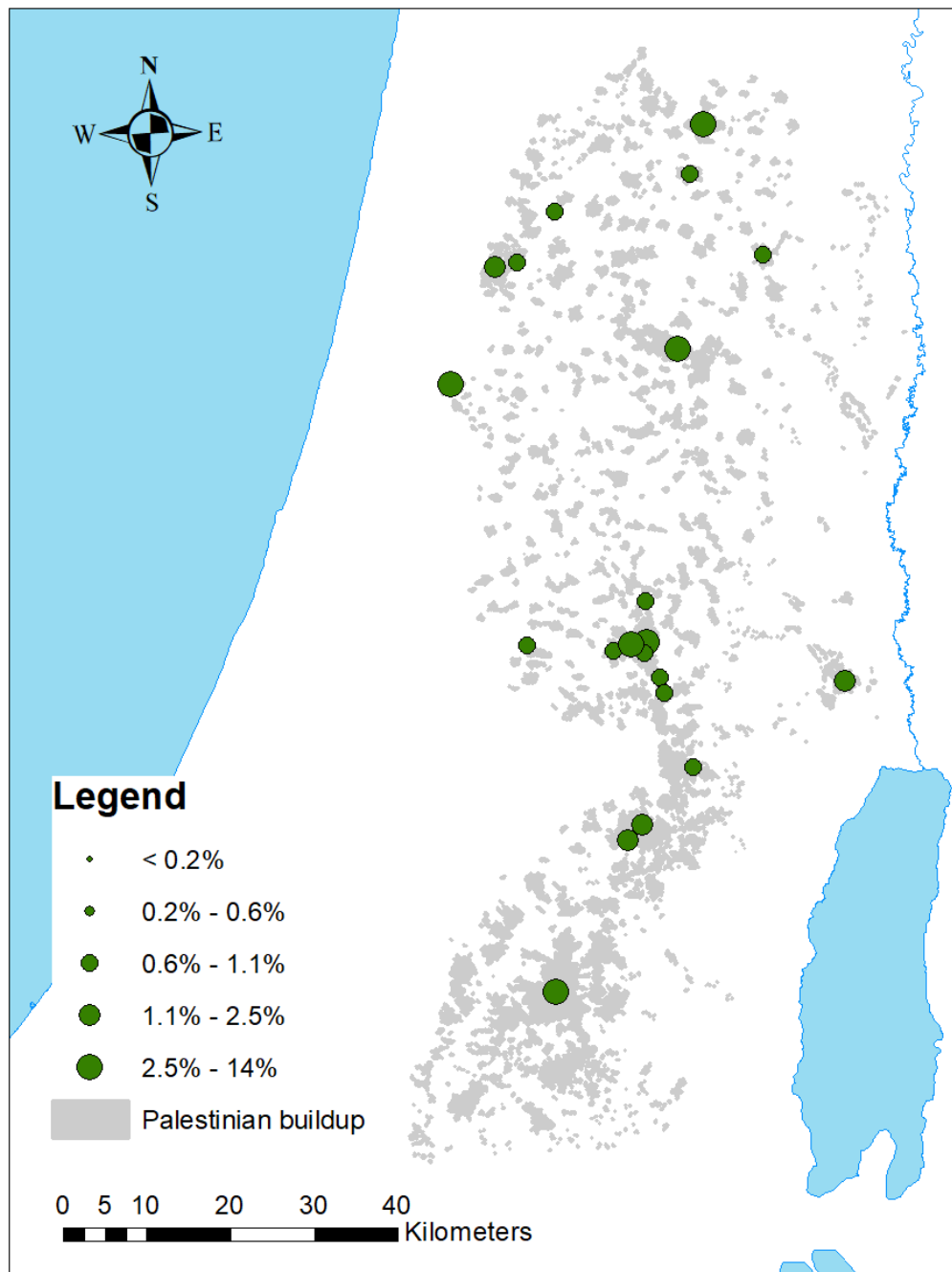
¹⁶Retailers and repairers are excluded.

Figure 3: Spatial distribution of the Palestinian establishments



Sources: UNOCHA, PCBS Establishment Census 2017.

Figure 4: Spatial distribution of the ICT establishments



Sources: UNOCHA, PCBS Establishment Census 2017.

Table 1: The ICT sector in the West Bank

	ISIC	industry	Estab.	Employed
Repair of computers and peripheral equipment	9511	S	244	325
Repair of communication equipment	9512	S	183	340
Other telecommunications activities	6190	J	160	282
Wired telecommunications activities	6110	J	96	1,337
Wireless telecommunications activities	6120	J	88	1,888
Computer programming activities	6201	J	79	957
Radio broadcasting	6010	J	47	454
Television programming and broadcasting activities	6020	J	25	351
Publishing of newspapers, journals and periodicals	5813	J	22	244
Other information technology and computer service activities	6209	J	18	112
Motion picture, video and television programme production activities	5911	J	18	87
Data processing, hosting and related activities	6311	J	13	101
News agency activities	6391	J	9	57
Computer consultancy and computer facilities management activities	6202	J	8	132
Publishing of books	5811	J	6	22
Sound recording and music publishing activities	5920	J	5	15
Other Publishing activities	5819	J	4	10
Satellite telecommunications activities	6130	J	3	6
Other information service activities n.e.c.	6399	J	3	22
Manufacture of measuring, testing, navigating and control equipment	2651	C	1	1
Manufacture of communication equipment	2630	C	1	0
Motion picture, video and television programme post-production activities	5912	J	1	6
Web portals	6312	J	1	1
Total, excluding maintenance and trade			520	4,197
Total			947	4,862

Notes: In the column “industry,” we follow the ISIC classifications for the sections: C is manufacturing, J is information and communication, and S is other service activities.

Sources: PCBS, authors’ calculations.

3 Description of the Survey and Other Data

3.1 Survey Instrument

The goal of the survey is to gain understanding of aspects of a business connected to spatial aspects. In particular, we are interested in learning in what dimensions the ICT sector differs from the other sectors of the economy. The survey captures measures of firm performance, capital accumulation, trade, and workforce, as well as the perception of growth and the challenges encountered.

The sample frame used is the universe of private sector establishments operating in the West Bank based on the Palestinian Central Bureau of Statistics (PCBS) Establishment Census 2017. The sample was selected using stratified cluster sampling. Strata are defined according to the following variables: North and South of the West Bank, large and small villages, large and small establishments (below and above 10 employees), and industry sub-groups (ICT, manufacturing, wholesale and retail trade, and other industries).^{17,18} Within a stratum, clusters were identified as establishments belonging to the same stratum and located in the same town. A sample of 10% of the establishments was selected in each cluster. Firms within the cluster have been identified using a random walk approach. The sample size has been chosen as to obtain unbiased estimates with 90% confidence intervals at 10% precision for the whole universe, as well as for the following industry sub-groups: IT, manufacturing, and wholesale and retail trade. The survey was conducted via face-to-face interviews and followed by call-back interviews to guarantee high quality of the data, in two phases, from 28/03/2019-05/06/2019 and from 22/12/2019-07/01/2020.¹⁹ More information on the methodology is provided in the appendix.

A total of 533 interviews were completed. For comparison, the World Bank 2019 Enterprise Survey for West Bank and Gaza consisted of 365 interviews, 205 of which were in the West Bank. Given our main focus on ICT, this industry is over-represented in the survey (table 2), representing 23.6% of the sample or 126 interviews and 14% of the existing establishments. The remaining 407 interviews cover the manufacturing sector (87 interviews), the retail and wholesale trade sector (202 interviews) and other industries (118 interviews).

As in the population of reference, almost half of the ICT firms interviewed are retailers or repairers (table 3), while the other half consists of firms conducting activities such as computer programming, telecommunications, information services, and other ICT related activities.²⁰

¹⁷Sectors excluded from the analysis are: agriculture, mining and quarrying, electricity and water supply, public administration and defense, compulsory social security, activities of households as employers, undifferentiated goods- and services-producing activities of households for own use, activities of extraterritorial organizations and bodies. Retailers of ICT products are excluded from the wholesale and retail trade. Repairers of ICT products are excluded from other industries.

¹⁸We will refer to the wholesale and retail trade sector as retail.

¹⁹In the second phase, call-backs and 65 additional interviews were conducted.

²⁰Businesses conducting maintenance and repair often also sell computers and other hardware components as secondary economic activity.

Table 2: Summary Statistics for the Survey

	Survey		Population		% of population
	N	%	N	%	
ICT	126	23.6%	894	0.05%	14.1%
Manufacturing	87	16.3%	15,110	14.21%	0.57%
Retail Trade	202	37.9%	54,618	51.36%	0.37%
Other Industries	118	22.1%	51,091	48.04%	0.23%
Total	533	100%	106,338	100%	0.50%

Notes: the population refers to the number of establishments according to the 2017 census. The last column is the number of interviews in the survey sample divided the number of establishments in the population. *Sources:* PCBS, authors’ survey.

3.2 Other Data

Jointly with the survey, auxiliary data is used in this paper.

Maps and Geographic unit. The primary geographic unit is the locality or town. The PCBS defined locality as “*a permanently inhabited place, which has an independent municipal administration, or a permanently inhabited, separated place, not included within the formal boundaries of another locality.*”²¹ The West Bank is partitioned in 443 villages as of 2007. The shapefiles on the location of the Palestinian buildups and other spatial information has been kindly provided by UNOCHA.

Population and Establishment Census. Access to the Establishment Census has been negotiated by the author during several visits to the West Bank. The two Census datasets contain data on population, employment, and establishment. The data used from the Establishment Census include jobs in non-farming private establishments, disaggregated by economic sector (ISIC4) and village. The analysis is restricted to establishments in operation at the moment of the data collection, with national or foreign ownership. Activities not classified as establishments or jobs in the public sector are not included in the job count.²²

Mobility restrictions. The data on the mobility restrictions, the Separation Wall, and the location of settlements and military areas come from the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). Data are available between 2003 and 2017 at a yearly frequency with gaps. UNOCHA also kindly provided geo-referenced data on the road network. Each road segment is classified as regional, primary, secondary, tertiary, residential, or track. UNOCHA also collects data on the road regime, and it classifies roads as either restricted for Israeli cars or unrestricted. The Applied Research Institute Jerusalem (ARIJ) provided information on the location of mobility restrictions at a yearly frequency since 1995.

²¹PCBS Population Housing and Establishment Census 2007.

²²The data exclude clusters (industry grouping * village) where the number of establishments was one or two. Moreover, between the two time periods, the ISIC classification changed. Some sectors have been merged, others have been disjointed. Economic sectors are reclassified based on the ISIC Revision 4.

Table 3: Main economic activity of ICT firms interviewed

	ISIC 4	interviews
Computer programming, consultancy and related activities	62	29
Telecommunications	61	15
Information service activities	63	6
Architectural and engineering activities; technical testing and analysis	71	6
Civil engineering	42	2
Publishing activities	58	1
Motion picture, video and television programme production, sound recording and music publishing activities	59	1
Total, excluding maintenance and trade		60
Repair of computers and personal and household goods	95	56
Retail trade, except of motor vehicles and motorcycles	47	9
Wholesale trade, except of motor vehicles and motorcycles	46	1
Total		126

Sources: Authors' survey.

Travel times. A key ingredient of the analysis is the estimate of travel times. We borrow this part of the analysis from [Fratto \(2019\)](#). Travel times are computed using the shortest route between the centroid of two locations using ArcGIS. Table 4 summarizes the assumptions on the travel times and delays at each obstacle. Vehicles cannot pass through roadblocks, earthmounds, barrier gates, and across the Separation Wall. Due to an absence of information on road gates, they are assumed to be open.

For the checkpoints, there are three independent sources. First, [Eklund and Martensson \(2012\)](#) conducted an extensive survey in 2009 in which they asked questions on the shortest delays at a checkpoint (ranging from 0 to 90 minutes, with responses concentrated between 0 and 30 minutes) and the longest delays (between 0 and 1,080 minutes, with responses concentrated between 0 and 360 minutes). They find an average shortest delay of 15 minutes. [Van Der Weide et al. \(2018\)](#) provide a similar average delay using information from the UN. The PCBS also conducted a survey on the topic in 2006 and found that the average shortest delay was 12 minutes and 35 seconds. In this paper, it is assumed that crossing a checkpoint entails a delay of 15 minutes. The road network is held constant. This is consistent with the evaluations from [IEG \(2010\)](#) that argue there has been little progress between 2000 and 2009 on the development of the Palestinian road network.

Table 4: Assumptions on travel times

Average traveling times by type of road	
regional	60kmh
primary	50kmh
tertiary	30kmh
residential	20kmh
track	10kmh
Israeli only	0kmh
Roadblocks, earthmounds, barrier gates, separation wall (planned and under construction)	infinite
Checkpoints	15min

Notes: Source for average travel times by type of road: [Van Der Weide et al. \(2018\)](#). Source for checkpoint travel time: PCBS, [Eklund and Martensson \(2012\)](#), and [Van Der Weide et al. \(2018\)](#).

4 Model

Consider a static model with J sectors and O localities. Workers live and work in the same location. We allow for intersectoral and interregional trade linkages. We allow industries to differ across a number of dimensions: location-specific exogenous productivity and production technology, consumption shares, elasticity to trade costs. Workers can freely move between locations and between industries.

4.1 Households

Workers have Cobb-Douglas preferences over consumption goods, with shares α_s . Preferences are homothetic of degree 1, so $\sum_j \alpha_j = 1$.

Utility over a consumption basket in location n is given by:

$$U(C_n) = \prod_j (c_n^j)^{\alpha_j} \quad (1)$$

where c_n^j is the consumption of final good, bought at prices P_n^j .

Workers supply inelastically one unit of labor and they receive wage w_n regardless of the industry in which they are employed. We do not have information on the trade imbalances between locations in the West Bank. As a result, we assume trade to be always balanced. Land is rented locally and receipts r_n are distributed equally across the workers in location n . Total local income is:

$$I_n L_n = w_n L_n + r_n H_n, \quad (2)$$

where L_n is the number of people living in n , and H_n is the amount of land available.

4.2 Final Goods

Final goods are non-tradable, and they are used for consumption and as material inputs into the production of intermediate goods.

Final goods are produced using varieties of intermediate goods $Y_n^j(z)$, indexed by productivity z , according to the following production function:

$$Y_n^j = \left[Y_n^j(z^j)^{1-1/\eta_j} \phi_i^j(z^j) dz \right]^{\frac{\eta_j}{\eta_j-1}}, \quad (3)$$

where $\phi_i^j(z^j)$ is the joint density of the vector of probability draws $z^j = (z_1^j, z_2^j, \dots, z_O^j)$, associated with the probability distribution of an Extreme Value Type I.

Producers of the final good then maximize profits subject to the cost of the intermediate goods:

$$\max_{\{Y_n^j(z^j)\}} P_n^j Y_n^j - \int P_n^j(z^j) Y_n^j(z^j) \phi_i^j(z^j) dz, \quad (4)$$

where $P_n^j(z^j)$ is the price of the intermediate goods and $P_n^j = \left(\int P_n^j(z^j)^{(1-\eta_j)} \phi_i^j(z^j) dz \right)^{\frac{1}{1-\eta_j}}$.

There is free entry in the market for final goods implying zero profits.

4.3 Intermediate Goods

There is a representative firm in each region i and sector j producing a continuum of varieties of intermediate goods that differ in their idiosyncratic productivity level, z_i^j .

Firms use a Cobb-Douglas technology to produce intermediate goods from labor, land, and material inputs, taking as given the rental rate of land, r_i , the wage rate, w_i , the price of final goods, P_i^j , and productivity, z_i^j . The production function for a variety of good j in location n associated with productivity level z_i^j is:²³

$$z_i^j \left[\left(L_i^j(z_i^j) \right)^{\beta_n^j} \left(H_i^j(z_i^j) \right)^{1-\beta_n^j} \right]^{\gamma_i^j} \prod_k (M_i^{jk}(z_i^j))^{\gamma_n^{jk}}, \quad (5)$$

where $M_i^{jk}(z_i^j)$ is the demand of final goods k used as material inputs in the production in location n industry j . Similarly, $L_i^j(z_i^j)$ and $H_i^j(z_i^j)$ are respectively the demand for labor and land. We maintain the assumption of constant returns to scale in the production function, i.e. $\sum_k \gamma_n^{jk} = 1 - \gamma_n^j$. Moreover, $\beta_n^j \in (0, 1)$.

Following Eaton and Kortum (2002), the productivity shock is modeled after a Frechet distribution with shape parameter θ^j and scale parameter A_i^j . Draws are independent across goods, sectors and regions A_i^j can be interpreted as the fundamental productivity of firms in town j in industry j , or the average productivity of a town i with industry j relative to other towns.²⁴ This captures factors equally affecting the productivity of all producers in a given location and a given industry.

²³We denote $X(z_i^j)$ a variable for a firm in location i , sector j , and with productivity draw z_i^j .

²⁴Formally, $E[z_i^j] = a_j A_i^j$ for some constant a_j .

The parameter θ^j measures the intra-location heterogeneity in productivity. This is a key parameter in the model, as it is linked to the elasticity of trade flows with regard to changes in wages and land prices.

The price of a good j sold in location n , $P_j^n(z^j)$, depends on z^j , which is the vector collecting the productivity realizations for all locations where goods j are produced.

In equilibrium,

$$r_i H_i^j(z_i^j) = \frac{1 - \beta_n^j}{\beta_n^j} w_i L_i^j(z_i^j). \quad (6)$$

The production function is exogenous. Changes in travel times affect the combination of inputs via changes in the relative prices, rather than by shifting the production technology.

The unit cost of an intermediate good with idiosyncratic shock z_i^j produced in location i is:

$$\frac{x_i^j}{z_i^j} = [\gamma_i^j (1 - \alpha_i^j)^{\alpha_i^j - 1} (\alpha_i^j)^{-\alpha_i^j}]^{-\gamma_i^j} \prod_k (\gamma_i^{jk})^{-\gamma_i^{jk}} \frac{[r_i^{\alpha_i^j} w_i^{1 - \alpha_i^j}]^{\gamma_i^j} \prod_k (P_i^k)^{\gamma_i^{sk}}}{z_i^j}. \quad (7)$$

We assume that firms face an iceberg trading cost. For each unit of good j shipped from town i to town n , only $1/\tau_{ni}^j \leq 1$ arrive, with $\tau_{nn}^j = 1$, $\tau_{ni}^j \geq 1$ and $\tau_{ni}^j \leq \tau_{ni'}^j \tau_{i'i}^j \forall i'$. The last assumption can be interpreted as more economical to ship a good straight from i to n than it is shipping it from i to i' and then from i' to n .

Given the iceberg structure of the trade costs, the marginal cost at destination has also to take into account the loss in output during the transport of the good. As a result the marginal cost at destination is $\tau_{ni}^j \frac{x_i^j}{z_i^j}$.

4.4 Equilibrium Prices and Trade Shares

There is perfect competition among firms producing the same variety z in sector j . Therefore, in any location, n , the price for variety z is the minimum among all firms producing that variety:

$$P_n^j(z^j) = \min_i \left\{ \tau_{in}^j \frac{x_i^j}{z_i^j} \right\}. \quad (8)$$

Thanks the properties of the EV distributions, we can solve for the distribution of prices. It can be shown that the equilibrium price is described by the following relation:

$$(P_n^j)^{-\theta_j} = k_{1j} \sum_{i \in O} (A_i^j)^{\theta_j} (x_i^j)^{-\theta_j} (\tau_{ni}^s)^{-\theta_j}, \quad (9)$$

where k_{1j} is a constant.²⁵

²⁵ $k_{1j} = \Gamma\left(1 + (1 - \eta_j)/\theta_j\right)^{1/(1 - \eta_j)}$

We can also solve for the expenditure share of region n 's total expenditures on sector j 's intermediate goods purchased from region i :

$$\pi_{ni}^j = \frac{(A_i^j)^{\theta_j} (x_i^j \tau_{ni}^j)^{-\theta_j}}{\Phi_n^j}, \quad (10)$$

with $\Phi_n^j \equiv \sum_{i'} (A_{i'}^j)^{\theta_j} (x_{i'}^j \tau_{ni'}^j)^{-\theta_j}$. The trade shares can also be interpreted as the probability distribution of trading conditional on destination n buying intermediate goods j .

Then, the actual trade volume of goods j from location i to location n is equal to $X_{ni}^j = \pi_{ni}^j X_n^j$, where X_n^j is expenditure of final good j in location n .

4.5 Labor Mobility

Because of free labor mobility across towns, workers' utility levels are equalized across locations:

$$\frac{I_n}{P_n} = \bar{U}, \quad (11)$$

where $P_n = \prod_{j \in J} \left(\frac{P_n^j}{\alpha_j} \right)^{\alpha_j}$ is the price index in location n .

4.6 Market Clearing Conditions

Expenditure of goods j in location n is equal to the amount consumed by workers and the amount used for material inputs for the production of other goods:

$$X_n^j = \alpha_j L_n I_n + \sum_k \gamma_{kj} \sum_i \pi_{in}^k X_i^k. \quad (12)$$

In any region, total expenditures on intermediate goods has to be equal to the location's total revenues from selling intermediate goods:

$$\sum_j \sum_i \pi_{ni}^j X_n^j + S_n = \sum_j \sum_i \pi_{in}^j X_i^j. \quad (13)$$

When trade is balanced, $S_n = 0$. Land market clearing requires that the amount of land used by all producers of intermediate goods is equal to the total amount available:

$$H_i = \sum_{j \in J} H_i^j = \sum_{j \in J} \int H_i^j(z_i^j) \phi_n^j(z^j) dz^j. \quad (14)$$

A similar condition applies for the labor market:

$$L_i = \sum_{j \in J} L_i^j = \sum_{j \in J} \int L_i^j(z_i^j) \phi_n^j(z^j) dz^j. \quad (15)$$

The market clearing conditions imply a relationship between rental rate, wages, and the supply of land and of labor in each location:

$$r_n H_n = \sum_j \frac{1 - \alpha_n^j}{\alpha_n^j} L_n^j w_n. \quad (16)$$

4.7 Equilibrium

Definition. Given land $\{H_n\}_n$ and $\{L_n\}_n$, a competitive equilibrium for this economy is a utility level U , a set of factor prices $\{r_n, w_n\}_n$, a set of allocations for labor and structure, final good consumption, and final goods prices, $\{L_n^j, H_n^j, X_n^j, c_n^j, P_n^j\}_{j,n}$, and bilateral trade flows for each sector $\{\pi_{ni}^j\}_{n,i,j}$ such that the following conditions hold: optimization conditions for workers hold; optimization conditions for intermediate good producers; optimization conditions for final good producers; all markets clear; trade is balanced; utility is equalized across all locations.

5 Identification of the mechanisms

We want to know what would happen to the industrial composition of the economy in the hypothetical case in which mobility restrictions were removed and the road network was brought back to the condition of 1995. The model allows us to translate the anecdotal evidence into mechanisms through which the mobility barriers impact the differential industrial growth. We first map the channels through which changes in the road network impact industries. In the following sections, we describe estimation strategy.

Industries differ in their elasticity to travel times. Given the small geographic unit we consider here, all industries are assumed to be tradable, while allowing for varying levels of elasticity to travel times to match the trade flows observed in the survey between the firms interviewed and their trading partners. This is the direct mechanism of the differential impact of changes in travel times across industries.

If we restrict the sample of ICT firms to those selling non-physical goods, which are thus unaffected by the changes in the cost of providing goods to their customers, we expect the changes in travel times to impact the ICT sector to a lesser extent compared to the rest of the economy. This is the story that has often been told: the ICT sector represents a promise for all those economies afflicted by high shipping costs, travel times, poor road infrastructure, and, in the case of the West Bank, road blocks and mobility barriers, to overcome such limitations and grow.

Another channel involves the industry-specific production technology: some industries rely more extensively than others on immobile factors of production. Through the lens of the model, this is linked to the assumption on the share of fixed land in the production function. Holding everything else fixed, firms relying more extensively on immobile factors of production are less able to relocate and would gain more from a removal of the mobility barriers. The ICT sector being more labor-intensive, it benefits more from the concentration of economic activity and resulting larger pool of labor that a better connected geography would allow.

The ICT sector tends to be more concentrated spatially than other industries (figures 3 and 4). Generally, these locations also coincide with the larger cities. In this model, we abstract from the causes of such phenomenon, which we take as given. We estimate average productivity levels for each location and industry. These quantities are chosen to match the

Table 5: Workers employed at ICT firms commute more than other workers

	ICT	ICT*	non-ICT	Manufacturing	Retail	Other Industries
Workers average commute	18.6	20.6	13.2	22.8	11.7	15
Observations	126	60	407	87	202	118
$H_0 : \text{ICT} = \text{non-ICT}$	0.001	0.0005				

Notes: ICT* excludes retailers and repairers. Time expressed in minutes. P-values reported for Wald tests. *Sources:* Authors' survey.

observed data and are exogenous and constant throughout the exercise. We rationalize the observed concentration of the ICT sector in the model by setting the productivity for ICT in location in which there are no ICT firms to zero. This however implies that we are not able to study the formation of new ICT clusters. Nevertheless, we do not expect this to have a strong impact on the analysis of the paper.

Moreover, in the model there are not systematic differences between ICT workers and other workers. Yet, ICT workers may have preferences for larger cities, and thus driving the observed clustering of ICT firms. In our data, we observe that workers in ICT firms travel on average 18 minutes, compared to 13 minutes for workers in the other sectors (table 5).²⁶ In the paper, we abstract from the role of commuting. We refer to Fratto (2019) for a discussion of their role.²⁷

Spillovers via input-output linkages describe another channel of the impact of a change in the road infrastructure on the industrial composition. In the model, we assume that the cost of transporting goods in industry j for consumption is the same as the cost of transporting those goods for use as material inputs.

We abstract from the role of externalities. If we decompose productivity into an exogenous and an endogenous component, $\ln A_i^j = \ln a_i^j + \psi_j \sum_n \ln \exp\{\kappa_{ni}^j L_n^j\}$, where κ_{ni}^j is a function of travel time between locations n and i , this is equivalent to assume that $\psi_j = 0$. Based on this specification, the level of productivity in location i industry j depends on some underlying exogenous component and it is increasing in the number of workers employed in that industry weighted by some function of travel time. While we consider this latter channel valid, it would simply strengthen the quantitative results while not altering the implications.

Often the ICT sector is deemed promising because of its ability to tap into the international markets. Yet, we do not find clear evidence of its greater ability to access international markets (table 6): ICT firms are as likely as others to import inputs from and to sell output abroad, even when excluding retailers and repairers from the sample. The high percentage of inputs and output exchanged on the domestic market paints a picture of an ICT sector

²⁶The figure includes only workers employed in Palestinian private firms. Most notably, it excludes workers employed in foreign firms either in Israeli settlements or in Israel.

²⁷An additional element worth investigating is the role of the access to the Israeli labor market. See for instance Etkes (2012).

Table 6: ICT firms do not import or export significantly more than other firms
Average share of input and output exchanged domestically:

	Inputs					
	ICT	ICT*	non-ICT	Manufacturing	Retail	Other Industries
% inputs from West Bank and Gaza	66%	61%	65%	54%	64%	68%
Observations	126	60	407	87	202	118
$H_0 : \text{ICT} = \text{non-ICT}$	(0.86)	(0.64)				

	Output					
	ICT	ICT*	non-ICT	Manufacturing	Retail	Other Industries
% output to West Bank and Gaza	76%	70%	77%	59%	79%	80%
Observations	126	60	407	87	202	118
$H_0 : \text{ICT} = \text{non-ICT}$	(0.75)	(0.29)				

Notes: ICT* excludes retailers and repairers. P-values for Wald tests reported in parentheses. *Sources:* Authors' survey.

as fundamentally oriented inwards. This is consistent with the conjecture that difficulties to import and export affect all firms, regardless of the industry. Given the lack of differentiation in the exposure to international markets between ICT and the rest of the economy, we abstract from these considerations in the model.²⁸

6 Empirical Results

In this section, we report empirical results that shed light on the individual mechanisms described above. We will complement the empirical strategy suggested by the model with other supporting evidence from the survey. Note that in this section we will not be able to estimate the relative importance of the different channels. This will be done in the next section, where we will compute counterfactuals, highlighting the effect of each mechanism separately.

The constraints to growth ICT firms face are the same as the constraints faced by other Palestinian firms. We asked business owners and managers their opinion on the major constraints to the growth of their businesses. Table 7 presents the results separately for ICT and for the other firms interviewed. The answers are remarkably similar whether the question was asked to an ICT firm or to other firms. A third replies that the current economic

²⁸For a discussion of the role of internal transportation infrastructure on international trade, see Coşar and Demir (2016).

condition of the country is a challenge for the growth of their business. Shortage of credit is also an important constraint, with ICT firms mentioning it twice as often as other firms, but it was one of the most chosen options for both industry groupings. The competition from local firms is also perceived as an important constraint, point again to the key role of the domestic market. Uncertainty places a key role, with uncertain government policies and political instability being the fourth most chosen option for both industry groupings. Results are in line with the recent takeaways from the OECD workshop on Strengthening the Palestinian business and climate investment (October 1, 2019) that mentions among the major constraints access to finance and better market access. However, the key market of reference is not the international market but rather the domestic market.

Table 7: What are the major constraints to the growth of your business? Pick up to three options. Fraction of owners that chose the following options:

ICT*		non-ICT	
Current economic conditions of the country	34.2%	Current economic conditions of the country	30.7%
Shortage of credit	22.5%	Too much competition /unfair competition from Palestinian firms	12.1%
Too much competition /unfair competition from Palestinian firms	14.8%	Shortage of credit	10.4%
Uncertain government policies and political instability	7.2%	Uncertain government policies and political instability	10.0%
Size of the internal market	6.7%	Size of the internal market	9.4%
Difficulty to import	2.6%	Difficulty to access local markets (within Palestine)	6.9%
Difficulty to access local markets (within Palestine)	2.2%	Lack of technical know-how	4.4%
Lack of skilled workers in the local job market	1.7%	Shortage of modern machinery/equipment/physical capital	3.1%
Lack of raw material or lack of access to raw material	<1.0%	Lack of skilled workers in the local job market	2.1%
Difficulty to export	<1.0%	Difficulty to import	1.8%
Lack of marketing services or transport facilities	<1.0%	Difficulty to engage with foreign firms	1.4%
Difficulty to engage with foreign firms	<1.0%	Too much interference by foreign officials	1.2%
Too much interference by local officials	<1.0%	Too much competition /unfair competition from foreign firms (including Israeli firms)	1.1%

Continued on next page

Table 7 – *Major constraints to the growth - Continued from previous page*

ICT*				non-ICT			
Difficulty to get licences/permissions from authorities			<1.0%	Lack of marketing services or transport facilities			1.0%
Inadequate premises/land			<1.0%	Difficulty to export			<1.0%
Shortage of modern machinery/equipment/physical capital			<1.0%	Lack of raw material or lack of access to raw material			<1.0%
Lack of transparency in official or government procedures			<1.0%	Workers absences			<1.0%
Too much competition /unfair competition from foreign firms (including Israeli firms)			<1.0%	Too much interference by local officials			0.0%
Lack of technical know-how			<1.0%	Difficulty to get licences/permissions from authorities			0.0%
Workers absences			<1.0%	Inadequate premises/land			0.0%
Too much interference by foreign officials			<1.0%	Lack of transparency in official or government procedures			0.0%
Lack of energy (electricity, fuel, etc)			0.0%	Lack of energy (electricity, fuel, etc)			0.0%
Difficulty to engage with foreign firms			0.0%	Difficulty to engage with foreign firms			0.0%
Use of intermediaries in order to get access to local markets (within Palestine)			0.0%	Use of intermediaries in order to get access to local markets (within Palestine)			0.0%
Other factors (specify)			2.0%	Other factors (specify)			3.3%

Notes: ICT* excludes retailers and repairers. All options available are included in the table. <1.0% indicates a non-zero fraction. *Sources:* Authors' survey.

When asked directly whether they think that mobility restrictions affect the growth of their businesses, ICT answers are also similar to other firms (table 8). Differences in answers between industry groupings are not statistically significant with only a few exceptions. More than half of ICT firms answered that obstacles have an impact on the mobility of people, compared to virtually 40% of other firms, consistent with the fact that ICT workers are commuting for a longer distance, but the difference is not statistically significant. Firms were less likely to see obstacles to the mobility of goods as an obstacle, and, interestingly, ICT firms were significantly more likely to mention obstacles to the mobility of goods in and out of the West Bank as a factor affecting growth. The proximity to settlements and to areas of clashes was perceived as less important for growth.

Obstacles have also a similar effect on ICT and on other firms (table 9). As a direct

Table 8: How much are these factors affecting growth?
Fraction of owners answering "somewhat" or more.

	ICT*	nonICT	Manufacturing	Retail	Other industries
obstacles to mobility of people within the West Bank $H_o : [ICT^* = j]$	52%	40% (0.20)	32%* (0.10)	39% (0.21)	48% (0.72)
obstacles to mobility of people in and out of the West $H_o : [ICT^* = j]$	51%	42% (0.29)	38% (0.35)	44% (0.47)	36%* (0.10)
obstacles to mobility of goods within the West Bank $H_o : [ICT^* = j]$	38%	34% (0.67)	29% (0.45)	36% (0.85)	30% (0.32)
obstacles to mobility of goods in and out of the West Bank $H_o : [ICT^* = j]$	47%	31%** (0.02)	37% (0.50)	36% (0.28)	27%** (0.03)
proximity to settlements $H_o : [ICT^* = j]$	24%	26% (0.77)	47% (0.11)	25% (0.92)	22% (0.82)
proximity to areas of frequent clashes $H_o : [ICT^* = j]$	37%	35% (0.80)	25% (0.27)	37% (0.99)	30% (0.50)

Notes: ICT* excludes retailers and repairers. Results are unchanged when including them in the sample. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. P-values for Wald tests reported in parentheses. *Sources:* Authors' survey.

effect of obstacles, firms in both industry groupings declare that demand from clients is reduced, they experience delays from suppliers, higher transportation costs. These findings are consistent with our own experience, during the COVID-19 pandemic, when reduced mobility decreased the demand for goods and services, and disrupted supply chains both locally and globally. The answers highlight the relevance of the interactions with clients and suppliers, and the tight economic linkages existing between firms.

6.1 Computing Counterfactuals

To solve the model, we follow the approach first proposed by [Dekle et al. \(2008\)](#), who compute the counterfactuals in changes. For each variable x , they define the relative change of x as

Table 9: How did obstacles affect your business? Choose 3 options
Fraction of owners that chose the following options:

	ICT	non ICT
Reduced demand from costumers/clients	13%	12%
Delays from suppliers	12%	19%
Transportation cost	12%	9%
Access to costumers/clients	5%	5%
Workers delays to get to work/reach their homes	5%	6%
Delays to supply product to clients	3%	9%
Difficulty to obtain supplies	1%	4%
None of the above	48%	31%

Notes: The options available were: access to clients; reduced demand from clients; difficulty to obtain supplies; delays from suppliers; delays to supply product to clients; workers delays to get to work/reach their homes; transportation cost; Other; None of the above. *Sources:* Authors' survey.

$\hat{x} \equiv x'/x$. The advantage of this approach is that it allows us to obtain estimates for the productivity levels for each industry and each location. In particular, the following holds:

Proposition. Given parameter values for the productivity dispersion θ^j , the expenditure shares α^j , and the input shares β^j , and given values or estimates for the bilateral trade shares π_{ni}^j , employment by industry and location, L_i^j , and wage rates in each location w_i , and given exogenous changes in trade costs τ_{ni}^j , we are able to compute counterfactuals for wages, \hat{w}_i , employment \hat{L}_i^j , trade shares $\hat{\pi}_{ni}^j$, expenditure \hat{X}_i^j and prices.

The parameters needed to solve the model are reported in table 10. The table also reports the data used to calibrate the parameters and compute the counterfactuals. In the next section we describe more in detail how we use the data to produce estimates for the model.

6.2 Estimation of Trade Costs and Trade Shares

For the West Bank, estimates of the trade flows between towns and villages are not available. However, we rely on our novel data collected with the survey instrument to obtain estimates for these flows. In this section, we describe how we proceed.

In the survey, we ask firms detailed information on the location of the trading partners. We combine these data with data from the Establishment Census and data on wages from the Labor Force Survey to estimate the gravity equation stemming from the model. This approach requires to obtain an estimate of the elasticity of trade flows to distance and an estimate of location- and industry-specific productivities. This section proceeds as follows. First, for the estimation of the elasticity of trade flows to distance, we estimate a logit of the probability that a firm interviewed in the survey, with establishment in location o has a

Table 10: Parameters and data used to solve the model

Parameters		
Productivity dispersion	$\theta^j = 3.29$	Caliendo, Parro (2015)
Trade costs by industry	τ_{ni}^j	Survey
Consumption expenditure shares	α^j	PCBS (National Accounts)
Land input shares	β^j	Survey
Share of value added in gross output	γ_n^j	EORA (Jordan 2010)
Input-output coefficients	γ_{jk}	EORA (Jordan 2010)
Data		
Total employment by industry and location	L_i^j	PCBS (Census 2007)
Wages	w_i	PCBS (Labor Force Survey)

trading partner in location d . We regress this probability on origin fixed effects, destination fixed effects, and the (log of the) distance between origin and destination. Second, for the estimation of the productivities, we invert an equation linking the demand of traded goods with its supply. We argue that the solution is unique and that we describe an approach to find it numerically. Notice that we only need estimates for productivities for manufacturing in order to recover trade shares. The other sectors are considered non-tradable, and we will not have estimates for industry-specific productivities in that case.

In the survey we ask the following information: From the largest to the smallest commercial partner (buyers or sellers), specify town, district, and average shipping time. This question allows us to compute the probability that a firm in location i has a client or seller in location n . We explicitly asked ICT firms if they were selling physical goods as output. 75% of them replied affirmatively.

We model trade costs as a function of distance. We assume that bilateral trade costs are a constant elasticity function of distance and a stochastic error, $\tau_{ni}^j = \text{time}_{ni}^{t^j}$ where t^j is a parameter to be estimated.

Equation 10 can be rewritten as

$$P(zjni = 1) = \exp\{\zeta_n + \zeta_i - t^j \theta^j \ln \text{time}_{ni} + e_{zjni}\} \quad (17)$$

The probability of a firm with productivity z operating in sector j , location i , having trading partners in location n is a function of origin-specific factors, ζ_i , destination-specific factors, ζ_n , and the distance between the origin and the destination. e_{zjni} is an error term.

To estimate this elasticity, we use the answers from the survey on the location of trading partners. Observations are the firms in the manufacturing sector with at least two trading partners outside of the town or village where their establishment is located.

Results are reported in table 11. The table reports results for a weighted and an un-weighted regressions. Standard errors have been clustered at the firm level. Origin and destination fixed effects are included but not shown in the table. In order to assess the explanatory power of the travel time, we report pseudo- R^2 for two competing models, one

Table 11: Elasticities of trade flows with respect to distance

	$-t^j\theta^j$
$j = ICT$	-3.971** (1.782)
$j = \text{Manufacturing}$	-0.995*** (0.317)
$j = \text{Retail}$	-1.354*** (0.354)
$j = \text{Other activities}$	-1.189*** (0.178)
Observations	10,493
Firms	392
Survey weights	Yes
Origin FEs	Yes
Destination FEs	Yes

Standard errors clustered at the firm level reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1 *Sources:* Authors' survey, [Fratto \(2019\)](#) for travel time.

in which travel times are included and one in which they are excluded. The increase in the pseudo- R^2 when including travel times suggests the variable has explanatory power. The resulting elasticity of trade flows to distance for manufacturing is about 1, consistent with estimates from other studies (for instance [Monte et al. \(2015\)](#)).

We estimate a high elasticity of trade flows to distance for the ICT sector. As a matter of fact, the answers from the survey indicate a strong geographic concentration of suppliers and buyers of ICT firms.

We use data on wages from the Labor Force Survey for the years 2000-2007. We regress the observed hourly wages on year fixed effects and individual characteristics. Finally, we include a fixed effect for each workplace location.

$$\ln w_{hit} = \gamma_0 + \gamma_1 X_{ht} + \zeta_t + \zeta_i + u_{hit},$$

where w_{hit} are the wages of person h in workplace location i in year t , X_{ht} are a set of individual characteristics, and ζ_i is a fixed effect for workplace location. More details are reported in the appendix.

Proposition. Given the dispersion of productivity, θ^j , estimates of wages, employment, marginal cost for intermediate goods $\{w_i, L_i^j, x_i^j\}$, and a parameterization of trade costs $(\tau_{ni}^j)^{\theta_j}$, there exist unique values of the unobserved productivities A_i^j for each location i and each sector j that are consistent with the data being an equilibrium of the model.

The proof is available in the appendix.

The resulting estimates of the internal trade shares are the solution to the following set

Table 12: Share of immobile inputs

	$FE_j = \ln \frac{1-\beta^j}{\beta^j}$	$sd(FE_j)$	$[Ho : FE_{ICT} = FE_j]$	β^j
ICT	1.8	0.07		0.14
Manufacturing	1.5	0.17	0.09	0.19
Retail	1.4	0.03	0.00	0.20
Other Industries	1.5	0.17	0.13	0.18

Notes: $FE_j = \ln \frac{1-\beta^j}{\beta^j}$ are fixed effects from a regression of the (log of the) share of land to labor on industry-specific fixed effects, FE_j , and location-specific fixed effects, FE_i . Given first-order conditions for the firm, industry-specific fixed effects map onto industry-specific input shares. OLS standard errors reported in the second column. P-values reported in the third column. *Sources:* Authors' survey.

of equations:

$$\pi_{ni}^j = \frac{(\tau_{ni}^j x_i^j)^{-\theta^j} (A_i^j)^{\theta^j}}{\sum_{i'} (\tau_{ni'}^j x_{i'}^j)^{-\theta^j} (A_{i'}^j)^{\theta^j}} \quad (18)$$

if $j = \{\text{ICT, manufacturing, retail and wholesale trade, other industries}\}$.

Total expenditure is set such that the trade balances in equation 13.

6.3 Mobile and Immobile Factors of Production

Mobility restrictions might affect differently the industries in the economy if they use mobile and immobile factors of production in different proportions. Land is, by definition, immobile: changes in the geography of the economy will translate into changes in the rental rate of land, and therefore higher costs of production for industries that more heavily use this input.

To pinpoint this channel, we use the fact that firms located in the same town face the same prices for land and workers. Therefore, differences in shares of input used between firms in the same town but in different industries can be attributed to differences in the production function rather than to differences in factor prices.

$$\ln \frac{L_i^j(z_i^j)}{H_i^j(z_i^j)} = FE_i + FE_j, \quad (19)$$

where $FE_j = \ln \frac{1-\beta^j}{\beta^j}$.²⁹

In our survey we ask the following questions, which inform this part of the analysis:

- How many square meters did the company own for its business operations?
- How many square meters did the company rent for its business operations?

²⁹In practice, the fixed effects FE_j are defined up to a scaling factor, which is sensitive to the units of measure used for the factors of production. So, we rescale the industry fixed effects such that the average is 0.2, which is the consensus in the literature on the economy-wide value for this parameter.

Table 13: share of material goods

	Manufacturing	ICT	Retail	Other industries
Manufacturing	0.73	0.18	0.09	0.31
ICT	0.07	0.04	0.02	0.09
Retail	0.01	0.13	0.56	0.07
Other Industries	0.18	0.66	0.34	0.53

Sources: UNCTAD-EORA

- What is the total number of employees?

These questions have been asked for the years 2018, and 2017.³⁰

We use the number of square meters owned and rented by a firm as a measure for $H_i^j(z_i^j)$.

Table 12 reports the results from this analysis. The third column tests the hypothesis that the input share for the ICT sector is the same as for the other industry groupings, and the last column reports the resulting coefficient. The ICT sector uses significantly less immobile factors than the other industries in the economy, with the exception of the last industry grouping, which is 0.14, compared with an average economy of 0.19. Unsurprisingly, the point estimate for the wholesale and retail trade sector is the largest, given its higher need for storage.

6.4 Input-Output Linkages

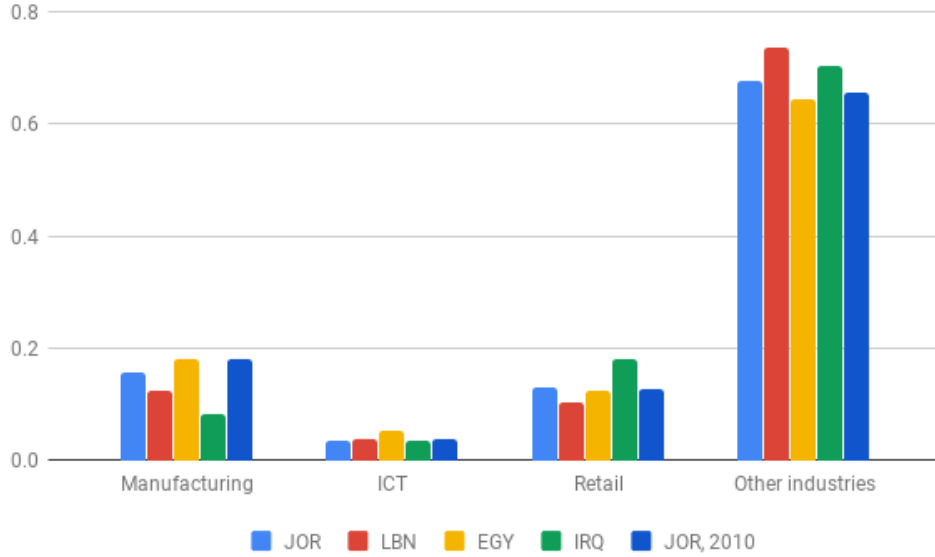
We use data from UNCTAD-EORA on input-output tables for the Jordanian economy in 2015 to estimate the relevant parameters for our model. This database measures trade in value added following the procedure described by Koopman et al. (2010). From the same database, we also use data on the compensation of employees for each industry. Using these data we compute the share of value added in gross output, $\{\gamma_i^j\}_{n,j}$, and the input-output coefficients $\{\gamma_{jk}\}_{j,k}$.³¹

Table 13 reports the corresponding parameters for $\{\gamma_{jk}\}_{j,k}$. 73% of the material inputs in the production of manufacturing goods come from manufacturing sector itself; 18% are produced by the service sectors; 7% by the ICT sector and only 1% by the retail and wholesale trade sector. The ICT sector buys 66% of its material inputs from the service sector, 18% from manufacturing, 13% from retail and wholesale trade, and 2% from ICT.

³⁰The first two questions are also asked for year 2016.

³¹We restrict the analysis to the industries included in our survey. The four industry groupings in our survey are matched to the following industries from the EORA database. Coefficients for manufacturing are estimated using data from the following industries: Food & Beverages; Textiles and Wearing Apparel; Wood and Paper; Petroleum, Chemical and Non-Metallic Mineral Products; Metal Products; Electrical and Machinery; Transport Equipment; Other Manufacturing. Coefficients for the wholesale and retail trade are estimated using data from the following industries: Maintenance and Repair; Wholesale Trade; Retail Trade. Coefficients for IT are estimated using data from Post and Telecommunications. Coefficients for the other industries are estimated using data from: Construction; Hotels and Restaurants; Transport; Financial Intermediation and Business Activities; Education, Health and Other Services.

Figure 5: The shares of ICT used as material inputs by other industry groupings are similar across countries



Sources: UNCTAD-EORA.

While the input-output table illustrates a great variety across industries, for all industry groupings, ICT goods are only a small fraction of the material used, even for the ICT sector itself. As a result, the production of ICT goods is limited by its domestic demand and the size of the overall economy.

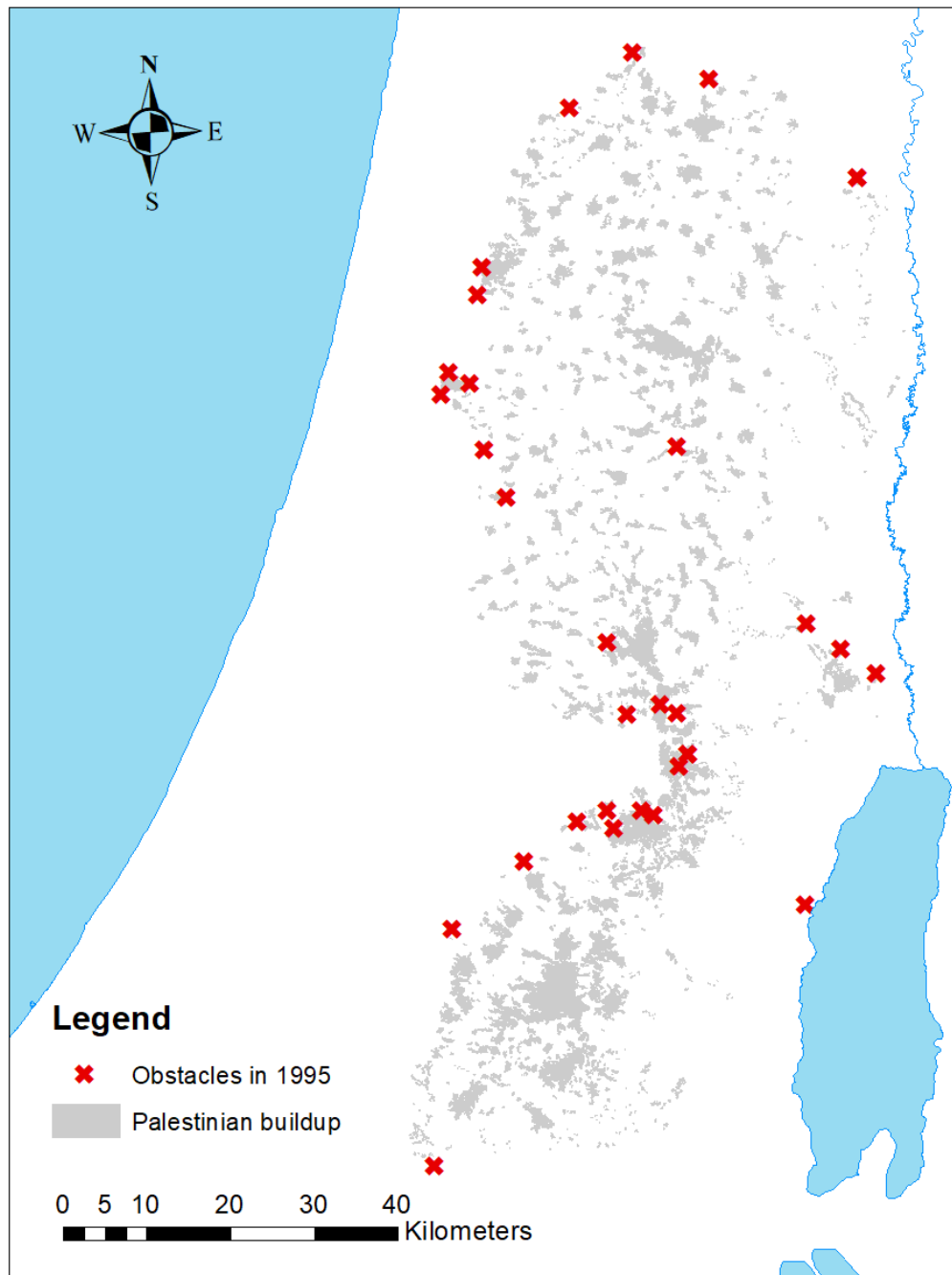
We use Jordan as a reference because it is the most similar economy for which these data are available. Figure 5 compares the input-output coefficients $\{\gamma_{ICT,k}\}$ for Jordan and other countries in the region. We also show the same coefficients for Jordan in 2010. Coefficients are similar, over time and in the cross section. The stability of the coefficients suggest that these countries use similar production technologies, and that using a different country as benchmark would not alter the results of the paper.

7 Effect of Changes in the Road Network on Industrial Composition

This section presents the results of a counterfactual exercise in which mobility is assumed as in 1995, when few obstacles were in place (figure 6). The construction of the separation wall would only start years later, after 2000.

The model is able to replicate the industrial composition of the economy as observed in the data. By construction, the model perfectly replicates the distribution of employment by

Figure 6: Mobility Barriers in the West Bank as of 1995



Notes: The map displays the position of obstacles (checkpoints, roadblocks, and earthmounds). *Sources:* UNOCHA, ARIJ.

Table 14: Industry groupings as a share of GDP

Panel a. Data				
Aggregate	Manufacturing	ICT	Retail	Other Industries
100%	27%	10%	27%	36%
Panel b. Calibrated Model				
Aggregate	Manufacturing	ICT	Retail	Other Industries
100%	25%	12%	11%	53%
Panel c. Counterfactual - Bringing mobility restrictions back to 1995				
Aggregate	Manufacturing	ICT	Retail	Other Industries
100%	36%	7%	21%	36%

Sources: PCBS, authors' calculations.

location and industry grouping. The overall contribution to GDP by industry grouping then depends on the prices for inputs, from wages, and from the estimated production function, including the trade shares. Table 14 compares the contribution to GDP of each industry grouping in the data (panel a) and in the model (panel b). We compare the model with data from the PCBS on national accounts for the West Bank in 2010.³² The data only includes the industries covered by our survey. The model is able to replicate the relative importance of the different industry groupings in terms of contribution to GDP. It should be noted that we did not target the contribution to GDP when calibrating our model. Besides the data from the survey, we only used employment by location and industry, and an estimate of average wage by location. In particular, wages in the model do not vary across industries. This fact makes us confident on the ability of the model to be informative of the issue at hand.

Indeed, removing mobility barriers would disproportionately and negatively affect ICT relative to other industries. Table 14 reports the results broken by industry grouping. Bringing mobility restrictions back to 1995 would imply a decrease of the ICT contribution to GDP from 12% to 7%, to the advantage of manufacturing and retail. Also the other industries would experience a reduction in the contribution to GDP.

With the focus on industrial composition, the paper does not attempt to provide an estimate of the overall effect of mobility restrictions on GDP growth. For this reason, results on GDP growth are not shown. However, it is worth mentioning that, while the ICT contribution to GDP would decrease in the absence of mobility restrictions, the ICT value added would still increase, although less than other industries.

Removing mobility restrictions allows people and production to concentrate towards the middle of the West Bank, while shipping goods to the outer areas (figure 7). As a result, the region around Ramallah and Nablus would experience an inflow in population, while the regions around Jenin, Bethlehem, and Hebron would experience an outflow. As a matter of

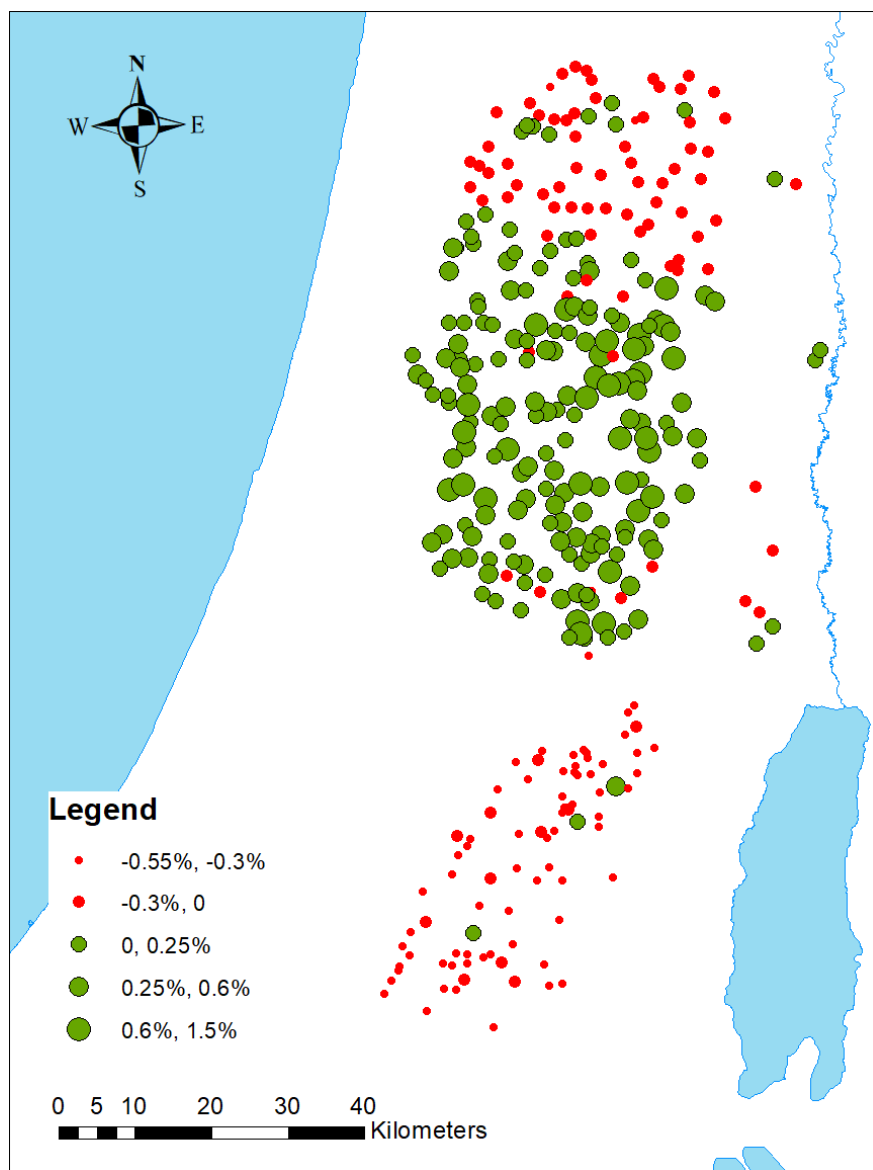
³²The first year in which the data include a break down for information and communication.

fact, the central areas would be better positioned to ship goods, and minimize transportation costs.³³

GDP would increase almost everywhere, which is an expected result of the reduction of trade costs (figure 8). However, there would be a concentration of output towards the central area, mirroring the findings on workers' spatial distribution. Overall, GDP per-capita increases everywhere (figure 9). Even in locations with an inflow of workers, GDP increases more than proportionally to population growth, with GDP per capita increases ranging from 0.5% to 3.7% depending on the location.

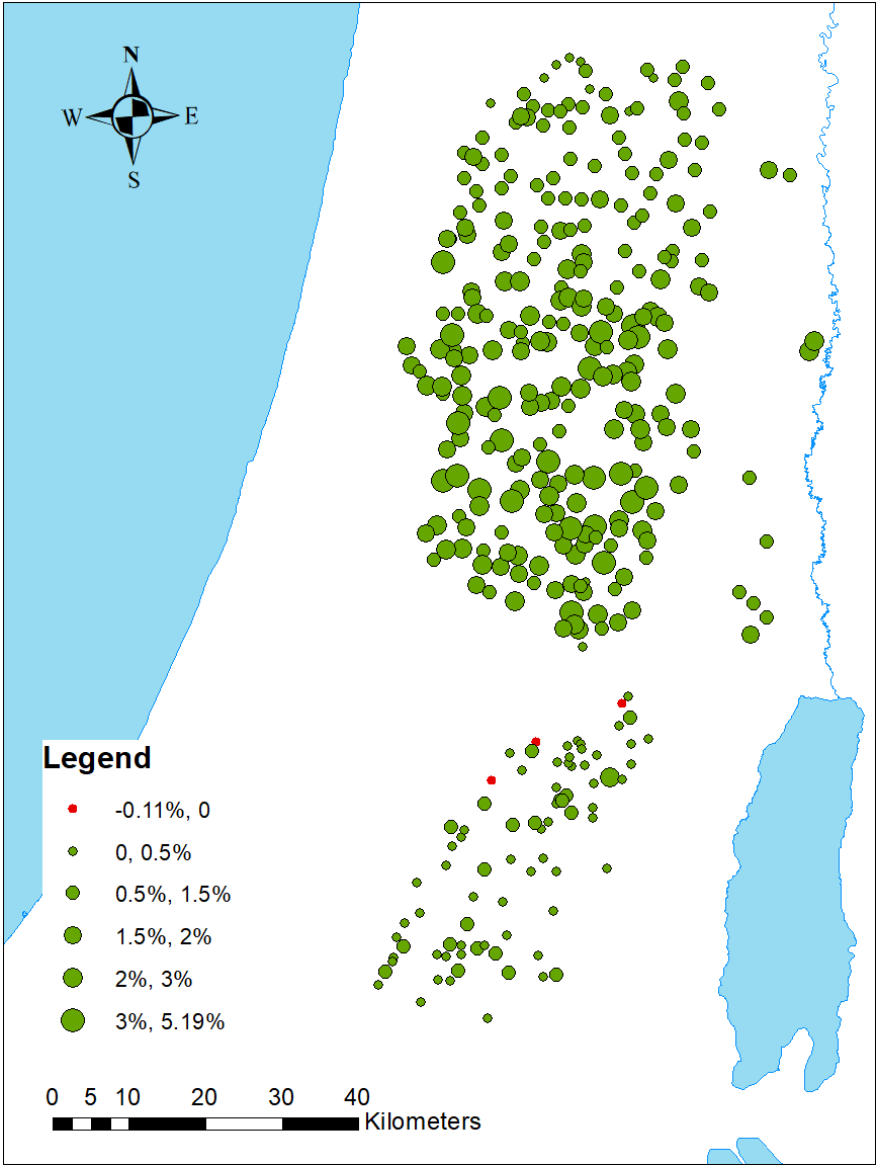
³³In the model, the total population is fixed. Therefore, some locations are bound to lose population to the benefit of others. Instead, in a world in which migration is possible, the removal of mobility restrictions would result in migration flows towards the West Bank. In this case, the central region would experience a more than proportional increase in population, while the outer regions would experience less than proportional increases.

Figure 7: Population reallocation after bringing mobility restrictions back to 1995



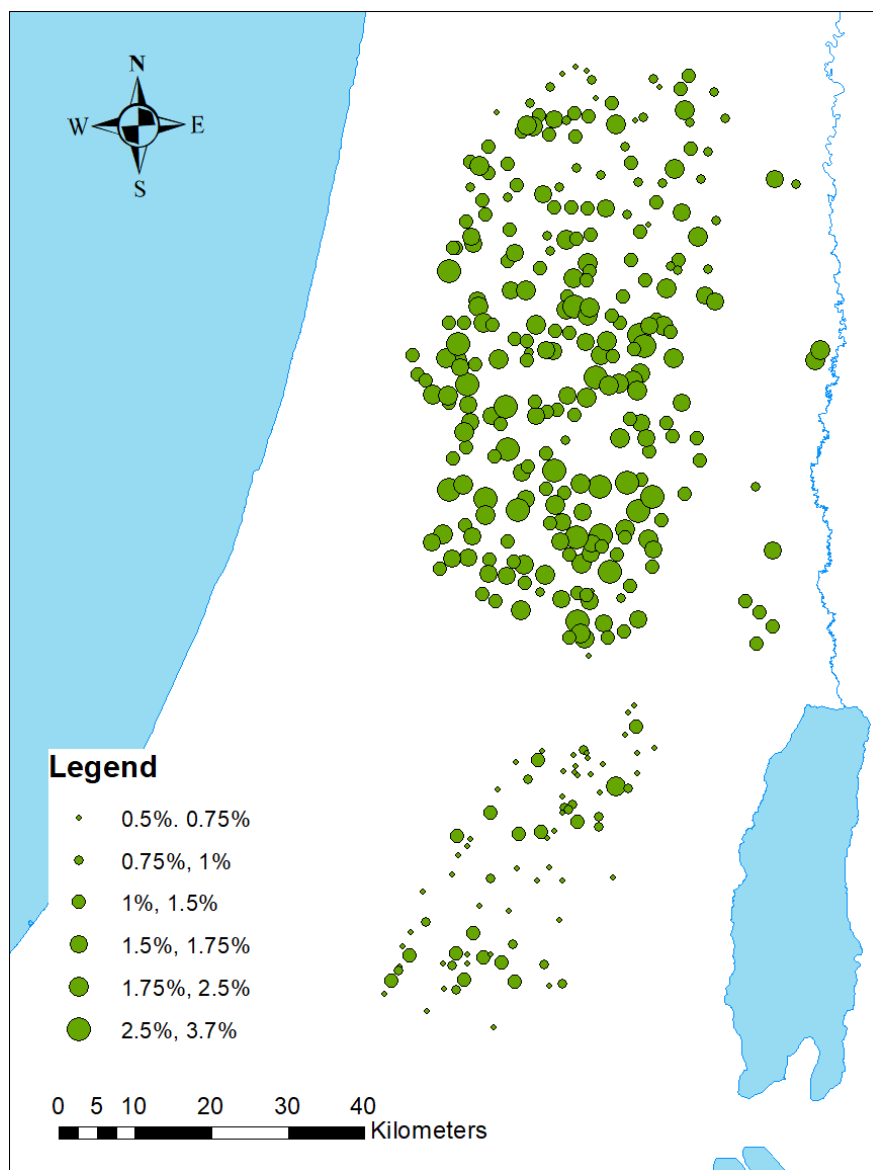
Source: UNOCHA, authors' calculations.

Figure 8: GDP percentage change after bringing mobility restrictions back to 1995



Source: UNOCHA, authors' calculations.

Figure 9: GDP percentage change after bringing mobility restrictions back to 1995



Source: UNOCHA, authors' calculations.

8 Exploration of the Mechanisms

The previous section only allows us to verify the extent to which the proposed mechanisms may play a role in the differential effect of mobility restrictions on industry grouping. However, so far, we have not been able to quantify the relative importance of such mechanisms and their overall effect on industry shares.

We repeat the exercise removing the assumption of input-output linkages in the economy. Table 15 reports the resulting changes in GDP by industry. The comparison between this and the previous table highlights the relevance of input-output linkages and how they represent a key mechanism. If we were to abstract from input-output linkages, we would estimate merely a 0.25% increase in the aggregate economy as a result of the removal of the mobility restrictions. Interestingly, the results suggest that linkages between industries are important also for the development of the ICT sector, which would grow only by 0.05% in this scenario.

Figure 10: Economy without IO linkages - Distribution of GDP Percentage Changes by location

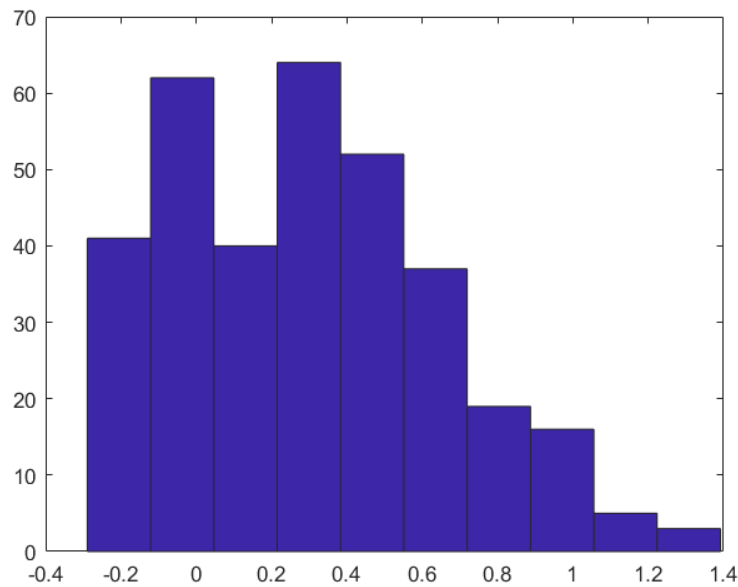


Table 15: Economy without IO linkages

Percentage change in GDP				
Aggregate	Manufacturing	ICT	Retail	Other Activities
0.25	0.27	0.05	0.32	0.24

9 Conclusions

Transport frictions are generally considered a significant barrier to growth, as they impose a high cost on the trade of goods. In fragile and conflict affected states, these frictions can be particularly burdensome, as in the West Bank, where a system of militarized checkpoints and roadblocks imposes heavy limits on the mobility of goods and people.

Yet, interestingly, the Palestinian ICT sector has witnessed a significant expansion. One explanation is that as mobility barriers decrease the incentives to invest in the production of physical goods, the opportunity cost of investing in ICT also falls – and the relative incentive to invest in ICT rises. In fact, focusing on software development and website design, the IT sector is able to employ the high-skilled labor force in the area while overcoming mobility restrictions.

Exploring the constraints to the development of the ICT sector can have important policy implications for other countries seeking to support the fast-growing ICT sector, especially conflict-affected countries where the transportation of goods is often difficult.

This paper points out the extent to which the ICT sector is deeply affected by deficiencies in physical infrastructures, such as the road network. The Palestinian ICT sector, although benefiting from an increase in the incentives to invest due to the mobility barriers, is still severely damaged in its growth prospects by the same constraints to growth as the other firms: the need to have clients nearby and the strong input-output linkages limit its ability to grow in an economy in which other industries suffer. This confirms the need to design a harmonious development plan and that focused investments in a limited set of industries can be hampered by the lag of other parts of the economy and its infrastructure.

Surprisingly, the Palestinian ICT sector is strongly focused on the domestic market, rather than producing for exporting. Besides the difficulties to export, typical of the political and economic situation in the West Bank, it would be interesting to further explore to what extent the ICT sector exhibits home bias as other industries.

References

- Alexei Abrahams. Hard Traveling: Redistributive Effects of Commuting Costs in the Second Palestinian Uprising. *working paper*, 2015.
- Philippe Aghion, Jing Cai, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros. Industrial policy and competition. *American Economic Journal: Macroeconomics*, 7(4):1–32, 2015.
- Francesco Amodio and Michele Di Maio. Making do with what you have: Conflict, input misallocation and firm performance. *The Economic Journal*, 2017.
- The World Bank and World Bank Group. *World Development Report 2016: Digital Dividends*. World Bank Publications, 2016.
- Nicholas Bloom, Raffaella Sadun, and John Van Reenen. Americans do it better: Us multinationals and the productivity miracle. *American Economic Review*, 102(1):167–201, 2012.
- A Kerem Coşar and Banu Demir. Domestic road infrastructure and international trade: Evidence from Turkey. *Journal of Development Economics*, 118:232–244, 2016.
- Donald R Davis and Jonathan I Dingel. A spatial knowledge economy. *American Economic Review*, 109(1):153–70, 2019.
- Robert Dekle, Jonathan Eaton, and Samuel Kortum. Global rebalancing with gravity: Measuring the burden of adjustment. *IMF Staff Papers*, 55(3):511–540, 2008.
- Jonathan I Dingel and Brent Neiman. How many jobs can be done at home? Technical report, National Bureau of Economic Research, 2020.
- Dave Donaldson and Richard Hornbeck. Railroads and american economic growth: A ”market access” approach. *The Quarterly Journal of Economics*, 131(2):799–858, 2016.
- Mirko Draca, Raffaella Sadun, and John Van Reenen. Productivity and ICT: A Review of the Evidence. 2006.
- Jonathan Eaton and Samuel Kortum. Technology, geography, and trade. *Econometrica*, 70(5):1741–1779, 2002.
- Lina Eklund and U Martensson. Using geographical information systems to analyse accessibility to health services in the West Bank, occupied Palestinian territory. 2012.
- Glenn Ellison, Edward L Glaeser, and William R Kerr. What causes industry agglomeration? evidence from coagglomeration patterns. *American Economic Review*, 100(3):1195–1213, 2010.
- Haggay Etkes. The impact of employment in Israel on the Palestinian labor force. *Peace Economics, Peace Science and Public Policy*, 18(2), 2012.

- Haggay Etkes and Assaf Zimring. When trade stops: Lessons from the Gaza blockade 2007–2010. *Journal of International Economics*, 95(1):16–27, 2015. 10.1016/j.jinteco.2014.10. URL <https://ideas.repec.org/a/eee/inecon/v95y2015i1p16-27.html>.
- Chiara Fratto. The reallocative effects of mobility restrictions on workers and firms: a West Bank application. *Working paper*, 2019.
- Thomas L Friedman. *The world is flat: A brief history of the twenty-first century*. Macmillan, 2005.
- IEG. The World Bank Group in the West Bank and Gaza, 2001–2009. Evaluation of the World Bank Group Program, 2010.
- Rico Ihle and Ofir D Rubin. Consequences of unintended food policies: Food price dynamics subject to the Israeli–Palestinian conflict. *Food Policy*, 42:96–105, 2013.
- Jed Kolko. Urbanization, agglomeration, and coagglomeration of service industries. In *Agglomeration economics*, pages 151–180. University of Chicago Press, 2010.
- Robert Koopman, William Powers, Zhi Wang, and Shang-Jin Wei. Give credit where credit is due: Tracing value added in global production chains. Technical report, National Bureau of Economic Research, 2010.
- Kala Krishna and Anne Krueger. Implementing free trade areas: Rules of origin and hidden protection. Technical report, National Bureau of Economic Research, 1995.
- Ferdinando Monte, Stephen J Redding, and Esteban Rossi-Hansberg. Commuting, migration and local employment elasticities. Technical report, National Bureau of Economic Research, 2015.
- Dimitris Papanikolaou and Lawrence DW Schmidt. Working Remotely and the Supply-side Impact of COVID-19. Technical report, National Bureau of Economic Research, 2020.
- Dan Senor and Saul Singer. *Start-up nation: The story of Israel’s economic miracle*. Random House Digital, Inc., 2011.
- The Portland Trust. Beyond Aid: A Palestinian Private Sector Initiative for Investment, Growth, and Employment. Technical report, 2013.
- UNOCHA. The humanitarian impact on Palestinians of Israeli Settlements and other infrastructure in the West Bank. *United Nations-Office for the Coordination of Humanitarian Affairs (OCHA)*, 2007.
- Roy Van Der Weide, Bob Rijkers, Brian Blankespoor, and Alexei Abrahams. Obstacles on the road to Palestinian economic growth, 2018.

APPENDIX to "Market Access and development of the IT sector in the West Bank"

Chiara Fratto and Elisa Giannone

October 2, 2020

1 Survey: Sample Representativeness, and Quality Assessment

The sampling methodology of this survey generates sample sizes appropriate for achieving the following objectives: to produce indicators for Palestinian firms in the West Bank as a whole; to produce indicators separately for the ICT sector, the manufacturing industry, and wholesale and retail trade sector.

To achieve these objectives, the sampling methodology:

- generates a sample representative of the whole non-agricultural private economy;
- and it generates a sample large enough for selected industries to conduct statistically robust analyses with levels of precision at a minimum 10% precision for 90% confidence intervals about:¹ population proportions at the industry level, and estimates proportional to the mean of the log of the number of employees at the industry level.

Therefore, inferences can be made for the whole economy, for ICT, for manufacturing, for retail and wholesale trade, and for the rest of the non-agricultural economy. Within the manufacturing industry, no stratification has been performed.

The target population is the universe of privately owned establishments currently operating in the West Bank, excluding East Jerusalem. We follow the same definition used by the PCBS for the 2017 Establishment Census. They define an establishment as "an enterprise or part of an enterprise in which one group of goods and services is produced (with possibility of having secondary activity)." The following economic sectors are excluded from the target population:

- agriculture;

¹This implies that we can guarantee that the population parameter is within 10% range of the observed sample estimate, except in 90% of the cases.

- mining and quarrying;
- electricity and water supply;
- public administration and defence;
- compulsory social security;
- activities of households as employers, undifferentiated goods- and services-producing activities of households for own use;
- activities of extraterritorial organizations and bodies.

In addition, we are also excluding the governmental and nongovernmental organizations and institutions, and non-profit organizations.

We use a two-stage stratified cluster sampling. We use the 2017 Establishment Census as a frame. The use of the 2017 Establishment Census as the sample frame limits the issue of non-eligible units.

The following levels of stratification were used in this survey:

- North/South of the West Bank,
- village size (2 groups),²
- firm size (less or more than 10 employees),
- industry.

Although stratification is performed according to different variables, observe that the survey does not guarantee representative samples for the sub-areas of the West Bank, nor village size or firm size.

The industry classifications are based on the ISIC4 Rev4.³

The universe of targeted establishments is stratified into one of the following industries:

1. ICT,
2. manufacturing,
3. wholesale/retail,
4. other sectors included in the target population.⁴

²The classification is based on the total population and the unweighted distribution of population in villages in the 2017 Census.

³The PCBS current ISIC classification can be found [HERE](#).

⁴All other sectors excluding:

- ICT,
- manufacturing,

The ICT is defined following the guidelines established by the OECD in 2011, and it includes the following ISIC codes:⁵

- 2610 "Manufacture of electronic components and boards,"
- 2620 "Manufacture of computers and peripheral equipment,"
- 2630 "Manufacture of communication equipment,"
- 2640 "Manufacture of consumer electronics,"
- 2651 "Manufacture of measuring, testing, navigating, and control equipment,"
- 2670 "Manufacture of optical instruments and photographic equipment,"
- 2680 "Manufacture of magnetic and optical media,"
- 3290 "Other manufacturing n.e.c.,"
- 3320 "Installation of industrial machinery and equipment,"
- 5820 "Software publishing,"
- 6110 "Wired telecommunications activities,"
- 6120 "Wireless telecommunications activities,"
- 6130 "Satellite telecommunications activities,"
- 6190 "Other telecommunications activities,"
- 6201 "Computer programming activities,"
- 6202 "Computer consultancy and computer facilities management activities,"
- 6209 "Other information technology and computer service activities,"
- 6311, "Data processing, hosting, and related activities,"

-
- wholesale retail trade,
 - agriculture, mining and quarrying
 - electricity and water supply
 - public administration and defence, compulsory social security
 - activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; activities of extraterritorial organizations and bodies.

⁵Page 34, Table 2A11, OECD Guide to Measuring the Information Society 2011.

- 7020, "Management consultancy activities" - this ISIC code also contains businesses that are not directly related to the ICT. The relevant description of the economic activity within this ISIC is "Business process management services,"
- 7110, "Architectural and engineering activities and related technical consultancy" - this ISIC code also contains businesses that are not directly related to the ICT. The relevant description of the economic activity within this ISIC is "Engineering services for telecommunications and broadcasting projects."
- 7729, "Renting and leasing of other personal and household goods" - this ISIC code also contains businesses that are not directly related to the ICT. The relevant description of the economic activity within this ISIC is "Leasing or rental services concerning televisions, radios, video cassette recorders and related equipment and accessories."
- 7730, "Renting and leasing of other machinery, equipment and tangible goods" - this ISIC code also contains businesses that are not directly related to ICT. The relevant description of the economic activity within this ISIC is "Leasing or rental services concerning computers with operator" and "Leasing or rental services concerning telecommunications equipment without operator."
- 9511, "Repair of computers and peripheral equipment,"
- 9512, "Repair of communication equipment."

The overall number of observations for each economic sector is defined as at least the minimum sample size necessary to obtain a 10% precision estimate for the (log of the) of the number of employees in the firm. We allocate a fixed number of observations among strata using an optimal allocation proportional to the size of each stratum and an estimate of the within-strata variance of the indicators estimated in the survey. The number of observations per stratum, n_i , is then rounded up to the nearest integer. A cluster is defined as the combination of PCBS area code and economic sector. Clusters are randomly selected. Within each cluster selected, we interviewed 1% or 10% of the establishments.

Data collection has been managed by Alpha International. In order to find establishments in the chosen cluster, enumerators were sent by field supervisors to areas believed to have a number of companies within the required sector. The field workers then searched for those companies on foot and interviewed whomever agreed. Furthermore, field supervisors also helped enumerators by researching companies within the area that is part of the required sectors, made appointments for them, and sent them directly there to fill the questionnaire on the first trial.

The targeted number of interviews is 90 for the ICT establishments (the number of establishments in the 2017 census operating in the ICT is 1401) and 410 for the non-ICT, for a total of 500 establishments, corresponding to 5% of all operating establishments interviewed by the PCBS as part of the Population Census 2017.

Table 1: Comparison of distributions across the main variables used in the stratification

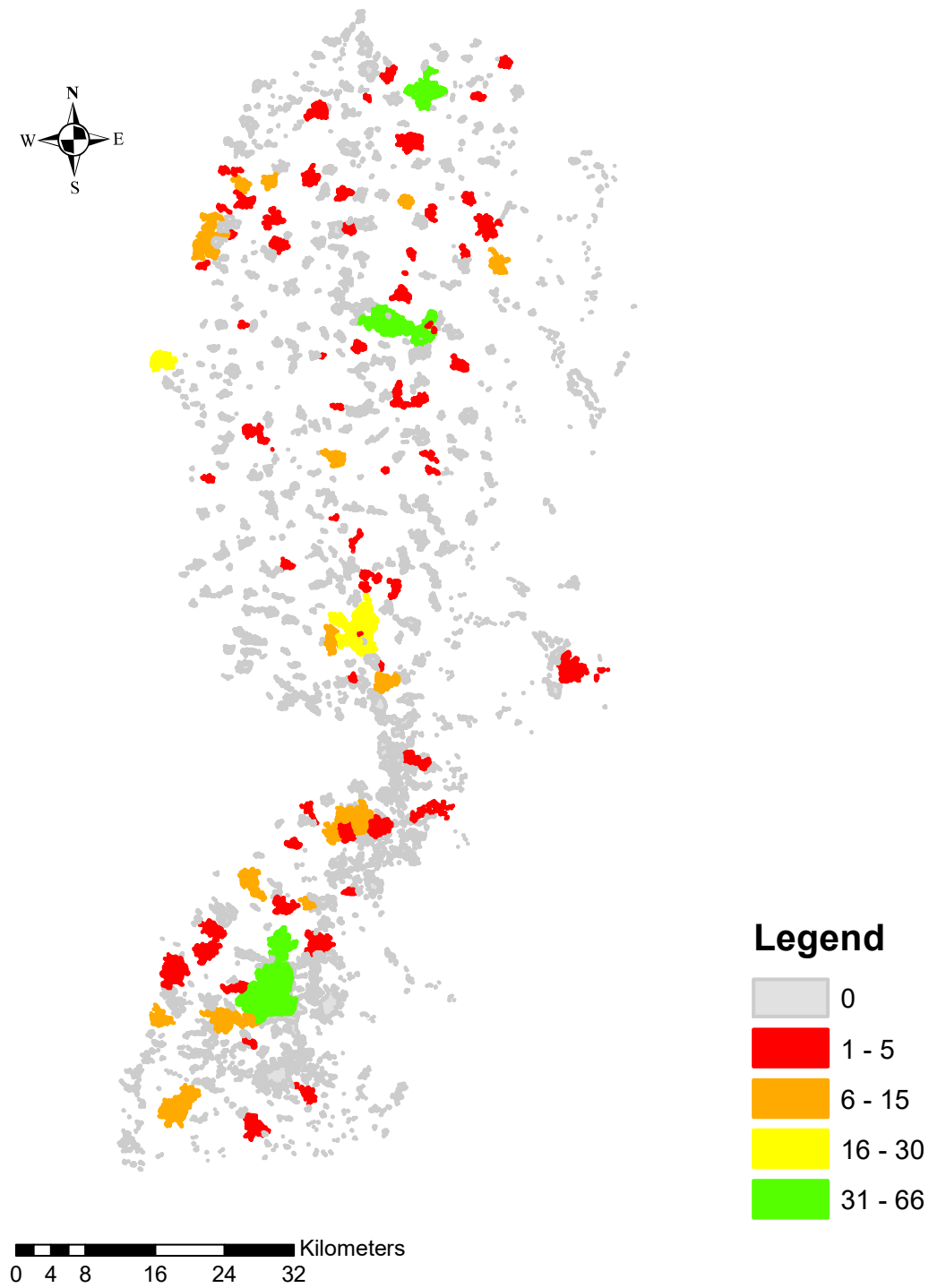
Panel (a): industry							
	Realized sample		Sample Selected		Sample Frame		%
	N	%	N	%	N	%	interviewed
ICT	70	13.78	77	14.34	629	0.05	11.13
Manufacturing	103	20.28	104	19.37	15,110	14.21	0.68
Other Economic Activities	121	23.82	119	22.16	51,091	48.04	0.24
WholeSale Retail Trade	214	42.13	237	44.14	54,618	51.36	0.39
Total	508	100	536	100	106,338	100	0.48

Panel (b): number of employees							
	Realized sample		Sample Selected		Sample Frame		%
	N	%	N	%	N	%	interviewed
0-10	448	88.19	509	94.80	95,293	95.85	0.47
11+	30	5.91	28	5.21	4,121	4.14	0.73
NA	30	5.91	0	0	0	0	0
Total	508	100	537	100	99,414	100	0.51

Panel (c): West Bank areas							
	Realized sample		Sample Selected		Sample Frame		%
	N	%	N	%	N	%	interviewed
South	183	36.02	181	33.71	32,138	30.22	0.57
Center	88	17.32	111	20.76	26,990	25.38	0.33
North	237	46.65	245	45.63	47,210	44.40	0.50
Total	508	100	536	100	106,338	100	0.48

Notes: In the column for number of targeted interviews, the totals are not the same across panels due to rounding. The two columns on population are based on the Establishment Census 2017 for the West Bank; it is based on tables 6 and 8, book 2384. The following economic sectors have been excluded from the analysis in the last two columns: mining and quarrying; electricity, gas, steam, and air conditioning supply; water supply, sewerage, waste management, and remediation activities; public administration and defense, compulsory social security; activities of households as employers, undifferentiated goods- and services-producing activities of households for own use; and activities of extraterritorial organizations and bodies. In the second panel (the last two columns) the number of firms is defined as the number of firms with (strictly) less than 10 employees, and the number of firms with 10 or more than 10 employees.

Figure 1: Spatial distribution of interviews in the survey



We expected a response rate of 80%, slightly below the response rate attained by the PCBS for its 2017 Census. For this reason, we identify 500/0.8 potential establishments to interview.

The sample size has been defined to guarantee that an estimator proportional to the (log of the) number of employees per establishment is representative for ICT, manufacturing, wholesale/retail trade, and other industries included in the target population.

1.1 Sample Representativeness

We use a stratified randomization to identify our sample. For each industry or group of industries, the sample size is identified in order to guarantee a 90% confidence interval with 10% precision. We do not correct for the correlation between indicators. First, we consider the case of proportions, i.e., random variables between 0 and 1. For finite samples, the minimum sample size needed to estimate a 90% confidence interval with a 10% precision is given by:⁶

$$n = \left[\frac{1}{N} + \frac{N-1}{N} \frac{1}{P(1-P)} \left[\frac{10\%}{z_{1-\alpha/2}} \right]^2 \right]^{-1}.$$

where P is the proportion of the population, N is the population size, and n is the sample size. We take P to maximize the variance (i.e., 0.5) and observe that the sample size is increasing in N and tends to 68.⁷

The survey also contains some quantities which are unbounded, such as the number of workers with a bachelor's degree. Because most of our indicators are fractions of the workforce in a firm, and, accordingly, the minimum sample size required for those indicators is lower than or equal to the minimum sample size for estimating employment, we analyze the minimum sample size for the latter to obtain an upper bound. In practice, we use the (log of the) number of employees, because the distribution in levels is typically highly skewed, which is standard practice.⁸

In case of continuous variables, the corresponding formula is:⁹

$$n = \left[\frac{1}{N} + \left[\frac{0.5\%}{z_{1-\alpha/2} CV_y} \right]^2 \right]^{-1},$$

where CV_y is the coefficient of variation of the indicator of interest, y .

We consider both paid and unpaid workers. Unpaid workers accounts for 7.36% of the total workers.

Table 3 summarizes the analysis for our sample.

⁶These formulae are based on simple random sampling and are actually not appropriate for the sampling strategy we used. They can be interpreted as baseline estimates.

⁷The corresponding sample size in the case of a 10% precision tends to 120.

⁸The World Bank ES does the same thing using log of sales as the reference variable.

⁹These formulae are based on simple random sampling and are actually not appropriate for the sampling strategy we used. They can be interpreted as baseline estimates.

Table 2: **(log) Employment distribution**

Strata	N	Mean	Std. dev.	CV	Minimum sample size
ICT	629	4.60	0.60	0.13	18
Manufacturing	15,110	4.34	0.64	0.15	24
Wholesale & retail trade	54,618	2.02	0.51	0.25	69
Other industries	51,091				

Source: PCBS Establishment Census 2017. In the table, the minimum sample size for the estimation of a 10% confidence interval for the (log) of number of employees with 5% precision is reported.

Table 3: Summary of the Minimum Sample Sizes

Industry	Population Size	Minimum Sample log employees	Minimum Sample proportions
ICT	629	18	61
Manufacturing	15,110	24	67
Wholesale & Retail Trade	54,618	69	68
Other industries	51,091		68
West Bank	106,338		68
Total	106,338		264

Source: PCBS Establishment Census 2017.

1.2 Quality Assessment 1

The number of cases and variables have been checked against the documentation. All categorical variables have been checked for out-of-range/wild codes. String variables have been provided both in Arabic (original version) and in its English translation. In successive revisions, format translation checks have been performed. In particular, the following have been verified: number of rows and cases are the same; number of decimal places are the same for numeric formats; string variables are not truncated; date/time are correctly formatted; definition of missing values are not lost.

The quality checks performed by Alpha during the data collection and the subsequent period are the following:

- Call backs: they called back some respondents throughout data collection to ensure validity of data and enumerator performance. Furthermore, they did callbacks for 15% of all respondents at the end of the data collection to check on enumerator performance.
- Contacting enumerators: field supervisors met daily with enumerators to get feedback, and check daily work. Field supervisors were also in daily contact with Alpha HQ regarding problems and to give enumerator feedback.
- Field checks: field supervisors also conducted field checks on enumerators, going to random interviews to observe enumerator performance and questionnaire understanding. Any problem on this end was directly reported Alpha HQ for further instructions and resolved.
- Frequency analysis: simple frequency analysis was done to questionnaires received on a daily basis to ensure that data entered was complete and relevant.

In addition, QAMyData¹⁰ has been run on the survey to assess the quality of the data. The following checks have been performed: date formats are not too specific and are not potentially disclosive; missing values are appropriately labelled; variable labels do not exceed length of 70 characters; spellcheck on string variables in English and Arabic; variables and value labels do not contain 'odd' characters; variables do not have missing values over 25%; outliers have been detected.

In the sampling design, strata sizes are proportional to the strata in the population. Figure 2 reports the distribution of strata in the survey and the distribution of strata in the population. The x-axis corresponds to the ratio between the number of establishments in stratum s and the number of establishments in industry i from the Establishment Census 2017. The y-axis reports the same quantity for the number of completed interviews in the survey. The closer the points are to the 45° line, the closer the strata distribution in the survey resembles the strata distribution in the population.

¹⁰MISSING REFERENCE

Figure 2: Strata distribution in the population and strata distribution in the survey

Notes: The figure reports the number of establishments in the stratum relative to the number of establishments in the industry among the realized interviews and in the population frame. The closer the dots are to the line, the closer the strata distribution in the sample resembles the strata distribution in the population.

Figure 3: Cluster size in the sample and in the population

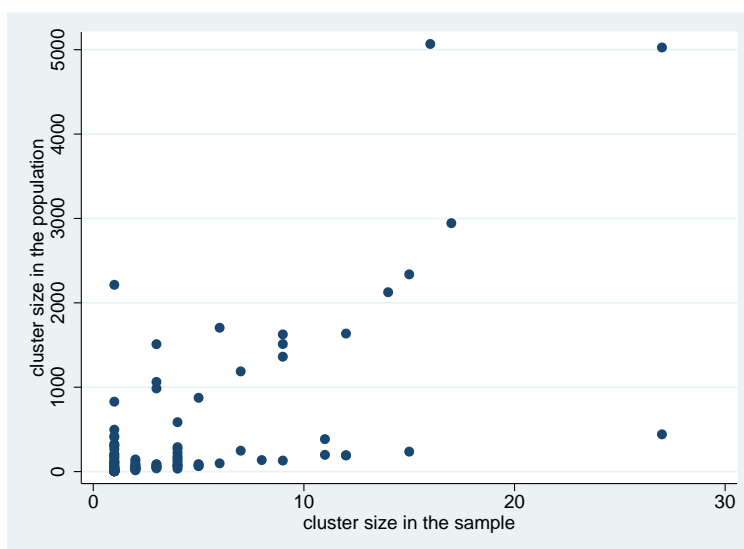


Table 4: Summary Stats

	population	sample
n clusters		
average cluster size		
maximum cluster size		
minimum cluster size		

Table 5: Non-responses

	Counts	Percentage
Completed Interviews	508	69%
Interview Stopped	19	3%
Refused	174	24%
Appointment cancelled due to finished sample	20	3%
Appointment set after data collection ends	14	2%
Grand Total	735	100%

1.3 Weights

Since the sampling design was stratified and employed differential sampling, individual observations should be properly weighted when making inferences about the population or subsets of the population. This comes from the fact that sample sizes are not proportional to the size of each stratum. Observations must be weighted by the inverse of their probability of selection.¹¹ A stratum is a collection of establishments sharing a common industry grouping, grouped by the following variables: firm size, West Bank area, and village size. Notice that a stratum is a finer partition than industry groupings. A stratum can be subdivided into several clusters. A cluster is defined as a set of establishments within a stratum sharing a common village and a common industry grouping. To sample establishments, a cluster is first selected at random (each cluster is selected with equal probability, independent of its size). If the cluster has 100 establishments or fewer, it is discarded and another cluster selected at random. If the cluster has between 101 and 400 establishments, a sample of 10% of the establishments are interviewed. If the cluster has more than 400 establishments, a sample of 1% of the establishments are interviewed.¹²

For each stratum, we select a number of establishments proportional to the stratum size within the population of establishments in industry i , $N_{si} \equiv \sum_v N_{vsi}$, i.e., $\frac{n_{si}}{\sum_s n_{si}} \approx \frac{N_{si}}{\sum_s N_{si}}$, where we are using uppercase for population quantities and lowercase for the corresponding quantities in the survey.

Denote n_i as the sample size attained in the survey for industry i , i.e., the number of completed interviews of establishments in industry i , and $N_i = \sum_s N_{si}$, the number of establishments in industry i in the population of reference. Because of considerations on the minimum sample size, the fraction of establishments in industry i in the survey, $\frac{n_i}{\sum_{i'} n_{i'}}$, is not proportional to the fraction of establishments in industry i in the population, $\frac{N_i}{\sum_{i'} N_{i'}}$. In particular, given the purposes of the survey, and the fact that typically the minimum sample size grows less than proportionally with the population size, the ICT sector is overrepresented in our survey. To the extent to which the ICT sector is not representative of the entire universe of establishments in the economy, we need to adjust for this aspect of the sampling design. So, in the final sampling probability, we have to adjust for it. The total number of firms with characteristics x in the entire population is:

$$\sum_i \sum_s \sum_v \frac{N_i}{n_i} \frac{N_{si}}{n_{si}} \frac{V_{si}}{v_{si}} \frac{N_{vsi}}{n_{vsi}} X_{vsi},$$

where the following notation is being used: X_{vsi} is the number of firms with characteristics x in cluster v , stratum s , industry i , whose population total we want to estimate; N_i is the number of establishments in the population in industry i ; N_{si} is the number of establishments

¹¹Probability weights. For further reference, see Scheaffer, Mendenhall III, Ott, Gerow (2012) MISSING REFERENCE

¹²There are 29 clusters with more than 400 establishments. In these clusters there are always small establishments; there are 3 clusters for manufacturing, 9 clusters for other industries, and the remaining are in the wholesale and retail trade.

in industry i in cluster s ; V_{si} is the number of clusters in the population within stratum s , industry i ; N_{vsi} is the number of establishments in the population in village v , stratum s , industry i ; finally, the lowercase variables are the sample counterparts.

2 More Details on the Empirical Estimation

2.1 Wages

To obtain data on wages, we use data from the Labor Force Survey for the years 2000-2007. We regress the observed hourly wages on year fixed effects and individual characteristics. Finally, we include a fixed effect for each workplace location.

$$\ln w_{iot} = \gamma_0 + \gamma_1 X_{it} + \zeta_t + \zeta_o + u_{io},$$

where w_{io} are the wages of person i in workplace location o in year t , X_{it} are a set of individual characteristics, and ζ_o is a fixed effect for workplace location.

We use the workplace-location fixed effects as our estimate for the wages. This allows us to abstract from issues related to possible heterogeneity in the workforce in a given location. The resulting wage differences between locations are attributable to location-specific characteristics, such as higher productivity or better access to consumer markets, and not to differences in the workers' ability or individual characteristics. Then, our estimate for the wages is $\ln w_o = \gamma_0 + \zeta_o$.

Table 6: Estimating wages

Constant (γ_0)	2.853*** (0.099)
Sex	-0.315 (0.005)
Age	0.048*** (0.002)
Age ²	0.000*** (2.29E-05)
Education: can read and write	0.138*** (0.032)
Education: elementary	0.197*** (0.031)
Education: preparatory	0.216*** (0.031)
Education: secondary	0.256*** (0.031)
Education: associate diploma	0.447*** (0.031)
Education: BA/BSc	0.647*** (0.031)
Education: Higher diploma	0.741*** (0.054)
Continued on next page	

Table 6 – continued from previous page

Education: Master Degree	0.888*** (0.038)
Education: PhD	1.249*** (0.043)
Did not work for wage in any kind of job including casual activities even for one hour	-0.026 (0.036)
Has other jobs	-0.040 (0.037)
Does not have any other job	-0.015 (0.037)
Worked less than 35 hrs: Personal reasons (Illness vacation)	-0.075*** (0.017)
Worked less than 35 hrs: No desire to work more	-0.044 (0.059)
Worked less than 35 hrs: Nature of work	-0.145*** (0.010)
Worked less than 35 hrs: Strike	0.007 (0.033)
Worked less than 35 hrs: Closure	-0.238 (0.173)
Worked less than 35 hrs: Could not find additional work	-0.002 (0.012)
Did not want to change his/her job or to get additional work last week	0.072*** (0.013)
N	36,096
R^2	0.40
Year FEs	Yes
Workplace FEs	Yes

Notes: OLS standard errors in parenthesis. Fixed effect for "Education: illiterate" dropped due to collinearity. People who did not work for wage might have assisted others in any kind of work, including casual activities. Wages are converted to hourly wages and refer to last time the person worked either as employees in national government, employees in foreign government, employees at UNRWA, employees at international organizations, employees at nonprofit organizations, regular employees in the private sector, or irregular employees in the private sector.

2.2 Estimate of the Trade Shares and Trade Flows

The optimality condition for the intermediate goods firm states that labor income in sector s location o is a fixed share of the total revenues for that sector and location:

$$w_o N_o^s = (1 - \beta^s) \sum_d X_{od}^s \quad (1)$$

Moreover, in equilibrium, workers in each destination consume a fixed fraction, μ^s of their income in consumption of good s , so that the total revenues for sector s location o are proportional to the average of each destination's income, weighted by the trade shares π_{sod} :

$$c_d^s = \alpha^s N_d I_d, \quad (2)$$

$$\alpha^s \sum_d N_d I_d + \quad (3)$$

Combining the two equations above gives a relationship between the demand of goods s and its supply produced in location o :

$$w_o N_o^s = (1 - \alpha^s) \mu^s \sum_d \pi_{sod} N_d I_d = (1 - \alpha^s) \mu^s \sum_d \frac{\tau_{sod}^{-\theta^s} (A_o^s)^{\theta^s} (x_o^s)^{-\theta^s}}{\sum_{o'} \tau_{so'o}^{-\theta^s} (A_{o'}^s)^{\theta^s} (x_{o'}^s)^{-\theta^s}} N_d I_d \quad (4)$$

$$x_o^s = (1 - \alpha^s)^{\alpha^s - 1} (\alpha^s)^{-\alpha^s} \left(\sum_{s'} \frac{1 - \alpha^{s'}}{\alpha^{s'}} N_o^{s'} (z_o^{s'}) \right)^{\alpha^s} \frac{w_o}{\bar{L}_o} \quad (5)$$

$$I_d N_d = w_d N_d + r_d \bar{L}_d + \dots = w_d N_d + \left(\sum_{s'} \frac{1 - \alpha^{s'}}{\alpha^{s'}} N_d^{s'} (z_d^{s'}) \right) \bar{L}_d, \quad (6)$$

$$\alpha^j (N_d I_d) + \sum_k \gamma_d^{kj} \sum_d \quad (7)$$

$$x_o^s = (1 - \alpha^s)^{\alpha^s - 1} (\alpha^s)^{-\alpha^s} \left(\sum_{s'} \frac{1 - \alpha^{s'}}{\alpha^{s'}} N_o^{s'} (z_o^{s'}) \right)^{\alpha^s} \frac{w_o}{\bar{L}_o} \quad (8)$$

$$I_d N_d = w_d N_d + r_d \bar{L}_d + \dots = w_d N_d + \left(\sum_{s'} \frac{1 - \alpha^{s'}}{\alpha^{s'}} N_d^{s'} (z_d^{s'}) \right) \bar{L}_d, \quad (9)$$

where we observe or we have estimates for total land, \bar{L}_o , wages w_o , employment for each sector N_o^s , trade costs $\tau_{sod}^{-\theta^s}$, and the marginal cost of intermediate goods, x_o^s .

Proposition. Given the dispersion of productivity, θ^s , our measures of wages, employment, marginal cost for intermediate goods $\{w_o, L_o^s, x_o^s\}$, and a parameterization of trade costs τ_{sod} , there exist unique values of the unobserved productivities A_o^s for each location o and each sector s that are consistent with the data being an equilibrium of the model.¹³

¹³For a proof of this proposition, see ?.

The previous proposition aims at finding a vector of productivities that minimizes the distance between the left-hand side and the right-hand side of equation 4, given the observables. We can prove that such a vector is unique up to a scaling factor.

The proof involves demonstrating that the excess demand for all locations sums up to zero, which is a specific case of Walras law:

$$D_o^s = w_o N_o^s - (1 - \alpha^s) \mu^s \sum_d \frac{\tau_{sod}^{-\theta^s} (A_o^s)^{\theta^s} (x_o^s)^{-\theta^s}}{\sum_{o'} \tau_{so'd}^{-\theta^s} (A_{o'}^s)^{\theta^s} (x_{o'}^s)^{-\theta^s}} N_d I_d \quad (10)$$

$$\sum_o D_o^s = \sum_o w_o N_o^s - (1 - \alpha^s) \mu^s \sum_o \sum_d \frac{\tau_{sod}^{-\theta^s} (A_o^s)^{\theta^s} (x_o^s)^{-\theta^s}}{\sum_{o'} \tau_{so'd}^{-\theta^s} (A_{o'}^s)^{\theta^s} (x_{o'}^s)^{-\theta^s}} N_d I_d \quad (11)$$

$$\sum_o D_o^s = \sum_o w_o N_o^s = (1 - \alpha^s) \mu^s \sum_d N_d I_d = 0 \quad (12)$$

$$\sum_o w_o N_o^s = (1 - \alpha^s) \mu^s \sum_d \sum_{d'} \sum_s X_{dd'}^s \quad (13)$$

where this result holds because of

- the workers' budget constraint,
- the workers' optimal consumption of good s given their total income,
- the zero profit condition for the firms.

The last equation states that the total labor income in sector s is equal to the fraction of total GDP workers spend in purchasing goods s , μ_s , multiplied by the fraction of expenditure in goods s that accrues to labor income, $1 - \alpha_s$.

The resulting estimates of the internal trade shares and trade flows are the solution to the following set of equations:

$$\pi_{sod} = \frac{\tau_{sod}^{-\theta^s} (A_o^s)^{\theta^s} (x_o^s)^{-\theta^s}}{\sum_{o'} \tau_{so'd}^{-\theta^s} (A_{o'}^s)^{\theta^s} (x_{o'}^s)^{-\theta^s}} \quad (14)$$

$$X_{od}^s = \mu^s \pi_{sod} N_d I_d \quad (15)$$

if $s = \text{manufacturing}$, and $\pi_{soo} = 1, \pi_{sod} = 0 \ \forall d \neq o$ if $s = \{\text{IT, retail and wholesale trade, other industries}\}$.

3 More Empirical Results

Table 7 reports the GDP growth resulting from the removal of mobility restrictions in the benchmark model. Aggregate GDP would increase by 1.16, mostly driven by manufacturing and retail trade, while IT would increase by 0.78%. These results should be considered floor estimates as the model is not designed to deliver aggregate estimates of the overall effect of mobility restrictions on GDP. First, migration flows out of the West Bank - imposed to be

Table 7: Benchmark - Bringing mobility restrictions back to 1995

Percentage change				
Aggregate	Manufacturing	IT	Retail	Other Activities
1.16%	1.31%	0.78%	2.06%	0.98%

zero in the model - would have a strong impact on the aggregate GDP, as a result of people migrating abroad and thus reducing production. Second, other effects are at play, most notably the role of commuting which would further increase the economic cost of mobility restrictions (see Fratto, 2019). Third, the constant returns to scale and the absence of production spillovers further reduce aggregate number.

4 Evidence on Other Mechanisms Not in the Model

4.1 Agglomeration Externalities

4.2 Capital Accumulation

4.3 Technological Adoption

Table 8: Agglomeration Externalities

Do you operate with other firms to promote technological innovation?
(fraction of firms that answered yes)

	IT	Manufacturing	Retail and wholesale trade	Other industries
p-value[$IT = nonIT$]	90.86%	11.55% (4E-26)	34.58% (4E-09)	39.27% (4E-10)
in your town p-value[$IT = nonIT$]	84.73%	8.73% (7E-26)	32.62% (2E-08)	34.98% (5E-09)
in the West Bank and Gaza p-value[$IT = nonIT$]	3.22%	8.64% (0.21)	15.91% (0.05)	14.13% (0.02)
in Israel p-value[$IT = nonIT$]	5.32%	6.75% (0.75)	4.33% (0.76)	3.53% (0.61)

Table 9: Capital Accumulation

	IT	Manufacturing	Retail and wholesale trade	Other industries
age (years)	12	19 (0.055)	9 (0.057)	14 (0.218)
Investments in physical capital, 2018	82.1%	59.4% (0.052)	40.3% (9.21E-06)	61.5% (0.001)
Investment in intangible capital, 2018	72.2%	25.3% (0.007)	14.0% (0.000)	33.1% (0.000)
Investments in physical capital, 2017	65.2%	37.0% (0.078)	41.0% (0.016)	46.3% (0.005)
Investment in intangible capital, 2017	68.2%	25.1% (0.013)	30.0% (0.000)	25.3% (0.000)

Table 10: Type of intangible investment (fraction of firms that answered yes)

	IT	Manufacturing	Retail and wholesale trade	Other industries
did the company acquire new software or other types of intangible? (2018)	27.61%	22.50%	9.35%	21.71%
p-value[$IT = nonIT$]		(0.776)	(0.004)	(0.399)
did the company renew licenses for software currently being used? (2018)	65.85%	24.77%	10.28%	21.14%
p-value[$IT = nonIT$]		(0.018)	(0.000)	(0.000)

Table 11: Internet presence

	IT	Manufacturing	Retail and wholesale trade	Other industries
Does the company have an online website?	62%	12%	8%	27%
p-value[$IT = nonIT$]		0.00	0.00	0.00
Is it possible to place order through the website?	16%	83%	72%	74%
p-value[$IT = nonIT$]		0.00	0.00	0.00
Is it possible to contact the company through the website?	29%	86%	100%	77%
p-value[$IT = nonIT$]		0.00	0.00	0.00
Is the company active on social media?	39%	37%	63%	65%
p-value[$IT = nonIT$]		0.83	0.01	0.01