Hard Traveling: Commuting Costs and Welfare in the Second Palestinian Uprising

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Abstract

Economists think commuting costs are purely welfare-reducing in the short run, but in labor markets typical of developing cities, with high unemployment and low-skill, substitutable laborers, commuting costs redistribute welfare, reducing job access for some while letting others seize vacancies. I model and test this idea by accessing confidential, spatially disaggregated Palestinian censuses of the West Bank, where the Israeli army deployed hundreds of road obstacles during a violent uprising (2000-2007) in an effort to defend Israeli settlements. Instrumenting for Palestinian locations' exposure to geolocated obstacles with proximity of settlements to commuter routes, 2SLS regressions find almost a one-to-one transference of employment as obstacles' labor-protecting effect (3.84%) largely mitigates their job-obstructing effect (-4.28%), with peripheral areas losing employment and population to core areas. Nighttime lights, firm census, and fatalities data indicate neither firm redistribution, trade, nor conflict are driving results.

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1 Introduction

[1] How do commuting cost changes affect laborers' welfare in the short run? In the long run, reduced commuting costs allow a city's population to suburbanize,[2] but economists have little to say about the welfare consequences of suburbanization, which may allow households to inhabit larger properties but may also reduce knowledge spillovers and lead to urban encroachment on natural areas.[3] But in the short run, while land use regulations, housing supply inelasticity, and various kinds of moving costs delay the spatial redistribution of firms and laborers, what are the welfare impacts of commuting cost changes? To date, empirics show an inverse relationship: a real estate subliterature finds that homeowners' property values rise when commuting costs decline between their neighborhood and commercial areas;[4] and the spatial mismatch literature (Kain (1968), Ihlanfeldt & Sjoquist (1998)) contends that in large American metropolitan areas, commuting costs harm the labor market outcomes of low-skill, minority, downtown residents by reducing their access to job vacancies in suburbs.[5]

Both of these literatures, however, have ignored the fact that like trade barriers, commuting costs have a protectionist quality that benefits a subpopulation of laborers even while harm-

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[2] See Baum-Snow (2007), Baum-Snow et al (2014), Baum-Snow & Turner (2014)

[3] See the literature on urban sprawl.

[4] See Debrezion et al (2007) for a review of papers focused on metro rail expansions in the developed world. For the developing world, see Gonzalez-Navarro & Quintana-Domeque (2014).

[5] In the long run, these laborers can relocate from the inner city to the suburbs and avoid these commuting costs altogether, but while low-income suburban housing options remain limited and racial discrimination in suburban housing markets persists, commuting costs reduce job access and welfare.

ing others. A rise in commuting costs harms the welfare of some laborers by reducing their access to jobs, but their subsequent absence from the market leaves jobs vacant, creating local labor supply shortages, and putting upward pressure on wages. If, as in many developing cities, laborers are very substitutable and there are initially high levels of unemployment across the city, the absence of any laborer from work leaves open a job vacancy that can quickly be seized by another unemployed laborer. Under such circumstances, a municipality's decision to improve or expand commuter infrastructure will not be purely welfare-enhancing; some laborers will benefit, but others will suffer. Likewise, a municipality's decision to neglect or destroy commuter infrastructure will not be purely welfare-reducing; some laborers will benefit, while others will suffer. In the absence of Pareto effects, any evaluation of aggregate welfare consequences will depend on how each laborer's welfare is weighted by the social planner.[6]

In this paper I model commuting costs as being both obstructive and protective, then test for dual welfare effects empirically by focusing on a commuter economy in the developing world: the Occupied Palestinian Territories of the West Bank. I negotiate access to confidential versions of Palestinian population censuses (1997, 2007) and a firm census (2004) to plot the positions of firms and laborers across 485 census locations of the West Bank, inter-connected by a road network. The West Bank is only 130km North-South and 50km East-West at its widest, roughly one quarter the size of New Jersey, and Palestinians' low overall participation in agriculture (6.8%) and high commuting rates (61%) means the territory resembles more the features of a sprawled city with multiple commercial centers, than a system of specialized cities trading goods. Consistent with the model's assumptions, West Bank laborers are highly substitutable, possessing low education levels (15% high school completion rate) and competing among each other for low-skill jobs focused around construction, retail, and small-time manufacturing. Unemployment rates in both 1997 and 2007 are also very high (19.1% and 14.9%), further contributing to the market's fluidity.

During a violent uprising (the Second Intifada, 2000-2007), the Israeli army built a 500km wall to block West Bank Palestinian militants from entering Israel, and deployed hundreds of checkpoints, roadblocks, and other types of obstacles along the West Bank's internal road network in an effort to deter or intercept militant traffic along roads leading to or passing

[6] This has obvious political economy implications. In municipalities whose constituents stand to lose jobs to inflowing commuters, the municipal government will tend to weigh its constituents' welfare more heavily and may oppose improvements to commuter infrastructure.

near Israeli settlements. Obstacles remained deployed throughout 2002-2007, and are widely reported to have had the unintended consequence of raising commuting costs for Palestinian civilian travel inside of the West Bank (World Bank 2007, B'Tselem 2007). To derive an index of commuting cost changes at the census location level, I obtain UN road network data and calculate bilateral commuting paths between every pair of census locations using ArcGIS Network Analyst. I georeference and digitize a series of UN poster-maps from 2003-2007 geolocating obstacles at 11 different instants during the uprising. I count the number of obstacles ever deployed along each bilateral route among Palestinian locations, or between Palestinian locations and border crossings into Israel, inversely weighting each route's count of obstacles by a function of pre-uprising route length. For each Palestinian location j, I create an obstacle exposure index by summing up these weighted counts along j's route to each other location k.

My identification strategy centers on the widely supported claim (World Bank 2007, B'Tselem 2007) that obstacles were deployed to defend Israeli settlements, without any particular reference to the economic conditions of Palestinian locations. If obstacles were deployed more often around Palestinian census locations with, say, a proclivity for violent confrontation, then the obstacle exposure index would be an endogenous regressor. I instrument for obstacle exposure with settlement proximity to commuter routes. I obtain polygon data of all Israeli settlements lying inside the West Bank during the uprising, and I draw defensive buffer zones around each settlement to identify segments of the road network that lay in close proximity to settlements. If indeed the army deployed obstacles to defend settlements, then these road segments would have been the likeliest places. I show that indeed the total length of such road segments traversed while commuting along the route between any pair of locations j and k is an excellent predictor of the total number of obstacles ever deployed along that same route. If a Palestinian's commuter route to work unluckily passed often within close proximity of Israeli settlements, that commuter faced a higher total increase to commuting costs. The resulting instrumental variable I call a segment index, which I define exactly like the obstacle exposure index, expect that instead of counting obstacles along j's commuter route to k, I count the total length of road segments inside defensive buffers along that same route.

The commuting model suggests a simple empirical architecture to tease apart the dual effects of commuting costs on post-uprising (2007) employment rates. The model predicts that the employment rate of residents of location j declines as commuting costs to any destination k rise; but that this decline is more pronounced when more firms are located at k. To quantify each location's obstruction due to obstacles, I therefore recalculate obstacles and segment indices for each location j, weighting destination locations k by their share of firms in 2004. Here I would preferably use pre-uprising shares of firms, since perhaps the shares of firms in 2004 are themselves responding to obstacle deployment during 2002-2004. In the absence of pre-uprising firm data, I present evidence that firms were neither opening nor closing in a manner responsive to obstacle deployment. As a further robustness check, I establish that nighttime light emissions as measured by DMSP[7] satellites are a credible proxy for locations' job counts, then impute pre-uprising job shares using pre-uprising nighttime lights emissions over Palestinian locations, adopting these as an alternative to the firm counts. I use radiance-calibrated nighttime lights imagery to avoid top-censoring of data in bright areas around Jerusalem, and I correct for blurring ('overglow') by applying a novel de-blurring method developed in Abrahams et al (2014).

The model also predicts that the employment rate of residents of j rises as commuting costs increase for residents of k on their route to j, and that this rise is more pronounced when a larger share of laborers dwells at k. To quantify each location's protection due to obstacles, I therefore recalculate obstacles and segment indices for each location j, using the 1997 Palestinian census to weight origin locations k by their pre-uprising labor force shares. Obstruction and protection indices are therefore statistically distinguished by exploiting differences in locations' firm shares and labor force shares.

I perform 2SLS regressions to estimate the dual effects of obstacles on 2007 (post-uprising) employment rates of 485 census locations. Integrating over location labor force sizes, the net effect of obstacles was to reduce total employment of the economy by just .44 percentage points, with the protective effect (3.84 percentage points) importantly mitigating the obstructive effect (-4.28 percentage points). Indeed, projecting the fitted values, some 180 of 485 Palestinian census locations enjoyed net gains to employment as a result of obstacles. The correlation of net employment effects of obstacles and pre-uprising proximity to jobs is 20.1%, indicating that residents of locations that were initially closer to jobs tended to fare

[7] The United States Defense Meteorological Satellite Program http://ngdc.noaa.gov/eog/

better when their more distant counterparts struggled to reach work.

According to the model, the laborers who are losing jobs are identical to those gaining them, and welfare changes are proportional to employment changes, so the small total employment loss (.44) means commuting costs redistributed welfare while causing negligible aggregate consequences. Beyond the model, one might be concerned that those who lost jobs were different from those who gained them. Indeed, if periphery-to-core commuters were filling jobs that unemployed core residents could have filled, one might think commuters were more productive. Aside from the fact that the West Bank labor market as a whole is low-skill, so that it stretches credibility to suppose there were permanent and sizeable productivity differences between laborers, more productive laborers should have tended to value their time more highly, and so to have outbid their less productive peers to dwell closer to jobs, *ceteris paribus*.[8] Although I cannot observe productivity, certainly the correlation between proximity to jobs and pre-uprising educational attainment is 27%, suggesting peripheral residents were actually less productive. Despite this difference between core and peripheral areas, the quasirandomness in exposure to obstacles ultimately means that controlling for educational attainment has no effect on the paper's point-estimates of interest. Controlling for households' agricultural land holdings likewise has no effect, suggesting that while peripheral residents may have had better or worse outside options relative to core residents, the quasirandomness of obstacle exposure upholds the model's handling of job-losing and job-gaining laborers as fundamentally identical.

The short-run welfare consequences of commuting costs are not particularly interesting if the short run is really short, i.e. if laborers and firms can quickly relocate to avoid these costs. In the spatial mismatch literature, the short-run consequences of commuting costs for minority residents of American inner cities are prolonged by housing market discrimination in the suburbs, which prevents these laborers from easily relocating to suburban areas. In the developing world, there are likewise many deterrents to relocation, including the importance of local family networks. Topalova (2010), Bryan et al (2013), and Munshi & Rosenzweig (2013) all find persistent welfare gaps between urban and rural areas in India and Bangladesh, and advance various theories explaining factor immobility. I present evidence that the West Bank likewise exhibits considerable factor immobility. Only 1.6% of 2007 labor force census

[8]In many American cities, 'ceteris paribus' does not hold, and more productive laborers dwell far from downtown areas where they work, avoiding high crime rates, pollution, and other downtown disamenities.

respondents reported moving between 2000-2007 for job-related reasons. I show that among the few laborers who did end up relocating, their relocation patterns do indeed respond to obstacle deployment, with obstruction from jobs tending to induce depopulation, while protected locations gain labor immigrants. Relatedly, I show that incidence of renting falls in obstructed locations and rises in protected locations, suggesting that some laborers may have adapted their commuting habits in response to obstacles, returning to their hometowns on a less frequent basis, while renting apartments near their places of work in the meantime. Owing to the small fraction of laborers and households that reported moving or changing their renting behavior, however, these results are statistically unstable. Regressions using firm census and nighttime lights data further suggest very weak statistical evidence that firms redistributed across locations in response to obstacles.

In addition to making a novel contribution to the literature on welfare and commuting costs, this paper also contributes to the debate over the effects of Israeli movement restrictions on the West Bank Palestinian economy (Cali & Miaari (2014), van der Weide et al (2014), World Bank (2007)). Whereas research has so far tended to argue that movement restrictions were purely harmful to Palestinian economic outcomes (one notable exception is Angrist (1996)), this paper finds robust evidence that the effect of obstacles was to redistribute welfare across subpopulations of the West Bank, generating economic inequality that adopted a clear spatial pattern: core locations benefited while peripheral locations suffered. Over time, this inequality will tend to encourage the spatial redistribution of firms and laborers. My results suggest firms are not moving, but there is some evidence that laborers are relocating to be closer to firms, abandoning peripheral areas in favor of core cities like Ramallah or Nablus. Given that the borders of a Palestinian state have yet to be determined, the depopulation of peripheral areas would seem to invite annexation, whereafter it will become even harder to reach a sustainable agreement on the geography of a two-state solution.

2 Context & Data

The West Bank is surrounded by Israel on its north, west, and south sides, while sharing an eastern border with Jordan. It is very small: about 56km (34.8 miles) at its widest and about 133km (82.6 miles) at its lengthiest, with roughly 1/4 the area of New Jersey. As depicted in Figure 1, the Israeli capital and historical city of Jerusalem, located inside Israel near the mid-section of the West Bank, is not much more than 75km (46.6 miles) from any

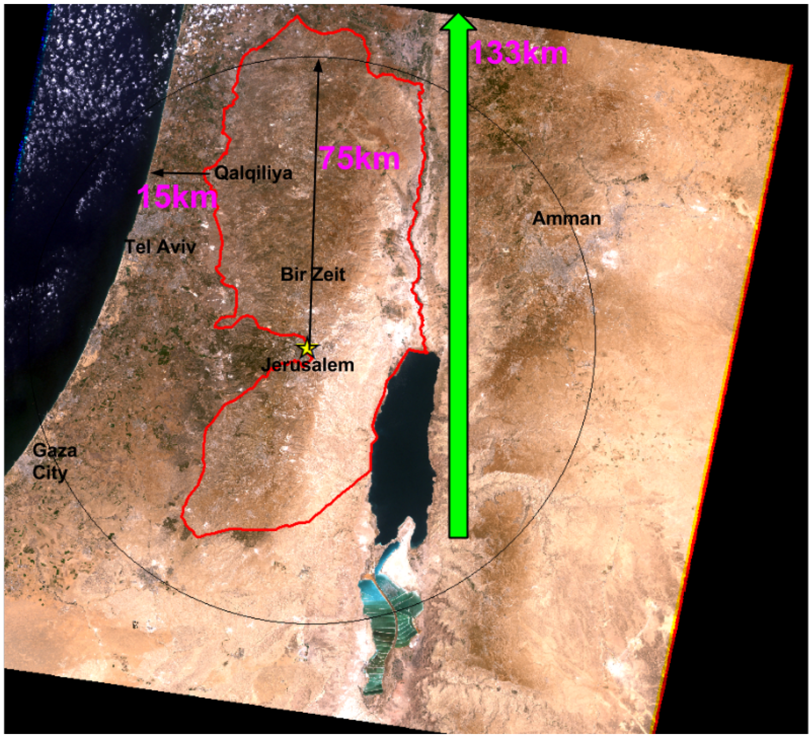

Figure 1: The West Bank is *small*

West Bank location. Without obstacles or restricted roads, a driver could reach Jerusalem in under an hour from any part of the West Bank. The West Bank is also within an easy commuting distance of most Israeli cities. The Palestinian town of Qalqiliya, for example, is just 15km from the coastal Israeli city of Netanya. More than 2 million Palestinians live in the West Bank, as do more than 300,000 Israeli civilian settlers.[9]

The West Bank has been under Israeli military occupation since 1967. Palestinian aspirations to achieve national self-determination have remained unrealized for over 47 years. Frustration has boiled over twice into extended popular uprisings. The first was in 1987-1991 (the First Intifada), a largely peaceful uprising that prompted negotations for a two-state solution. When the peace process failed, economic stagnation and political frustration resulted in a second popular uprising in 2000-2007 (The Second Intifada),[10] which was accompanied by an escalation in violence as militant Palestinian elements used conventional and suicide

[9]Current population estimates are drawn from the World Bank report on Area C (2013).

[10]See the joint Israeli-Palestinian economic think tank AIX Group's report entitled 'Twenty Years after Oslo and the Paris Protocol' for a detailed and thorough discussion. http://www.aixgroup.org/research

attacks against Israeli military and civilian targets.

Labor force and employment

Censuses of Palestinian residents of the West Bank were conducted in 1997 and 2007, pre- and post-dating the Second Intifada. Table 1 lists aggregate descriptive statistics of the Palestinian West Bank. Depressed economic conditions in the late 1990s are evident in the low employment rate (80.9%) recorded in 1997. Formally, I define labor force as

Table 1: Palestinian West Bank: summary of census data 1997, 2007

	1997	2007
Population	1.5 million	2 million
Labor force	408,618	472,916
Employed	330,667	402,366
As a percentage of labor force:		
Employed	80.9%	85.1%
Male	86.0%	85.1%
Female	14.0%	14.9%
As a percentage of those employed:		
Commuting to Palestinian locations	74.0%[11]	45.7%
Commuting to Israel	21.6%	13.0%
Commuting to settlements	2.7%	2.5%
Major job sectors:		
Construction	NA	23.2%
Retail	NA	10.9%
Education	NA	10.8%
Public sector	NA	10.1%
Farming	NA	6.8%
Transportation	NA	4.5%
Materials manufacture	NA	4.1%
Minerals	NA	3.2%
Health	NA	3.1%
Vehicle sale & repair	NA	3.1%
Hospitality	NA	2.3%
Wholesale	NA	2.2%
Furniture	NA	1.8%

$$labor\_force = \#employed + \#unemployed\_but\_available\_to\_work$$

I therefore exclude those who report they are not available to work because they are instead studying, doing house chores, too old, disabled, or on pension. The correlation between location labor forces and populations is over 99% in both 1997 and 2007, so labor force participation rates do not vary over locations in a meaningful way. I then define the employment rate as

$$employment\_rate = \frac{\#employed}{labor\_force}$$

Unemployment benefits

The West Bank has one of the world's highest rates of per-capita receipt of international aid, as a result of which living standards rarely reach such low levels as would be found in urban slums of sub-Saharan Africa or India. In 1997, 80% of West Bank Palestinians households owned houses while almost all of the remainder rented. 86% of households owned TVs and 81% owned fridges. Likewise, 94% were connected to a public electric grid, and were hooked up to either public (79%) or private (15%) water networks. 23% owned private vehicles. Impoverished families receive subsidies from the Palestinian Authority, itself significantly funded by international aid[12]; and various international organizations offer aid to the unemployed and impoverished more directly, such as food stamps available through the UN World Food Program.

Commuting

Table 1 indicates high rates of commuting inside the West Bank and into Israel in both 1997 and 2007. Even in 2007, with obstacles deployed throughout the West Bank, 61% of employed Palestinian laborers still reported working outside of their location of residence. Less than a quarter of these commuted across the border into Israel; the majority commuted to other Palestinian locations inside the West Bank.

Internal trade

Alongside labor flows, there may have been internal flows of traded goods that were likewise disrupted by road obstacles, and one might be concerned that trade disruption, rather than commuting disruption, drives the paper's main results. In Section 5 I address this concern empirically, showing that point-estimates for the commuting story are unaffected by controlling for trade-related variables. Table 1 points to some historical reasons why that result is not surprising. As of 2007, despite low participation in agriculture (6.8%), most West Bank jobs were in the service sector, with only 10% in manufacturing. These statistics reflect a kind of 'false' structural transition (Gollin et al (2013)). Prior to 1967, the West Bank was chiefly an agrarian economy. When Israel captured the West Bank, however, low-skill urban

[12]See the AIX Group report 'Twenty Years after Oslo and the Paris Protocol', Section 2.3.

job opportunities suddenly became accessible to West Bank Palestinians, who could commute daily to Israel and work below minimum wage. Palestinians drained out of agriculture and the West Bank became a resource export economy where unskilled labor, rather than cocoa or oil, was the primary export (Hilal (1977), Graham-Brown (1979)). Wages earned by Palestinian laborers in Israel were then spent on imports (often Israeli) and services in the West Bank, thus giving rise to a predominantly service-oriented economy without the industrial base characteristic of classical structural transformations. Israeli demand for unskilled Palestinian labor also disincentivizes human capital accumulation, thus retarding the growth of high-skill service or manufacturing (Galor and Mountford, 2008). Furthermore, reports by AIX Group document various measures taken by the Israeli authorities to thwart the growth of Palestinian tradeables. All of this contributes to the low share of manufactures (10%) in overall employment. The World Bank report on Area C (2013) likewise highlights the lack of a substantial tradeables sector.

Low-skill jobs

Table 1 suggests West Bank Palestinians mostly occupy low-skill jobs. Indeed, the average educational attainment of 1997 laborers was just 9.24 years of school, with only a 15% high-school graduation rate. By definition, low-skill jobs require less training and laborers are more substitutable, which supports the narrative below.

Rising employment rates with proximity to jobs

I generate location-level statistics from the population (1997 and 2007) and firm (2004) censuses, and map them using UN-OCHA polygon and centroid point data of census locations. I am able to identify 485 Palestinian locations (accounting for 99.5% of the West Bank 1997 labor force) for which census data are available.[13] Using the 2004 firm census I count the number of employees per location k (*not* the number of residents of k who happen to have a job, but rather the number of laborers, hailing from any part of the West Bank, whose workplace is k). Calculating the minimum road distance between each pair of locations with ArcMap Network Analyst, I generate a location-level index of proximity to jobs for 2004

[13] See online appendix for details.

(ignoring obstacles):

$$job\_proximity_j = \sum_{k=1}^{J} \frac{employees_k}{\tau_{jk}}$$

Where τ_{jk} is the minimum road-distance in kilometers between locations j and k (without road obstacles).

I define location j's employment rate as

$$employment\_rate_j = \frac{\#employed_j}{labor\_force_j}$$

And I define for each location j an 'internal' employment rate, measuring the fraction of laborers dwelling at j who are employed in a Palestinian location:

$$internal\_employment\_rate_j = \frac{\#employed\_at\_palestinian\_location_j}{labor\_force_j}$$

I regress 'internal' 1997 (pre-uprising) employment rates on job proximity, supposing for a moment that the spatial distribution of jobs in 2004 was identical to that of 1997:

$$internal\_employment\_rate_{j,1997} = \beta_0 + \beta_1 job\_proximity_j + \epsilon_{j,1997}$$

Statistics such as $internal\_employment\_rate_{j,1997}$ are measured with less accuracy when location j's labor force is small. I therefore weight observations by the size of their 1997 labor force.[14] Using robust standard errors, I find $\beta_1 > 0$ and statistically significant, and $R^2 = 34\%$, meaning proximity to jobs explains 1/3 of the variation in 1997 'internal' employment. locations tended to enjoy higher employment rates when closer to jobs.

Immobility of firms and laborers

The job proximity measure is compiled using filled job counts from 2004. By regressing 1997 employment rates on this measure, I am implicitly assuming that the spatial distribution of jobs was unchanged between 1997 and 2004. In Section 5 I use firm census data to present evidence that firms neither opened or nor closed in a manner correlated with obstacle deployment. Without panel data on employee counts, however, I cannot say if they redistributed

[14] In Stata, this is done by running a regression using the a-weight option.

during the uprising. To address this issue I generate a panel dataset of nighttime lights over Palestinian locations, show that lights closely track production activity, and take lights as a proxy for employee counts pre- and post-uprising years. I then show that proximity of locations to lights changes minimally over the course of the uprising, indicating that jobs did not spatially redistribute.

Nighttime lights satellite imagery are well established as a correlate of economic activity.[15] Many recent studies[16] rely on lights as a proxy for GDP and GDP growth in the absence of more traditional data sources. Consistent with findings in other regions of the world, Levin & Duke (2012) shows that lights emitted over Israel and the West Bank correspond to economic realities on the ground, and reflect economic inequalities between Israeli and Palestinian societies. In co-authored work with van der Weide et al (2014), we use nighttime lights to track relocation of economic activity in the West Bank after the removal of road obstacles in 2009. For a thorough description of nighttime lights, see Abrahams et al (2014).

Do lights over Palestinian locations measure production or consumption? If the workday is over when the satellite passes by (typically 730-830pm local time), businesses will be closed and their lights may be turned off. In that case, lights are more likely to correlate with income of local residents, as they consume electricity at their homes. If, however, laborers are still at work, then lights should correlate with production activity. To isolate these two potential sources I calculate light emissions recorded over polygon extents of Palestinian locations and regress lights on residential labor force counts and employee counts:

$$radiance_{j,t} = \beta_0 + \beta_1 employees_{j,t} + \beta_2 labor\_force_{j,t} + \epsilon_{j,t}$$

Where t corresponds to the period 2004-2007.[17] Table 2's results indicate that employee counts per location strongly correlate with nighttime lights. Interpreting the regression coefficients in Column 2, each additional employee at location j increases j's total radiance by 0.21 units, while each additional laborer dwelling at location j only increases radiance by

[15]See Doll et al 2006, Chen and Nordhaus 2011, Henderson et al 2012,

[16]Storeygard (2014), Baum-Snow & Turner (2014), Alesina et al (2014).

[17]Precisely, labor force counts are calculated from the 2007 population census, employee counts are drawn from the 2004 firm census, and radiance-calibrated lights are from 2006. Ideally I would have population, jobs, and lights data all from the same year. The anachronisms of the regression are unproblematic as long as locations' populations in 2004 were proportional to their populations in 2007, and as long as lights in 2006 were proportional to lights in 2004.

Table 2: Do lights measure production or consumption?

	(1)	(2)
employees	0.29	0.207
	(0.025)	(0.033)
labor_force		0.05
		(0.019)
constant	36.445	15.855
	(8.668)	(10.194)
Observations	485	485
R^2	0.8265	0.8351

.05, a magnitude over four times smaller. Comparing Columns 1 and 2, we see furthermore that employee counts on their own explain 82.65% of the variation in lights, and introducing labor force to the regression raises R^2 by less than 1%.[18] Lights net of labor forces are simply

$$radiance\_net\_of\_labor_{j,t} = radiance_{j,t} - \widehat{\beta}_2 labor\_force_{j,t} - \widehat{constant}$$

In the absence of pre-uprising employee counts, I take 1997 census labor force counts and 1996 radiance-calibrated nighttime lights[19] and generate pre-uprising radiance net of labor. These residuals correlate 98% with 1996 radiance. I apply them as a proxy for pre-uprising employee counts:

$$job\_proximity_j = \sum_{k=1}^{J} \frac{radiance\_net\_of\_labor\_1996_k}{tau_{jk}}$$

Regressing $internal\_employment\_rate_{j,1997}$ on this radiance-weighted job-proximity index, I find $\beta_1 > 0$ and statistically significant, with $R^2 = 13.5\%$. This confirms that the positive relationship between proximity to jobs and 1997 employment rates was not an artefact of using 2004 employee counts; the result persists even when using pre-uprising, radiance-imputed

[18] I cannot credibly add 2007 population to the RHS of the regression in Column 2 since 2007 labor force and 2007 population correlate over 99%, meaning these variables are effectively collinear.

[19] Radiance-calibrated lights data are available only for years 1996, 2000, 2006, and 2010, whereas stable lights data are available for every year 1992-2012. The major advantage to using radiance-calibrated data is that they are not top-censored (see Elvidge et al (1998) or Doll (2008)). Stable lights imagery over West Bank locations in the vicinity of Jerusalem suffer top-censoring, which is problematic since Ramallah and associated locations lie within this area and are known to be important job destinations for Palestinians throughout this time period.

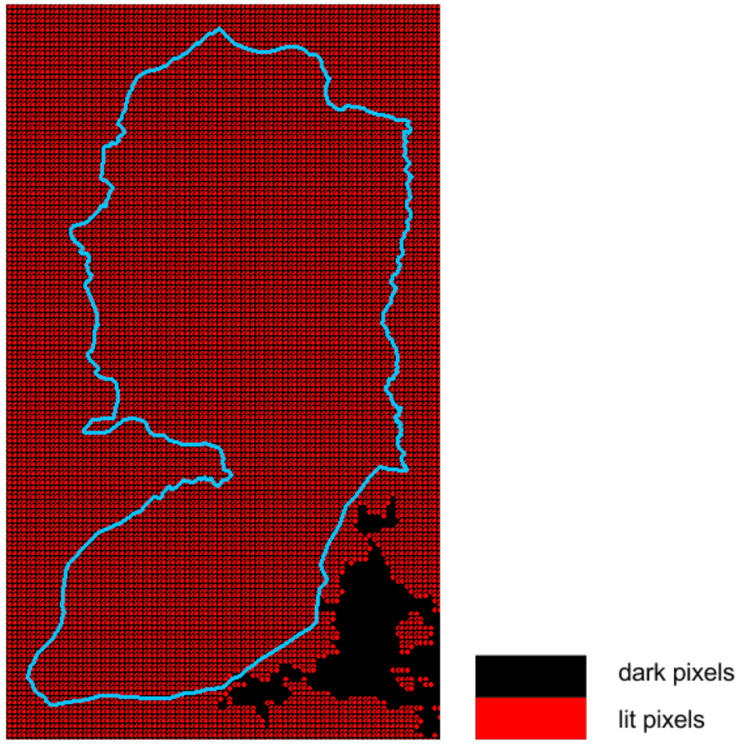

Figure 2: Blurred image, F16-2006

employee counts.

While using radiance-calibrated imagery avoids the problem of topcoding, there is a further source of error prevalent in all nighttime lights data known as 'overglow' (Croft (1979), Small, Pozzi, Elvidge (2005), Pinkovskiy (2011)). Essentially, the imagery suffer from significant blurring, with light emitted at one location spilling onto nearby locations. This is particularly problematic in the West Bank since locations lie very close together: the average minimum as-the-crow-flies distance between Palestinian locations is just 1.81km, and between Palestinian locations and Israeli settlements is just 2.12km.

This paper, along with van der Weide et al (2014), is the first to apply the novel overglow correction method of Abrahams et al (2014). In that paper, the authors study the DMSP satellites' optics and derive a nonparametric representation of the elliptical distortion, then provide a deconvolution algorithm by which nighttime lights imagery can generally be deblurred. I apply that method here to all radiance-calibrated imagery of the West Bank.

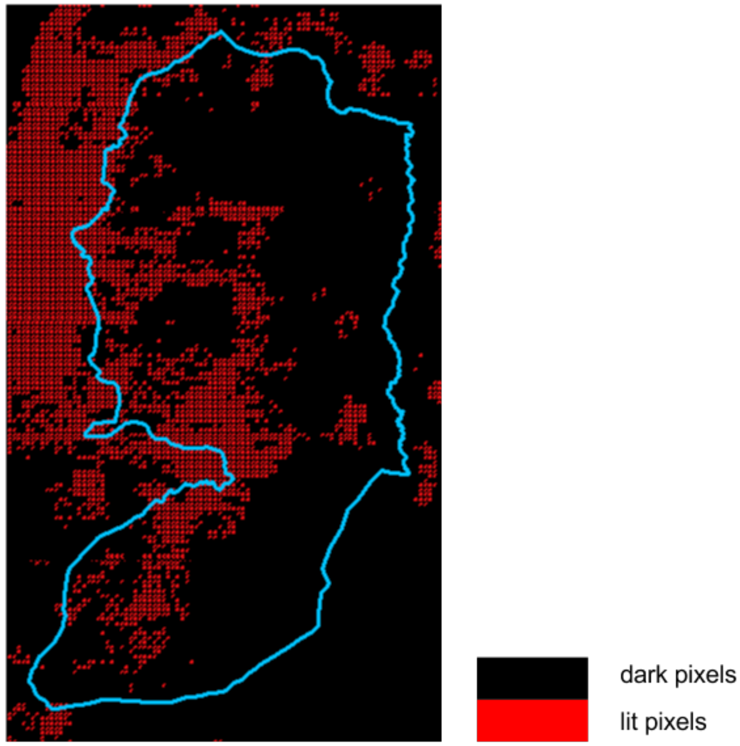

Figure 3: De-blurred image, F16-2006

Figures 2 and 3 provide a comparison of the 2006 image before and after de-blurring.

I calculate job proximity before and after the uprising using radiance net of labor from 1996 and 2006. Though ten years apart, the correlation between the two measures is 97.6%. This means that, *ignoring obstacles*, the proximity of locations to jobs changed minimally during the uprising. Meanwhile, the 2007 census indicates just 7,774 respondents (1.6% of the 2007 labor force) moved during 2000-2007 for job-related reasons. The correlation between 1997 and 2007 location labor forces is over 99%; between populations it is 98%. The evidence therefore indicates that neither laborers nor firms substantially redistributed over space, despite the fact that changes in commuting costs due to Israeli road obstacles likely generated inequality in utility levels. This apparent immobility of laborers and firms despite changes to real income is not unique to the West Bank: Topalova (2010), Bryan et al (2013) and Munshi & Rosenzweig (2013) find similarly puzzling behavior in India and Bangladesh, where migration rates are low despite real rural-urban gaps in living standards. A new report on the Egyptian labor force (World Bank, 2014) likewise documents low migration rates (and high commuting) despite apparent rural-urban inequality. Munshi & Rosenzweig (2013) argues that the value of local networks makes would-be migrants reluctant to leave.

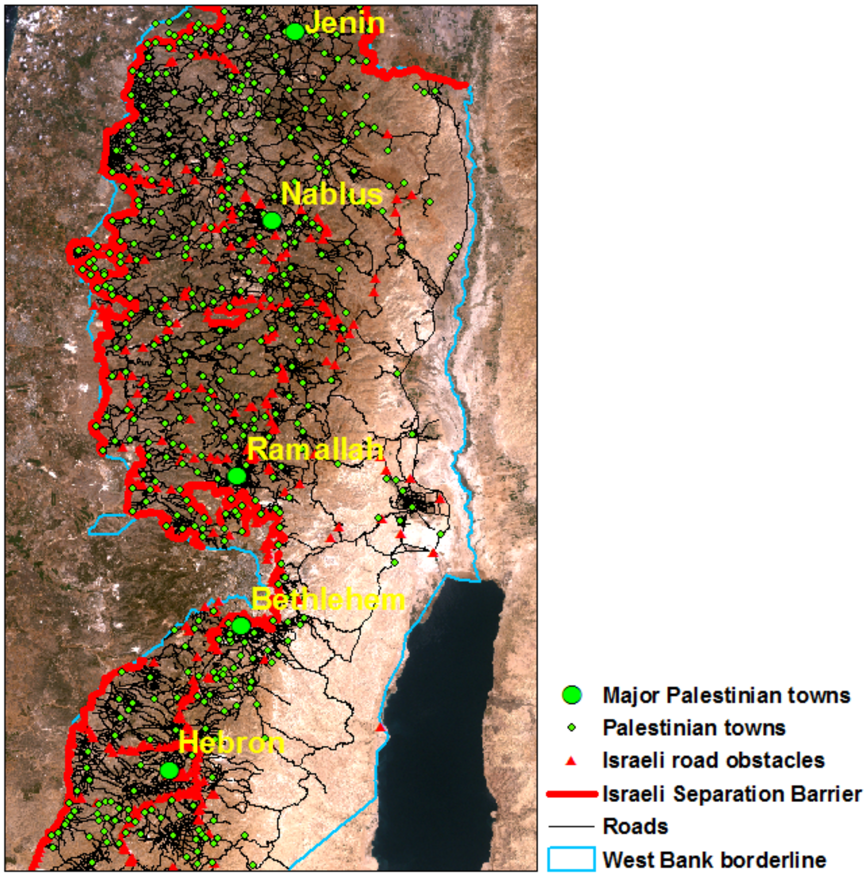

Figure 4: Author's digitization of UN-OCHA map (2007)

Cammett (2014) shows that local networks in Lebanon tend to replace most of the functions that, in developed countries, would be handled by the state. The same is likely true in the West Bank, perhaps especially given the unresolved political situation and ongoing military occupation.

Furthermore, relocating had to be weighed against expectations of how long road obstacles would remain deployed. As we shall now see, there was always good reason to believe obstacles would be removed as soon as the uprising ended.

Road obstacles

As violence escalated during the Second Intifada, the Israeli army responded to militant activity with both offensive retaliations (Paserman 2008) and defensive efforts aimed at intercepting militants before they could reach Israeli civilian destinations. This latter policy was known as 'Operation Defensive Shield', and involved the deployment of numerous physical obstacles. A 500km wall was built to separate Israel from the West Bank, but most Israeli settlers dwelt beyond the wall and could not rely upon it for protection. Instead, the army deployed hundreds of obstacles *inside* the West Bank, along the internal road network, in order to intercept militant traffic before it could approach Israeli settlements. Quoting B'Tselem:

Israel's primary justification for the movement restrictions is that they are necessary to protect Israelis within its jurisdiction and Israelis living in the West Bank or traveling on West Bank roads.

...the settlement enterprise, including the roads built for it, was one of the primary factors in shaping the restrictions regime that Israel has forced on the Palestinians since the beginning of the Second Intifada.
(B'Tselem, Ground to a Halt, 2007)

Consistent with their defensive purpose, obstacles did not forbid commuting between locations, but rather introduced significant delays as vehicles were checked for weapons:

I saw the soldiers were carefully checking a Palestinian taxi. They dismantled the seats, the door panel and many other parts of the taxi. They spent a lot of time inspecting it...
(B'Tselem, Ground to a Halt, 2007)

As of September 2003, UN-OCHA[20] began publishing poster-sized maps depicting the precise locations of obstacles along the West Bank's internal roads. Through to the end of 2007 a total of 11 posters were published.[21] I georeference all 11 poster-map pdfs and digitize all obstacles (6,180 obstacles plus the separation barrier), superimposing the new data over the poster imagery. Figure 4, for example, displays the digitized December 2007 map, where more than 500 obstacles were deployed along with 500km of wall.

Not all obstacles were the same. While checkpoints were manned by soldiers and could not be passed without inspection, the UN also identifies 'partial checkpoints', which had all the appearance of checkpoints yet rarely interfered with passing traffic. Unmanned obstacles

[20] The United Nations Office of the Coordination of Humanitarian Affairs

[21] The entire time series of posters is available in pdf format from UN-OCHAs website: http://www.ochaopt.org/

included ‘roadblocks’, usually giant boulders set in the middle of roads by army bulldozers; or ‘earthmounds’, described as mounds of dirt dumped in the middle of roads by bulldozers. UN-OCHA reports that earthmounds were a particularly ineffective type of obstacle, since Palestinian traffic usually circumvented them with ease, or drove over them repeatedly until they flattened out. Although results are similar with their inclusion, I exclude earthmounds, partial checkpoints, and incomplete sections of the separation wall from the regression analysis of Section 5 in order to reduce attenuation bias.

Not all obstacles stayed in the same place. Indeed, at any given time some 40% of checkpoints were temporary, ‘flying’ checkpoints (World Bank (2007)), set up suddenly along road segments with the intention of surprising militants. While UN-OCHA faithfully recorded obstacle locations, their maps amount to a series of snapshots that capture both permanent and temporary obstacles. As such, when I calculate obstacle exposure indices I introduce a lot of attenuation bias by supposing that commuters faced the same obstacle for many months, when in fact it may as often as not have been deployed only for a few days. As will become clear in Section 5, my instrumental variables approach greatly mitigates attenuation bias by isolating the subset of obstacles deployed in the immediate vicinity of settlements. Settlements required perpetual defending, so obstacles in the vicinity of settlements were most likely to have been enforced with permanent vigilance.

3 Model

I develop a commuting model incorporating the stylized facts reviewed in Section 2: many locations, unemployment at all locations, more unemployment farther away from jobs, unemployment benefits, commuting, and substitutability of laborers. The purpose of the model is to predict how obstacles affect employment rates of Palestinian locations in the short run, when neither firms nor laborers can relocate, and to relate short-run employment rate changes to short-run welfare changes. The model draws on the modeling framework of Ahlfeldt et al (2014), but assumes laborers are homogeneously productive, and therefore perfectly substitutable. I introduce unemployment benefits coupled with randomness in job search in order to generate unemployment in equilibrium. While some models of spatial mismatch speculate that differential search costs or effort are to blame for employment rates declining with residential distance from jobs (Wasmer & Zenou (2002), Smith & Zenou (2003)), my model remains agnostic. In particular, I assume that laborers dwelling far from firms search for jobs with just as much success as laborers dwelling close. But when it comes time to accept or decline the job offer, laborers dwelling farther away are more likely to decline, since their commuting costs effectively raise their reservation threshold. Accordingly, firms set wage offers to maximize expected profit, uncertain about the reservation utilities of their prospective laborers. In equilibrium, laborers choosing to dwell near to firms enjoy higher probability of employment, while laborers dwelling far from firms are unemployed more often but pay lower land prices. When commuting costs subsequently rise, laborers dwelling far from firms suffer a decline in earnings and employment as commuting becomes costlier. The reduced supply of labor to firms induces a rise in wages, from which laborers dwelling nearby are able to benefit disproportionately, enjoying increases to earnings and employment. A full derivation is available in the online appendix. Here I only present main results and intuition.

I posit an economy of N homogeneous laborers with identical preferences for a composite consumption good x

$$U = x \tag{3.1}$$

And an endogenous number of profit-maximizing firms M with identical production functions

$$y = \theta l \tag{3.2}$$

where the productivity of the quantity of laborers l employed by a firm is multiplied by exogenous technology θ.[22]

Utility maximization and profit maximization occur in two stages. In the first stage, laborers and firms decide where to locate. There exist J census locations, each endowed with a different supply of land L_j available for commercial and/or residential use, where α_j denotes the endogenous fraction of location j's land used for commercial activity. Notably, land enters neither into laborers' utility functions nor firms' production functions, so laborers and firms do not value land intrinsically.[23] Rather, as shown below, firms (laborers) value locations only by their proximity to laborers (firms), and pay absentee landlords for the

[22] The constant returns to scale of labor assumed here is in agreement with Henderson, Storeygard, Deichmann (2014), where the urban services sector has an identical production function.

[23] In general, consumers may enjoy renting more spacious properties, or productivity of a firm's employees may be declining in the quantity of land rented. Without data on land parcels or rental rates, however, any modeling decision in this context is speculative. Moreover, this model demonstrates that these other ways of valuing land are not necessary for generating predictions about the effects of commuting costs on welfare.

opportunity to locate there. Laborers dwelling in j pay $p_{j,r}$, while firms pay $p_{j,f}$.[24] The prices of land faced by firms and laborers in each location j can alternatively be thought of as entry fees: a laborer or firm must purchase exactly 1 unit of land in j in order to locate there.[25]

In the second stage, firms post wage offers.[26] Laborers are each endowed with 1 unit of labor and are homogeneously productive, producing θ units of the composite consumption good. Laborers undertake job searches and each laborer discovers exactly one firm,[27] drawn at random *and with replacement* from among the economy's M firms.[28] Observing wage offers, laborers decide whether to accept or decline jobs. For a laborer dwelling at location j, if he accepts a job offer at location k, he produces θ units for the firm and is compensated with wage w_k, from which a commuting cost d_{jk} is subtracted. If he declines the offer, he receives a 'reservation wage' (unemployment benefits) worth $\bar{w}$, drawn from $U[0,1]$. The laborer's decision rule is simple:

$$\textit{accept } w_k \Leftrightarrow \bar{w} < w_k - d_{jk} \tag{3.3}$$

[24] Ahlfeldt et al (2014) insists on a single, prevailing price of land p_j for each location, in order to match the Berlin dataset. To achieve spatial equilibrium, the Berlin model introduces unobserved location-specific amenities B_j. The price p_j is set so as to make firms indifferent over location choices, while the amenities B_j, valued only by residents, are used to make laborers indifferent over location choices. As discussed in that paper's technical appendix, in general there may be a wedge between rental rates of residents and firms. For example, the government may tax or subsidize commercial land usage in ways different from residential usage. In the depressed Old City of Hebron, for example, the Palestinian Authority is known to pay shopkeepers to stay open, while in Hebron's busy downtown areas the author has interviewed business owners and municipal workers claiming high rental rates for office space.

[25] This feature of the model is for the sake of parsimony, so as not to distract from the model's purpose. The data contain no information on sizes of properties or heterogeneity in preferences for real estate, so any attempt to model those features would be speculative.

[26] This is a departure from Ahlfeldt et al (2014), where laborers discover firm-laborer match productivity shocks and then decide which firm to work with. In that case, there are $N \cdot J$ idiosyncratic shocks (one for each firm-laborer match). I avoid this by introducing imperfect information.

[27] Trivially, the model can be altered to allow laborers to discover 1 firm with probability < 1.

[28] The job search therefore is not a function of commuting costs, i.e. within this model, laborers do not search nearby locations with more success than distant ones. This is a modeling decision for the sake of parsimony: the model should predict that expected wages are higher among laborers near firms, and as I show, this prediction arises even when success in finding jobs is not a function of commuting costs to where jobs are offered.

Firms located in k anticipate 3.3 and set wage offer w_k to maximize expected profit:

$$max_{w_k} E(\pi) = (\theta - w_k)\frac{N}{M}(w_k - \sum_{j=1}^{J} d_{jk} n_j) - p_{k,f} \tag{3.4}$$

The difference $(\theta - w_k)$ quantifies the surplus enjoyed by the firm, i.e. the difference between the value of what the laborer produced and his compensation. A lower wage offer w_k allows the firm to extract greater surplus, but also reduces the probability $(w_j - \sum_{j=1}^{J} d_{jk} n_j)$ that a (random) laborer will accept the offer. The firm's maximization problem is to balance this tradeoff optimally. The FOC of 3.4 gives

$$w_k^* = \frac{\theta}{2} + \frac{\sum_{j=1}^{J} d_{jk} n_j}{2} \tag{3.5}$$

This shows that profit-maximizing wage offers are an increasing function of average commuting cost to labor. Holding firm and labor location choices fixed, the implication is that wages will rise with commuting costs. This is the distinguishing feature of the model, and the reason why commuting costs have dual welfare consequences. The firm's expected profits are therefore

$$E(\pi(w_j^*)) = \frac{N}{M}(\frac{\theta}{2} - \frac{\sum_{k=1}^{J} d_{jk} n_k}{2})^2 - p_{j,f} \tag{3.6}$$

Laborers anticipate that firms located in k will make a wage offer of w_k^*. Therefore in the first stage, when each laborer's reservation wage is not yet revealed, the laborer calculates his expected utility conditional on dwelling in each location, and chooses where to live. Expected utility of a laborer dwelling in j turns out to be

$$E[U_j] = \frac{1}{2} + \frac{1}{2}\sum_{k=1}^{J} m_k (w_k^* - d_{jk})^2 - p_{j,r} \tag{3.7}$$

This says simply that a laborer dwelling in j can expect to earn $\frac{1}{2} + \frac{1}{2}\sum_{k=1}^{J} m_k (w_k^* - d_{jk})^2$, of which a quantity p_j is payed to an absentee landlord, while the remainder is spent on consumption good x.

Equilibrium

Since laborers and firms are free to locate anywhere, expected utility and profits must be equalized across all locations in equilibrium:[29]

$$\frac{1}{2} + \frac{1}{2}\sum_{k=1}^{J} m_k (w_k^* - d_{jk})^2 - p_{j,r} = \bar{U}, \text{ for each } j = 1, ..., J \tag{3.8}$$

[29] In the data, some locations to which commuting labor is flowing are Israeli, and Palestinians are forbidden to locate there. The model easily accommodates this: the share of the Israeli labor force and Israeli firms

$$\frac{N}{M}\left(\frac{\theta}{2} - \frac{\sum_{k=1}^{J} d_{jk} n_k}{2}\right)^2 - p_{j,f} = \bar{\pi} \text{ for each } j = 1,..,J \tag{3.9}$$

Expressions 3.8 and 3.9 determine equilibrium land prices $p_{j,r}$ and $p_{j,f}$ for laborers and firms in all j. Firms enjoy free entry and exit. As long as expected profits are positive, firms will continue to enter the economy. With each additional entry, laborers are spread more thinly among firms ($\frac{N}{M}$ declines) and expected profits fall. In equilibrium, $\bar{\pi} = 0$, and M is determinate.

In equilibrium, demand for land must equal supply. Since each firm and each laborer uses 1 unit of land, the demand for commercial land in j is just M_j, and the demand for residential land in j is just N_j. We have

$$n_j = (1 - \alpha_j)\frac{L_j}{N}, \text{ for each } j = 1, ..., J \tag{3.10}$$

$$m_j = \alpha_j \frac{L_j}{M}, \text{ for each } j = 1, ..., J \tag{3.11}$$

The system of equations in 3.8, 3.9, 3.10 and 3.11, along with the condition $\bar{\pi} = 0$, characterizes equilibrium. See the online appendix for a simple sufficient condition under which a long-run equilibrium always exists.

Employment

In order for a laborer dwelling at location j to be employed at a job in location k, two things must happen: the laborer must be randomly matched with a firm at k; and the firm must offer a wage high enough to induce the laborer's acceptance. The probability that this coincidence occurs is

$$Prob(\text{laborer dwelling in } j \text{ is employed in } k) = m_k\left(\left(\frac{\theta}{2} + \frac{\sum_{i=1}^{J} d_{ik} n_i}{2}\right) - d_{jk}\right) \tag{3.12}$$

Expression 3.12 is the bilateral commuting flow $outflow_{jk}$ of labor from j to k. It follows that the probability that a laborer dwelling in j will be employed at all is just

$$Prob(\text{laborer dwelling in } j \text{ is employed}) = \sum_{k=1}^{J} m_k\left(\left(\frac{\theta}{2} + \frac{\sum_{i=1}^{J} d_{ik} n_i}{2}\right) - d_{jk}\right) \tag{3.13}$$

located at the Israeli location are taken as exogenous to the model. In equilibrium, the price of land in Israeli locations need not equalize utility of its residents to utility of residents in Palestinian locations; nor need profits of Israeli firms equalize with profits of Palestinian firms, since there is no freedom to relocate to Israeli locations. In other words, equilibrium conditions for the West Bank economy do not pin down any characteristics of Israeli locations.

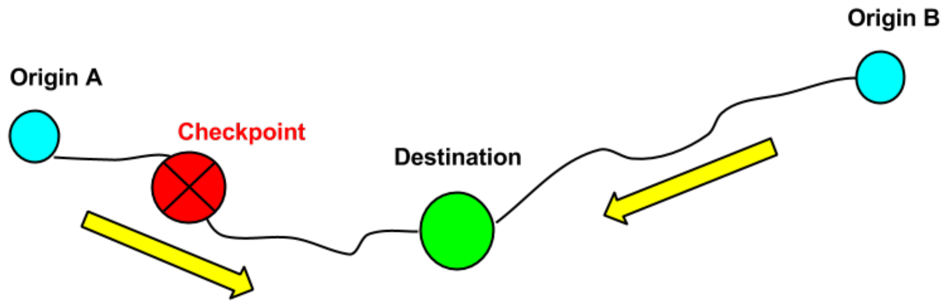

Figure 5: Transference of employment: A's loss is B's gain

Expression 3.13 is the employment rate of location j, and is observable in the census data.

Dual effects of obstacles on employment

How do commuting costs affect employment rates in the short run? I define the short run as a period of time when neither firms nor labor are mobile (m_k and n_k are fixed for all k).[30]

Figure 5 helps with intuition. Suppose laborers are commuting from Origin A and Origin B to work at Destination. When a checkpoint is deployed along the road between A and Destination, laborers from A face higher commuting costs to reach work, causing some to give up their jobs (see 3.12). Firms at Destination respond to diminished labor supply by raising wages (see 3.5). When wages rise, some unemployed laborers from B are now willing to accept jobs at Destination (see 3.12). The effect of the checkpoint's deployment, therefore, should be to decrease employment of A's laborers but *increase* employment of B's laborers. In short, A's loss is B's gain.

To show this formally, suppose laborers commuting from j to work at k face a commuting cost of d_{jk}. Differentiating 3.13 with respect to d_{jk}, I obtain

$$\frac{\partial Prob(employed)}{\partial d_{jk}} = m_k(\frac{n_j}{2} - 1) < 0 \tag{3.14}$$

[30]In the long run, changes in commuting costs d_{jk} will cause laborers (firms) to relocate to maximize expected utility (profits). The increased (decreased) demand for land in each location will cause land prices p_j to adjust.

This says that an increase to commuting costs faced by laborers residing in j can only harm their chances of employment. The cross partials are

$$\frac{\partial Prob(employed)}{\partial d_{jk} \partial m_k} = (\frac{n_j}{2} - 1) < 0 \tag{3.15}$$

$$\frac{\partial Prob(employed)}{\partial d_{jk} \partial n_j} = \frac{m_k}{2} > 0 \tag{3.16}$$

According to 3.15, an increase to m_k exacerbates the commuting-cost-based employment losses in j. The larger is m_k, the more important it is as a destination for laborers from j, in which case an increase to d_{jk} is more harmful to their employment chances. Holding m_k fixed, however, 3.16 says that an increase to the mass of laborers dwelling at j mitigates the employment losses caused by an increase to d_{jk}. The larger is n_j, the more important it is as a source of labor to firms in k, so that a rise in commuting cost d_{jk} will induce a larger increase in wage w_k^*, thus partially offsetting losses.

What happens to the employment rate in j when commuting costs rise between i and k? Partially differentiating, I obtain

$$\frac{\partial Prob(employed)}{\partial d_{ik}} = m_k \frac{n_i}{2} > 0 \tag{3.17}$$

This says that an increase to commuting costs faced by laborers residing in i on their commute to work at k will *increase* the employment rate at location j. Together, 3.14 and 3.17 formalize the simple intuition of Figure 5, where town A's losses were converted into town B's gains. Calculating cross partials, I obtain

$$\frac{\partial Prob(employed)}{\partial d_{ik} \partial m_k} = \frac{n_j}{2} > 0 \tag{3.18}$$

$$\frac{\partial Prob(employed)}{\partial d_{ik} \partial n_i} = \frac{m_k}{2} > 0 \tag{3.19}$$

Evidently the positive effect on employment in 3.17 is amplified by k's importance as a destination for j. In particular, 3.18 says that for a larger mass of firms at k, laborers at j enjoy an even greater increase to their employment chances when laborers from i lose access. The positive effect is likewise amplified if i is a large source of labor to k: when commuting cost d_{ik} rises, wage offer w_k^* will rise significantly, benefiting laborers from j even more (3.19).

Checkpoints and roadblocks along the road between j and k delay laborers originating from *j and* laborers originating from k. The marginal effect on employment rates of obstacle deployment along bilateral linkages is therefore the sum of 3.14 and 3.17:

$$\triangle employment\_rate_j = m_k(\frac{n_j}{2} - 1) + m_j \frac{n_k}{2} \tag{3.20}$$

The first term is negative, and identifies the loss to j's employment rates due to remotification from jobs at k; while the second term is positive, identifying the gain to j's employment rates due to remotification from labor at k. If the econometrician only measures each location's total obstacle 'exposure', she will end up estimating 3.20, without being able to distinguish the dual effects 3.14 and 3.17. The key contribution of my regression analysis below is to identify separately the dual effects.

Dual effects of obstacles on welfare

In equilibrium, utility of laborers is equalized across all locations (see 3.8). When commuting costs change, the economy is thrown out of equilibrium. In the short-run, m_j and n_j do not change, i.e. neither firms nor laborers relocate, so there is no increased (decreased) demand for L_j for any j, so absentee landlords do not adjust prices $p_{j,f}$ or $p_{j,r}$. Therefore we can calculate the effect of commuting costs on expected utility of residents of location j (3.7) by its partial derivative w.r.t. d_{jk}:

$$\frac{\partial E[U_j]}{\partial d_{jk}} = m_k(w_k^* - d_{jk})m_k(\frac{n_j}{2} - 1) = outflow_{jk}\frac{\partial Prob(employed)}{\partial d_{jk}} < 0 \tag{3.21}$$

Short-run welfare of location j therefore declines as commuting costs to work destination k rise. On the other hand, the partial derivative of expected utility w.r.t. d_{ik} yields

$$\frac{\partial E[U_j]}{\partial d_{ik}} = m_k(w_k^* - d_{jk})m_k\frac{n_i}{2} = outflow_{jk}\frac{\partial Prob(employed)}{\partial d_{ik}} > 0 \tag{3.22}$$

Increased commuting costs between i and k raise j's welfare. The misfortune of laborers from i is therefore a boon for laborers at j.

The marginal effect on j's welfare of obstacle deployment along the bilateral linkage between j and k is therefore the sum of 3.21 and 3.22:

$$\triangle welfare_j = outflow_{jk}\triangle employment\_rate_j \tag{3.23}$$

3.23 shows that when commuting costs d_{jk} rise, short-run welfare changes are simply short-run employment rate changes multiplied by initial outflow of labor from j to k. Identifying the dual effects of obstacles on employment rates is therefore *sufficient* for identifying their effects on welfare.

4 Identification Strategy

In this section I use the commuting model to develop two generic treatment variables, 'obstruction' and 'protection', to capture the dual roles of obstacles as costly obstructions to job access on the one hand, and protective blockades against the inflow of competing labor on the other hand. I then develop instruments for these variables, arguing that Israeli settlement proximity to commuter routes largely predicted obstacle deployment during the uprising.

To measure each location j's obstruction, I count obstacles lying along j's primary routes[31] to other locations. If I knew the workplace of each laborer, I could compute pre-uprising bilateral flows between each pair of locations j and k. Bilateral flows would allow me to weight obstacles by the pre-uprising importance of location k as a destination for laborers from j: if x% of j's laborers worked at k, I could weight obstacles along the road from j to k by x%. As with Ahlfeldt et al (2014), however, I lack flow data. Turning to the commuting model for guidance, expression 3.15 states that the negative effect on j of commuting costs along the path from j to k will be magnified by k's pre-uprising share of firms m_k. I therefore weight k's importance to j by its year-2004 count of firms in k, having argued already that firms did not relocate during the uprising (see also Section 5 for evidence that firms did not open or close in a manner endogenous to obstacles). As a robustness check, however, I use year-2000 pre-uprising nighttime lights as an alternative weighting. Expression 3.14 meanwhile states if pre-uprising d_{jk} was high, then few laborers from j would have commuted to k. I therefore down-weight destinations k by an increasing function of their road-distance.

A large portion of 1997 laborers commuted to Israeli locations. To address this issue, I identify from the UN-OCHA maps 10 border crossings (Green-line Checkpoints) along the 1967 armistice line and treat them as if they were locations of destination.[32] I define the

[31] Without obstacles, each location has a shortest path by which to reach location k. I count the obstacles along this path to k.

[32] I am not interested in how Palestinians commuted to work *after* crossing the border, since no obstacles were deployed inside Israel during the uprising.

fraction of a Palestinian location j's labor force employed in Israel as

$$work\_isr_{j,1997} = \frac{\#employed\_in\_israel_{j,1997}}{labor\_force_{j,1997}}$$

I calculate the Palestine-bound and Israel-bound parts of the index separately and then sum together, weighting by $(1 - work\_isr_{j,1997})$ and $work\_isr_{j,1997}$, respectively. Finally, the 2004-firm-share-weighted index of obstruction is

$$ob\_firms_j = (1 - work\_isr_{j,1997}) * \sum_{k=1}^{J} \frac{\#obstacles_{jk} * \frac{firms\_2004_k}{\sum_{k=1}^{J} firms\_2004_k}}{\tau_{jk}}$$

$$+ work\_isr_{j,1997} * \frac{\#obstacles_{j,border}}{\tau_{j,border}}$$

and the 2000-radiance-share-weighted index of obstruction is

$$ob\_bright_j = (1 - work\_isr_{j,1997}) * \sum_{k=1}^{J} \frac{\#obstacles_{jk} * \frac{radiance_{k,2000}}{\sum_{k=1}^{J} radiance_{k,2000}}}{\tau_{jk}}$$

$$+ work\_isr_{j,1997} * \frac{\#obstacles_{j,border}}{\tau_{j,border}}$$

The left-hand side of Figure 6 depicts a spatial histogram of ob_firms, where each location's quantity of obstruction determines its color coding. Notably, in the northern half of the West Bank, along the border south and west and northwest of Ramallah, locations are heavily obstructed from the major job-offering areas of Ramallah and Nablus.

Complementing the obstruction indices, I design a protection index for each location, based on predictions 3.17 and 3.19. In 3.17, the model predicts that obstacles faced by laborers from i on their way to k will raise wages in k, thereby indirectly benefiting laborers from j. 3.19 shows that this beneficial effect is magnified by i's share of labor force. A simple index of j's protection is therefore to let $k = j$ and measure obstruction of each location i on its primary route to j, weighting by pre-uprising labor force share of i:

$$protection_j = \sum_{k=1}^{J} \frac{\#obstacles_{kj}}{\tau_{kj}} * \frac{labor\_force_{k,1997}}{\sum_{k=1}^{J} labor\_force_{k,1997}}$$

The right-hand side of Figure 6 depicts a spatial histogram of $protection$, which in many ways complements the histogram for ob_firms. Laborers dwelling in the zone between Ra-

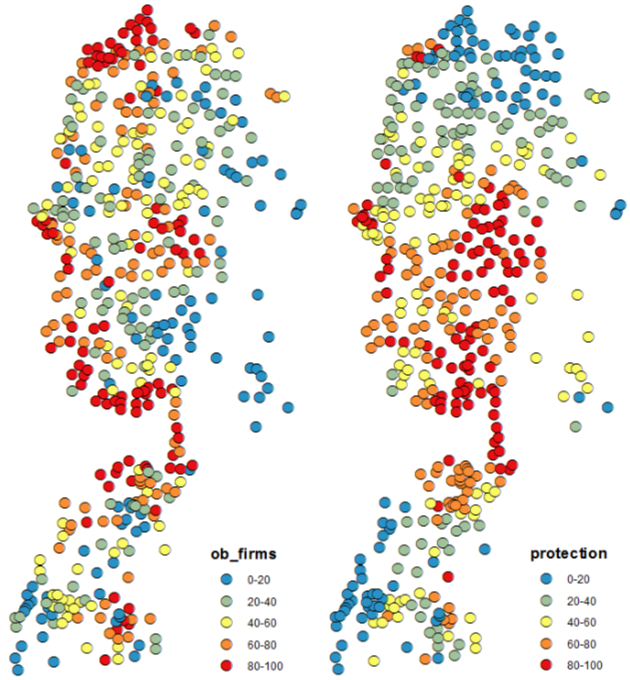

Figure 6: Spatial histograms of ob_firms and $protection$

mallah and Nablus enjoy the highest levels of protection as obstacles block out inflowing labor from more peripheral areas south, west, and north of this zone.

Instruments

In Section 5 I regress locations' post-uprising (2007) employment rates on obstruction-protection pairs ob_firms and $protection$; and ob_bright and $protection$; in order to estimate the dual effects of obstacles on location employment rates. These indices, however, may be correlated with unobserved variables influencing economic outcomes. For example, if locations with poor economic prospects had low opportunity costs to violence (see Miaari, Zussman, Zussman (2014)), then during the Second Intifada they may have been involved in more confrontations with the Israeli army, which may have responded by deploying more obstacles on roads leading to and from those locations. More obstructed locations, therefore, may be systematically different from less obstructed locations in a way that affects economic outcomes like post-uprising employment rates.

Seeking exogenous variation in obstruction, I develop an instrument based on the aforementioned narrative that obstacles were deployed to protect Israeli settlements. Figure 8 displays UN-OCHA polygon data of settlements from 2005. Most settlements are effectively

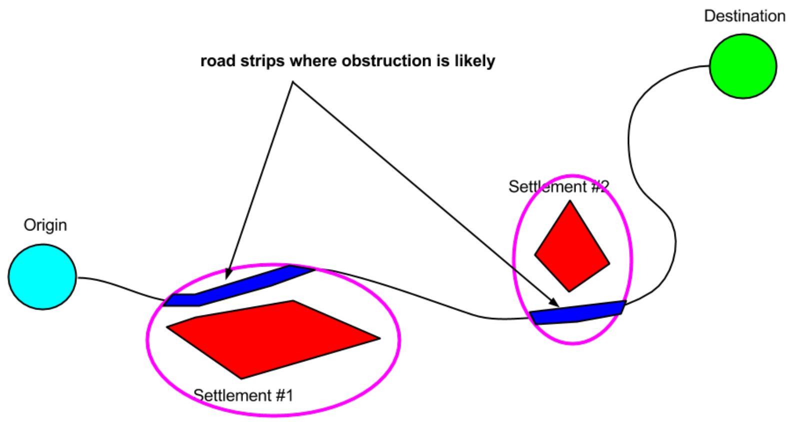

Figure 7: Road segments where roadblocks and checkpoints are likely

commuter suburbs of Jerusalem, the largest among them being Ma'ale Adumim, located at the West Bank's midsection, just east of Jerusalem. A few settlements are ideologically oriented, such as Kiryat Arba'a and nearby settlements inside the Old City of Hebron, near the Tomb of Abraham. Finally, there are several large agricultural settlements in the Jordan Valley.

If indeed the Israeli army was deploying obstacles in order to protect settlements, then obstacle deployment should be predictable by settlement location. In particular, the army would have insisted on enforcing defensive buffer zones, intercepting all Palestinian traffic passing close to settlements. Figure 7 demonstrates this concept for a fictional pair of Palestinian locations, 'origin' and 'destination'. Since two Israeli settlements lie near the connecting road, Palestinian commuter traffic from 'origin' cannot help but pass through the settlements' buffer zones on their way to 'destination'. The intersecting road segments, colored dark blue, are where traffic faced a high likelihood of being detained and searched.

How wide were these buffer zones likely to have been? Arbel et al (2010) documents housing price fluctuations in the West Bank Israeli settlement of Gilo after repeated incidents of gunshot attacks by Palestinian militants at a range of 650m. I set buffer width to 500m (see Figure 8), then identify all segments of road intersecting buffer zones around settlements.[33] For each location j, I count the number of meters of road that must be traversed within

[33] Results are similar if I use narrower (300m) or wider buffers (1km).

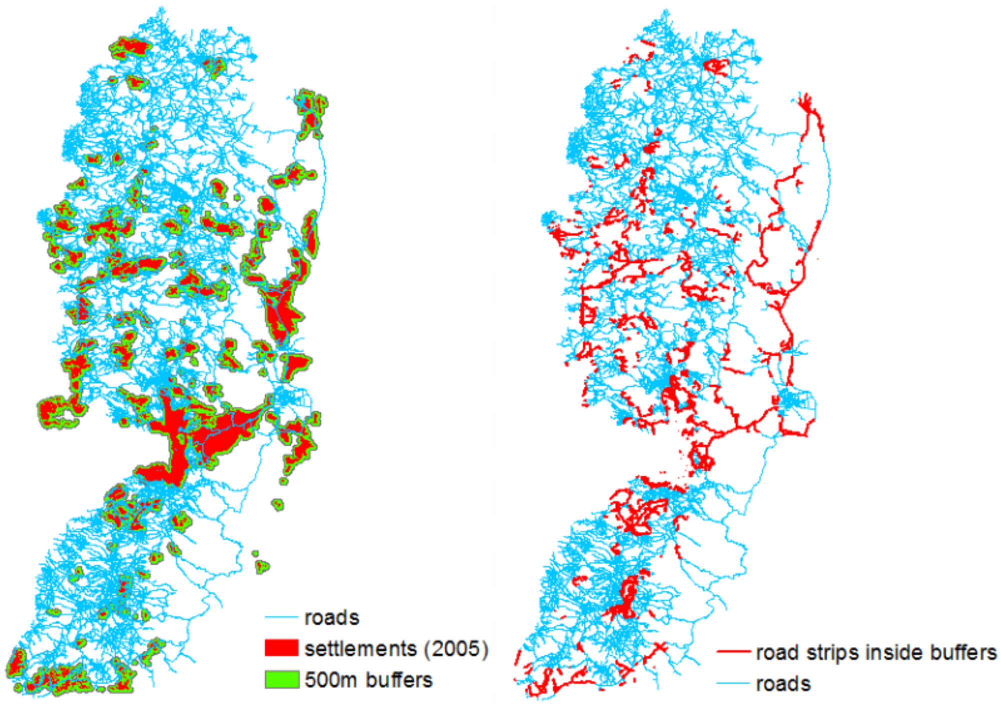

Figure 8: Defensive buffer zones around Israeli settlements

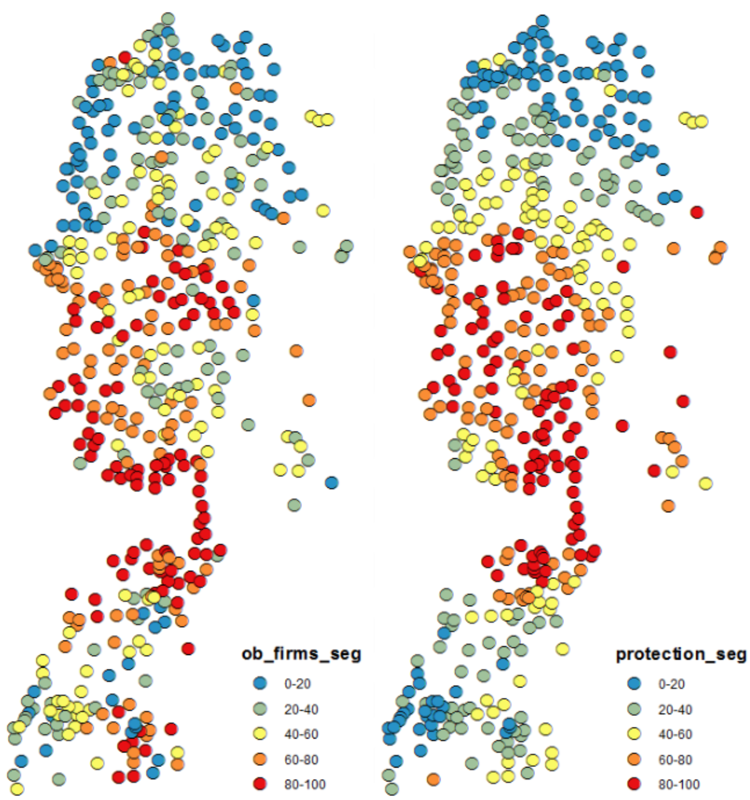

Figure 9: Spatial histograms of ob_firms_seg and $protection\_seg$

500m of Israeli settlements on the way to or from each other location k, forming indices

$$ob\_firms\_seg_j = (1 - work\_isr_{j,1997}) * \sum_{k=1}^{J} \frac{seg\_length_{jk} * \frac{firms\_2004_k}{\sum_{k=1}^{J} firms\_2004_k}}{\tau_{jk}}$$

$$+work\_isr_{j,1997} * \frac{seg\_length_{j,border}}{\tau_{j,border}}$$

$$ob\_bright\_seg_j = (1 - work\_isr_{j,1997}) * \sum_{k=1}^{J} \frac{seg\_length_{jk} * \frac{radiance_{k,2000}}{\sum_{k=1}^{J} radiance_{k,2000}}}{\tau_{jk}}$$

$$+work\_isr_{j,1997} * \frac{seg\_length_{j,border}}{\tau_{j,border}}$$

$$protection\_seg_j = \sum_{k=1}^{J} \frac{seg\_length_{kj}}{\tau_{ij}} * \frac{labor\_force_{k,1997}}{\sum_{k=1}^{J} labor\_force_{k,1997}}$$

These latter three indices are therefore defined exactly the same way as the former set, except that in the former set I count along the path to each destination the total number of obstacles, whereas in the latter I count along the path to each destination the total length of road segments inside settlement defensive buffer zones. Whereas the obstruction indices quantify obstruction of outflowing labor from j, the protection indices quantify protection from inflowing labor to j. Comparing ob_firms to *protection*, we see that whereas non-j locations are weighted by their firm shares in ob_firms, non-j locations are weighted by their labor force shares in *protection*. Indeed, if we consider a location j from which zero laborers commute to Israeli destinations, then ob_firms and *protection* are distinguishable only by differences in firm shares and labor force shares of non-j Palestinian locations. Similarly, *ob_bright* and *protection* are distinguishable only by differences in radiance shares and labor force shares. Since each obstruction index never appears in any of my regressions except accompanied by a protection index, its regression coefficient is therefore always statistically distinguished by the differences in radiance and labor shares, thus obviating any calculation of radiance-net-of-labor. When the flow of laborers from j to Israeli destinations is nonzero, then *protection* is statistically distinguishable from ob_firms and *ob_brigh* in part by these share differences, and in part by the fact that Israeli destinations demand but do not supply Palestinian labor, so that obstacles along primary routes to Israeli destinations affect ob_firms and *ob_bright* but not *protection*. Similar reasoning applies to the road-segment-based indices.

Figure 9 depicts the spatial histograms of indices ob_firms_seg and *protection_seg*, which largely mirror those of ob_firms and *protection* in Figure 6. In the next section, I show that the segment-based indices are valid instruments for the obstacle-based indices, finding them to be both strongly correlated and exogenous. I then use them to identify the dual effects of obstacles on post-uprising employment rates via 2SLS regressions.

5 Regression Analysis

In this section I test the model's predictions 3.14, 3.17, and 3.20, showing that obstacles had dual effects on post-uprising employment rates of Palestinian locations. I use 2SLS regressions and provide strong evidence that the instrumental variables approach, relying on settlement proximity to commuter routes to predict obstacle exposure, is robust to the inclusion of many relevant covariates. I show supporting evidence that locations' net-immigration rates of labor and household incidence of renting react in a manner consistent with what the model and overall narrative of the paper predict, although the results are statistically weak owing to the low total quantity of internal migration and change in renting behavior. Finally, I show that net-opening rates of firms across locations do not respond in a statistically stable way to obstacle deployment, further confirming that the spatial economy did not undergo any long-run reorganization in response to obstacles.

Main specification

I run 2SLS regressions with the following basic specification:

$$employment\_rate_{j,2007} = \beta_0 + \beta_1 obstruction_j + \beta_2 protection_j + \beta_3 work\_isr_{j,1997} + \epsilon_{j,2007}$$

The dependent variable is the vector of location employment rates in 2007, at the uprising's end. The main 2SLS regression uses ob_firms for *obstruction*, instrumented for with ob_firms_seg. Meanwhile, *protection_seg* instruments for *protection*. As a robustness check on firm locations, a second 2SLS regression uses *ob_bright* for *obstruction*, proxying for each location's pre-uprising job count by pre-uprising nighttime light emissions. *ob_bright_seg* instruments for *ob_bright*.

By Expression 3.14, I expect that any increase to $obstruction_j$ will cause a marginal decline in j's employment rate: $\beta_1 < 0$. Meanwhile, Expression 3.17 predicts that any increase to $protection_j$ will cause a marginal increase to j's employment rate: $\beta_2 > 0$. All regressions include $work\_isr_{j,1997}$, which accounts for the effect of increased border costs on location employment rates. Locations with a higher fraction of their pre-uprising labor force employed in cross-border jobs faced higher exposure to increased border costs (Miaari, Zussman, Zussman (2014)). If I run regressions without controlling for $work\_isr_{j,1997}$, then when a laborer dwelling at j loses his cross-border job, the loss will be attributed entirely to increased commuting costs resulting from obstacles along the primary route from j to the border, whereas in fact the loss of his job is due partly to obstacles but also partly to increased costs of crossing the border.

Table 3: First-stage regression results

	(1)	(2)	(3)	(4)
Endogenous regressor	ob_firms	ob_firms	protection	protection
ob_firms_seg	0.434***	0.378***	-0.0531	-0.0719
	(0.0775)	(0.0701)	(0.0536)	(0.0586)
protection_seg	-0.181**	-0.198**	0.594***	0.485***
	(0.0766)	(0.0823)	(0.0637)	(0.0622)
ob_firms			0.293**	0.268***
			(0.115)	(0.0823)
protection	0.355***	0.338***		
	(0.102)	(0.114)		
work_isr	0.0217***	0.0234***	-0.0122**	-0.00976***
	(0.00355)	(0.00428)	(0.00480)	(0.00308)
Covariates	No	Yes	No	Yes
Observations	480	463	480	463
R-squared	0.702	0.859	0.663	0.847
Adjusted R-squared	0.700	0.825	0.660	0.811

All standard errors robust. Weighted regressions use 2007 labor force.

First-stage regression results

Table 3 lists 2SLS first-stage regression results where indices $ob\_firms\_seg_j$ and $protection\_seg_j$ instrument for indices ob_firms_j and $protection_j$, respectively.[34] In Column 1, ob_firms_j is regressed on $ob\_firms\_seg_j$, controlling for $protection_j$ and $protection\_seg_j$, along with $work\_isr_{1997}$. The coefficient on $ob\_firms\_seg_j$ is positive and highly significant. In Column 3, $protection_j$ is regressed on index $protection\_seg_j$, controlling for ob_firms_j, $ob\_firms\_seg_j$ and $work\_isr_{1997}$. The coefficient on $protection\_seg_j$ is positive and highly significant. Indices $ob\_firms\_seg_j$ and $protection\_seg_j$ are therefore strong predictors of ob_firms_j and $protection_j$, respectively. The inclusion of many relevant covariates (described below) in Columns 2 and 4 do not destabilize the instruments' relationships with the endogenous re-

[34]First-stage results for radiance-based indices are available upon request.

gressors.

Table 4 lists the paper's main regression results. Column 1 presents the paper's main result, instrumenting for *ob_firms* with ob_firms_seg, and for *protection* with $protection\_seg$. Column 2 repeats Column 1's regressions with numerous covariates. For reference, Column 3 displays the results of running Column 1's corresponding OLS regression, i.e. *without* instrumenting for obstruction and protection. Column 4 displays the reduced-form regression, where post-uprising employment rates are projected directly onto the instruments. For ease of interpretation, I scalar-multiply each index so that its mean value among all locations is 1.0.

Table 4: Main results: effects of obstacles on 2007 employment rates

	(1)	(2)	(3)	(4)
Regression type	2SLS	2SLS	OLS	OLS
ob_firms	-4.900***	-5.176***	-1.041	-1.960***
	(1.840)	(1.927)	(0.642)	(0.634)
protection	3.744***	4.933***	0.941*	2.099***
	(1.313)	(1.728)	(0.564)	(0.631)
work_isr	-0.0681	0.0647	-0.216***	-0.187***
	(0.0702)	(0.0761)	(0.0284)	(0.0280)
Weighted	Yes	Yes	Yes	Yes
Covariates	No	Yes	No	No
Observations	480	463	480	480
R-squared	0.273	0.526	0.351	0.369
Adjusted R-squared	0.269	0.415	0.346	0.365

All standard errors robust. All observations weighted by 2007 labor force.

In Column 1 we see that a 1-unit increase to *obstruction* resulted on average in a 4.90 percentage-point loss to employment rates as laborers struggled to reach their jobs. On the other hand, we see that a 1-unit increase to *protection* resulted on average in a 3.74 percentage-point gain to employment rates. The key point to recognize here is that for every Palestinian location j, the deployment of obstacles along the path from j to k increased both $obstruction_j$ *and* $protection_j$. The total effect of obstacles on 2007 employment rate per location j projects as

$$\triangle employment\_rate_j = \widehat{\beta}_1 obstruction_j + \widehat{\beta}_2 protection_j$$

Integrating across locations' 2007 labor forces, the total effect of obstacles was to reduce

Table 5: Main results over different samples

	(1)	(2)	(3)	(4)
Regression type	2SLS	2SLS	2SLS	2SLS
ob_firms	-4.900***	-5.175***	-5.663**	-5.173**
	(1.840)	(1.910)	(2.311)	(2.322)
protection	3.744***	4.325***	4.537**	3.823**
	(1.313)	(1.448)	(1.899)	(1.824)
work_isr	-0.0681	-0.0445	0.0145	0.0118
	(0.0702)	(0.0766)	(0.0975)	(0.0979)
Weighted	Yes	Yes	Yes	No
Covariates	No	No	No	No
Min. laborers	0	100	200	200
Max. laborers	∞	10,000	5,000	5,000
Observations	480	368	298	298
R-squared	0.273	0.215	0.089	0.023
Adjusted R-squared	0.269	0.209	0.080	0.013

All standard errors robust. Weighted regressions use 2007 labor force.

Table 6: Main results, weighting obstruction by radiance

	(1)	(2)	(3)	(4)
Regression type	2SLS	2SLS	OLS	OLS
ob_bright	-2.718***	-4.724**	-0.939*	-1.446***
	(0.990)	(1.863)	(0.553)	(0.472)
protection	1.116***	2.943***	0.506**	0.882***
	(0.330)	(1.092)	(0.232)	(0.249)
work_isr	-0.152***	0.0305	-0.218***	-0.207***
	(0.0392)	(0.0674)	(0.0281)	(0.0248)
Covariates	No	Yes	No	No
Weighted	Yes	Yes	Yes	Yes
Observations	480	463	480	480
R-squared	0.332	0.462	0.353	0.367
Adjusted R-squared	0.328	0.335	0.349	0.363

All standard errors robust. Weighted regressions use 2007 labor force.

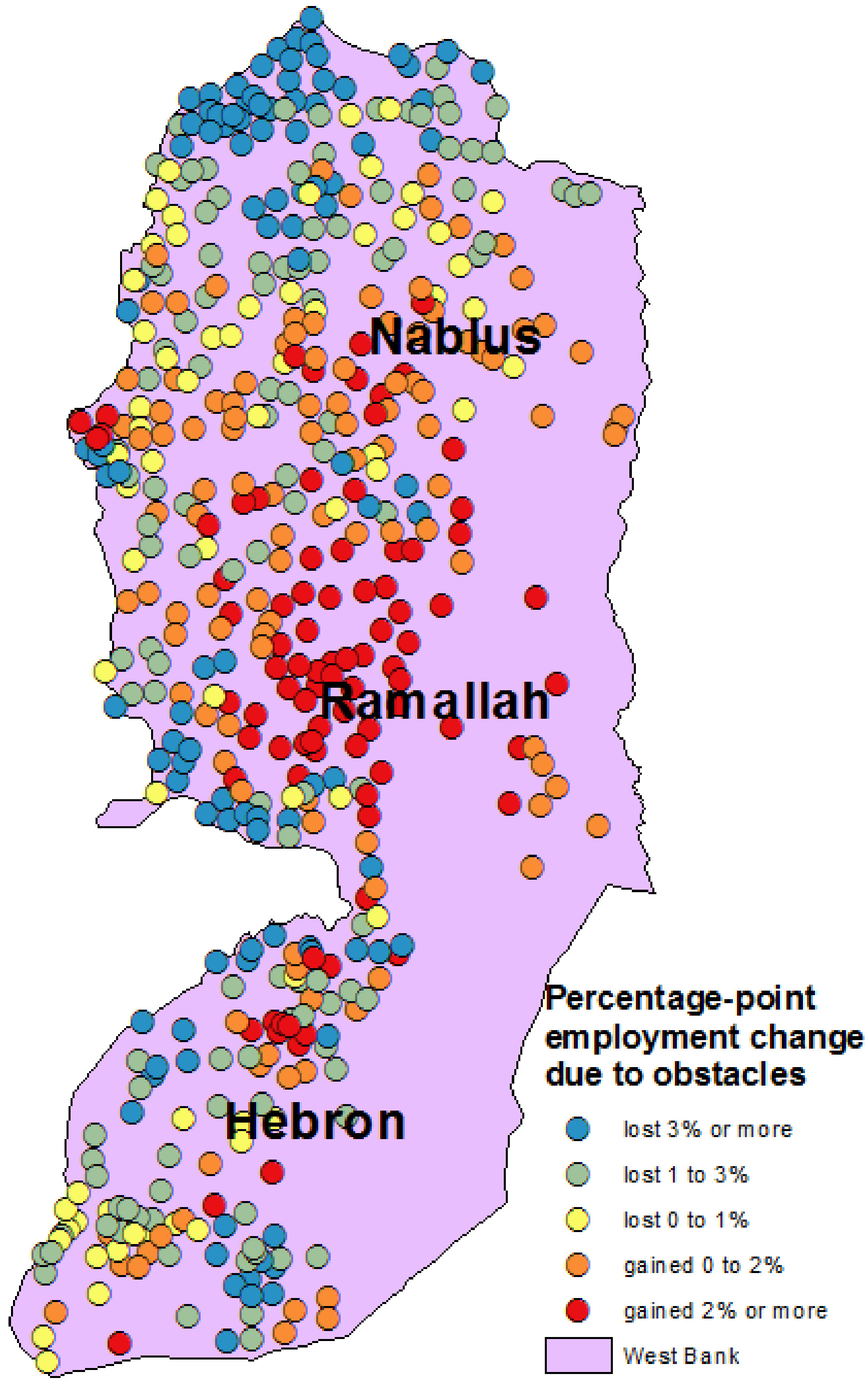

Figure 10: %-point change in employment due to obstacles (Table 4, Column 1)

Palestinian post-uprising employment by .44 percentage points. In other words, out of 472,916 laborers in 2007, the total number of employed laborers (402,366) was 2,103 smaller than it would have been had obstacles never been deployed. The obstructive effect of obstacles integrated over labor forces is -4.28 percentage points, meaning obstacle deployment caused 20,262 laborers to lose their jobs. But the protective effect of obstacles integrated over labor forces is 3.84 percentage points, meaning some 18,158 laborers *gained* jobs as an indirect consequence of obstacle deployment.

Expression 3.23 showed $\triangle welfare_j \propto \triangle employment\_rate_j$. Location j is therefore a net-beneficiary of obstacle deployment (i.e. expected utility increases) as long as $\triangle employment\_rate_j$ is nonnegative. The fitted values therefore indicate that 180 of 485 locations were net-beneficiaries. Figure 10 plots a spatial histogram of total effects of obstacles by location. The spatial correlation with job proximity (see Section 2) is 20.1%: locations enjoying the highest net-benefits of obstacle deployment tend to be drawn from those 'core' areas most proximate to jobs in the pre-uprising era. This is particularly noticeable in the north-middle area between Nablus and Ramallah. Those dwelling in 'core' areas (i.e. where most jobs were offered) would have tended to commute short distances and cross few obstacles on their way to work. Those dwelling in 'peripheral' areas, far from jobs, would have tended to commute farther and been more vulnerable to obstacles. The deployment of obstacles stymied the inflow of competing labor from peripheral to core areas, raising core wages and employment rates in a way that disproportionately benefited core laborers. From this perspective, core residents had reason to resent their peripherally-dwelling countrymen, and to rejoice when obstacles made their journeys to work prohibitively costly.[35] The B'Tselem report quoted earlier mentions that "in almost every instance, the persons most harmed by the [besieging of cities] are the residents of the villages situated outside the [besieged cities], who depend on the services provided there." The spatial distribution of losses and benefits due to obstacles matches this core-periphery narrative well.

But are the instruments truly exogenous? If the instruments generate quasirandom variation in obstruction (protection), then I should be able to include numerous covariates on the

[35]Residents of Ramallah actually have a derogatory term with which to refer to Palestinians from other parts of the West Bank who commute to Ramallah for work. The word is 'Thailandiya', a bitter allusion to the immigration of foreign laborers, many of them from Thailand, who moved to Israel and filled low-skill jobs that had since 1967 mostly been monopolized by Palestinian laborers commuting from the West Bank. See Friedberg, Sauer (2003).

right-hand side of Column 1's regression without substantially altering the point-estimates for ob_firms_j and $protection_j$. In Column 2 I re-run Column 1's regression but include 86 covariates that seem relevant *a priori* to 2007 employment rates. I now describe each of the included covariates, explaining why they might reasonably be expected to affect 2007 employment rates, and why they might correlate with the obstruction (protection) indices.

Settlements as employers

In addition to affecting the placement of obstacles, settlements themselves were a limited source of employment for Palestinian laborers. Indeed, 2.7% of the 1997 Palestinian labor force worked on settlements, as did 2.5% of the 2007 labor force. The covariate $work\_settle_{1997}$ controls for the fraction of each census location's 1997 labor force employed on settlements. locations with larger pre-uprising employment in settlements may have been more or less affected by elevated security concerns during the uprising. The proximity of settlements positively affects ob_firms_seg and $protection\_seg$ since their defensive buffer zones overlap with roads leading out of Palestinian locations. Their proximity also offers an employment opportunity for Palestinian laborers, and an occasion for increased violent confrontation (Arbel et al (2010)), therefore either increasing or decreasing $employment\_rate_{2007}$. I account for each location j's proximity to its nearest settlement with a nonparametric (local-linear) function of binary variables indicating if a location's nearest settlement is 0-1km, 1-2km, ..., or 9-10km away.

Obstacle proximity

If deployment of obstacles spatially correlated with deployment of Israeli army troops, then whenever obstacles were proximate to a Palestinian location, troops were likely also nearby. The presence of troops could have occasioned violent confrontation, leading to disruptions in the labor market beyond the direct channel of commuting costs. To account for this possibility I control for proximity of obstacles by counting the number of each type of obstacle lying in each of 10 distance bands (0-1km, 1-2km, ..., 9-10km) around each Palestinian location.

Violent confrontation

The Israeli army may have deployed more obstacles in the vicinity of locations heavily involved in violent confrontation during the uprising. Following Miaari, Zussman & Zussman (2014) and Cali & Miaari (2014), I use B'Tselem location-level data on Palestinian fatalities during the 2000-2007 period, generating a location-level count of all Palestinian fatalities. I generate an indicator $any\_killed_{2000-2007}$ for whether a location suffered any fatalities during 2000-2007 and use it as a proxy for the location's tendency to confront (be confronted by) the Israeli army. If this tendency was related to (lack of) economic opportunities, then this covariate should correlate with 2007 employment and treatment variables, therefore affecting point-estimates of interest. By similar reasoning I include each location's 1997 employment rate as a covariate. If settlements tended to lie nearest to Palestinian locations with low pre-uprising employment, then those locations would have suffered higher quantities of obstruction (protection). If these locations' low 1997 employment rates were the result of poor location fundamentals, then these fundamentals would tend to negatively influence 2007 employment rates. Alternatively, if low pre-uprising employment rates meant that residents had low opportunity costs of confrontation during the uprising, then subsequent incursions by the army might likewise have negatively affected 2007 employment rates.

Education & experience

I control furthermore for average pre-uprising educational attainment (in years) avg_educ_{1997} and age avg_age_{1997} of each location's labor force. Reports indicate that younger men were more likely to be profiled as militants and tended to be detained longer at checkpoints, so obstacles should have had larger effects on locations with low average age of labor force. Laborers with higher educational attainment, meanwhile, would have been less substitutable, so employers would have tended to retain them despite late arrivals to work.

Public sector

The commuting model accounts for the behavior of profit-maximizing, private-sector firms, but in 2007 fully 10.1% of employed Palestinians were government workers. When its employees ran into obstacles on their way to work, the government may have responded differently, perhaps more leniently, laying off laborers more reluctantly. I control for the share of each location's pre-uprising labor force employed in the public sector.

Net-immigration rates

For each person who relocates from location j in order to keep his job at location k, location j's employment rate declines and location k's increases. In this way, obstacles can produce the reaction in employment data predicted by the model, but by the long-term channel (relocation) instead of the short-term channel (wage adjustments). To confirm that the short-term channel largely accounts for observed employment changes, I control for net-immigration rates of locations. In particular, I calculate the number of persons immigrating to each location for job-related reasons during 2000-2007, and subtract the number of persons emigrating for job-related reasons during 2000-2007, dividing the difference by the 2007 labor force. The resulting covariate is the net-immigration rate, which I include on the RHS as a covariate. In a later table I show that although net-immigration rates do not interfere with my main results, they do indeed respond to obstacles as one might expect, and in that way lend further credibility to my overall narrative of dual effects.

Firm openings and closings

Related to the issue of decreased demand and laying off laborers, some firms may have altogether closed down. Alternatively, firms may have continued to open in locations less affected by changing trade conditions, while ceasing to open in more affected locations. Since the firm census records closed firms and firms preparing to open, I calculate the fraction of all firms in each location that are closed or preparing to open and include these as two covariates.

Industrial sectors, trade, and border costs

Using the firm census I categorize firms by 15 broad industrial categories, including agriculture, manufacturing, retail, mining, etc. I calculate the fraction of each location's firms belonging to each of these categories. By including the resulting 15 covariates, I am controlling for variation in locations' sensitivity to changes in trade conditions. For example, if the West Bank's retail sector sold imported goods to Palestinians, then increased border costs during the uprising may have raised the sale prices of merchandise, reducing demand and potentially leading to lower employment. locations with a larger percentage of firms involved in retail should therefore have experienced more employment losses. Meanwhile, census locations exporting agricultural produce, manufactured goods, or mined goods (Jerusalem stone, for example. See World Bank (2013)) would have been sensitive to changes in demand among other Palestinian locations or among consumers in the outside world. Increased border costs would have raised the price of exports in foreign markets, decreasing demand; while obstacles would have raised the price of exports in the marketplaces of other Palestinian locations, decreasing Palestinian demand for these tradeables. Facing decreased demand, employers would have curbed supply, potentially laying off laborers. To confirm that commuting, and not trade, drives my results, I therefore include these 15 sector covariates to see if point-estimates change.

Private cars
I control for the fraction of each location's households owning a private car in the pre-uprising era. If private cars were better able to circumvent obstacles, or if they were treated differently by soldiers when crossing a checkpoint, then treatment effects would covary.

Outside options
The model emphasized that laborers give up employment when wages-net-of-commuting-costs are exceeded by 'reservation' wages. One possible outside option available to Palestinian laborers was to return to agricultural activity. The 1997 census recorded the number of dunums[36] of agricultural land owned by each respondent. I calculate average number of dunums owned by laborers in each location j and include this as a covariate named $agri\_per\_laborer_{1997}$. Laborers with more agricultural holdings would have had more to live on if unemployed, so they should have exhibited a greater tendency to give up employment when facing obstructions. If any of these covariates correlated strongly with both instruments and endogenous regressors, then their inclusion would cause point-estimates of the instruments' coefficients to shift significantly.

Column 2 of Table 4 repeats Column 1's regression, but includes all covariates discussed above. R^2 increases over 25 percentage points, from 27% to 52%, yet neither the point-estimates of interest, nor their statistical significance, are affected. This result strongly affirms the validity of the instrumental variables approach. The large increase in R^2 suggests that indeed the added covariates are relevant and explain a lot of the variation in employment rates across locations, yet they leave the commuting narrative unaffected. Furthermore, the R^2 is very high in Column 2. If the introduction of more unobservables were to continue to move point-estimates at a similar rate to how they move between Columns 1 to 2, then R^2 would reach 100% long before either point-estimate of interest could reach zero.

Columns 3 and 4 allow us to peek under the hood of the 2SLS regression to see what the instruments are doing. Column 3 displays the OLS regression result with endogenous regressors, while Column 4 displays the OLS reduced-form regression, i.e. using the instruments

[36] A dunum is a traditional Palestinian farmland area unit.

directly as regressors. The point-estimates are signed as expected in both columns, but do not achieve statistical significance in Column 3. The likeliest explanation for this is attenuation bias. While UN-OCHA maps accurately report the locations of obstacles at the time of recording, the World Bank and B'Tselem consistently report that obstacles often changed places from day to day. In particular, the army often set up makeshift, 'flying' checkpoints in an effort to surprise militants with spot inspections (World Bank, 2007). So whereas the instrumental variables draw on areas that required perpetual defending (settlements and their immediate surroundings), obstacle counts draw partially from areas that were only temporarily guarded, but happened coincidentally to be guarded at the time when UN-OCHA drew up its maps. This idea also extends to the issue of how intensely checkpoints were guarded: around settlements, they were probably guarded with great vigilance, since Israeli civilian lives were at stake; while elsewhere there may have been more variability in enforcement. The obstacle counts are therefore noisier and so estimates of β_1 and β_2 are attenuated in Column 3. In Column 4, by contrast, the focus on friction zones around settlements filters out the noise introduced by enforcement variability and flying checkpoints.

In Table 5, the main regression is re-run over different restricted samples. Column 1 re-prints the results of Table 4, Column 1, for ease of comparison. Column 2 restricts focus to all Palestinian locations where at least 100 laborers dwelt in both 1997 and 2007, and where no more than 10,000 laborers dwelt in either year. The upper bound of 10,000 eliminates outlier cities like Nablus and Hebron, while the lower bound discards over 100 small villages that contribute a lot of noise to the main regression. Point-estimates do not substantially change between Columns 1 and 2, owing to the fact that, since Column 1's regression is weighted by 2007 labor force, the small-village observations were already being heavily discounted. Given this weighting scheme, however, it is comforting to see that the exclusion of large outlier towns makes so little difference to point-estimates, since one might be concerned that their outcomes were weighted too heavily in Column 1. Likewise in Column 3, when locations with labor forces smaller than 200 or greater than 5,000 are excluded, point-estimates are remarkably stable, suggesting very small and very large towns are not driving the paper's main results. In Column 4, I re-run Column 3's regression without weighting observations, to demonstrate that likewise the weighting scheme is unnecessary once the tails of the distribution of location sizes are chopped off.

Table 6 repeats the regressions of Table 4, only this time the destination locations are weighted by radiance, not by firm counts, instrumenting for *ob_bright* with *ob_bright_seg*. The similarity in signs, statistical significance, and even magnitudes between Column 1 of Table 6 and Column 1 of Table 4 is not far short of a miracle, and ought to be interpreted as an extraordinary affirmation of the efficacy of nighttime lights in tracking production activity. Note that, since both *protection* and *ob_bright* are included in the regression, the point-estimates on these variables are identified off the *differences* in labor shares and radiance shares (for a full discussion, see Section 4). In other words, the point-estimate on *ob_bright* is identified off of the *residual* light, *after* a location's residential labor force share is accounted for. So these regression results are not exploiting the fact that the total light of a location will be larger when its residential labor force is larger. Instead, the regression specification implies that total light *net of* residential labor force identifies the point-estimate on *ob_bright*. In view of these facts, it is incredible that the point-estimates in Column 1 of Table 4, where *ob_firms* weights destination locations by the count of firms as recorded by the Palestinian Central Bureau of Statistics, are so similar to the point-estimates in Column 1 of Table 6, where *ob_bright* weights destination locations by the count of light as recorded by US Air Force meteorological satellites. As such, Table 6's results act as an extraodinary validation of Table 4's results, drawing on an utterly different data source to lend credibility to the firm census; and as an extraordinary validation of lights data as a meaningful source of economic information, in that they are able to track Palestinian production activity net of residential size with such finesse as to rival the census bureau's own firm counts.

Spatial autocorrelation

If for each j my indices of obstruction and protection were built using pre-uprising characteristics of j itself, then there would be concern that j's 2007 employment rate was effectively being regressed on a function of lagged characteristics of j, whose correlation with 2007 characteristics might subtly introduce endogeneity problems. For example, if j's pre-uprising radiance (proxying for job counts) were highly correlated with its post-uprising job counts, and if those positively predicted j's 2007 employment rate, then the presence of j's pre-uprising radiance in j's protection index would bias upward my estimate of the (positive) protective effect of obstacles. Although the pre-uprising characteristics of j are *not* used to form j's treatment indices, this endogeneity concern persists through spatial autocorrelation: if k's pre-uprising characteristics are used in j's obstruction (protection) index, and if k is *near* to j, then I am effectively regressing j's 2007 employment rate on correlates of j's 1997 characteristics, which are themselves correlates of j's 2007 characteristics. To address this

Table 7: Effect of obstacles on locations of firms and laborers

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	net immigration	net immigration	renting incidence	renting incidence	net firm openings	net firm openings
ob_firms	-1.943*	-1.167*	-5.392**	-2.550**	-1.115	-0.395
	(1.008)	(0.596)	(2.484)	(1.024)	(1.672)	(1.375)
protection	3.906***	1.522**	6.681**	2.031**	1.310	2.647*
	(1.239)	(0.693)	(2.833)	(0.927)	(1.602)	(1.400)
work_isr	0.0502	0.00946	-0.0899	0.0552*	0.0739	0.0422
	(0.0369)	(0.0246)	(0.0892)	(0.0291)	(0.0947)	(0.0559)
Observations	480	463	478	463	464	463
R-squared	0.094	0.713	0.281	0.901	0.013	0.492
Adjusted R-squared	0.088	0.646	0.277	0.878	0.006	0.376

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

concern, I re-run all of the regressions in Tables 3 and 4 insisting that partner locations k are at least 20km away from each j, finding very similar results.[37]

Spatial redistribution of firms and laborers

The commuting model predicts welfare losses and gains in the short run, when firms and laborers have not yet relocated or redistributed over space. Relocation and spatial redistribution of the economy would have tended to mitigate the welfare consequences of obstacles. Table 7 shows that there is some statistically weak evidence that laborers relocated, and very weak evidence that firms redistributed in response to obstacles. Taken together with evidence presented in Section 4, Table 7's results justify this paper's focus on the short run, and are consistent with the broader literature's finding that there can be persistent factor immobility in developing country settings, even in the presence of significant spatial welfare inequality.

In Columns (1) and (2), the dependent variable is the net-immigration rate, i.e. the difference between the number of persons immigrating to and emigrating from each census location during 2000-2007, divided by the location's 2007 labor force and multiplied by 100. The commuting model predicts that when obstacles remotify a location from job opportunities, expected utility derived from dwelling in that location declines, leading to net-emigration (negative net-immigration) in the long run. To the degree to which obstacles protect local laborers from inflow of competing labor, expected utility should rise, leading to net-immigration in the long run. Agreeing perfectly with the model's predictions, the

[37]Results available upon request.

point-estimate of the marginal effect of *obstruction* on net-immigration is negative in Column (1), while the marginal effect of *protection* is positively signed. The point-estimate for *obstruction* is not significant at the 5% level, however. Furthermore the point-estimates are not stable when covariates are introduced in Column (2). The point-estimate on *protection* is more than halved, while the point-estimate on *obstruction* remains insignificant at the 5% level. In summary, the results in Columns (1) and (2) support the overall narrative, but their statistical weakness supports this paper's focus on short-run consequences.

In Columns (3) and (4), the dependent variable is the percentage of households who report in 2007 that their property of residence is rented. An anecdotally supported hypothesis about the effect of obstacles is that Palestinian laborers, unwilling to undertake high commuting costs daily, began to rent apartments in their workplace locations, returning to their hometowns only on weekends, bi-monthly, or at sparser intervals. The results in Columns (3) and (4) suggest that there is likely some truth to that hypothesis: rental incidence in 2007 is a declining function of *obstruction* but an increasing function of *protection*. The effect is significantly mitigated by the inclusion of covariates, but remains statistically significant at the 5% level, and given the very high R^2 achieved in Column (4), there is not much unobserved variation left over that could otherwise account for the results. It remains only to say that, like net-immigration of labor, the total amount of change in rental incidence between 1997 and 2007 is quite small: if for each location I take the absolute value of the difference between 1997 and 2007, the sum across all locations is 8,527, or just 2.3% of households in 2007.

In Columns (5) and (6), the dependent variable is the net firm openings rate, i.e. the difference between the number of firms recorded as preparing to open and the number of firms closed in each census location, divided by the total number of firms (closed, open, or opening) censused in that location in 2004. None of the point-estimates in Columns (5) or (6) is significant at the 5% level, undermining any alternative hypotheses in which firms tend to open or close at different rates in response to obstacles. Coupled with the radiance-based evidence presented earlier, I conclude that firms did not redistribute over space in response to obstacles.

6 Conclusion

Economists have always found that commuting costs and laborers' welfare are inversely related in the short run, but this paper finds robust empirical evidence of a simple labor market channel by which commuting costs act in much the same way as trade barriers, protecting some laborers while harming others. My empirical findings suggest that in cities of the developing world, where laborers are very interchangeable and unemployment rates are high, commuting cost increases will cause one set of laborers to lose out on job access but replace them with another set of laborers of similar quality. As we move to advise mayors and municipalities around the developing world about infrastructure investments, the absence of a clear, Pareto welfare gain would seem to undermine significantly the argument for costly investment in maintaining or expanding commuter infrastructure. In the case of the West Bank, however, this paper's results put some urgency in the case for investing in ways to buoy the economic prospects of peripheral Palestinian locations. In particular, the presence of Israeli settlements creates the necessity for defensive zones and spot inspections of vehicles and passengers. The sluggishness of commuter traffic along these routes tends to disconnect peripheral Palestinian areas from core Palestinian areas, generating economic inequality and encouraging periphery-to-core migration. The ensuing depopulation of rural areas leaves them vulnerable to annexation, making the possibility of a two-state solution ever more tenuous.

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