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Gains from Trade: Lessons from the Gaza Blockade 2007-2010

By

Assaf Zimring
Stanford Institute for Economic Policy Research
Stanford University
Stanford, CA 94305
(650) 725-1874

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Gains from Trade: Lessons from the Gaza Blockade 2007-2010

Assaf Zimring*

January 2, 2013

Abstract

This paper uses detailed household expenditure and firm production data to study the welfare consequences of the blockade imposed on the Gaza Strip between 2007 and 2010. Using the West Bank as a counterfactual, I find that being removed from world markets reduced welfare by 17%-28% on average. Moreover, households with larger pre-blockade expenditure levels experienced disproportionately larger welfare losses. These effects are substantially larger than the predictions of standard trade models. I show that this large decline in welfare may be due to a combination of resource reallocation and reduced productivity. Using firm level data I find that the blockade triggered reallocation of workers across firms and sectors, especially from manufacturing to services, and from industries that use imported inputs intensively, or export. In addition, labor productivity fell sharply by 23%. This decline was however significantly higher in manufacturing (39%) than in services (5%). These findings suggest that access to world markets did not only determine the location of the Gaza economy on a given Production Possibility Frontier, but also determined the shape of this PPF.

JEL Classifications: F13,F16

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1 Introduction

While almost all economists agree that international trade is beneficial, measuring just how beneficial it is, is difficult. As Irwin (2005) explains: “In theory, the gains from international trade are represented by comparing welfare at the free-trade equilibrium with welfare at the autarky equilibrium. In practice, such a comparison is almost never feasible because the autarky equilibrium is almost never observed”. This paper studies the consequences of a rare episode in modern history, in which the Gaza Strip came close to being autarkic, as a result of an Israeli and Egyptian blockade that was imposed on it between September 2007 and June 2010.

The first part of the paper studies the welfare implications of the blockade on Gaza. An important advantage of the analysis is the existence of a natural counterfactual, the West Bank, which at the time the blockade began, had similar economic and political institutions, and had very similar trends in prices and consumption, but which was not blockaded. Using detailed expenditure data at the household level, I calculate the monetary equivalent of the welfare loss caused by the blockade, based on the concept of compensating variation. I find that the average welfare loss for a household in Gaza was equal to between 17% and 28% of the value of its pre-blockade expenditure. Moreover, I find that all measures of welfare losses are disproportionately larger for wealthier households.

I contrast these results with the welfare effects predicted by an important class of trade models. Using the formula in Arkolakis, Costinot, and Rodriguez-Clare (2012), I calculate that the predicted welfare loss in Gaza according to these models is only 2.9%-5.6%.

The second part of the paper studies the economic mechanisms that led to this large welfare loss. Using detailed firm level data, I document three facts about the adjustment of production in Gaza during the blockade.

First, there was a large reallocation of workers away from manufacturing, where employment fell by 31%, and into services, where employment rose by 27%. A more disaggregated analysis suggests that the loss of access to world markets was the cause for this reallocation: Workers were reallocated away from industries that exported, used imported inputs intensively, or were capital intense.

Second, the distribution of firm size in manufacturing changed, with the weight of large firms declining substantially: the share of large manufacturing firms, employing over 40 employees, in total manufacturing employment de-

clined from 16.1% in 2006 to 7.0% in 2009. In services on the other hand, the share of large firms in total employment remained almost constant between 2006 and 2009.

Third, I find that average worker's productivity in Gaza, as measured by real added value per worker, declined by 23% during the blockade. The decline in productivity was very different between the manufacturing and the services sectors: a 45% decline in manufacturing, and only a 5% decline in services. Moreover, a more disaggregated analysis of 72 industries reveals that the overall decline was predominantly the result of a decline in productivity within industries, and not of reallocation of workers between industries.

These findings suggest a strong complementarity between imported inputs and labor, especially in the manufacturing sector. In many models of international trade, the important margin of adjustment is between import competing and exporting industries and firms. In Gaza, however, manufacturing as a whole depended on access to world markets, both for inputs such as raw materials and for machinery. Lacking this access, both import competing and exporting industries experienced a large decline in productivity and in employment, and workers were reallocated to the less productive services sector.

Since the blockade lasted only three years, and Gaza had been an open economy for a long time before, my analysis captures the relatively short run effects of moving from a trading equilibrium to autarky. On the one hand, Gaza may not have fully adjusted to its new state of near autarky by 2009. On the other hand, Gaza was still able to use machinery, and to some extent raw materials, that were previously imported, and not produced domestically. While the first consideration suggests that the short-run welfare losses I calculate may exceed the long run welfare costs, the second consideration implies the converse. The question which effect is likely to be larger is beyond the scope of this paper. At any rate, the short run effects of autarky are important to study for a few reasons.

First, short run effects are key to the analysis of trade policy. Economic sanctions, or the threat of using them, are still very much a part of international relations, and the study of the Gaza experience improves our understanding of their possible implications. Extreme changes to trade policy can also lead to a large decline in trade volume, and the study of the short run effects of the collapse of trade in Gaza can serve as a cautionary tale against the dangers of trade wars.

Second, studying the short run effects of the blockade on Gaza can inform our thinking about the long run consequences of trade. While Gaza did not yet fully adjust to its new state of near autarky, the large adjustments that already took place can nonetheless inform our thinking about what the long run adjustments will have to be, and how likely they are to successfully compensate for the loss of access to international markets.

The rest of the paper is organized as follows: Section 2 surveys the relevant literature. Section 3 gives an historical account of the blockade on Gaza, and section 4 introduces the household and firm level data I use. Section 5 describes the welfare calculations I perform based on consumption and price data, and contrasts them with welfare predictions of an important class of trade models. Section 6 documents changes to production in Gaza following the blockade, focusing on the reallocation of workers and changes to their productivity. Section 7 concludes.

2 Related Literature

This paper contributes to three strands of the gains from trade literature: the study of historical autarky episodes, the study of gains from trade based on quantitative models, and the study of the relationship between international trade and productivity.

Only two historical episodes in which autarky equilibrium was observed have been analyzed to date, and both are from the nineteenth century. Bernhofen and Brown (2005) examine Japan's forced opening to trade in the 1850s, and find an upper bound of 8% for the gains through the channel of comparative advantage. Irwin (2005) explores the self imposed "Jeffersonian Embargo" in the U.S. between December 1807 and March 1809, and concludes that losses from the embargo in the U.S. amounted to 5% of 1806 GDP. In both of these papers, the measurement of welfare changes is based on measuring the gains from comparative advantage. Since in both cases no data on consumption or production is available, they use data on prices and on trade flows to estimate bounds on the gains from trade. The main advantage of this paper is the availability of consumption and production data. This allows me to make two contributions. First, this paper uses household level data, and not economy aggregates, to calculate the welfare losses, and therefore the results do not depend on assuming a representative agent. Moreover, the data allow me to study the distribution of the welfare

changes. Second, having firm level data allows me to study the adjustment of the production process to being removed from world markets. Finally, an important advantage of this historical episode is that it provides us with a natural “control group” - the West Bank.

Some natural experiments short of a move between full autarky and free trade have also been used to evaluate gains from trade. Feyrer (2009a) uses the closing of the Suez canal between 1967 and 1975 as an exogenous (for most countries) shock to trade costs, to explore the relations between trade and income. Feyrer (2009b) uses the advancement in air transportation technology, which had a differential effect on countries with short air routes but long sea routes between them, and countries for which both routes are of similar length. Both papers find substantial and positive effect of trade on income. However, since they analyze relatively small changes, it is not easy to extrapolate from them to the overall gains from trade.

Since natural experiments are rare, another strand of the literature uses quantitative trade models in order to evaluate the gains from trade. One of the most commonly used framework, is the one developed in Eaton and Kortum (2002), in which they make distributional and structural assumptions, that allow them to create counterfactual autarkic economies based on observed data of the trading economies, and based on these counterfactuals, they calculate the gains from trade. They find remarkably low gains ranging from 0.2% for Japan, to 10.3% for Belgium. Though these gains seem surprisingly small, many other quantitative models predict gains that are no larger. Arkolakis, Costinot, and Rodriguez-Clare (2012) have shown that an important class of trade models, including some variations of Melitz (2003), Krugman (1980) and the Armington model for example, all yield the same results for the overall gains from trade, conditional on two sufficient statistics: the share of imports out of total expenditure, and the elasticity of imports with respect to variable trade costs. However, Ossa (2012) has shown that this result depends on using the average elasticity of imports, and that when using industry specific elasticities, the gains from trade are substantially larger. In documenting the decline of the manufacturing sector in Gaza, and its dependency on some imported inputs, this paper gives some support to the importance of different trade elasticities for different imported goods.

Some papers have documented the importance of imported inputs for domestic production. Amiti and Konings (2007) and Topalova and Khandelwal (2011) use establishment level data and find that trade liberalization led to

productivity increases in domestic firms both through increased competition and through access to imported inputs. Goldberg, Khandelwal, Pavcnik, and Topalova (2010) also find that that greater access to imported inputs led to an increase in the variety of domestically produced final goods. Yi (2003) also emphasizes the importance of trade in inputs, and argues that vertical specialization can explain the large response of trade volume to relatively small tariff reductions. My results are consistent with these findings, and show that in the extreme case of an almost complete absence of imported inputs, the manufacturing sector as a whole is severely restricted.

3 The Blockade on Gaza

This section gives a brief historical outline of the blockade on Gaza, with an emphasis on its economic effects.

From the beginning of the decade, and until 2005, the Gaza Strip was an open economy with effectively a fixed exchange rate, since it did not issue its own currency but used the Israeli Shekel. Imports averaged 35.6% of total expenditure between 2000 and 2005, and exports were much smaller, equal on average to about 10% of imports during these years. The large trade deficits of the Gaza Strip were funded using three sources. First, unilateral transfers from the West Bank, from UN agencies, and from other donor countries; Second, remittances from Palestinians working abroad; And third, foreign direct investment.

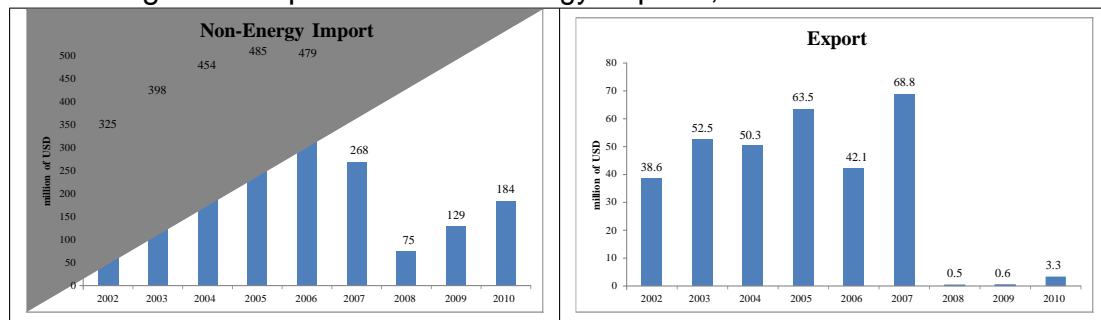
On September 12th, 2005, after controlling the Gaza Strip since the Six Days war in 1967, the Israeli army completed a unilateral withdrawal of all military forces from the Gaza strip, and the evacuation of the 8,000 Israelis who lived in settlements there. A week later, the Israeli minister of internal affairs declared the five passages between Israel and the Gaza Strip “border stations”, effectively drawing a border between the Gaza Strip and Israel. From this point, the Gaza Strip was under the complete control of the Palestinian Authority. At this time, the GDP in Gaza was 1.43 billion USD, and the population was 1.35 million people.

In January 2006 the religious Hamas movement won the elections to the legislator of the Palestinian Authority, and after a year and a half of power struggle with the more moderate, and secular, Fatah movement, it finally assumed complete control over the Gaza Strip in June 2007. Alarmed by this development, on September 19th 2007, Israel’s Ministers Committee to

National Security Affairs voted for decision B/34, which declared the Gaza Strip a “Hostile Territory”, and ordered the army and the navy to impose restrictions on the movement of goods and people into and out of the Gaza Strip, allowing for humanitarian considerations. The Egyptian authorities of the time, also alarmed by the rise of Hamas to power, cooperated, and closed the land crossing between the Gaza Strip and Egypt. The beginning of the blockade can therefore be dated to September 2007, and there is no reason to believe it was anticipated.

The details of the restrictions were not always clear: some are secret, about others there are conflicting reports of various interested parties. At any rate, what is not disputed, is that following decision B/34, exports from Gaza were essentially eliminated and non-energy imports were greatly reduced: According to Palestinian National Accounts, exports of goods from Gaza was 0.6 million USD in 2009, down from an average of 52.8 million USD per year in 2005-2006, and non-energy imports decreased by 75%, from an average of 504 million USD per year in 2005-2006 to 128 million USD in 2009.¹ Figure 1 summarizes imports (excluding energy) and exports for Gaza for the years 2005-2011.

Figure 1: Exports and Non-Energy Imports, Gaza 2002-2010



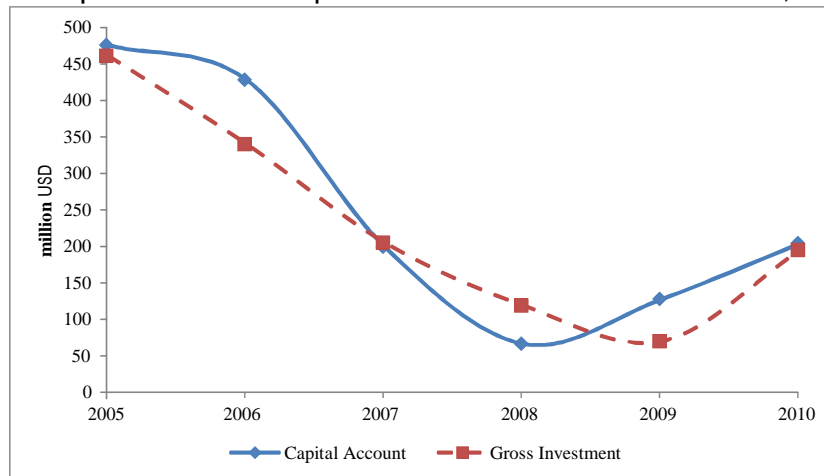
Notes: Data is in million of current USD, taken from national accounts published by the PCBS. Since some food imports were still allowed, imports are still positive during the years of the blockade.

Since imports declined much more than exports, the closing of the Gaza

¹The reason I do not include energy imports in this calculation is that a large share of total imports to the Gaza Strip consist of fuels and electricity, which by a decision of the Israeli Supreme Court from July 2007 in *Albasioni Ahmad and Others v. The Prime Minister and Defense Minister of Israel* (case number 9132/07), were either not restricted at all (electricity) or very little (Fuels).

Strip led to a direct loss of available resources of 300 million USD. As Figure 2 shows this number is essentially identical to the decline in gross investment in Gaza during these years. I address intertemporal considerations in detail later in the paper, but for now it is important to note that the loss of available resources can be accounted for in the decline of investment, so if it did affect consumption, it was through intertemporal optimization of households, and not mechanically through a smaller amount of resources available for consumption.²

Figure 2: Capital Account Surplus and Gross Investment in Gaza, 2005-2010



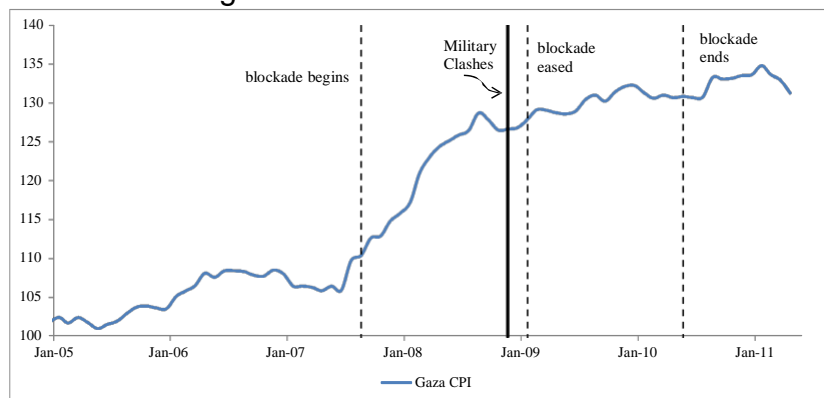
Notes: Data is from the National Accounts Statistics published by the Palestinian Central Bureau of Statistics. Numbers are in millions of USD.

Between December 27, 2008 and January 18, 2009, the Israeli army launched a series of strikes in the Gaza Strip that were later known as “Operation Cast Led”. These strikes led to some disruption in the Gaza economy,

²I also calculate the loss of return on lost investments. I use the average of interest rates to prime borrowers and interest rate in interbank lending in the West Bank and Gaza from the CIA World Fact-book (no data is available for Gaza by itself) as a proxy for annual return, even though they reflect the risk adjusted marginal return on investment, not the average, risk free return. Aggregating the lost returns on all the lost investments in 2007-2008, yields a loss of 26 million USD for the year 2009. Adding that to the difference between the fall in trade deficit and the fall in investment, the effect that the loss of resources on consumption per household is about 64 USD over the whole year of 2009, or about 5.5 USD per month. That is less than 1% of average household consumption in 2006.

though reports about the extent of the damage vary widely by source. An important evidence that these strikes had relatively small effect can be found in price data. As can be seen in Figure 3, which shows prices in Gaza at a monthly frequency, the strikes had no effect at all on prices, especially relative to the very noticeable effect of the blockade.

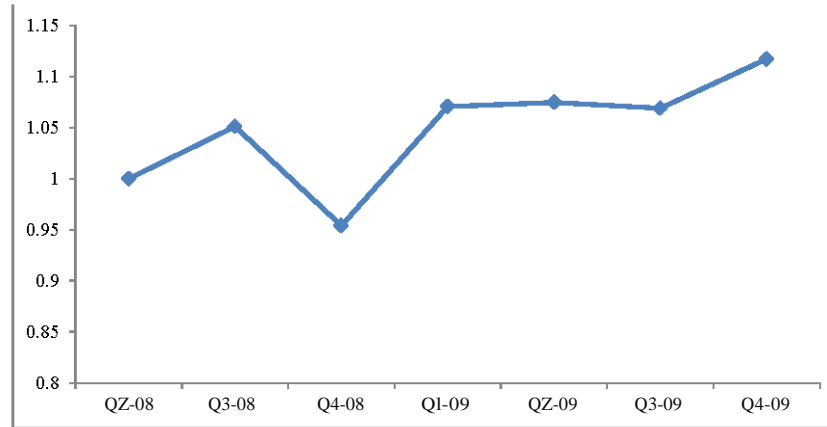
Figure 3: Gaza CPI and Timeline



Notes: Monthly price data is from the CPI files of the Palestinian Central Bureau of Statistics.

Moreover, aggregate GDP data show that the effects of Operation Cast Led were limited to only the fourth quarter of 2008. Figure 4 shows quarterly data on the real GDP per capita in the Gaza Strip. It clearly shows that the effects of the clashes were limited to the fourth quarter of 2008, and that already in the first quarter of 2009, the Gaza economy experienced growth in real GDP per capita of 1.8% relative to the *third* quarter of 2008.

Figure 4: Real GDPPC in Gaza by Quarter (Q2-2008=1)



Notes: Real GDP per Capita by quarter is from the Palestinian national accounts, and are normalized to 1 for the second quarter of 2008.

Other than Operation Cast Led, the years of the blockade, and especially 2009, were relatively quiet. Table 1 reports the number of Palestinian Casualties in Gaza, and the number of rockets fired from it for the years 2005-2010³ which provide further support that the level of conflict intensity in 2009 was much lower than in 2006. In fact, except for Operation Cast Led, the number of casualties in the Palestinian side was lower than its 2006 level at each year during the blockade.

³The data about casualties is compiled by the NGO B'tselem, and is based on the names and circumstances of death of individuals who died as a direct result of the conflict. The data on rockets fired from Gaza is published by the Israel Security Service, known as the "Shabak".

Table 1: Measures of Conflict Intensity in Gaza 2005-2010

Year	Rockets	Mortar Shells	Palestinian Casualties in Gaza
2005	401	858	103
2006	1722	55	525
2007	1276	1531	295
2008*	2048	1672	414
2009*	566	287	42
2010	146	211	68

Notes: *The numbers for **2008 and 2009** do not include casualties during the time of Operation Cast Led. Casualties numbers are from the **NGO B'tselem**, that keeps a list of each casualty by name and circumstances of his/her death. Rockets and mortar shells numbers are published by the Israel Security Service.

While Operation Cast Led was a dramatic event in many ways, there is no evidence that it had a sizable macro-economic effect.

The blockade was first eased in February 2009, when facing diplomatic pressure, Israeli authorities expanded the list of goods that were allowed to be imported into Gaza, while still banning all exports. A major change in policy came in June 2010, when following a violent clash between Israeli commandos and political activists on a Gaza bound Turkish flotilla, diplomatic pressure led Israel to implement a more substantial easing of restrictions, most notably switching from a "white list" of which goods are allowed in, to a "black list" of which goods are not. Exports were also allowed again, though still restricted.

While up to date data about the movements of goods into and out of Gaza is not yet available, it is clear that the trade restrictions were not completely removed. As of March 2012, the Israeli government maintains a list of goods of "dual use", i.e. goods that have both a military and a civilian use, that are banned from entering Gaza, and the enforcement of this restriction adds to trade costs of even the allowed goods. According to the Palestinian Trade Center (PalTrade), an industry group, the number of trucks entering Gaza in the first half of 2012 is only 40% of what it was in the first half of 2007, and the number of trucks leaving Gaza is only 3% of the equivalent number in 2007.

As the fact that imports were not zero suggests, the blockade was never perfectly enforced. Food, medical supplies, and some humanitarian equipment (eg. blankets, diapers) were allowed into Gaza, though under at least some restrictions, throughout the whole period. In January 23, 2008 a part

of the fence separating Gaza from Egypt was brought down, and for a few days there was movement of people between Gaza Strip and Egypt. Finally, the smuggling industry was active, most notably through the use of underground tunnels between the city of Rafah in the south of the Gaza Strip and the Egyptian city by the same name across the border⁴. No credible data about the magnitude of trade that went through the tunnels exists. A report by the U.S. Congressional Research Service mentions estimates of a 1,000 tunnels at the end of 2010, but supplies no details of their size or the value of trade that goes through them. The Israeli newspaper “Haaretz” reported at the end of 2008, that there were 850 tunnels registered with the Palestinian police in Gaza, though only 400 of them were paying the fixed tunnel fee of 2,500 USD per year. However, the ability of even a few hundred tunnels to substitute for open borders is very limited, considering that before the blockade an average of 10,000 trucks entered Gaza each month⁵.

At any rate, if imports into the Gaza Strip were even higher than official data report⁶, then estimates of the welfare costs of the decrease in trade volume are biased downward.

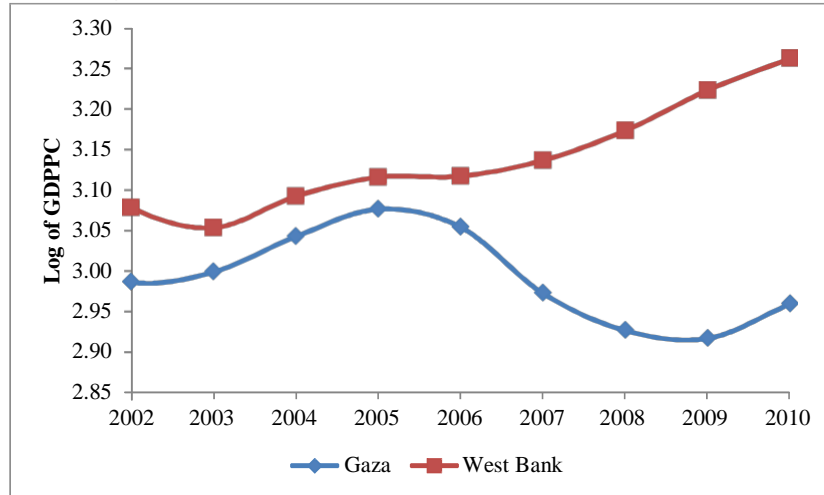
Figure 5 gives a birds eye view of the economic effects of the blockade, showing trends in real GDP per capita in Gaza and in the West Bank, from 2002 to 2010. As can be seen, the blockade was imposed on the Gaza Strip following 4 years of growth that began after the end of the second intifada in 2002, and it was associated with a substantial economic downturn, while in the West Bank the previous trend continued. Following the easing and later the removing of the blockade, GDP per capita in Gaza began to grow again.

⁴Smuggling may be a misnomer. While Israeli and Egyptian authorities tried to stop the tunnels activity, it was accepted, and even regulated and taxed by the Palestinian authorities.

⁵Reported by the NGO Gisha, based on data collected by UNSCO

⁶The PCBS refused to answer whether the import data does or does not include imports through tunnels

Figure 5: Real GDPPC, Gaza and the West Bank



Notes: Each point in graph is the natural log of a two years moving average of real GDPPC, with 2004 as the base year for prices. The data is taken from the Palestinian national accounts and population statistics published by the PCBS.

4 Data

4.1 Consumption Data

I use two main data sources for calculating welfare: the household expenditure survey and the consumer price index, both published by the Palestinian Central Bureau of Statistics (PCBS) separately for Gaza and the West Bank. Since the household expenditure survey is conducted on an annual basis, I use data from 2006, the last full year of data before the beginning of the blockade, and 2009 the last full year of data in which the blockade was still effectively enforced.

The household expenditure survey is a repeated cross section, and it is representative of the population. In 2006 the survey covered 428 households in Gaza and 853 households in the West bank, and in 2009 it covered 828 households in Gaza and 968 in the West Bank. The survey documents the monthly household total expenditure on 658 items in 2006 and 756 items in 2009, the difference being a result of a the use of a more disaggregated questionnaire in 2009, especially in textiles. However, it is straightforward to aggregate up the data from 2009 to the level of aggregation of 2006. For

98 durable goods, the survey asks about annual expenditure, and I divide that expenditure by 12 to get an estimate of the monthly expenditure. For 7 items (new and used vehicles), the survey asks for total expenditure in the three years prior to the survey taking place. This time window is too wide to be able to identify the effects of the blockade, so I do not use data on vehicles purchases. This is likely to lead to understating of the welfare loss, since new cars were not at all allowed into Gaza, and it is unlikely that a substantial number of cars were smuggled through tunnels.⁷

In addition to the total value of expenditure on each item, for 328 items in 2006 and 386 items in 2009 the expenditure survey includes data, at least for some households, on the quantity purchased, and hence on price paid. I use this price data only for items for which there is no price data from the CPI files, and only if there are at least 10 observation from Gaza and 10 from the West Bank with price data for the item in each year. Because the price data from the expenditure survey is noisy, I calculate an average price of an item by iteratively removing observations with prices more than 2.5 standard deviations from the mean price. This process yields price data for 122 items in Gaza and 148 items in the West Bank.

The expenditure survey also has a large number of questions about household characteristics which I use in analyzing the distribution of the welfare losses. This data includes details about the housing situation, ownership of vehicles and large appliances, number of people in the household and their ages, and the household main source of income.

The main source of price data I use is the CPI files, which includes prices of 237 goods and services in Gaza and in the West Bank, most of them map exactly to items in the expenditure survey, but some are more finely defined. In cases where a few CPI items map into a single item in the expenditure survey, I use a simple average of the prices of the relevant items from the CPI as the price of the item in the expenditure survey.

Combined, the CPI files and the data on prices from the expenditure survey give the prices of 279 items for both 2006 and 2009. On average, these items constitute 76% of household expenditure in Gaza, and I could find no pattern in the items for which price data exist, except for the fact that they were relatively large expenditures, as suggested by the fact that less than half of the items constitute 76% of expenditure. As a robustness check, I

⁷Although a video aired by the BBC shows a car being smuggled into Gaza through a tunnel in 2011.

repeat all the welfare calculation using only households for which price data covers more than 75% of total expenditure, and the results are essentially unchanged. As a second robustness check, I repeat all the welfare calculations while giving precedence to price data from the expenditure survey, i.e. using the expenditure survey as a primary source for price data, and the CPI price data only for items for which no price is available from the expenditure survey. Results are essentially identical.

4.2 Production Data

The source of data on production in Gaza in 2006-2009 are the services and manufacturing firms surveys. These surveys, also conducted by the PCBS, include detailed firm level data on revenue on domestic sales, revenue on exports, the value of domestic purchases, value of purchases from abroad, the firm work force, and the firms use of electricity, water, and fuels.

The manufacturing survey in Gaza was based on a stratified, representative sample of 888 firms in 2006⁸ and 685 in 2009, that were drawn from the establishment census. Firms were classified by their main output, using four digit isic.3 classification system (eg. “manufacture of furniture” or “Manufacture of wearing apparel”). The services survey in Gaza was based on a stratified, representative sample of 719 firms in 2006 and 440 firms in 2009, which were also drawn from the establishment census. The firms in the services survey are classified using a 2 digit isic.3 system (eg. “hotels and restaurants” or “computer & related activities”).

Up until 2007, the PCBS also conducted similar surveys for the construction sector, but during the years of the blockade, including 2009, these surveys cover a very small sample, and they contain very limited information even for the establishments that were surveyed, making them practically unusable. There are no similar Surveys for agriculture, which is of significant

⁸The PCBS files of the 2006 surveys do not contain a variable that distinguish West Bank firms from Gaza firms. To obtain this information, I used the establishment census file from 2004, which is the population from which the sample for the establishment survey was constructed. The establishment census files have limited data on each firm, including location and the 4 digit isic.3 classification. A simple algorithm matches firms identification numbers in the census and the surveys files. I ascertain the validity of that match using the isic.3 variable, which exists in both files: the algorithm produces a 96.2% match rate, which is essentially a zero probability event unless this is the way the original numbers were manipulated. I thank Roy Mill for developing this algorithm.

size in Gaza. However, while the data I have does not cover all of production in Gaza, manufacturing and services account for the majority of non governmental economic activity in Gaza throughout the period in question. During the years I study it constituted between 59.2% and 69.1% of non governmental economic activity, measured by added value.

5 The Welfare Cost of the Blockade

I turn now to perform three calculations for the welfare loss that resulted from the blockade on Gaza. Two calculations are based on the concept of compensating variation (CV). The first uses the concept of Slutsky CV, and the second uses the Hicks CV. The Last calculation is a Slutsky equivalent variation (EV). These three calculations are, respectively, an upper bound, an approximation, and a lower bound for the welfare losses in Gaza. Using these concepts allows me to put a monetary value on the welfare losses in Gaza. When expressed as a percentage of the base period value of consumption, CV can be interpreted as the change in real consumption, which is the concept that is used as a welfare measure in the ACR formula. In this sense, the results of the consumption based calculation are comparable to the results of the ACR formula.

5.1 Methodology: Calculating Welfare Losses

I start with calculating the Slutsky Compensating Variation (CV). Formally, it is defined as

$$CV_i^s = e(p^a, c_i^t) - e(p^a, c_i^a)$$

where $j \in \{a, t\}$ refers to autarkic⁹ and trading conditions respectively, and $e(p^j, c_i^j)$ is the cost of consumption bundle c of household i when prices are given by the vector p^j .¹⁰ Intuitively, this measures the following: how much

⁹For the rest of this section, for purposes of clarity and brevity, I will refer to the state of the Gaza Strip during the blockade as autarkic. As mentioned before, the Gaza Strip was not completely autarkic during this time.

¹⁰Note that this is not the standard definition of the expenditure function. The standard expenditure function is defined over prices and utility level, and it calculates the cost of obtaining a given level of utility under a given vector of prices. Under the definition used here, $e(p^j, c_i^j)$ is simply $p^j \times c_i^j$. I keep the function notation to make the comparison to the Hicks CV simpler.

more money a household in blockaded Gaza needs in order for it to be able to purchase the same bundle it did prior to the blockade. The main advantage of this measure is that it imposes very little restrictions on households preferences, requiring only the Weak Axiom of Revealed Preference. The main weakness of this measure is that it ignores the ability of households to substitute away from goods that became relatively more expensive, and so it tends to overstate welfare loss. It is best interpreted as an upper bound on welfare loss.

To account for possible substitutions in the consumption bundle, I also calculate the Hicks CV:

$$CV_i^h = e(p^a, u_i^t) - e(p^a, u_i^a)$$

where u_i^j is the utility of household i under trading conditions $j = \{a, t\}$. Intuitively, this measures how much more money a household in blockaded Gaza needs to be as *well off* as it was before the blockade. Since one possible consumption bundle that will make a household as well off as it was before the blockade is simply the same bundle it had prior to the blockade, the Slutsky CV is always weakly higher than the Hicks CV. In practice, since relative prices changed, so did the optimal consumption choice, and in general the Slutsky CV will be strictly greater than the Hicks CV.

To calculate the Hicks CV it is necessary to specify a utility function¹¹, and I assume a Cobb-Douglas utility function for all households: $U_i = \prod_k (c_{k,i})^{\alpha_{k,i}}$ with $\sum_k \alpha_{k,i} = 1$ for all i . For each household i , the $\alpha_{k,i}$ are the observed expenditure shares. This utility function imposes a unit price elasticity, which given the level of disaggregation of the expenditure survey is a reasonable assumption (Deaton and Meullbauer (1980), p.79).

Since the households data is not a panel, I do not observe consumption choices for the same household both before and during the blockade, and I therefore cannot directly calculate CV^s or CV^h , as defined here, at the household level. In order to use as much data at the household level as possible, I do the following: First, it is instructive to rewrite the CV^s as the sum of two differences, by adding and subtracting $e(p^t, c_i^t)$:

$$CV_i^s = [e(p^a, c_i^t) - e(p^t, c_i^t)] + [e(p^t, c_i^t) - e(p^a, c_i^a)]$$

and similarly for the CV^h , adding and subtracting $e(p^t, u_i^t)$:

¹¹Technically, one only needs to specify an expenditure function. This distinction is not critical to the discussion here.

$$CV_i^h = [e(p^a, u_i^t) - e(p^t, u_i^t)] + [e(p^t, u_i^t) - e(p^a, u_i^a)]$$

The first difference in each of these expressions is the increase in the cost of the pre-blockade consumption bundle (or the cost of the pre-blockade utility level) when moving from a trading to a blockaded economy. The second difference is the change in the total value of the household consumption bundle when moving from trade to autarky.

To understand the intuition for this calculation, consider a household that consumed a consumption bundle that cost 100 Shekels in 2006. If in 2009 the cost of the same consumption bundle was 120 Shekels, and the household total value of consumption was only 90 Shekels, the Slutsky CV would be the sum of these two changes, or in this case 30 Shekels.

Finally, I also calculate a Slutsky EV, which is a lower bound on the welfare loss that is comparable to the Hicks and Slutsky CV. The Slutsky EV is defined as:

$$EV^s = e(p^t, c_i^t) - e(p^t, c_i^a) = [e(p^a, c_i^a) - e(p^t, c_i^a)] + [e(p^t, c_i^t) - e(p^a, c_i^a)]$$

Intuitively, this is the amount of money you have to take away from a household in pre-blockade Gaza so that it will only be able to afford the consumption bundle it had during the blockade. To see why it is a lower bound, notice that the difference between the Slutsky EV and the Slutsky CV is only that the Slutsky EV calculates the change in the cost of the autarky consumption bundle, while the Slutsky CV calculates the change in the cost of the free trade consumption bundle. This is exactly the difference between the Paasche price index, which is a lower bound on the change to the cost of living, and the Laspeyres price index, which is an upper bound.

Since I observe both p^t and p^a , the first difference in all of these measures is observed at the household level, and it uses all of the data about the household consumption. However, since I do not observe the same household under both trading and blockaded conditions, I do not observe the second difference. Instead, I create a synthetic panel in the following way: I place all households from both the pre-blockade and the during-blockade sample into bins based on the number of people in the household. I then give each household, in each bin, the average change to the value of consumption in the bin to which it belongs.

The fact that the expenditure data is not a panel, but a repeated cross section, also means that the Slutsky EV, which uses the 2009 sample, is based on a different sample than the CV's, which are based on the 2006 sample. Thus, comparing the Slutsky EV with the Hicks and Slutsky CV can only be done at an aggregate level, and not for each household separately.

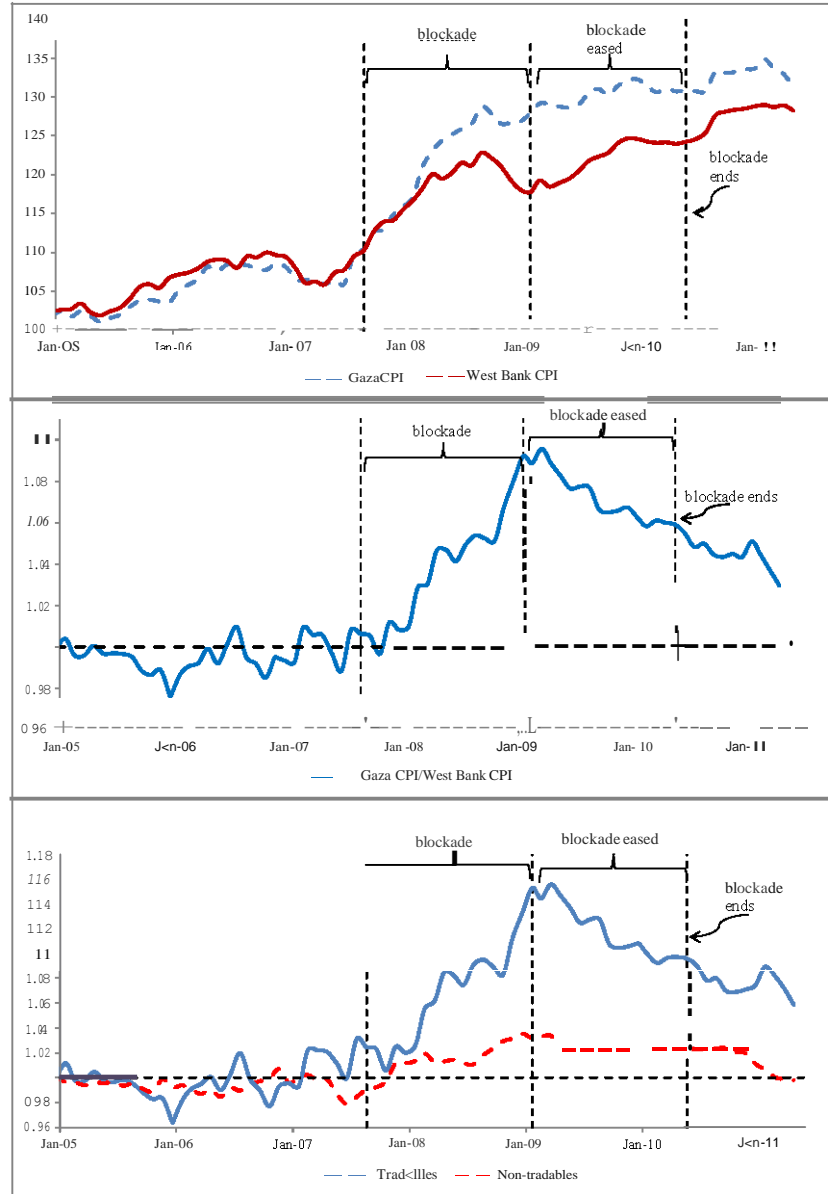
5.2 Using the West Bank as a Counterfactual

As Helpman and Krugman (1985) clarify, the autarky-free trade framework is not about comparing an economy before and after it opened (or closed) to trade. Rather, it is a counterfactual exercise, comparing the state of the economy if it could trade, to its state if it could not. In the case of the blockade on Gaza there is a concern that some of the changes in prices and expenditure that we observe are the result of unobserved trends that are unrelated to the blockade. Moreover, since some imports, especially food, were allowed into Gaza even during the blockade, some of the price changes we observe may reflect, at least in part, an increase in world prices and not the effects of the blockade. To address this concern, I perform a difference-in-difference calculation, using the West Bank as a counterfactual for the Gaza Strip.

The West Bank is home to about 60% of the total population living under the control of the Palestinian authority. While it is geographically separated, many of its economic and political institutions are similar to those of the Gaza Strip. However, unlike Gaza, it was not blockaded. Since the two key variables in my welfare calculations are prices and household consumption, necessary conditions for the West Bank to be a good counterfactual for Gaza, are similar trends in these variables. Figure 6 shows monthly data on the CPI¹² in Gaza and in the West Bank between 2005 and 2011. The top Panel shows the CPI for Gaza and for the West Bank, the middle panel shows the ratio of CPI in Gaza to the CPI in the West Bank, and the bottom panel shows this ratio separately for the tradeable and the non tradeable components of the CPI.

¹²To avoid problems that may arise from the use of different weights in the calculation of the CPI in the West Bank and Gaza, I recalculate the West Bank CPI using the Gaza weights.

Figure 6: CPI in Gaza and the West Bank, 2005-2011



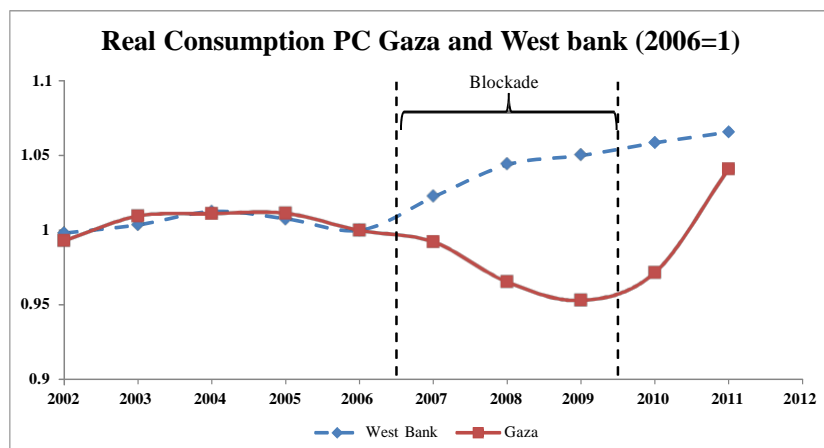
Notes: Monthly price data is from the CPI files of the Palestinian Central Bureau of Statistics, using the Gaza weights for both Gaza and the West Bank.

Four patterns in the data suggest that the West Bank is indeed a good counterfactual. First, before the blockade on Gaza, price indices in the West

Bank and in Gaza followed a very similar path. Second, soon after the blockade began, a noticeable gap opens. Third, after the blockade was eased, the indices begin to converge again. Fourth, the divergence in prices is much stronger for tradeable goods than for non-tradables. Put together, the first three facts suggest that the West Bank price trends are a good counterfactual for Gaza price trends. The last two facts, showing that the divergence in prices happened almost only in tradeable goods, and started reversing after the blockade was eased, strongly supports the claim that this divergence is indeed due to the blockade.

Figure 7 shows annual data on real consumption per capita since 2002 in the Gaza Strip and in the West Bank, both normalized to one in 2006, the last year before the blockade,¹³

Figure 7: Real Consumption per capita in the West Bank and Gaza, 2002-2011



Notes: Data on consumption and population is from the Palestinian Central Bureau of Statistics, and is in logs of 1000 USD. The levels of both the West Bank and Gaza are normalized to 1 in the year 2006, the last year before the blockade.

Here too, three patterns in the data, that were also present in the price data, suggest the West Bank is a good counter-factual: The trends were similar before the blockade, diverged sharply during the blockade, and after the blockade was eased the trends begin converging again. This figure also underscores the importance of using the West Bank as a counter-factual: in

¹³Throughout the whole period, the West Bank had higher level of consumption.

2006 there was a dip in consumption but it was essentially identical in the West Bank and in Gaza. While the West Bank recovered almost immediately, consumption in the Gaza Strip didn't start converging back its historic trend until after the blockade was eased.

A final concern with using the West Bank as a counterfactual is that it is possible that the West Bank was also affected by the blockade. Since Gaza was a trade partner of the West Bank, it is possible that loss of access to that market led to higher prices, and lower growth in the West Bank as a result of the blockade. Both of these effects will bias my estimates of the losses in Gaza downward. If the West Bank was in competition with Gaza in other countries, the West Bank may have benefited from the elimination of this competition, and this too would have led to higher prices in the West Bank, but to lower growth.

While it is possible that the blockade on Gaza had some effect on the West Bank, it is unlikely that it was substantial. Total exports From Gaza in 2005-2006 was less than 3% of total imports into the West Bank in these years. Even if the West Bank were the only economy importing from Gaza, which it clearly was not, losing Gaza as a source for imports would have had a minimal effect on the West Bank.

It is even less likely that eliminating Gaza as a competitor had significant effects on demand for exports from the West Bank. The total value of goods exported from Gaza in 2005-2006 was about 11% of the value of the goods exported from the West Bank, and the overlap in the type of goods exported is limited. Moreover, exports during these years were 15% of GDP in the West Bank. Even if demand for West Bank exports increased by the full amount of the decrease in exports from Gaza, which is highly unlikely, it would have had a very small effect on growth in the West Bank.

To conclude, based on trends in prices and consumption, both before and after the blockade on Gaza, the West Bank seem like a good counterfactual for the Gaza Strip. The fact that the divergence in prices happened almost exclusively to tradeable goods supports the claim that the blockade is the cause for the divergence. Finally, it is also unlikely that the blockade had more than a negligible direct effect on the West Bank.

In order to use the West Bank as a counterfactual for the welfare calculation, I calculate for each household the CV's and Slutsky EV as follows: to calculate the increase in the cost of the consumption bundle (or of the utility level), I use the extra increase in its cost in Gaza relative to the increase in its cost in the West Bank. For the change in the value of household expenditure,

I use the change in the value of consumption of a household in Gaza relative to the change of a similar household in the West Bank.

Intuitively, this calculation describes how much money a household in blockaded Gaza would need to be as well off as it would have been (or buy the same bundle as it would have) if it was in the West Bank during these years. Essentially, the household is compensated not for the full increase in prices, but for the extra increase of the prices in Gaza relative to the price increases in the West Bank, and is also compensated for the change in the value of its consumption relative to the change experienced by a similar household in the West Bank.

5.3 Results: Total Welfare Losses and Distributional Effects

The results for the calculation described above are reported in Table 2. Using the West Bank as a counterfactual, the average Slutsky CV for a household in Gaza is equal to 28% of 2006 value of consumption, the average Hicks CV is 19%, and the average Slutsky EV is 17%.

There is substantial variation in the size of welfare losses across households. According to the Slutsky CV, the most affected 10% of households suffered a welfare loss more than 3 times larger than the least affected 10% of households. Using the Hicks CV, the most affected 10% of households suffered more than 6 times larger welfare losses than the least affected 10%, and according to the Slutsky EV, the most affected households suffered 4 times as much as the least affected households. These patterns lend strong support to the fundamental idea in trade theory that trade creates “winners” and “losers”, or at least bigger and smaller winners.

The relationship between international trade and inequality in developing economies is a topic of great interest.¹⁴ Having data at the household level enables me to gain some insight about the distribution of the welfare losses that resulted from the blockade on Gaza. I turn now to test the correlation of welfare losses and the level of expenditure, by estimating the following regressions:

$$CV_i^j = \alpha + \beta_1 EXP_i + \beta_2 Z_i + E_i$$

¹⁴See Goldberg and Pavcnik (2007) for a review of the empirical literature. On the theoretical side, the assumption of homothetic preferences, and its implications for trade models has been studied in Pablo Fajgelbaum, Gene M. Grossman (2011)

Table 2: Compensating Variation for Gaza 2006-2009, using the West Bank as a control group

	Mean	Median	Least affected 10%	Most affected 10%
	<u>Percent of 2006 expenditure</u>			
Slutsky CV	28%	27%	13%	42%
Hicks CV	19%	19%	5%	32%
Slutsky EV†	17%	17%	6%	24%
	<u>Shekels (per month)</u>			
Slutsky CV	531	382	142	989
Hicks CV	371	263	63	724
Slutsky EV†	384	315	65	704

Notes: †The Slutsky EV calculation is based on a sample of households from 2009, unlike the Hicks and Slutsky CV which are based on the 2006 sample. The Hicks CV is defined here as the increase in the income that will enable a household in blockaded Gaza to consume a bundle of consumption that is as good as the one it would have consumed if it was located in the West Bank. The Slutsky CV is defined here as the increase in the income that will enable a household in blockaded Gaza to consume the same bundle of consumption it would have consumed if it was located in the West Bank. The Slutsky EV is the amount a household in open Gaza is willing to pay to avoid being blockaded. Data on consumption is from the 2006 household expenditure survey, and data on prices is from the 2006 and 2009 household expenditure survey, and from the CPI data for both years.

and

$$EV_i^s = \alpha + \beta_1 EXP_i + \beta_2 Z_i + E_i$$

Where CV_i^j , $j \in \{h, s\}$, is the Hicks or Slutsky CV for household i expressed as a percentage of 2006 expenditure, and EV_i^s is the Slutsky EV for household i , also expressed as a percentage of 2006 expenditure. EXP_i is the natural log of total value of expenditure in 2006 by household i , and Z_i are household characteristics such as the number of persons in the household, and whether it is from a rural area, urban area, or a refugee camp. An important control variable for this regression is as the share of total expenditure that is spent on food. The reason it is necessary to control for food expenditure is that the Israeli authorities allowed some food items to enter the Gaza Strip even

during the blockade, and if poorer households spend a larger share of their income on food, this may lower their welfare losses relative to rich households.

The results of these regressions are reported in Table 3. The dependent variable in columns 1-2 is the Hicks CV, in columns 3-4 the Slutsky CV, and in columns 5-6 the Slutsky EV. In column 1 I control only for the share of total expenditure that is spent on food. There is a highly significant and positive correlation between the Hicks CV, when expressed as a share of 2006 level of expenditure, and the 2006 level of expenditure. The size of the coefficient suggest that a doubling of the value of 2006 expenditure, increases the Hicks CV by 3 percentage points, or a 15.7% increase on the average Hicks CV of 19%. As expected, large expenditure on food is associated with lower welfare losses. in Column 2, I also control for the total number of persons in the household, and for the type of locality it is in - urban, rural, or a refugee camp. The results are essentially unchanged.

Columns 3-4 replicate columns 1-2 but with the Slutsky CV as a dependent variable. The results are similar, but the coefficient on total expenditure is larger. The coefficient on the share of food out of total expenditure is also substantially larger than in the Hicks CV specifications. This is not surprising, since the Slutsky CV, which does not allow for substitution between goods, is more sensitive to the composition of the original consumption bundle.

Columns 5-6 report the results of the same regressions, but using the Slutsky EV as a dependent variable. There is still a significant negative correlation between 2006 expenditure and the welfare loss, but it is smaller than implied by both the Slutsky and Hicks CV. However, since the Slutsky EV is calculated for different sample of households than the other two measures, it is hard to compare between them.

Table 3: Compensating Variation and Total Expenditure

	Hicks CV	Hicks CV	Slutsky CV	Slutsky CV	Slutsky EV	Slutsky EV
Total Expenditure 2006	0.03*** (0.009)	0.03*** (0.01)	0.05*** (0.01)	0.04*** (0.01)	0.01*** (0.002)	0.01*** (0.002)
Food Share 2006	-0.20*** (0.04)	-0.20*** (0.04)	-0.28*** (0.05)	-0.30*** (0.05)	-0.06*** (0.02)	-0.05*** (0.02)
Number of Persons in the HH		0.001 (0.001)		0.004** (0.002)		-0.002*** (0.000)
Type of Locality	*	Yes	*	Yes	*	Yes
N	419	419	419	419	953	953

Notes: Expenditure is in logs. Type of locality: urban, rural, or a refugee camp. Food share is the share of items in groups 1-10 in the expenditure survey, which is the definition id the Palestinian Bureau of Statistics for food expenditure. Standard errors are in parenthesis. * = P-value < 0.1, ** = P-value < 0.05, *** = P-value < 0.01

To better understand the sources of the differences across households, I use the change in the cost of the household consumption bundle, or the change in the cost of its utility level, as the dependent variable in the regression. For each household, denote the difference in the cost of the pre-blockade consumption bundle when the prices changed to autarky prices as $\Delta e_j^s \equiv e(p^a, c^t) - e(p^t, c^t)$ ¹⁵, and the change in the cost of the pre-blockade welfare level as $\Delta e_j^u \equiv e(p^a, u^t) - e(p^t, u^t)$. The regression I estimate is:

$$\Delta e_j^j = \alpha + \beta_1 EX P_i + \beta_2 Z_i + E_i$$

for $j \in \{h, s\}$, and all other variables are as before. The results are reported in Table 4, and across all specifications they are very similar to the results from the regressions that used the CV as a dependent variable.

¹⁵Note that the Slutsky CV and the Slutsky EV both use $\Delta e_j^s \equiv e(p^a, c^t) - e(p^t, c^t)$, so unlike the previous set of regressions, this set of regressions only has two dependent variables, and not three.

Table 4: Changes to Cost of Consumption and Total Expenditure

Total Expenditure 2006	0.03*** (0.008)	0.03*** (0.01)	0.03*** (0.008)	0.03*** (0.01)
Food Share 2006	-0.23*** (0.04)	-0.21*** (0.04)	-0.23*** (0.04)	-0.23*** (0.04)
Number of Persons in the HH		-0.003* (0.001)		-0.0002 (0.001)
Type of Locality		Yes		Yes
N	419	419	419	419

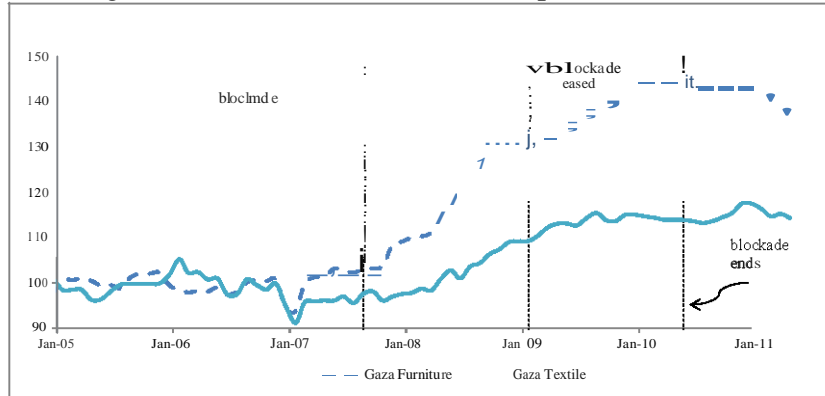
Notes: Expenditure is in logs. Type of locality: urban, rural, or a refugee camp. Food share is the share of items in groups **1-10** in the expenditure survey, which is the definition in the Palestinian Bureau of Statistics for food expenditure. Standard errors are in parenthesis. * = P-value < 0.1, ** = P-value < 0.05, *** = P-value < 0.01

The similarity in the results between the two sets of regressions is partly due to the fact that using a synthetic panel reduces the variation in changes to expenditure level between households. But, the results do suggest that there are substantial differences in welfare losses between households that are due to differences in their consumption bundles.

5.4 Model Based Prediction for Welfare Loss

It is not possible to implement welfare calculations based on comparative advantage models to the case of Gaza as in Bernhofen and Brown (2005) and Irwin (2005). The main difficulty is that the extensive use of imported intermediate goods, especially in exporting industries, makes the distinction between export goods and import goods less clear cut: Export goods from Gaza included in them a substantial imported component. As a result, most of the goods Gaza used to export increase in price during the blockade. Figure 8 shows the price changes in Gaza of two of its main export industries: furniture and textiles. Soon after the blockade was imposed, the prices of furniture and textiles in Gaza spiked - contrary to the naive interpretation of comparative advantage.

Figure 8: Prices of Gaza Main Exports, 2005-2011



Notes: Monthly price data is from the CPI files of the Palestinian Central Bureau of Statistics.

To get the welfare predictions of a more general set of trade models, I use the formula from Arkolakis, Costinot, and Rodriguez-Clare (2012) (henceforth ACR). This formula gives the welfare prediction of an important class of trade models, including Armington model, Krugman (1980), Eaton and Kortum (2002), and some variations of Melitz (2003), based on two sufficient statistics: the change in the share of total expenditure that is spent on domestically produced goods, and the elasticity of imports with respect to variable trade costs

$$W = \frac{\Delta \omega}{\epsilon}$$

Where W is the change in welfare, $\Delta \omega$ is the change in the share of domestic expenditure out of total expenditure, and ϵ is the elasticity of imports with respect to variable trade costs. Applying this formula to a very unbalanced economy is not straightforward. For a country that has a trade deficit, and assuming that deficits have to be repaid, the share of imports out of total expenditure may overstate the true benefits of trade. That said, I replicate the calculation ACR perform for the U.S using data from Gaza.

For the trade elasticity parameter, I use the range -5 to -10 for the elasticity of imports, the same range that ACR use, based on a survey by Anderson and van Wincoop (2004). For $\Delta \omega$ - the change in the share of total expenditure that is spent on domestic goods, I use the data from Gaza national accounts and trade statistics, to get the share of non energy expenditure that is spent on domestically produced goods. This number changed from 70.3% in 2006 to 93.5% in 2009. The result is a welfare loss of 2.9%-5.6%, which is

significantly less than the 17%-28% I find based on household consumption data.

Another way to clarify the gap between the results of the formula and what I observe in consumption patterns is to do the opposite calculation: how much does trade have to decline to lead to welfare losses equal to what I find based on consumption data in Gaza? This approach avoids many of the difficulties of applying the formula to Gaza. Even using the lowest level of elasticity (which leads to the highest loss of welfare), the share of import out of total expenditure would have to decline from 60% to 0% in order to produce a welfare loss of 17%, which is the lower bound for what I find for Gaza. In reality, the import share declined from 29.7% to 6.5%.

6 Production

The goal of this section is to document three facts about the adjustment of production in Gaza: the decline in labor productivity, the reallocation of workers between sectors, industries, and firms, and the changes to the distribution of firm size. Put together, these facts can help explain the magnitude of the welfare losses during the blockade.

6.1 Real Added Value per Worker

Ideally, we would like to measure changes to productivity as a “Sollow residual” at the firm level, i.e. the change in output of a firm that is not explained by the changes in labor, capital and inputs. However, data on the cost of capital in Gaza is not available at all, and data on wages in Gaza is only available at a very aggregate level. Moreover, the firm manufacturing and services surveys in Gaza are conducted as a repeated cross section and panel data is not available. I therefore measure value added per worker at the industry level, admittedly imperfect, but nonetheless informative measure of labor productivity.

I start with calculating the 2006 level of value added. I do that by subtracting total expenditure on inputs of all firms from the total revenue of all firms in that industry. I then divide this number by the total number of workers in the industry to get the nominal value added per worker of the average worker in the industry.¹⁶ To measure the change in value added in

¹⁶This is the same as calculating a weighted average of added value per worker over all

an industry, I use the Divisia method, as in Basu and Fernald (1997):

$$\Delta V A_i = \frac{\Delta Y_i - s_{m,i} \Delta m_i}{1 - s_{m,i}}$$

Where ΔY_i is the change in real output, Δm_i is the change to real inputs¹⁷, and $s_{m,i}$ is the share of total revenue that is spent on inputs - all measured at the industry level. As Basu and Ferland explain this measure can be thought of as a “partial Sollow residual, subtracting materials growth from output growth, weighted by the share of intermediate inputs in revenue”¹⁸. To get the change in value added per worker, I then divide the result by the change in the number of workers in the industry.

Table 5 presents changes to average real added value per worker and the total number of workers at an aggregate level, and separately for manufacturing and services in Gaza. The total decline was of 24%, while the total number of workers remained quite stable, declining by only 2%. However, the changes were very different between the manufacturing and the services sectors: the manufacturing sector experienced a decline of 39% in average real added value per worker, and a decline of 31% in total labor, while the services sector experienced only a 5% decline in average real added value per worker, and saw an increase of 27% in employment.

firms in an industry, using the number of workers as weights.

¹⁷Measuring changes to real inputs requires an industry specific input price index, which in turn requires on an input-output table, which does not exist for the Gaza Strip nor the West Bank. For the results I report here, I use an input price index I created using an Israeli input-output table. As a robustness check I also used a Vietnamese input-out table, and the results are qualitatively similar.

¹⁸For the share of inputs in total revenue, I use the average of 2006 and 2009, which is a discrete time approximation of the continuous time definition used here. However, it is noteworthy that for many industries this share remained fairly constant between 2006 and 2009, and at the most aggregate level - manufacturing as a whole and services as whole, the change in the share was less than 2 percentage points.

Table 5: Average Worker Productivity, and Number of Workers in Gaza by Sector 2006-2009

	ΔVA per worker	$\Delta Labor$
Manufacturing	-39%	-31%
Services	-5%	+27%
Total	-24%	-2%

Notes: Data is from industry and services surveys for Gaza in 2006 and 2009. Real added value in an industry is total sales in the industry minus total purchases of inputs in the industry. Change to value added is calculated using the Divisia method.

However, the measured decline in value added per worker can be the result of reallocation between industries, and not only of a decline in productivity within industries. If the bulk of the decline in value added per worker is the result of reallocation into industries which had lower value added (in 2006 prices), then productivity was not very affected. To decompose the effects of reallocation between industries and reduced productivity within industries. I decompose the total decline in value added per worker into a “reallocation effect” and a “productivity effect”.

The method of decomposing the decline in average productivity to the effect of productivity decline and the effect of reallocation between industries is as follows: Let $a_{i,t,j}$ denote the added value per worker in activity i , in year t , in firm j . Aggregating up, the average added value per worker in activity i , in year t is then $a_{i,t} \equiv \sum_j a_{i,t,j} \times w_{i,t,j}$, where $w_{i,t,j}$ is the share of workers in firm j out of total number of workers in year t , in activity i . Averaging over all activities, $a_t \equiv \sum_i a_{i,t} \times w_{i,t}$ is the economy wide average added value per worker in year t . The change in the economy wide added value per worker between 2006 and 2009 can then be expressed as:

$$a_{2009} - a_{2006} = \sum_i w_{i,2009} \times a_{i,2009} - \sum_i w_{i,2006} \times a_{i,2006}$$

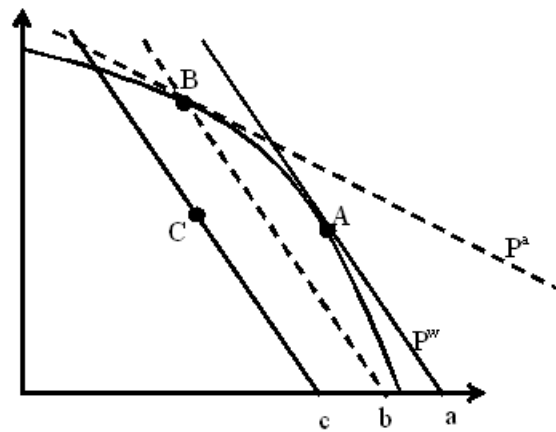
Adding and subtracting $\sum_i w_{i,2009} \times a_{i,2006}$, and rearranging, the total change can be written as a simple sum of two terms:

$$a_{2009} - a_{2006} = \sum_i w_{i,2009} \times (a_{i,2009} - a_{i,2006}) + \sum_i a_{i,2006} (w_{i,2009} - w_{i,2006}) \quad (1)$$

The first term can be interpreted as the intensive margin change, or the productivity change effect. Intuitively, this term answers the following question: if there was no reallocation of workers between activities, but within each activity added value per worker changed as it did in the data, what would have been the decline in the average added value per worker in the economy? Similarly, the second term can be interpreted as the change along the extensive margin, or the reallocation effect. It answers the complementary question to the one just stated: if there were no changes to added value per worker within each activity, but reallocation of workers between activities was as it was in the data, what would have been the decline in the measured real added value per worker?¹⁹ Figure 9 describes a two goods version of this calculation. When the relative price faced by domestic producers changes from P^w to P^a , their new optimal point moves from A to B. If they move all the way to point B, there will be a decline in the measured value of production evaluated according to old prices, P^w , from point a to point b. If the PPF in the relevant range is not too concave, the distance a-b is the “reallocation effect”, and by itself it does not represent a decline in productivity. If the move to autarky also moves the PPF itself inwards, production may be at point like C, and the total decline in output, measured in the old prices, will be the distance a-c. The distance b-c is the “productivity effect”.

¹⁹One attractive feature of this decomposition is that using shares of total labor in each activity (as opposed to absolute numbers) sidesteps changes to overall employment. However, it is important to note that total combined employment in manufacturing and services declined only by 1.3%.

Figure 9:



The results of this decomposition are reported in Table 6. Column 1 reports the results of the decomposition when performed at the finest level of disaggregation that the data allows: 4 digits (isic.3) for manufacturing and 2 digits for services. This gives a total of 72 economic activities in which there was a positive level of employment in both 2006 and 2009, 11 of which are classified as services, and 61 as manufacturing. The key result is that the productivity effect was much larger than the reallocation effect. Out of a total decline of 23%, the productivity effect explains 90% while the reallocation effect explains only 10% of the total decline.

A few industries experienced a very large change in added value per worker, and so raise a concern about measurement error. Column 2 repeats all the calculation of column 1, but excluding all economic activities which experienced more than a four fold change in their productivity. This reduces the number of activities in the sample from 72 to 65. The overall decline is five percentage points smaller, and the share of the total decline that is explained by productivity change is also a bit lower, with 88% of the total decline explained by the within industry change, relative to 90% in the full sample. However, in either case, the change of productivity within industries explains much more of the total decline than the reallocation of workers does.

Because of the large difference between manufacturing and services with respect to productivity changes, in columns 3 and 4 I repeat the calculations of column 1 and 2, but limit the sample to include only manufacturing. The total decline in added value per worker in manufacturing is much larger

Table 6: Decline in Added Value per Worker (single deflator) in Gaza, 2006-2009

	(1) full sample	(2) excluding outliers	(3) only manufacturing	(4) only manufacturing - services/ excluding outliers	(5) manufacturing
Total decline (% of 2006)	23%	18%	39%	38%	24%
Productivity effect (% of total decline)	90%	88%	85%	84%	87%
Reallocation effect (% of total decline)	10%	12%	15%	16%	13%
# of Activities	72	65	61	54	2

Notes: Real added value per worker in an industry is the sum of the industry sales minus its purchases of inputs, divided by total employment. Added value in 2009 is deflated by the increase of the industry main output price. Data is from industry and services survey for Gaza 2006 and 2009.

than the economy average - a 39% decline in manufacturing, and a 23% decline for the economy as a whole. The productivity effect still much larger than the reallocation effect, and explains 85% of total decline. Removing the outliers makes little difference. In column 5 I report the results for the same calculation when they are done at the most aggregated level - treating all firms in the sample as either belong to “services” or to “manufacturing”. Interestingly, the results are very similar to the results when using the most disaggregated analysis.

To conclude, an important effect of the blockade seem to have been a large decline in productivity as measured by value added per worker. Part of the decline is explained by the reallocation of workers from industries with high value added to industries with lower value added, especially from manufacturing to services, but between 85%-90% of the decline is explained by a decline in productivity within industries.

6.2 Workers Reallocation

While the Gaza economy could not fully adjust to the elimination of access to world markets, substantial reallocation of workers did take place. The pattern of the reallocation is consistent with the decline in the manufacturing sector relative to the services sector. Moreover, workers were reallocated also within manufacturing and within services.

To further understand the patterns of reallocation, I run the following regression:

$$\Delta L_i = \alpha + \beta_1 k_i + \beta_2 EX_i + \beta_3 IM_i + \beta_4 Z_i + E_i$$

Where ΔL_i is the change to the log number of workers in industry i , k_i is capital intensity of industry i , measured as the ratio of the value of non-building capital to the number of workers. Since Gaza does not have heavy industry, capital can be thought of as another type of imported input. EX_i is the share of total output in the industry that is exported, and IM_i is the share of total value of inputs in the industry that is being imported, Z_i is a vector of controls, including total sales and total number of workers in 2006, and a dummy that takes the value of 1 for industries in the manufacturing sector.

The surveys I use report for each firm the share of inputs that is imported directly by the firm. which can then be aggregated to the industry level.

However, a true import dependency measure must take into account the imports of upstream industries. Consider for example the textile industry in Gaza. In 2006, the industries of “manufacture of wearing apparel” (isic.3 code 1810) and “manufacture of made-up textile articles, except apparel” (isic.3 code 1721) purchased over 95% of their inputs domestically. However, the “spinning of textile fibers” industry in Gaza (isic.3 1711) imported 94% of its inputs. As this example makes clear, the true dependency on imported inputs may depend on the share of imported inputs of upstream industries. To take into account the import share of upstream industries, it is necessary to use an input-output table, which Gaza does not have, so here too I am using the Israeli table.

The results of this regression are presented in table 7. In column 1 and 2 I exclude the food industry, since food was allowed into Gaza, even if in a limited way. The coefficients show a reallocation away from industries that use imported inputs, away from industries that export, and away from capital intense industries, even when controlling for the services-manufacturing difference. In columns 3 and 4 I exclude small industries with less than 5 active firms in either year, and in column 5 I use the full sample, including the food industry. The results in all of these specifications are similar, except that when the food industry is included in the sample, the coefficient for imports share is positive (though not statistically significant). In column 6 I use more disaggregated data, which increases power, but for which I could not calculate import shares of inputs in upstream industries²⁰.

In a comparative advantage framework, access to world markets changes the composition of production, especially in manufacturing, between export oriented and import competing goods. The pattern of reallocation in Gaza suggest that a large part of the manufacturing in Gaza depended on access to world markets, and lacking this access, it employed less workers, which were reallocated to services, and experienced a substantial decline in added value per worker. Moreover, even within manufacturing (and within services), there was substantial reallocation away from industries that use imported inputs, including capital, which is a type of imported input in Gaza.

²⁰The input output tables have only 26 industries for which Gaza had positive employment in both 2006 and 2009

Table 7: Changes to employment by industry in Gaza, 2006-2009

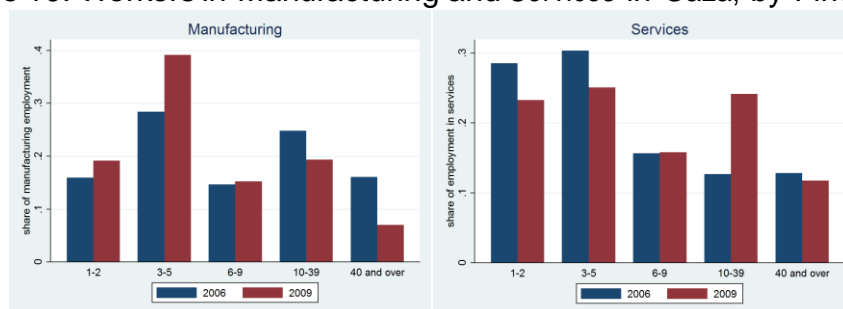
	(1) Excluding food sector	(2) Excluding food sector	(3) Excluding activities with <5	(4) Excluding activities with <5 firms	(5) Full Sample	(6) Disaggregated sample
Share of inputs imported	-1.17* (0.60)	-0.86 (0.64)	-1.43** (0.61)	-1.08 (0.65)	0.13 (0.64)	-0.89** (0.43)
Share of output exported	-3.15** (1.39)	-2.60* (1.43)	-2.93** (1.35)	-2.34 (1.40)	-3.65** (1.70)	-2.95*** (0.91)
Capital intensity	-0.52*** (0.12)	-0.53*** (0.12)	-0.52*** (0.13)	-0.52*** (0.12)	-0.34** (0.13)	-0.31*** (0.12)
Manufacturing dummy	N	Y	N	Y	Y	Y
N	25	25	23	23	26	42

Notes: Data is from the industry and services surveys of 2006 and 2009. Dependent variable is the change in the log number of workers. All regressions include controls for total sales and total number of workers in 2006. * = P-value < 0.1, ** = P-value < 0.05, *** = P-value < 0.01.

6.3 Firm Size

The distribution of firm size in the manufacturing sector changed substantially following the imposition of the blockade, reducing the share of large firms. Figure 10 shows the share of workers employed in manufacturing and services by firm size.

Figure 10: Workers in Manufacturing and Services in Gaza, by Firm Size



Notes: Data is from the Industry Survey and Services Survey for 2006 and 2009, conducted by the PCBS.

The share of employees in the largest manufacturing firms - firms employing 40 or more workers, declined by 57%, from 16.1% to 7.0%, and the share of the smallest firms, with five workers or less, increased from 43% to 58%. The collapse of large firms was most evident in the textile industry: in 2006, 1,511 people worked in firms employing 10-39 workers, and 1550 worked in firms employing 40 workers or more. In 2009, the parallel numbers were 90 and 139, a total decline of 92%. At the same time, the number of workers in small textile firms, employing less than 10 workers, saw a relatively modest decline of only 13%. In the services sector, the share of workers in large firms, employing 40 workers or more, declined only marginally, from 12.8% to 11.7%. However, unlike the case of manufacturing, the share of small firms, employing less than 10 workers, also declined, from 74% in 2006 to 64% in 2009, and medium size firms, with 10-39 workers increased their share at their expense.

This change may have contributed to the decline in labor productivity in manufacturing. Data from Gaza suggest that larger firms had significantly higher labor productivity before the blockade. Table 8 reports the results of

the following regression:

$$\frac{VA_i}{L_i} = \alpha + \beta_1 L_i + \beta_2 Z_i + E_i$$

where the dependent variable is log of value added per worker for firm i , L_i is the log of the number of workers in firm i , and Z_i is a vector of control variables, including a dummy for the services sector, dummies for the textile and furniture industries that had a disproportional number of large firms, and a measure for capital intensity. The results suggest that prior to the blockade, a doubling of the firm labor force is associated with an increase is 13% in the value added per worker, and 27% when the sample is limited only to manufacturing.

Table 8: Labor Productivity and firm size in Gaza before the blockade

	Full Sample	Manufacturing Only
# Workers	0.13** (0.06)	0.27*** (0.06)
Services Dummy	-0.29** (0.13)	*
Capital Intensity	0.007 (0.004)	0.05*** (0.01)
N	1,448	870

Notes: Data is from the industry and services surveys of 2006 and 2009. The dependent variable is value added per worker. All regressions include dummies for the textile and the furniture industry. * = P-value < 0.1, ** = P-value < 0.05, *** = P-value < 0.01.

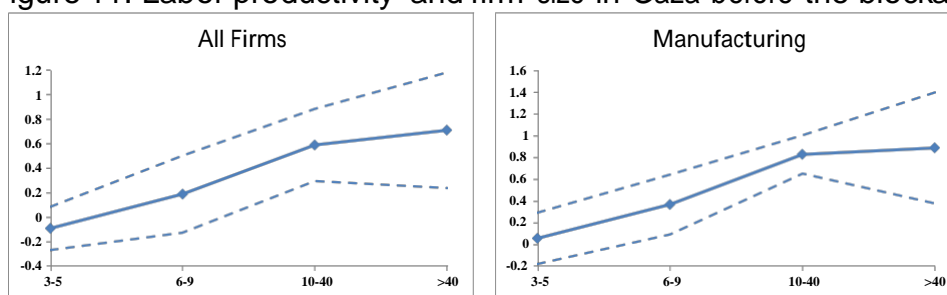
Figure 11 shows the coefficients on the β 's from a similar regression, with dummies for firm size:

$$\frac{VA_i}{L_i} = \alpha + \sum_j \beta_j DL_{j,i} + \gamma Z_i + E_i$$

where $DL_{j,i}$ is a set of dummy variables for firms with 3-5 workers, 6-9 workers, 10-39 workers, and more than 40 workers, and the omitted category is firms with less than 3 workers. The results suggest a monotone relationship

between size and labor productivity. Moreover, it is the largest firms that have substantially higher labor productivity.

Figure 11: Labor productivity and firm size in Gaza before the blockade



Notes: Data is from the Industry Survey and Services Survey for 2006 and 2009, conducted by the PCBS. Each point is the point estimate of the coefficient on a dummy for firms of that size in the regression $\frac{VA_i}{L_i} = \alpha + \sum_j \beta_j DL_{j,i} + \gamma Z_i + E_i$. Firms with less than 3 workers are omitted category. the Dashed lines are 95% confidence intervals.

The direction of causality between size and productivity can go both ways, and this affects the interpretation of the results for Gaza. If large firms are more productive because of economies of scales, that the fact that firms became on average smaller during the blockade was a cause for a decline in productivity. If, however, more productive firms tend to grow more, then when the size distribution changes for some exogenous reason, it need not affect productivity. Since the data on firms is not a panel, it is not possible to determine if large firms exited, or if all firms became smaller. Future research will have to address this issue in more detail.

7 Conclusion

What can the blockade on the Gaza Strip teach us about the gains from trade?

The first lesson is that for a small economy, the short run cost of being removed from world markets may be substantially larger than what standard models predict. The decline of welfare in Gaza, as calculated based on expenditure survey, was at least four times larger than the predictions of standard trade models. Moreover, the costs of the blockade on Gaza were

not borne equally: Wealthier households suffered disproportionately more, and that because of the composition of their consumption bundle.

A second lesson is that access to world markets did not only allow the Gaza economy to better allocate its factors of production, it also greatly increased their productivity, especially in manufacturing. When access to world markets was eliminated, 39 out of 61 manufacturing industries in Gaza, which employed 92% of workers in manufacturing before the blockade, experienced a decline in workers productivity. The fact that a large part of workers reallocation was from manufacturing and into the services sector is further evidence to the dependency of the Gaza economy on imported inputs.

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