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Effects of violent political conflict on the supply, demand and fragmentation of fresh food markets

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Abstract

Violent political conflict has been documented to have comprehensive adverse effects on economic activity and, thus, substantially harm social welfare. As conflict escalations are often reported to fragment economic space, we suggest an empirical framework which allows for estimating changes in the size of markets often split by frontlines. This approach uses a differentiated goods oligopoly model to separate effects of conflict intensity on consumer demand, costs of trade, market size, and market structure. We combine daily sales of apples in Hebron - one of the focal points of the Israeli–Palestinian conflict - and variables quantifying complementary aspects of conflict intensity. Conflict is found to suppress demand and affect competition more significantly than it increases costs of trading. Simulations indicate a 15% reduction in total daily consumption during conflict of high intensity while a pacification would yield a 20% welfare gain. This empirical framework allows disentangling the effects of conflict on food markets. The results suggest that relief policies should consider alleviating effects of fragmentation of economic space, e.g., by ensuring humanitarian corridors.

Keywords Changes in market size · Conflict · Differentiated goods · Economic space · Food demand · Fresh food marketing · Israeli-Palestinian conflict · MENA · Palestine

JEL D74 · L11 · L13 · L66 · Q11

1 Introduction

Violent political conflict is a widespread phenomenon in the developing world (World Bank 2011). Blattman and Miguel (2010) comprehensively review the state of the art of research on economic consequences and causes of conflict. They stress that "micro-level analysis and case studies are also crucial to decipher war's causes, conduct, and consequences" (Blattman and Miguel 2010, p. 3). In those countries heavily affected by violent political conflict, large parts of the population are poor and food purchases account for significant shares of household expenditures (Aitchison and Brown 1954). Thus, violent conflict often substantially impairs the availability, access and stability dimensions of the Right to Food (World Bank 2011; EC-FAO 2008). We focus on analysing consequences of conflict on economic and physical access to food, that is, the second dimension of food security (EC-FAO 2008, p. 1). We assess implications for economic and physical access to food as this is one of the core aspects often being reported to be impeded in during conflict escalations causing transitory food insecurity.

Existing research, such as the one conducted, for example, in the framework of Microcon (2018), takes a broad and interdisciplinary social-science perspective without zooming in on food markets in particular. We add to the limited recently emerged literature that analyses micro-economic effects of

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conflict on food demand and supply acknowledging the role the food economy plays in the countries affected where food accounts for relatively more in household expenditures (Seale et al. 2003).

We contribute to closing this gap by disentangling the effects of violent conflict into four aspects of which one of them is changes in market size. This aspect is of great importance as movement restrictions and physical threats often fragment markets by preventing market access in areas subject to escalations of political violence (WFP 2009; UNCTAD 2014).

This analysis contributes to the literature in several ways. Although selected effects of violent political conflict on food markets have been studied by a small literature (e.g., D'Souza and Jolliffe 2013; Ihle and Rubin 2013), differentiated goods oligopoly pricing and demand models (Berry 1994; Berry et al. 1995) have not been used so far for decomposing the impact of conflict intensity on food demand and pricing. We tailor the model to account for food markets becoming temporarily fragmented due to conflict as such transient partitioning of economic space is frequently being reported by international organizations.

As consumers in low-income countries spend on average a higher share of their total food expenditures on fruits and vegetables than consumers in high-income countries (Seale, Regmi and Bernstein 2003, Table 3), we focus on fruits. In particular, we analyse daily quantities and prices of apples traded in the Hebron wholesale market between May 2007 and September 2010. We measure complementary aspects of conflict intensity by various variables. The analysis is concluded by assessing welfare implications of selected conflict intensity scenarios.

Our framework allows separating impacts of conflict on consumer demand, marginal costs of marketing, wholesalers' conduct and market competitiveness, and the potential size of the market (e.g., Berry 1990). Under some circumstances, conflict provides an excellent exogenous mechanism by which supply behaviour can be identified. This decomposition into various components facilitates comprehending and quantifying economic consequences of violent conflict on food markets as well as informing relief missions carried out by local or international organizations. The quantification of various elements of conflict influence may enhance the efficacy of such missions by guiding efforts to alleviate the aspects of economic live of civilians most affected. For example, if market logistics are found to be most severely impeded, then aid policies can be tailored to focus on subsiding transportation costs or arranging UN backed transportation. But if the main consequence of conflict is found to be non-competitive conduct of traders, then policies such as temporal price caps may be a more suitable choice for relief.

The paper is organized as follows. Section 2 provides a concise review of the current literature studying economic effects of conflict. Section 3 highlights key aspects of the institutional background of the Israeli-Palestinian conflict and the induced fragmentation of economic space. Section 4 presents core aspects of the empirical framework while section 5 summarizes the datasets analysed. Section 6 presents the estimation and simulation results. Section 7 concludes and discusses extensions of the paper. This main text presents key aspects in order to hold the analysis concise. Comprehensive ancillary information for each of its sections – including detailed results of economic tests and elaborated argumentations – is provided in the Electronic Supplementary Material.

2 Literature review

Markets of many commodities have been studied using a discrete-choice framework with product differentiation based on a random utility (e.g., Berry et al. 1995; Verboven 1996). This method has increasingly been applied to processed food commodities (e.g., Nevo 2001), but to the best of our knowledge, this paper is a first attempt to employ this methodology to study fresh food markets in the context of violent political conflict in developing economies.

Arias et al. (2019) examined the effects of conflict on agricultural activities of farmers in Columbia. Rockmore (2015) studied how livestock portfolio and the choice of crops are affected by conflict in Uganda. In both cases it was reported that the risk of violence diverted farmers' decisions towards low-return activities. Focusing on the 2014 Gaza conflict, Brück et al. (2019) found that households' food security was not directly affected by the conflict but households' resilience capacity deteriorated. As more micro-level data such as in these studies becomes available, Martin-Shields and Stojetz (2019) provide a detailed analysis on the sources of and remedies for endogeneity in the empirical analysis of the relationship between food security and conflict.

Violent political conflict such as (civil) war or terrorism have been found to create negative economic effects (Murdoch and Sandler 2004, Abadie and Gardeazabal 2008, Cerra and Saxena 2008, Douarin et al. 2012, and others). For example, Abadie and Gardeazabal (2003) study the economic implications of political conflict in the Basque region of Spain. They find that terrorism reduces the per capita GDP in the Basque region relative to neighbouring regions. Ali and Lin (2010) find that civil wars significantly raise the average cost of food.

One specific conflict to which the economic literature has devoted much attention is the one between Israel and the Palestinians. Its economic effects have been studied by Fielding (2003); Eckstein and Tsiddon (2004); Zussman and Zussman (2006); Berrebi and Klor (2006); Ihle and Rubin (2013), and others. For example, Benmelech et al. (2010) estimate the macro-economic effect of Palestinian suicide

attacks against Israeli targets on the Palestinian economy. They find that suicide attacks cause a significant increase in unemployment rates and a significant decrease in wages, as well as a decrease in the number of Palestinian workers employed in Israel. Ihle and Rubin (2013) study the micro-economic effects of movement restrictions on price dynamics of bilateral fruit and vegetable trade between Israel and the Palestinian Authority. They find that such restrictions increase the volatility of food prices and thus harm welfare.

Recent literature on the effects of violent conflict on preferences indicates that it has profound impact on shaping preferences and behaviour. This yields significant implications for recovery and economic development as preferences determine levels of consumption, saving and investment. Callen et al. (2014) investigate the relationship between conflict and risk preferences in Afghanistan. They show that individuals exposed to violence exhibit increased preference for certainty. The intensity of violent events is found to be positively correlated to the degree of risk aversion. Cecchi et al. (2016) show that exposure to conflict reduces risk aversion and increases altruism resulting in increased in-group cooperation as well as out-group antagonism. In the context of the Israeli-Palestinian conflict, Gould and Klor (2010) study the effects of terror attacks on the preferences of the Israeli electorate while Shayo and Zussman (2011) study the effects of conflict on judicial in-group bias.

3 Institutional background

In order to understand the challenges of the empirical analysis, we now elaborate on institutional aspects of the Israeli-Palestinian conflict (for a comprehensive overview, see Tinnes 2014 and Tinnes 2018). Hebron is a city with a significant history of violent incidents caused by the Israeli–Palestinian conflict (Clarke 2000). Its inhabitants have been strongly affected by escalations of political violence in recent decades. The city hosts the largest wholesale market in the West Bank serving about 550,000 residents (PCBS 2013). The entire market consists of some 50 individual wholesale trader shops which trade about 100 types of fruits and vegetables in total. Few of these goods are locally grown due to the arid environment, most of them are brought there from the Jordan valley in the Northern West Bank or imported from Israel, Jordan or other countries (WFP 2009, p. 44).

Households in Hebron spend the highest income shares on food in comparison to all Palestinian cities. In 2011, the average household in Hebron spent on average 39% of total monthly expenditures on food while the Palestinian average amounted only to 33% (PCBS 2012). While Palestinian households of at most 3 members spend on average 35% of their expenditures on food, this share rises to more than 43% for households with more than 10 members (PCBS 2012). Similarly, expenditures on fruit and vegetables account for 7.1% of household expenditures (PCBS 2012).

As households' own food production is among the lowest in the Palestinian areas, they heavily depend on food purchases. Consequently, food price increases are of substantial importance for households in Hebron due to households' high economic vulnerability as food price shocks might yield in severe expenditure shocks. As they also spend relatively larger expenditure shares on food, livelihoods of the residents of this region are extremely sensitive to the development of the conflict.

In the Palestinian context apples are not considered a luxury food but play the most important role in household expenditures for fresh fruit. FAO (2005, p.3 and p. 17) finds that the dietary energy supply in the Palestinian Authority is mainly met on the basis of fruit and vegetables (703 g/day) and cereals (364 g/day). The monthly consumption of apples of the average Palestinian household amounts to 5 kg which corresponds to about one third of the monthly quantity of bread consumed (17.6 kg, PCBS 2011a, Table 3.1). The average monthly household expenditures calculated based on PCBS (2011a, Table 3.1) and PCBS (2011b, issue 2010, Table 9) are 27.5 NIS for apples, 22.9 NIS for bananas and 13 NIS for water melons. Thus, monthly expenditures for apples account in the Palestinian context for about 40% of the expenditures for bread. This evidence indicates the relevance of apples for food expenditures and thus the economic access to food (EC-FAO 2008) of the civilian population that is living subject to the conflict. As apple supply depends heavily on imports from Israel, trade flows but also access to market places are potentially highly challenged by conflict escalations (WFP 2009).

Escalations of violence have been reported to lead to temporary fragmentation of economic space in the West Bank and Gaza (Akkaya et al. 2008; OCHAoPt 2011; UNCTAD 2014). This fragmentation is caused by movement between and within cities being temporarily restricted by the attempts of the Israel Defence Forces (IDF) to control the situation (EC-FAO 2007). Conflict-related restrictions on human movement or frontlines trench large cities or cut them off from their surrounding regions (WFP 2009; p. 17; OCHAoPt 2011, p. 2; OCHAoPt 2017). Road gates will be closed, temporary checkpoints will be erected, and curfews will be imposed. These measures, together with the presence of armed and fighting forces in and around large cities, will considerably suppress economic activity for a number of days so that the economic size of the market which equals in peace times the entire city including its surroundings is likely to be temporarily split off. Both, the political science as well as the economic literature agree that conflict incidences and intensities in the context of the Israeli-Palestinian conflict are exogenous to food prices as the cause of this conflict is the struggle for political and geographic control.

Violent political conflict in such a context can thus impact consumer and trader behaviour in several ways. Conflict creates economic costs, uncertainty and disincentives for economic agents (Blattman and Miguel 2010). Food trade is a process involving several stages and is being carried out across geographic space. Thus, food supply and demand may become heavily impaired by conflict and markets can become fragmented (Woertz 2017; Veninga and Ihle 2018). Front lines through cities, curfews and movement restrictions may prevent farmers, traders and consumers to reach their areas of economic activity and to do business. Conflict might change purchase decisions and preferences (Callen et al. 2014) as well as marginal costs of marketing (WFP 2009).

4 Modelling demand and pricing under violent conflict

For being able to decompose economic consequences of violent conflict, we modify the logit demand model of Berry (1994) to explicitly account for the effects on demand, marginal costs, market competitiveness and potential market size. We implement this modified framework to model the transactions of apple varieties traded in the wholesale fruit and vegetable market of Hebron. We focus on sales of wholesalers to their clients, who can be either retailers or consumers. In our study, an observation consists of the aggregate daily transactions per apple variety, that is, total daily sales and the daily average price of apple variety $j \epsilon \{1, \ldots, V\}$. The number of wholesale traders at the Hebron fruit and vegetables market is very limited. Trader shops are spatially very closely located to each other; thus, traders are plausibly assumed to be price setters. Abramzon (2017), Dobers et al. (2018) and WFP (2009, pp. 43–45) document actually existing oligopolistic market structures. Thus, traders are plausibly assumed to maximize their short-run profits given the prices of other traders in the market. This suggests that prices follow a Nash-Bertrand equilibrium pricing game that results in an oligopolistic pricing rule (e.g., Verboven 1996; Fershtman and Gandal 1998).

Marginal costs are modelled as linear functions of observable characteristics of each variety and cost indicator variables W_{jt} , among them input prices, as well as unobservable cost characteristics ω_{jt} . As for demand, marginal costs of variety j on day t can be affected by a set of conflict variables C_t as well. Therefore, ω_{jt} may also consist of unobservable conflict-related cost attributes. This yields the following estimable pricing equation (for the detailed derivations, see the Electronic Supplementary Material):

$$P_{jt} = W_{jt}\gamma + C_t\eta + \frac{1}{\alpha\left(1-S_{jt}\right)} + \omega_{jt} \tag{1.1}$$

where γ and η are coefficients and $1/\alpha(1-S_{jt})$ is the mark-up term to be estimated.

We modify the estimable demand equation $\ln\left(\frac{S_{jt}}{S_{0t}}\right) = X_{jt}\beta - \alpha P_{jt} + Z_t\lambda + \xi_{jt}$ (A3.1 derived in section 4 of the Electronic Supplementary Material).

and (1.1) to account for potential market fragmentation. Note that $S_{0t} = \frac{M_t - \sum_{j\in V} q_{jt}}{M_t} = 1 - \frac{\sum_{j\in V} q_{jt}}{M_t}$ is the market share of the outside good, $j = 0$, which is available for consumption instead of all apple varieties j in the market. Substitute the definitions of the market share S_{jt} of the j-th variety and S_{0t} into the demand Eq. (A3.1) to obtain

$$\ln\left(\frac{S_{jt}}{S_{0t}}\right) = \ln\left(\frac{q_{jt}}{M_t - \sum_{j\in V} q_{jt}}\right) = X_{jt}\beta - \alpha P_{jt} + Z_t\lambda + \xi_{jt} \tag{1.2}$$

and rearrange to get

$$\ln\left(q_{jt}\right) = \ln\left(M_t - \sum_{j\in V} q_{jt}\right) + X_{jt}\beta - \alpha P_{jt} + Z_t\lambda + \xi_{jt}. \tag{1.3}$$

To model the influence of conflict intensity on the potential market size, M_t has to be multiplied by the term $\left(1 + \mu D_t^{conf}\right)$ so that market size $M_t^{conf} = \left(1 + \mu D_t^{conf}\right)M_t = M_t + \mu D_t^{conf} M_t$ is obtained. Thus, the market size during conflict escalations M_t^{conf} may be smaller or equal to the size of the market during peace times M_t. The dummy variable D_t^{conf} signals the days on which conflict escalation in Hebron occurred. M_t^{conf} affects demand elasticities as well as mark-ups and, thus, the market structure (for details see Table A.2 in the Electronic Supplementary Material). The coefficient μ measures the magnitude of this market fragmentation effect. In consequence, we obtain the following estimable system of demand and pricing equations:

$$\ln\left(q_{jt}\right) = \ln\left(\mathrm{M}_t^{conf} - \sum_{j\in V} q_{jt}\right) + X_{jt}\beta - \alpha P_{jt} + Z_t\lambda + \xi_{jt} \quad \text{and} \tag{2}$$

$$P_{jt} = W_{jt}\gamma + C_t\eta + \frac{1}{\alpha\left(1 - \frac{q_{jt}}{M_t^{conf}}\right)} + \omega_{jt}, \quad M_t^{conf} = \left(1 + \mu D_t^{conf}\right)M_t. \tag{3}$$

We use instrumental variables methods to account for the potentially endogenous prices and quantities in our empirical model.

Our main identification assumption is that conflict intensity possibly affects demand and pricing of food while not vice versa, that is, the conflict variables are exogenous in the demand Eq. (2) and in the pricing Eq. (3). There is ample consensus in the literature confirming from a macro as well as from a historical perspective that the Israeli-Palestinian conflict is about land and political control and not about food prices. Thus, the intensity of this particular conflict is plausibly not affected by food price levels; or in other words, a deviation of the price or the quantity of a specific apple variety from their means does not affect the variables quantifying conflict intensity.

This assumption may not hold for other conflicts in which political conflict is plausibly caused or fuelled by the dissatisfaction about food expenses. The literature has found empirical evidence that causality between food prices and intensity of violent conflict in general may run in both directions (Martin-Shields and Stojetz 2019). However, there is ample consensus that the Israeli-Palestinian conflict belongs to that class of conflicts which are caused by fundamental political dissent about political control instead of dissatisfaction about people's food expenses.

Both the economics as well as the political science literature agree that dissatisfaction with food price does not play any role in causing conflict escalations in the context of this particular conflict. Bar-Tal (1990a, 1990b), Falah (1996) or Tessler (2009) elaborate on its reasons, history and dynamics from a political science perspective. Jaeger and Paserman (2008, p. 1592) directly assess the dynamic pattern of violence and find that Palestinians "deliberately choose to randomize the timing of their response to Israeli violence". The only causal relation they are able to robustly confirm is that Palestinian violence causes Israeli violence but not vice versa. Jaeger and Paserman (2006) establish that the Israeli response depends on which Palestinian group has committed violent acts first – again, food playing no role. Zussman and Zussman (2006, p. A194) suggest to interpret the Second Intifada "as a form of economic warfare" emphasizing the relevance of violence escalations for stock prices in Israel – again with no mention of any potential causal role of food prices.

Consequently, the extent to which our results are transferable to other political conflicts depends on their specific food expenditure and food marketing context. Our approach is transferable to the analysis of conflict contexts in which food prices are plausibly not affecting conflict intensity.

5 Data

We use a unique set of trade transactions at the Hebron wholesale fruit and vegetable market (HWM 2011, see ARIJ 2018 for institutional details). These consist of the daily average prices and total quantities of daily transactions of all apple varieties traded in the market. From qualitative interviews with Palestinian traders, we know the quality level and the origin of each variety considered. Our dataset consists of 3162 observations of aggregated daily transactions of 13 apple varieties. The observations cover the period between May 2007 and the end of September 2010, corresponding to 932 days. This is combined with a comprehensive set of variables quantifying complementary aspects of the intensity of conflict at daily level based on conflict-caused fatality counts collected and published by B'Tselem (2013a).

The varieties differ in a range of attributes based on characteristics, quality or consumer perception. The literature in horticultural sciences and consumer studies has established that the variety of an apple matters for consumers' purchases (e.g., Yue and Tong 2011). We follow Nevo (2001) in using one dummy variable for each of the apple varieties.

Based on a comprehensive dataset of daily conflict-caused fatality counts (B'Tselem 2013a) as well as closures within the West Bank, that is, effective restrictions on the movement of Palestinians (B'Tselem 2013b), we develop a number of indices measuring differing aspects of conflict (Table 1). The conflict variables are proxies for differing degrees of political violence potentially affecting local food markets in Hebron. We follow Rubin and Ihle (2017) for constructing and including variables into the analysis that quantify various complementary conflict intensity dimensions and time horizons.

Variables C1 to C11 in Table 1 measure conflict intensity on various geographical scales (for details see section 5 of the Electronic Supplementary Material). Conflict escalations in regions of differing distance and of more or less widespread character might affect economic agents in Hebron differently. We also consider the local conflict level in Hebron which is likely to have the most severe effects. In addition, conflict escalations in the West Bank and/or the Palestinian Authority in general are also likely to result in local effects in Hebron, as it is the economic centre of the West Bank. Lastly, if the conflict leads to fatalities in Israel, security measures on the West Bank and Gaza will be immediately enforced by the IDF. This is likely to also lead to local effects in Hebron food markets. The conflict variables constructed are mostly based on either fatality numbers of both Palestinians and Israelis, or fatality numbers of Palestinians in various geographical regions.

Table 2 presents the weighted-in-sales average prices and the average daily apple sales on days of conflict and without conflict – conflict being defined by variable C13. The daily total quantity of apples traded is reduced by 25% during days of conflict indicating that conflict suppresses economic activity. This finding strongly motivates the econometric analysis for identifying whether this effect was caused by a reduction in supply or a reduction in demand or both.

Table 1 Summary statistics of the conflict variables

Variable	Mean	Min	Max	Std. dev.
C1: Dummy for at least 30 fatalities in the last 30 days	0.31	0	1	0.46
C2: Dummy for any fatalities in the last 3 days	0.49	0	1	0.5
C3: Dummy for an exceptionally deadly day in the Palestinian Authority	0.03	0	1	0.16
C4: Dummy for any fatalities in Israel in the last 7 days	0.04	0	1	0.21
C5: Dummy for any fatalities in the West Bank in the last 3 days	0.22	0	1	0.42
C6: Interaction of dummy for imported apples and C1	0.18	0	1	0.39
C7: Interaction of dummy for imported apples and C2	0.28	0	1	0.45
C8: Interaction of dummy for imported apples and C3	0.02	0	1	0.13
C9: Interaction of dummy for imported apples and C4	0.02	0	1	0.14
C10: Interaction of dummy for imported apples and C5	0.13	0	1	0.34
C11: Dummy for any fatalities in Hebron in the last 7 days	0.08	0	1	0.26
C12: Dummy for comprehensive closure	0.15	0	1	0.36
C13: Dummy for local conflict in Hebron (D_t^{conf})	0.09	0	1	0.28

Source: Authors' calculations based on B'Tselem (2013a, 2013b). We follow the approach suggested by Rubin and Ihle (2017) for the generation and selection of these variables. Table A.3 in the Electronic Supplementary Material contains the summary statistics of the remaining independent variables which are not related to conflict

Table 2 Price and quantity: conflict vs. non-conflict and local vs. imported varieties

	Price[a] (NIS/kg)	Quantity (kg/day)
All periods		
All varieties	2.52	9105
Imported varieties	2.97	4145
Locally produced varieties	2.14	4960
Conflict periods[b]		
All varieties	2.39	6946
Imported varieties	3.02	3104
Locally produced varieties	1.89	3842
Non-conflict periods[b]		
All varieties	2.53	9356
Imported varieties	2.97	4266
Locally produced varieties	2.17	5089
Percentage change due to conflict (%)[c]		
All varieties	−5.51***	−25.76**
Imported varieties	1.74	−27.26*
Locally produced varieties	−12.95***	−24.50**

Notes: ***, **, * denote significance at the 0.01, 0.05 and 0.1 levels, respectively

[a] Average price is weighted by sales

[b] The effect of the conflict was calculated according to variable C13

[c] Significance was calculated using a two-tailed t-test for difference between two means

Price and quantity effects of conflict defined by alternative variables are robust, see for details Table A.5 and Table A.6 in the Electronic Supplementary Material

Source: Authors

6 Estimation and simulation

We apply the generalized method of moments to simultaneously estimate the system of demand Eqs. (2) and pricing Eqs. (3) for each variety. The variables on the left hand side are the natural log of the quantity traded in day t and its price, respectively. We account for non-linearity and cross-equation restrictions associated with the parameters α and μ as well as for possible correlations between the errors ξ_{jt} and ω_{jt} in both equations.

In the demand Eq. (2), the price as well as quantities appearing on the right-hand side are endogenous. In the pricing Eq. (3), quantities inside the mark-up term are endogenous. We use dummy variables for months as well as index variables for week numbers, squared week numbers and the number of other apple varieties traded in the market on a given day to instrument the quantities of specific apple varieties. We use the prices of three apple varieties in the wholesale market in Tel Aviv to instrument the price of apple varieties traded in Hebron. As mentioned above, the consensus in the political science as well as in the economic literature about causes of the conflict suggests that conflict is exogenous as escalations of the Israeli-Palestinian conflict are not influenced by food prices (more details on the instruments used as well as assessments of their quality are presented in sections 6.3 and 6.4 of the Electronic Supplementary Material).

6.1 Estimation results

Table 3 to Table 5 report the estimation results of the demand Eq. (2) and the pricing Eq. (3), respectively. Table 3 shows the results for the non-conflict-related explanatory variables. As expected, the coefficient of the price -α is negative and

Table 3 Estimates of the coefficients of non-conflict-related explanatory variables

Variable[a]	Coefficient in demand Eq. (2)	Coefficient in pricing Eq. (3)
Price ($-\alpha$)	−1.210***	−1.210***
Year 2007	−0.405***	−0.199***
Year 2008	0.368***	−0.214**
Year 2009	0.437***	−0.006
Weekend	0.602***	0.057***
Muslim holiday	1.606***	0.066
Ramadan	0.221***	0.177***
Labour cost index commerce WB		0.046***
Transportation cost index WB		0.012**
Communication cost index WB		0.079***
Mean apple price at Tel Aviv		0.329***
Daily transaction frequency		−0.006
No. of observations	3162	3162
Pseudo R^2 [b]	0.10	0.55

Notes: ***, **, * denote significance at the 0.01, 0.05 and 0.1 levels, respectively

[a] Both the demand and pricing equations include variety dummy variables as well as conflict-related variables (see Table 5 for the results of the explanatory conflict-related variables)

[b] Pseudo R^2 is the square of the correlation between the dependent variable's predicted and observed values

Source: Authors

Table 4 Elasticities and mark-ups

	Own price elasticity[a]	Mark-up[a,d] (%)	Mark-up[a] (NIS/kg)
All periods			
All varieties	2.90	37.88	0.87
Imported varieties	3.45	30.99	0.86
Locally produced varieties	2.45	43.64	0.88
Conflict periods[b]			
All varieties	2.74	41.59	0.87
Imported varieties	3.46	30.82	0.88
Locally produced varieties	2.16	50.29	0.87
Non-conflict periods[b]			
All varieties	2.92	37.56	0.87
Imported varieties	3.44	31.00	0.86
Locally produced varieties	2.48	43.05	0.88
Percentage change due to conflict[c] (%)			
All varieties	−6.0	10.7	0.3
Imported varieties	0.4	−0.6	1.4
Locally produced varieties	−12.6	16.8	−0.6

Notes: [a] The average own price elasticities in absolute values and the average mark-ups are weighted by sales

[b] Days of conflict are defined by the variable C13 taking the value 1 which is the conflict measurement quantifying the incidence of local conflict in the city of Hebron

[c] This is the percentage change between the corresponding estimates during non-conflict periods and conflict periods

[d] The percentage mark-up is calculated by dividing the mark-up in absolute terms by price

Source: Authors

significant being estimated as −1.21. The higher the price, the lower the utility for the consumer and the lower the quantities purchased. One of the apple varieties is used as the reference variety while the reference year is 2010. Most of the control variables have a significant influence on demand as well as on marginal costs of marketing. Table 3 suggests that apple demand during weekends is higher than on other days. Muslim holidays and Ramadan have a strongly positive and significant demand effect which is consistent with the traditional food served by Palestinians during these holidays.

The variables of the pricing equation explain the marginal costs of apple marketing. The results in the third column of Table 3 show a convergence of marginal costs towards 2010 levels. In 2007 and 2008, marginal costs were significantly lower than in 2010. In 2009, the marginal marketing costs of apples did not significantly deviate from 2010 levels. The estimated coefficients of the weekend dummy indicate that marginal costs rise slightly (0.06 NIS/kg) but significantly relatively to the rest of the week. Muslim holidays, not including Ramadan, do not affect marginal costs. During Ramadan, marginal costs increase significantly by 0.18 NIS/kg. As expected, the cost indices positively affect marginal costs.

We find that demand for each apple variety is elastic - a result of many substitutes in the market (Table 4). The own price elasticity of all apples varieties is 2.9 in absolute terms while it is slightly less elastic on days of conflict (2.74, conflict being defined by C13 taking the value 1). Demand for local apples is less elastic than demand for imported apples.

Table 4 also indicates that the own price elasticity of all varieties decreases by 6% between periods with conflict in comparison to periods without conflict. When this change is differentiated between imported and locally produced varieties, then a substantial contrast becomes visible. While the price elasticity of imported varieties barely changes (0.4%), a distinct decline of almost 13% happens for locally produced varieties. Imported varieties have longer storability as Israeli growers and traders enjoy better access to input factors, capital and storage facilities. Therefore, Hebron consumers seem to prefer to purchase

Table 5 Estimates of the coefficients of the conflict variables

Variable	Coefficient in demand Eq. (2)	Coefficient inpricing Eq. (3)
C1: Dummy for at least 30 fatalities in the last 30 days	0.052	
C2: Dummy for any fatalities in the last 3 days	0.162**	0.062***
C3: Dummy for an exceptionally deadly day in the Palestinian Authority	0.360*	
C4: Dummy for any fatalities in Israel in the last 7 days	−0.103	
C5: Dummy for any fatalities in the West Bank in the last 3 days	−0.209**	
C6: Interaction of dummy for imported apples and C1	0.568***	
C7: Interaction of dummy for imported apples and C2	0.015	
C8: Interaction of dummy for imported apples and C3	−0.617**	
C9: Interaction of dummy for imported apples and C4	0.166	
C10: Interaction of dummy for imported apples and C5	0.121	
C11: Dummy for any fatalities in Hebron in the last 7 days		0.055
C12: Dummy for comprehensive closure		0.023
C13: Dummy for local conflict in Hebron (μ)	−0.145**	−0.145**

Notes: ***, **, * denote significance at the 0.01, 0.05 and 0.1 levels, respectively

Source: Authors

Israeli varieties in times of conflict. Hence, what we observe might be interpreted as temporarily lowered consumption levels of the local produce on the expense of keeping the level of the imported varieties stable.

Table 5 displays the estimates of the coefficients of the variables quantifying complementary aspects of conflict intensity. The estimated coefficient of the market size parameter μ of 0.145 is significant. This estimate suggests that escalations of violence that have local effects on the city of Hebron indeed reduce potential market size by a substantial magnitude of 14.5%. Additional robustness checks show that the estimates of μ and α are robust throughout different measures of potential market size. Results are available from authors upon request. This finding confirms the qualitative evidence documented by OCHAoPt (2017) and other sources such as EC-FAO (-2008) that violent conflict indeed may substantially fragment economic space.

In the demand equation, a number of determinants play a role. If there is an exceptional escalation of violence, then import demand for apples collapses in the short run (variable C8). However, in the middle run, demand for imported apples rises if some conflict took place in the last month (variable C6). If any fatalities for either conflict party in either region are observed in the prior three days, then demand rises slightly (variable C2) while demand shrinks if there are conflict escalations only in the West Bank (variable C5).

In the pricing equation, marginal costs are positively, albeit slightly impacted (0.06 NIS/kg) by the general level of conflict in the short run (variable C2). The positive effects on marginal costs due to local conflict in Hebron (variable C11) and to closure of the West Bank Barrier (variable C12) are not statistically significant.

Table 4 shows that the weighted-in-sales average mark-up of apples is 0.87 NIS/kg. The exogenous variation in availability and variety of apples due to conflict did not shift the mark-up in NIS/kg as they barely change between conflict and non-conflict periods. During days of conflict, apple quantities q_{jt} are reduced by 12.6%. The percent mark-up during days of conflict is higher (Table 4) due to the reduction in own price elasticity. The average percentage mark-up of all varieties raises by almost 11% - which is mainly due to the substantial increase of 16.8% for locally produced varieties while the percentage mark-up of imported varieties virtually stays constant in both periods.

We preformed comprehensive robustness checks of these results such as estimating a nested logit version and a random coefficient version of the demand equation as well as alternative pricing rules such as collusion and strategic impact of the conflict (see section 6 of the Electronic Supplementary Material). This comprehensive examination of robustness shows that the estimation results reported are robust across all alternative specifications. Detailed results are available from the authors upon request. As part of this, we also examined whether model results are driven by the inclusion of conflict variables. We ran several specifications of the model and found that the results are stable (Table A.7 in the Supplementary Material). This is in line with Rubin and Ihle (2017) who show that it is possible to construct various conflict variables based on a common dataset that measure complementary aspects of conflict. We follow their approach for the generation and selection of the variables reported in Table 1 in order to avoid issues such as the one highlighted by Schrodt (2014).

6.2 Simulation results

Based on the estimated parameters, the system of demand and pricing Eqs. (2) and (3) of apple varieties makes up an

equilibrium model enabling to estimate the welfare impacts of various scenarios depending on the intensity of the conflict (e.g., Fershtman and Gandal 1998; Tchetchik et al. 2008; Fleischer et al. 2018; Bar-Nahum et al. 2018, see section 6.2 of the Electronic Supplementary Material for a detailed explanation of this approach). We use observed prices, observed quantities and model covariates to derive a calibrated baseline market equilibrium of a representative day which is defined by the averages of the observed conflict variables in the sample. After an exogenous change in conflict intensity, the model searches for sets of J variety prices and quantities that solve simultaneously the demand and pricing equilibrium equations. Exogenous to the equilibrium model is the conflict's intensity level. Based on that, we consider the following two scenarios for simulation which we compare to the baseline:

Scenario 1. **High-intensity local conflict:** this represents a scenario of a day in which local conflict has been observed to be of very high intensity. This is operationalized by letting the variable C13 equal the value one for all observations and using the average values of the other observed explanatory variables when C13 = 1.

Scenario 2. **Low-intensity local conflict:** this represents a scenario of a day in which local conflict has been observed to be of very low intensity. This is operationalized by letting the variable C13 equal the value zero for all observations and use the average values of the other observed explanatory variables when C13 = 0.

Table 6 Simulated changes on a daily basis

Change of	High-intensity local conflict	Low-intensity local conflict
Price	+1%	−1%
Total quantity	−15%	+4%
Consumer surplus[a]		
In absolute terms	−8352 NIS	+4487 NIS
In percentage terms	−13.3%	+7.1%
Producer surplus		
In absolute terms	−3403 NIS	+1685 NIS
In percentage terms	−13.2%	+6.6%
Welfare		
In absolute terms	−11,755 NIS	+6172 NIS
In percentage terms	−13.3%	+7.0%

Note: [a] The consumer surplus is calculated based on the formula for consumer surplus per consumer in the logit model $CS = \ln\left(\sum_{j=0}^{V} e^{\delta_j}\right)/\alpha$

Source: Authors

Table 6 reports the simulated daily changes in the average price of all apples, the total traded quantity, consumer surplus, wholesalers' surplus, and welfare. Local conflict of high intensity creates a significant cost in terms of economic welfare, estimated at 11,755 NIS (3185 USD) per day corresponding to about 50% of the average daily revenue of apples in the Hebron wholesale market. Similarly, low intensity of local conflict creates a significant gain in economic welfare, estimated at 6172 NIS (1672 USD) per day corresponding to about 25% of the average daily revenue of apples in the Hebron wholesale market. Hence, the effect of suppressing demand appears to be more significant than the increase in marginal cost visible in the price changes. The sum of the welfare gains of both scenarios amounts to 18,000 NIS (4878 USD, 20% welfare increase). This gives an estimate of the total welfare gain in apple wholesale trade for a change from high-intensity to low-intensity local conflict, aka *peace dividend* in the literature (e.g. Fershtman and Gandal 1998). This amount is of substantial magnitude as it accounts for 75% of the average daily revenue in apple wholesale trade in Hebron. The magnitude of this peace dividend would be emphasized by extrapolating it to the total daily revenue of fresh fruit and vegetable trade in the entire West Bank.

7 Conclusions and discussion

The current literature has mostly analysed economic effects of war, violent conflict, and terrorism (e.g., Benmelech et al. 2010) or conflict as a result of threatened food security (e.g., Koren and Bagozzi 2016) at the macro-level. Recently a limited number of studies have started to focus on the micro-economic effects of conflict on food markets. In this paper, we introduce an empirical framework that enables decomposing micro-economic effects of violent political conflict on food markets. The framework enables quantifying and isolating the magnitudes of transitory economic effects of conflict-caused escalations of violence on several aspects of food markets in conflict contexts where threats to food security are plausibly not affecting conflict incidence or intensity. This applies to violent conflicts which have some fundamental political disagreement at their core in contrast to food riots which are caused by threats to food security (scuh as the Arab Spring). Examples are the conflict between Israel and the Palestinians as well as the conflicts in Syria, Iraq, Libya or Afghanistan (see section 6.3 of the Electronic Supplementary Material for details).

We suggest the use of a structural equilibrium model for that aim. In particular, we suggest a differentiated goods oligopoly model which can be estimated with data typically available even in the context of conflict in developing countries. We complement this standard framework by tailoring the approach using several variables measuring complementary aspects of conflict intensity (as suggested, e.g., by Rubin and Ihle 2017) and by allowing for variations in market size. This explicit consideration

of political instability of physical and economic access to food is a crucial precondition for food security (EC-FAO 2008) which barely has received attention in the literature although economic fragmentation has been frequently reported to be one major implications of violent conflict as frontlines often fragment major cities. The extended framework we suggest is able to separately identify whether and to what extent conflict intensity affects market size. It decomposes effects of conflict into partial effects on marginal costs, food prices and market competitiveness by also allowing for assessing potential fragmentation of physical market access.

Combining daily data on the sales of apples – one major ingredient of Palestinian diet – in the Hebron wholesale market with daily measurements of conflict intensity, we find significant effects of conflict on apple marketing and demand. Demand for imported apples collapses on days of escalating conflict whereas it increases on days of moderate conflict. Market size as well as total daily apple consumption quantities are found to be substantially reduced during intensive conflict at local level. The simulation results indicate a considerable welfare loss in times of high-intensity conflict and a welfare gain resulting from conflict pacification. In an environment of low-intensity conflict compared with the situation of conflict of highest observed intensity, a total welfare gain of about 20% - corresponding to almost 5000 USD per day – is realized.

Our results are useful for informing relief policies in a targeted way because they disentangle transitory micro-economic effects of violent political conflict on various aspects of food security. The effect of suppressing demand is found to be more significant than the increase in marginal costs. This is noteworthy to observe as availability is often conceptualized as representing the supply side of food security while access pertains to demand, our findings suggest that it is access in the given case that is more severely impeded by conflict. Our results suggest that it is important for relief policies to focus on alleviating effects of fragmentation of economic space, e.g., by negotiating humanitarian corridors within cities so that physical cut-offs from food supply are avoided.

The framework suggested based on a standard approach for estimating demand in differentiated product markets using market transactions data can be used as a feasible tool for empirically assessing micro-economic effects of violent political conflict on other food commodities or on aggregated local, regional or national food markets. The framework we suggest fits a wide range of similar contexts in which developing countries suffer from political destabilization and understanding micro-economic consequences of conflict escalations on market equilibrium and stakeholders' welfare is crucial. Data requirements are fair and not too demanding – given the challenges of data collection in conflict contexts in developing economies - for making the analysis feasible in many relevant contexts. For using this approach for another particular conflict, its institutional structure is decisive as it determines the plausibility of the main identification assumption concerning the exogeneity of food prices to conflict. Otherwise, it is necessary to account for potential endogeneity as discussed, e.g., in Martin-Shields and Stojetz (2019). This analysis highlights the benefits of food price and food trade monitoring (Baltussen et al. 2019) for being able to monitor short-run food security in environments of political destabilization.

Future research - motivated by the widespread occurrence of violent political conflict throughout the Middle East, North Africa or Sub-Saharan Africa (World Bank 2011) - might evolve into several directions. It could deepen and extend the understanding of economic effects of violent political conflict on food markets, food security, actual nutritional patterns and nutrition vulnerability at the micro-level. Such improved understanding could be achieved by gathering more quantitative measurements, but also via qualitative socio-economic research which could contribute to understand the underlying mechanisms leading to insights as, e.g., reported in Table 5. Straightforward extensions might focus on providing comparative analyses of pricing and demand for a number of fresh food commodities in more than one market or more than one conflict. An analysis of conflict effects on processed and storable foods for which supply is more constant due to potential stockpiling, would be insightful too. We thank an anonymous reviewer for pointing out that analysing the extent to which food prices act as threat- or anger-multipliers in violent political conflict would contribute to improving the understanding of conflict dynamics. Lastly, further research could also assess nutritional impacts of conflict when demand effects of various commodities are translated into nutritional intake. In this way, a comparison of impacts across food commodities of various expenditure shares or nutritional importance can be achieved.

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Compliance with ethical standards

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