TÜRKİYE CUMHURİYET MERKEZ BANKASI

WORKING PAPER NO: 15/28

How Does a Shorter Supply Chain Affect Pricing of Fresh Food? Evidence from a Natural Experiment

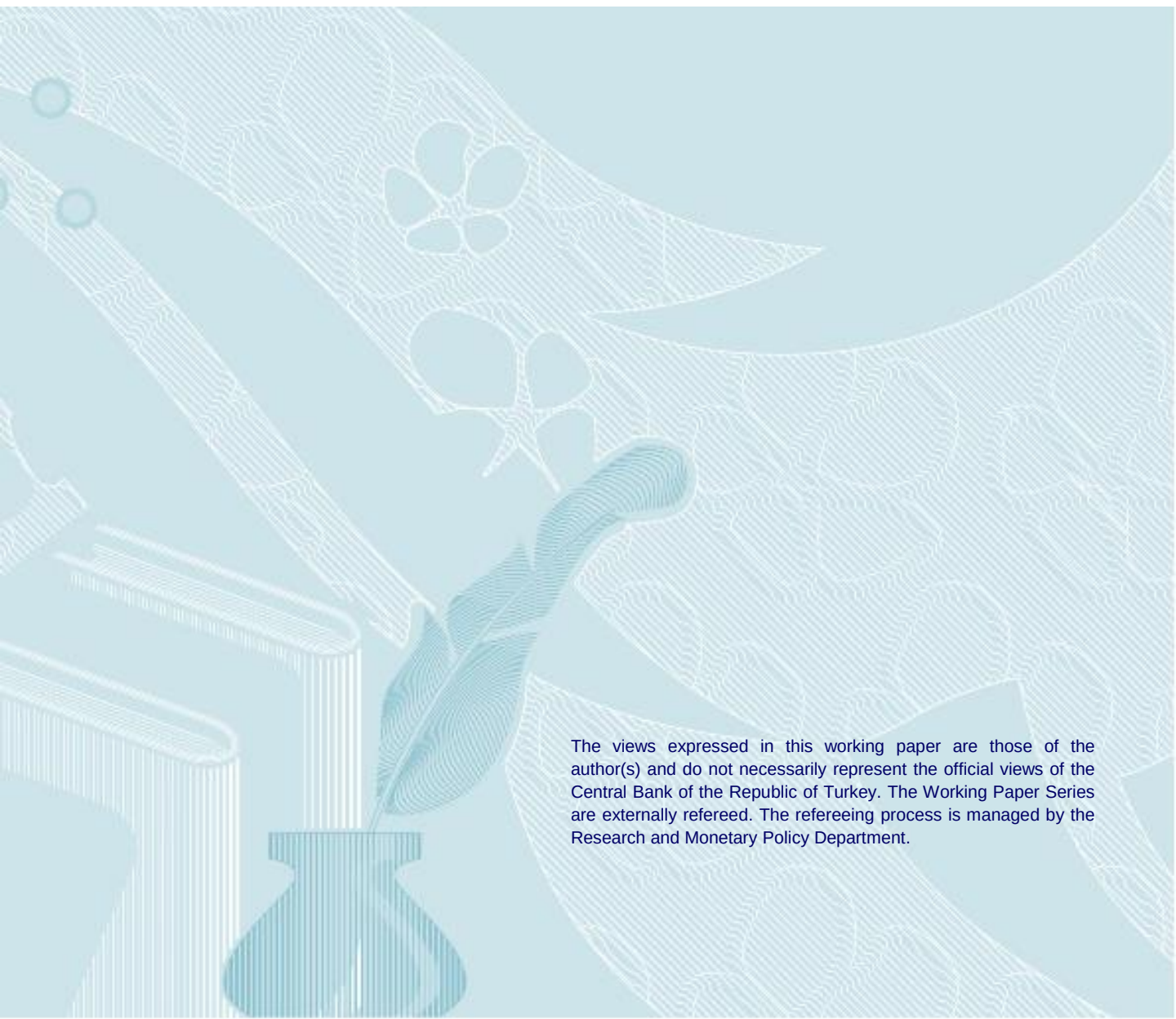
October 2015

Cevriye AYSOY
Duygu HALİM KIRLI
Semih TÜMEN

Address:
Central Bank of the Republic of Turkey
Head Office
Research and Monetary Policy Department
İstiklal Caddesi No: 10
Ulus, 06100 Ankara, Turkey

Phone:
+90 312 507 54 02

Facsimile:
+90 312 507 57 33



How Does a Shorter Supply Chain Affect Pricing of Fresh Food? Evidence from a Natural Experiment*

Cevriye Aysoy †
Central Bank of the Republic of Turkey

Duygu Halim Kirli ‡
Central Bank of the Republic of Turkey

Semih Tumen §
Central Bank of the Republic of Turkey and *IZA*

Abstract

The market for fresh food is often characterized by a large number of intermediaries delivering the product from the farmer to the retailer. The existence of these intermediaries, especially the informal ones, is often claimed to introduce market frictions that push fresh food prices up. We test the hypothesis that scaling down these frictions reduces the level of prices. Our data come from a policy reform in Turkey concerning the supply chain regulations in the market for fresh fruits and vegetables. Starting from January 1st, 2012, a new law is enacted (*i*) to remove informal intermediaries, (*ii*) to reduce the farmers' cost of access to formal intermediaries such as wholesale market places, and (*iii*) to provide the farmers with the option to directly sell their products to retailers—bypassing the wholesale intermediaries. This policy reform resembles a natural experiment that exogenously reduces the supply chain barriers in the market for fresh fruits and vegetables. Using quasi-experimental methods, we show that the policy reform has strikingly reduced the prices in the wholesale market. We also provide some rough evidence that there is no price effect in the retail market, which suggests that part of the wholesale markups may have been transferred to the retailers. Taken at face value, these results provide some hints that consumers have not received any direct benefits from the reform—ignoring the general equilibrium effects.

JEL codes: C21; L52; Q11; Q18.
Keywords: Supply chain reform; fresh food prices; incomplete pass-through; quasi-experimental design.

*We thank seminar participants at the Central Bank of the Republic of Turkey, Ministry of Food, Agriculture, and Livestock, the participants of the EconAnadolu 2015 Conference in Eskisehir, and EY International Congress in Ankara for valuable comments. We also thank Marc Bellemare (the Editor) and two anonymous referees for their careful reading and useful suggestions. Earlier versions of this paper was circulated under the title "The Effect of Reducing Supply Chain Barriers on Fresh Food Prices: Evidence from a Natural Experiment." The views expressed here are of our own and do not necessarily reflect those of the Central Bank of the Republic of Turkey. All errors are ours.

†cevriye.aysoy@tcmb.gov.tr. Research and Monetary Policy Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

‡duygu.halim@tcmb.gov.tr. Research and Monetary Policy Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

§semih.tumen@tcmb.gov.tr. Research and Monetary Policy Department, Central Bank of the Republic of Turkey, Istiklal Cad. No:10, 06100 Ulus, Ankara, Turkey.

1 Introduction

The fresh food sector has an extensive supply chain encompassing agricultural production, transportation, classification/processing, and related commercial services.[1] As a result, many agents are involved in the process of delivering the product from the farmer to the final seller. Achieving a well-monitored supply chain is an important policy priority and has recently attracted a lot of attention from policymakers and researchers. Tracing the supply chain is also economically important, because each of the link in the chain corresponds to an additional activity affecting the formation of fresh food prices. However, existence of informal intermediaries—which is a major obstacle for traceability of the supply chain—and excessive bureaucratic formalities—which prevent direct contact between farmers and retailers—are often regarded as important "supply chain barriers" in the market for fresh food.[2] Reducing these barriers has been an important food policy issue. In fact, over the past 30 years, policies that favor more traceable supply chains have been widely implemented [Aubry and Kebir (2013), IFC (2013)]. These policies encourage retailers to source directly from farmers rather than from channels that involve several layers of anonymous transactions. The main concerns driving this policy shift include issues related to health, safety, quality, and productivity. Most importantly, reducing supply chain barriers is expected to reduce the prices and, thus, to offer consumers cheaper and healthier access to fresh fruits and vegetables.

In this paper, we formally test the hypothesis that reducing supply chain barriers leads to a decline in the price levels of fresh fruits and vegetables. To answer this question, we exploit a policy reform in Turkey concerning the supply chain regulations in the market for fresh fruits and vegetables. Starting from January 1st, 2012, a new law is enacted (i) to remove informal intermediaries, (ii) to reduce the farmers' cost of access to formal intermediaries such

[1] The term "fresh food sector" is generally used to describe the sectoral activity of producing a group of farm-produced items including fruits, vegetables, meats, grains, oats, etc. In this paper, we focus on a specific category of fresh food: fresh fruits and vegetables.

[2] The costs that the farmers face in accessing the markets are typically high in Turkey. These costs include not only the direct costs of harvesting, storage, and transportation, but the other bureaucratic formalities including imposts, certain pesticide tests, and quality certification of the produce. The informal intermediaries in the market for fresh fruits and vegetables in Turkey typically exploit the existence of these costs and other formalities. Farmers are mostly visible to the authorities, while the informal agents can hide. They are not registered with the authorities and, thus, are able to avoid those costs conditional on not getting caught. Being able to avoid these costs and other taxes, the informal agents buy the produce from the farmers "on the tree" and serve as an intermediary between the farm and the final seller. The informal intermediaries either sell these produce directly to the consumers in the designated "local bazaars" or to the retailers. Typically, more than one informal intermediaries are involved in the process, which translates into multiple markups added on the final price.

as wholesale market places, and (*iii*) to provide the farmers with the option to directly sell their products to retailers—bypassing the wholesale intermediaries. The pre-reform period can be marked as an imperfectly-monitored market, in which informal intermediaries also try to capture profits along the supply chain. In the post-reform era, informal intermediaries have been eliminated to a large extent and the journey of each product from the farm toward the final seller has been monitored through computerized systems. At the end, the policy reform is expected to reduce the price levels of fresh fruits and vegetables in Turkey.

This policy reform resembles a natural experiment that exogenously reduces the supply chain barriers in the market for fresh fruits and vegetables. To evaluate the impact of the policy reform, we employ a quasi-experimental method: the regression discontinuity design. We perform the empirical analysis along the wholesale/retail divide using two different data sets. In other words, we investigate the impact of the reform on both wholesale and retail prices. For wholesale prices, we use daily price data collected from the Antalya Wholesale Market—a major market hall that supplies a significant fraction of the fresh fruits and vegetables consumed in Turkey, especially in the Winter season. For retail prices, we use nationally representative consumer price data collected and published on a monthly basis by the Turkish Statistical Institute.

We find that the reform has helped to reduce the wholesale prices in the range of 21–31 percentage points, which is quite significant.[3] This result is not sensitive to alternative empirical specifications. Although the case for retail prices is not as clear as the case for wholesale prices due to data limitations, it is still possible to obtain some hints that can be used in interpreting the general effectiveness of the reform. For retail prices, we provide rough evidence that the reform has not made a statistically significant impact, which implies that consumers have not received any direct benefits. Taken at face value, these results say that wholesalers reduced their prices after the reform, but the retailers did not, although they face lower costs in the post-reform period.

[3]Note that the estimates are reported in terms of "log points" in the Tables presented at the end of the paper, while they are converted into "percentage points" in the text using the conversion rules for regression coefficients summarized in Halvorsen and Palmquist (1980). Specifically, the log points are converted into the percentage-point terms using the formula $(\exp(x) - 1) \times 100$.

The plan of the paper is as follows. Section 2 compares the current paper to the relevant work in the related literature. Section 3 describes the policy reform along with the institutional setup in the market for fresh fruits and vegetables in Turkey. Section 4 provides detailed data description and summary statistics. Section 5 presents our empirical strategy. Section 6 discusses the empirical results. Section 7 concludes.

2 Related Literature

Our paper presents a detailed econometric evaluation of a unique policy reform aiming to reduce the supply chain barriers in the market for fresh fruits and vegetables in Turkey. It is possible to interpret the findings of this paper in the light of the extensive literature on incomplete pass-through from wholesale to retail prices [see, e.g., Goldberg and Verboven (2001), Nakamura and Steinsson (2008), and Nakamura and Zerom (2010)]. The correlation between the wholesaler-level versus retailer-level price shocks is a key issue in understanding the formation of prices. The consensus in the literature is that there is incomplete pass-through from the wholesale to retail prices in a wide range of products. Our results support this view by providing suggestive evidence that reductions in the wholesale prices are not fully reflected on the retail prices in the market for fresh fruits and vegetables in Turkey. In other words, there is likely an incomplete pass-through from wholesale to retail prices in case of a decline in wholesale prices.

The incomplete pass-through literature is closely related to the asymmetric price transmission (APT) literature. To understand APT, suppose that there are two levels of prices for a specific product: a supply-point price (p_1) and a final price (p_2). The asymmetric price transmission (APT) is called as "positive" if an increase in p_1 is reflected fully on p_2, but a decline in p_1 makes only a negligible effect on p_2. On the other hand, the APT is "negative" if an increase in p_1 generates a negligible impact on p_2, while a reduction in p_1 is reflected remarkably on p_2. In his seminal paper, Ward (1982) documents—building on the asymmetry procedures developed by Wolffram (1971), Gollnick (1972), Houck (1977), and Young (1980)—that there are substantial asymmetries between the pricing behaviors of retailers, wholesalers, and farmers. Further

research has shown that this finding is more like a rule rather than exception. Peltzman (2000), in his breakthrough work, using an extensive sample of items mostly consisting of food and agricultural products, shows that vertical price transmission is indeed asymmetric. A detailed review of the asymmetry literature is provided by Meyer and von Cramon-Taubadel (2004). Although there is a wide consensus on the existence of such an asymmetry, the direction of the asymmetry is a rather controversial issue [Bailey and Brorsen (1989)]. While Ward (1982) presents evidence favoring negative APT, a stream of the subsequent literature [see, e.g., Kinnucan and Forker (1987)] argues that food prices exhibit positive APT, which means that there is no consensus in the literature about the sign of APT.[4] Our results provide rough evidence that a decline in wholesale prices does not generate a significant change in retail prices in the market for fresh fruits and vegetables. Given this finding, there is room for reaching a—rather speculative—conclusion on the direction of APT. Based on the definitions provided above, our findings rule out the negative APT case and, instead, suggest that if there is APT, the sign of it is likely positive.

Our paper contributes to the related literature in several ways. **First**, this is the first paper in the literature to evaluate the effectiveness of the supply chain reform in the market for fresh fruits and vegetables in Turkey. In particular, we exploit a policy reform which aims to reduce the supply chain barriers in the market for fresh fruits and vegetables to understand the impact of removing those barriers on the pricing behavior of wholesalers and retailers. This is the main contribution of the paper. **Second**, to the best of our knowledge, this is the first paper in the literature using quasi-experimental microeconometric techniques—as explained by Angrist

[4]There is also no consensus on the potential mechanisms underlying the asymmetry in pricing. For example, Borenstein et al. (1997) and McCorriston et al. (2001) point out that differences in market power between wholesalers and retailers can explain the degree and direction of APT. Another explanation is price stickiness. Whether the degree of price stickiness differs across wholesale and retail markets of a certain product may also determine the degree and sign of APT. See, e.g., Ball and Mankiw (1994) and Buckle and Carlson (2000) for explanations related to menu costs of price adjustments. Existence of inventory adjustment costs offers another explanation [see, e.g., Blinder (1982)]. Finally, the lack of consumer information about wholesale versus retail pricing behavior may affect the nature of APT [Miller and Hayenga (2001)]. For some of the other important studies in the pricing asymmetry literature, see, e.g., Pick et al. (1990), Zhang et al. (1995), and Ward and Stevens (2000). The literature regarding APT on fresh food products provides some sector-specific insights that are worth mentioning. Ward (1982) and Kim and Ward (2013) show that the market for fruits and vegetables exhibits negative APT, perhaps due to the perishability of fresh fruits and vegetables, which suggests that retailers may not be willing to raise prices because of the risk of being left with a spoiled product. These papers rely on time-series econometric techniques concerning lag structures and, therefore, rely on non-experimental data reflecting long-run price developments. On the theoretical front, Weldegebriel (2004), assuming oligopoly power in the retail market and oligopsony power in the farm input market, shows that it is not possible to predict *a priori* the degree of pricing asymmetry. Other papers that study several aspects of price transmission in food markets include Cudjoe, Breisinger, and Diao (2010), Hassouneh, Radwan, Serra, and Gil (2012), Baquedano and Liefert (2014), and Burke and Myers (2014).

and Pischke (2008), Imbens and Lemieux (2008), and Lee and Lemieux (2010)—to examine the degree of incomplete pass-through from the wholesale to retail prices in the market for fresh fruits and vegetables rather than relying on time-series evidence. We argue that this is potentially due to a much weaker market power of wholesalers relative to retailers. As we discuss in Section 3, the wholesale market for fruits and vegetables in Turkey has a relatively fragmented structure, while the retail sector is dominated by large multi-national retail chains. **Third**, contrary to the findings reported by Ward (1982) and Kim and Ward (2013), we show that, if there is APT in the market for fresh fruits and vegetables, it is likely positive rather than negative in the sense that large decreases in wholesale prices generate only negligible effects on retail prices. **Finally**, our work implicitly links incomplete pass-through to public policy in that the regulations affecting the intensity of direct interactions between the farmer and retailer determines the degree of pass-through from wholesale to retail prices.

3 The Supply Chain Reform

3.1 Pre-reform Institutional Environment

In the overall, the pre-reform period is characterized by (*i*) the existence of informal intermediaries, (*ii*) high costs faced by farmers to access the wholesale market, and (*iii*) centralization around the wholesale market. Providing a brief description of the pre-reform institutional environment will be useful in understanding in which ways the policy reform has changed the structure of the market in Turkey. The legal arrangements in the pre-reform period (namely the Law #552) were based on a more centralized viewpoint. In particular, excluding some very exceptional cases, the farmers were not allowed to sell their products directly to retailers and/or consumers; instead, they had to sell their products to the wholesalers and the retailers had to buy from the wholesalers. In other words, the wholesale market was serving as a "formal intermediary."

The wholesale markets are mostly established and administered by the local municipalities. Each market hall consists of many small stores. The right to own a store in the wholesale

market is initially provided by open auctions and then traded in the secondary market.[5] In the pre-reform period, the farmers, who wanted to sell their products to the wholesale stores in the market, were taxed by the 2 percent of their total sales revenues by the administrator. Adding up this tax to the costs of harvesting and transportation, the process of market access, as a whole, was quite burdensome for the farmers. The existence of these costs provided incentives for certain informal intermediaries to operate. For example, to avoid those costs, the farmers were selling the products "on the tree" to the informal intermediaries, who were then bearing the costs of harvesting, transportation, and market taxes. For some products, several levels of informal intermediation were involved in the process. As the number of agents involved in the process goes up, the prices are also expected to go up due to the increased number of markups. Finally, the existence of informal transactions made it impossible to monitor the supply chain and there were only limited information about the characteristics of the items traded.

The retail sector is dominated by large supermarket chains, some of which are partly owned by giant multinational corporations. There are also small retail stores (such as groceries), but their share is very small. Most of the supermarket chains operate in multiple cities spread over a large region and some of them have nation-wide coverage. So, the retail market has a rather oligopolistic structure. In the pre-reform period, the retailers purchase fruits and vegetables only from the wholesale market places. They have almost no incentives to engage informal transactions as they are large and quite "visible" to the authorities. Next we describe the details of the policy reform and how the pre-reform institutional structure has changed after the reform.

3.2 Description of the Reform

The existence of informal intermediaries and the high cost for farmers to gain direct access to the market have often been interpreted as "barriers" or "frictions" that affect price formation

[5] After a wholesale market is established and the number of stores is decided by the corresponding local municipality, an open auction is typically performed to sell the right to operate the stores. Depending on the preference of the local administration, the stores can either be permanently sold or rented for a fixed term. If a store is privately owned, then the owner can re-sell the store to another agent. The price is competitively set in the secondary market—similar to the secondary market for housing or real estate. By "secondary market," we mean that the prices are determined by the supply/demand forces, rather than set beforehand as in the primary market.

in the market for fresh fruits and vegetables in Turkey. As of 2014, there are 192 wholesale markets in Turkey, which is quite high relative to the standards.[6] For example, there are around 60 wholesale markets in the entire EU region. Since the number of wholesale markets is very high compared to the other countries, it is difficult to inspect/monitor the price setting mechanisms in the market for fresh fruits and vegetables. The existence of informal intermediaries amplifies these difficulties. To reduce the barriers preventing healthy price formation, a new law is enacted (the Law #5957) on January 1st, 2012.[7] The main goal of the law is to liberate the farmers from wholesale trade restrictions. The policy reform enables the farmers to bypass the wholesalers and sell their products directly to the retailers—and even to the consumers. The only requirement is to formally report the source, characteristics, quantity, quality, and the price of the produce subject to trade. The introduction of this alternative marketing channel is expected to increase competition in the sector, reduce the volume of informal activity, and lower the prices of fresh fruits and vegetables. The cost of farmers' access to the wholesale markets has also been regulated by the law. The retailers (supermarkets, groceries, and local markets) and entities that buy food for their own use—such as hotels, restaurants, factories—are allowed to buy fresh fruits and vegetables directly from the producers out of the wholesale markets by paying a 2 percent tax. The tax rate for the transactions in the wholesale market is reduced to 1 percent—which was 2 percent before the reform.

Another goal of the reform is to increase the traceability of the supply chain. Before the reform, the existence of informal intermediaries made it almost impossible to monitor the stages through which a certain item proceeds. A computerized system is established to increase the tractability of the items in their journey from the farm to the final consumer. Farmers, wholesalers, and retailers all register with the authorities. They are given identification tags and barcodes. Increased monitoring capacity enables the retailers and consumers to receive better information about the characteristics, quality, origins, and healthiness of the products.

[6] The total number of stores in these 192 wholesale markets is 11,303, 9,500 of which are "commission agents" and the rest are "merchants." Based on the 2014 figures, the total trade volume in these wholesale markets is around 50 million tons per year.

[7] The law is originally endorsed on March 26th, 2010, but the enactment is delayed until January 1st, 2012 for the purpose of leaving enough time to furnish the required computer systems.

It provides a better account of the supply/demand conditions in the market and gives a better idea for future production planning. Moreover, it also discourages informal activities in the market for fresh fruits and vegetables.

To summarize, the new law mainly targets (*i*) to remove informal intermediaries, (*ii*) to reduce the farmers' cost of access to formal intermediaries such as wholesale market places, and (*iii*) to provide the farmers with the option to directly sell their products to retailers. At the end, these new measures are expected to reduce the prices of fresh fruits and vegetables in Turkey.

4 Data

We use two different data sets in our analysis: the wholesale price data and the retail price data. For the wholesale market, we use fresh fruit and vegetable prices collected from the Antalya Metropolitan Municipal Wholesale Market (AWM). The prices are collected on a daily basis and are freely accessible from the official website of the Antalya Metropolitan Municipality.[8] Approximately, 6.3 million tons of fresh fruits and vegetables are produced in the Antalya region per year. This corresponds to around 40 percent of the total production in Turkey. The AWM is the largest wholesale market in Turkey and its annual volume of trade (including exports and imports) is more than 30 million tons of fresh fruits and vegetables. Around 60 percent of all fresh fruits and vegetables in Turkey are delivered through the AWM. It is also a major hub for the imports and exports of fruits and vegetables. Based on the 2013 figures, the AWM accommodates around 800 wholesale stores and more than 5,000 individuals are employed in the AWM. Overall, it is a large formal organization operating as an intermediary in the market for fresh fruits and vegetables. The AWM wholesale price data can, therefore, reflect nation-level wholesale price developments.

Our baseline analysis sets a two-month window centered around the date of policy change, January 1st 2012. This means that we gather daily data covering the period December 1st – January 31st. The data are collected everyday except Sundays and official holidays. Based on this restriction, we have 52 daily price observations for each fresh food or vegetable item

[8] To access the price data, see http://www.antalya.bel.tr.

in the sample. Only the items for which the price data are fully available in our data horizon (i.e., in each of the 52 days) are selected. Other items are dropped. We also drop the imported goods—i.e., the fruits and vegetables that are not produced in Turkey. These restrictions yield a sample of 37 items. At the end, the total number of price observations is 1,924. Table (1) lists these items and provides some summary statistics. Note that two prices are quoted on each day for each item: a minimum and a maximum price. The item price that we use in our analysis is the average of these two prices.

As retail prices, we use national level prices collected and published by the Turkish Statistical Institute (TurkStat). We focus on the same time period as the wholesale prices described above: December 2011 – January 2012. The TurkStat data set offers monthly average prices, which are nationally representative. These prices are used to calculate the monthly realizations of the Consumer Price Index (CPI).[9] So, these prices can also be interpreted as "consumer prices." Due to data availability restrictions, the retail price sample has 28 items, which is somewhat smaller than the wholesale price sample. However, there is a quite large degree of overlap between the items in both samples. For each fresh food or vegetable item in the sample, we have 2 observations, which means that the total number of retail price observations is 56 in our baseline analysis. Table (2) presents summary statistics for the items in the retail price sample.

Figure (3) plots the nationally-representative trends in the producer and consumer prices of fresh fruits and vegetables in Turkey between January 2011 and December 2012—one year before and after the policy reform. Both data series are obtained from the official figures published by the TurkStat. The producer prices of fresh fruits and vegetables come from the Producer Price Index of the Agricultural Products, while the source of consumer prices of fresh fruits and vegetables is the sub-indices of the Consumer Price Index. For both producer and consumer prices, the average price in 2011 is set as 100 and the official weights of the individual items within the corresponding index are used to obtain the aggregate numbers. The vertical line indicates the date of the policy reform. The figure suggests that the prices of fruits and

[9]The consumer price data are publicly available from http://www.turkstat.gov.tr.

vegetables exhibit substantial seasonality—as expected. It also says that, after the policy reform, the volatility of producer prices has declined relative to that of the consumer prices of fresh fruits and vegetables. Moreover, the producer prices exhibit a declining trend after the reform, while the consumer prices fluctuate. These are rough observations and do not say much about the causal impact of the policy reform on the prices of fresh fruits and vegetables. Next, we focus our attention on investigating the existence of such a causal relationship.

5 Empirical Strategy: Regression Discontinuity Design

Our goal is to estimate the impact of the policy reform reducing barriers in the supply chain of fresh fruits and vegetables on the prices of these items. Taking one step backward, the main goal of the paper is to estimate the impact of the existence of barriers in the supply chain—such as the existence of institutional arrangements and interest groups distorting the connections between producers and consumers—on price formation. Without the reform, one could only estimate the impact of supply chain barriers on prices using a rough comparison of prices in different sectors with differing degrees of supply chain barriers. In such a setting, one would regress the prices on a set of time dummies and a variable describing the degree of supply chain barriers in each sector. Then, the coefficient of the variable describing the degree of supply chain barriers would be interpreted as the impact of supply chain barriers on the price levels, controlling for the period-specific price shocks. However, such an analysis would be subject to the classical endogeneity criticism, since the pricing principles and demand/supply conditions in the "high-barrier" sectors will be selectively different from those in the "low-barrier" sectors.

The policy reform we focus on resembles a natural experiment that exogenously reduces the degree of supply chain barriers after a certain cutoff date. This allows us to design our empirical strategy as if the data is coming from a randomized experiment. To evaluate the impact of the policy reform, we employ a well-known quasi-experimental method: the regression discontinuity design (RDD). Below we describe the details of the identification strategy we adopt in our RDD design.

Our RDD strategy can be described within a standard regression setup as follows. We construct a dummy variable R taking value 1 in the post-reform (or post-treatment period) and 0 in the pre-reform (or pre-treatment) period. The assignment variable is time, which is described by days in our wholesale-price data and by months in our retail-price data.[10] The time variable is denoted with t. The final RDD equation can be expressed as follows:

$$\ln p_{it} = \alpha + \gamma \cdot R_{it} + f_n(t) + \mu_i + \epsilon_{it}, \tag{5.1}$$

where i indexes items, t indexes the period of observation, $\ln p_{it}$ is the natural logarithm of the nominal price level for item i in period t, $f_n(t)$ defines the time trend as a polynomial of order n, μ_i describes the item fixed effects, and ϵ_{it} is an error term.[11] In this case, the main parameter of interest is γ. It measures the log-point change in the prices of fresh fruits and vegetables as a response to the policy reform. As for the polynomial $f_n(t)$, we follow the advice provided in Gelman and Imbens (2014) and choose a low-order polynomial. In particular, we almost exclusively focus on a linear specification since we use price data and, most of the time, prices smoothly fluctuate around a linear time trend.

We perform the RDD exercise for both the wholesale and retail prices of fresh fruits and vegetables. The wholesale prices of fresh fruits and vegetables are provided on a daily basis, so an RDD strategy is perfectly justified in such an environment since the assignment variable—which is "time" in our case—can be observed continuously. Applying RDD on the monthly retail prices is more tricky, since our baseline scenario covers only two months (December and January)—see Section 4. We make the RDD implementable for the retail prices by gradually extending the data horizon from 2 months to 4 and 6 months.

In the next section, we report and discuss the estimates obtained from the Equation (5.1) expressed above. Then we present the refinements of the baseline estimates by trying alternative window sizes and/or specifications.

[10] See Davis (2008) for a prominent example in the literature using time as the assignment variable in an RDD exercise. See also Lee and Lemieux (2010) for further discussion.

[11] Additional time fixed effects are included for extended window sizes.

6 Results and Discussion

We present the empirical results in three steps. We start with a thorough discussion of the effect of the policy reform on wholesale prices. Then, we focus on the impact of the policy reform on retail prices. Finally, we compare the policy effects on wholesale and retail prices for the purpose of (*i*) to assess the effectiveness of the policy reform in reducing the price levels of fresh fruits and vegetables and (*ii*) to check whether we can detect any visible incomplete pass-through patterns from wholesale to retail prices. For both the analyses of wholesale and retail prices, we implement the RDD technique supplemented by additional robustness exercises.

6.1 The Effect of the Reform on Wholesale Prices

Our analysis for wholesale prices uses the AWM data set, which consists of daily price observations for 37 items between December 1st, 2011 – January 31st, 2012. Table (3) provides our RDD estimates for the effect of the policy reform on wholesale prices of fresh fruits and vegetables. Columns 1, 2, and 3 report our estimates for window sizes of 2 months (December 1 – January 31), 1 month (December 15 – January 15), and 10 days (December 25 – January 5), respectively. The reason why we do not focus on larger window sizes in our baseline analysis is twofold. First, we already have a quite large number of observations even for the smallest window; so, there is no need to extend the data period for the purpose of gaining extra degrees of freedom. Second, the probability that other confounding factors—such as other exogenous demand and supply factors that would be hard to account for—will increase as the data window gets larger. We find that the RDD estimates range between 22.5 and 31.3 percentage points, depending on the size of the analysis window. Table (4) reports the estimates for quadratic and cubic forms. For higher-order trend polynomials, we use the largest window size (2 months) for the non-linearity to make some sense. As Table (4) indicates, the estimates for linear, quadratic, and cubic trend terms range between 20.6 and 31.3 percentage points.

Figure (1) visually verifies the validity of our regression discontinuity exercise. The y-axis

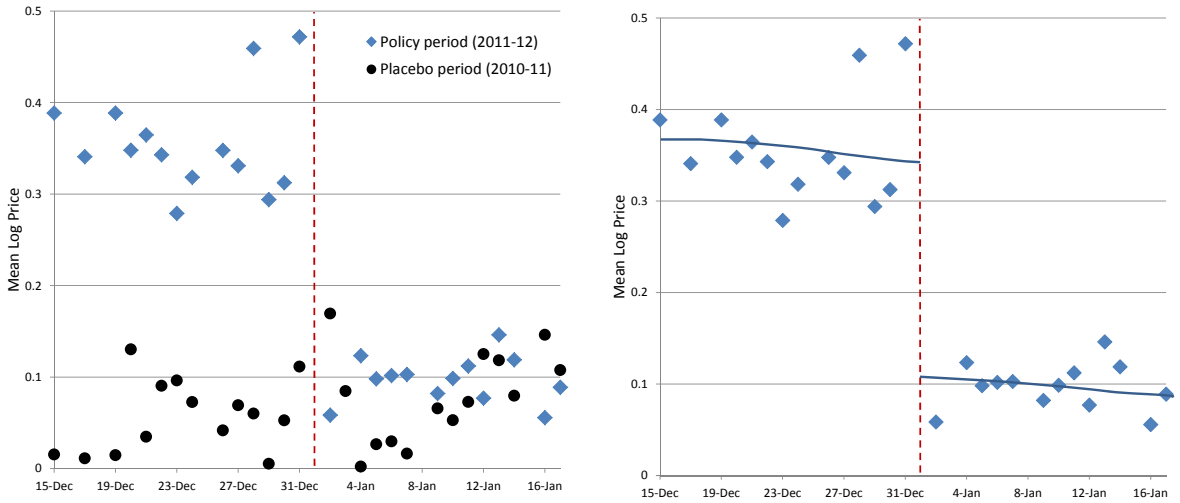


Figure 1: **Regression discontinuity design (wholesale prices).** These plots provide a visual test of feasibility for the RDD analysis in wholesale prices. The left panel compares the observations for the policy period with those of the "placebo" period. The right panel presents the locally weighted scatter-plot smoothing (LOWESS) estimates of the underlying RDD trends.

indicates mean log prices for the items in the sample, whereas the x-axis indicates the date. The square markers show the price observations for the 2011–2012 period—i.e., the period in which the policy has started to be implemented. The policy implementation date is indicated by the vertical red dashed line. Clearly, there is a sharp drop right after the policy reform. Whether this sharp drop can be interpreted as the causal effect of the policy reform or not is the key point. On the left panel, the round markers show the price observations for the 2010–2011 period and the red vertical line indicates the "placebo" treatment—i.e., as if the policy has started on January 1st of 2011 rather than 2012. Obviously, there is no visible effect of the placebo treatment. On the right panel, the trend line is estimated using the locally weighted scatter-plot smoothing (LOWESS) procedure—see, e.g., Cleveland (1979) and Cleveland (1981). The remarkable break in the trend line suggests that the wholesale prices of fresh fruits and vegetables have changed as a consequence of the policy reform. Therefore, the RDD passes the eyeball test.[12]

At this point, it would perhaps be useful to mention that the RDD exercise described above can be classified as a "sharp" RDD rather than a fuzzy design [see, e.g., Trochim (1984,

[12]Another important point is related to whether the policy reform is anticipated by the economic agents or not. If the policy change is anticipated, then the estimated effects can be biased. However, we believe that the anticipation effect does not exist since the original reform date was March 26, 2010, but the implementation of the reform was delayed several times. At the actual reform date (January 1st, 2012), almost nobody was expecting that the reform will be implemented without further delays.

2001)]. In a sharp RDD, the assignment of the treatment is a deterministic function of a given cutoff value, which is "date" in our case, i.e., the reform date is January 1st, 2012. All of the units observed on or after January 1st, 2012 are assigned to the "treated" status. While our assignment variable "date" is a continuous variable around the cutoff value, the conditional expectation of the observed outcome exhibits a notable jump at the cutoff.[13]

One important practical issue related to RDD estimation is the selection of the functional form for the trend variable [see, e.g., Lee and Lemieux (2010)]. Typically, researchers tend to use high-order polynomials (typically 3rd- or 4th-order ones) to improve the fit of the model to the data. However, recent work by Gelman and Imbens (2014) shows that choosing high-order polynomials reduces the accuracy of the RDD estimates. Moreover, they recommend using either linear or quadratic forms. In our case, the dependent variable is the nominal price level and the assignment variable is time. The trend in nominal prices is called "inflation." The common practice in applied macro studies is to assume that nominal prices fluctuate over time around a linear inflation trend and this conjecture has empirical support. Thus, our baseline analysis assumes a linear trend.

Overall, the RDD estimates under different specifications suggest that the most sensible and reliable range of estimates for wholesale prices is roughly 22–28 percentage points. In other words, the policy reform that aims to reduce supply chain barriers in the market for fresh fruits and vegetables reduces wholesale prices of these items in the range of 22–28 percentage points. This estimate is robust to (*i*) size of the data analysis window and (*ii*) alternative specifications of the trend term.

At this point, the critical question is whether this effect falls if we further enlarge the analysis window to, say, 4 or 6 months (i.e., 2 or 3 months both before and after the policy reform). The estimates have declined to the range of 15 to 18.5 percentage points. One should note that the probability of confounding the other factors affecting the demand/supply conditions with the effects of the policy reform gets larger as the window size gets larger. Taken at face value, finding significantly high negative estimates even for large window sizes suggests that

[13] See Imbens and Lemieux (2008) for the rest of the technical issues related to the sharp RDD implementations.

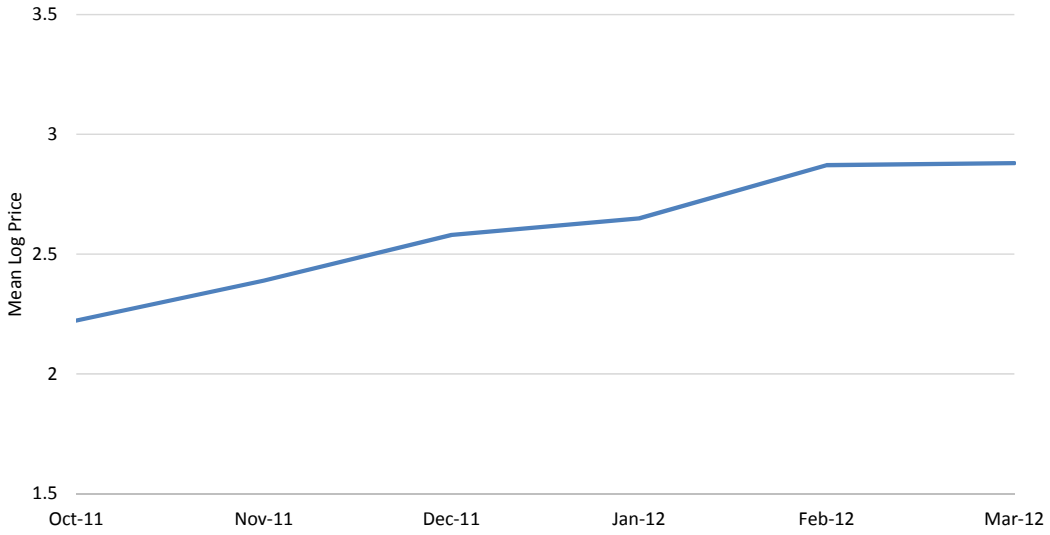


Figure 2: **Regression discontinuity design (retail prices).** A visual test of the RDD analysis for retail prices.

the effect of the policy has been permanent over a significantly long data horizon.

6.2 The Effect of the Reform on Retail Prices

To estimate the impact of the policy reform on retail prices, we use nationally representative TurkStat data set published in monthly frequency for 28 items of fresh fruits and vegetables. The case for the RDD exercise in retail prices is not at all as clear as the one for wholesale prices for two main reasons. First, we do not observe a jump in the retail price data right after the policy reform; and, second, the time horizon is defined in terms of months rather than days. So, due to these two reasons, the RDD estimates for the retail-price effects of the policy reform would not be as precise as the ones reported for the wholesale-price effects. However, there is still some merit in performing RDD as if it is a valid exercise; because, it would be useful to see if there is at least some sign of change in the retail prices as a consequence of the policy reform.

Table (5) reports the RDD estimates. The RDD is performed for three different window sizes: 2-month (December–January), 4-month (November–February), and 6-month (October–March) windows. The estimates are reported in columns 1, 2, and 3 of Table (5), respectively. The estimates are small and range from -4.4 to 3.6 percentage points, all of which are statisti-

cally insignificant. These estimates provide some rough evidence that the policy reform does not have a statistically significant effect on retail prices. We interpret and discuss the implications of these results in the next sub-section. Figure (2) suggests that there is no visible jump in the retail prices of fresh fruits and vegetables around the cutoff date. The sharp contrast between Figure (1) and Figure (2) indicates that the reform has been effective on wholesale prices, while there is no visible sign of a retail price change. It should, again, be noted that the picture for retail prices is not conclusive due to data limitations.

6.3 Discussion

In the overall, the empirical results summarized above suggest that the policy reform has substantially reduced the wholesale prices of fresh fruits and vegetables. There are also some hints that the reform had almost no effect on retail prices. We discuss the importance of these findings in the following order. First, we perform some robustness checks. Second, we evaluate our results in terms of a comparison between "what is targeted with the policy reform" versus "what is achieved." Third, we assess the estimated price effects in light of the evidence presented in the related literature. Finally, we discuss the further implications of these results in terms of policy alternatives and recommendations.

Table (6) presents the results of our robustness-check exercises. The actual cutoff date for the policy reform is January 1st, 2012. As a robustness check, we re-constructed our RDD analysis based on four different placebo cutoff dates: (1) January 1st, 2010, (2) January 1st, 2011, (3) January 1st, 2013, and (4) January 1st, 2014. In other words, we run our baseline regressions as if the policy reform took place on the same day at different years. The robustness exercises are performed for both wholesale and retail prices. The results suggest that the estimated effects are very small and statistically insignificant. We conclude that our original results are robust to using placebo treatment dates.

The policy reform to reduce supply chain barriers in the market for fresh fruits and vegetables targets to achieve (*i*) increased traceability of the transactions, (*ii*) substantially reduced informal activity, and (*iii*) lower consumer prices for fruits and vegetables. The first two

goals have mostly been achieved since the supply chain is thoroughly computerized and only authorized parties have access to the system. Detecting the impact of the reform on consumer prices is not a trivial task given the data limitations. However, we are still able to put together some rough evidence showing that consumer prices have not responded to the supply chain reform. Although our findings on retail price changes are suggestive, we believe that we have enough evidence that would enable us to speculate on the underlying forces. One of the main changes that the new policy brings is that retailers are now allowed to buy fruits and vegetables directly from the farmers. Given that wholesalers have significantly cut their prices after the policy reform, it is very likely the case that wholesalers have engaged in a price competition with farmers. The wholesale firms are generally small and the market they operate is heavily regulated by the local government. Thus, their capacity for price setting is limited. On the other hand, the retail market is dominated by large retail chains most of which have been at least partially owned by giant multinational firms. As a result, the pricing power of the retail firms is significantly larger than those from wholesalers and farmers. Moreover, their incentives to respond to lower wholesale prices by reducing prices in the retail market are quite low. This means that part of the profit margins of the wholesalers may have been transferred to the retailers. Apart from the general equilibrium and other second-order effects, the reform does neither affect consumer prices nor their welfare, if our results are correct.

Our baseline results say that a reduction in the wholesale price is not reflected in the retail price. In other words, there are signs of incomplete pass-through in the market for fresh fruits and vegetables in Turkey. Based on this finding, it is also possible to speculate on the implications of our results on pricing asymmetries. If we have to derive from our estimates any conclusion on the direction of asymmetric price transmission (APT), it has to be "positive APT." That is, retail prices are easy to go up as a result of a cost push, but difficult to come down when costs are reduced. This is contrary to the findings reported by other papers in the literature, which have investigated the direction of pricing asymmetries in the market for fruits and vegetables [see, e.g., Ward (1982) and Kim and Ward (2013)]. The main difference between these studies and our study is that we rely on quasi-experimental microeconometric techniques

rather than times-series methods. Our approach has some advantages, since we use a policy reform as a natural experiment. The most important one is that not every change in the cost conditions arise from exogenous changes. For example, changes in wholesale prices over time are mostly driven by market forces. The response of the retail price might be different when the wholesale prices increase due to market forces driving the demand and supply conditions related to fruits and vegetables rather than exogenous shocks. It should be noted, however, that we only have partial evidence suggesting that reductions in wholesale prices are not fully reflected on the retail prices, whereas we do not have any evidence regarding how retail prices would react to increases in wholesale prices.

These discussions motivate recommendations for further policy actions. If the target is to reduce consumer prices of fruits and vegetables, then policies targeting the profit margins of the retailers should be favored over the policies affecting the pricing behavior of farmers and/or wholesalers in Turkey. The other policy issue is related to consumer price inflation. Prices of fresh fruits and vegetables have increasingly become a concern for central banks, because the debates related to global warming suggest that most of the currently productive land pieces in the world will likely suffer from heavy drought in the near future. Therefore, if the pessimistic scenarios become true, then prices of fresh fruits and vegetables will increasingly become more important over time. As a result, understanding the pricing behavior of the supply-side market participants (i.e., farmers, wholesalers, and retailers) and figuring out the alignment of market power across these participants are important for developing the best policies to regulate the market for fruits and vegetables.

7 Concluding Remarks

In this paper, we investigate the impact of reducing supply chain barriers in the market for fresh fruits and vegetables on the wholesale and retail prices of these items in Turkey. We employ quasi-experimental microeconometric techniques (i.e., the regression discontinuity design) for the purpose of attributing "causal" meanings to our estimates—as much as we can. We find that the policy reform reduces the wholesale prices of fresh fruits and vegetables to

a large extent. We also provide rough evidence that there is no change in retail prices. Taken at face value, these results signal that the policy reform may have transferred the wholesale markups to the retailers, but the consumers have not received any first-order benefits. The results also highlight the existence of incomplete pass-through from wholesale prices to retail prices in the market for fresh fruits and vegetables. To speculate on these findings further, our results can also be interpreted as an evidence of "positive" asymmetric price transmission in the market for fresh fruits and vegetables, which is contrary to the earlier findings in the related literature. Other studies rely mostly on time-series techniques, while we employ micro-level quasi-experimental methods to detect pricing asymmetries in the market for fresh fruits and vegetables. We argue that the differences in the competition structures across the wholesale and retail markets are driving our results. Moreover, our work implicitly links incomplete pass-through to public policy in the sense that the regulations affecting the intensity of direct interactions between the farmer and retailer determine the degree of pass-through from wholesale to retail prices.

References

Angrist, J. D. and J.-S. Pischke (2008): *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton, NJ: Princeton University Press.

Aubry, C. and L. Kebir (2013): "Shortening Food Supply Chains: A Means for Maintaining Agriculture Close to Urban Areas? The Case of the French Metropolitan Area of Paris," *Food Policy*, 41, 85–93.

Bailey, D. and B. W. Brorsen (1989): "Price Asymmetry in Spatial Fed Cattle Markets," *Western Journal of Agricultural Economics*, 14, 246–252.

Ball, L. and G. N. Mankiw (1994): "Asymmetric Price Adjustment and Economic Fluctuations," *Economic Journal*, 104, 247–261.

Baquedano, F. G. and W. M. Liefert (2014): "Market Integration and Price Transmission in Consumer Markets of Developing Countries," *Food Policy*, 44, 103–114.

Blinder, A. S. (1982): "Inventories and Sticky Prices: More on the Microfoundation of Macroeconomics," *American Economic Review*, 72, 334–348.

Borenstein, S., A. C. Cameron, and R. Gilbert (1997): "Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes?" *Quarterly Journal of Economics*, 112, 305–339.

Buckle, R. A. and J. A. Carlson (2000): "Inflation and Asymmetric Price Adjustment," *Review of Economics and Statistics*, 82, 157–160.

Burke, W. J. and R. J. Myers (2014): "Spatial Equilibrium and Price Transmission between Southern African Maize Markets Connected by Informal Trade," *Food Policy*, 49, 59–70.

Cleveland, W. S. (1979): "Robust Locally Weighted Regression and Smoothing Scatterplots," *Journal of the American Statistical Association*, 74, 829–836.

——— (1981): "LOWESS: A Program for Smoothing Scatterplots by Robust Locally Weighted Regression," *The American Statistician*, 35, 54.

Cudjoe, G., C. Breisinger, and X. Diao (2010): "Local Impacts of a Global Crisis: Food Price Transmission, Consumer Welfare and Poverty in Ghana," *Food Policy*, 35, 294–302.

Davis, L. W. (2008): "The Effect of Driving Restrictions on Air Quality in Mexico City," *Journal of Political Economy*, 116, 38–81.

Gelman, A. and G. W. Imbens (2014): "Why High-Order Polynomials Should not be Used in Regression Discontinuity Designs?" NBER Working Paper #20405.

Goldberg, P. K. and F. Verboven (2001): "The Evolution of Price Dispersion in the European Car Market," *Review of Economic Studies*, 68, 811–848.

Gollnick, H. (1972): "Zur Statistischen Schatzung und Prufung Irreversibler Nachfragefunktionen," *Agrarwirtschaft*, 21, 227–231.

Halvorsen, R. and R. Palmquist (1980): "The Interpretation of Dummy Variables in Semilogarithmic Equations," *American Economic Review*, 70, 474–475.

Hassouneh, I., A. Radwan, T. Serra, and J. M. Gil (2012): "Food Scare Crises and Developing Countries: The Impact of Avian Influenza on Vertical Price Transmission in the Egyptian Poultry Sector," *Food Policy*, 37, 264–274.

Houck, J. P. (1977): "An Approach to Specifying and Estimating Nonreversible Functions," *American Journal of Agricultural Economics*, 59, 570–572.

IFC (2013): "Working with Smallholders: A Handbook for Firms Building Sustainable Supply Chains," International Finance Corporation.

Imbens, G. W. and T. Lemieux (2008): "Regression Discontinuity Designs: A Guide to Practice," *Journal of Econometrics*, 142, 615–635.

Kim, H. and R. W. Ward (2013): "Price Transmission across the U.S. Food Distribution System," *Food Policy*, 41, 226–236.

Kinnucan, H. W. and O. D. Forker (1987): "Asymmetry in Farm-Retail Price Transmission for Major Dairy Products," *American Journal of Agricultural Economics*, 69, 285–292.

Lee, D. S. and T. Lemieux (2010): "Regression Discontinuity Designs in Economics," *Journal of Economic Literature*, 48, 281–355.

McCorriston, S., C. W. Morgan, and A. J. Rayner (2001): "Price Transmission: The Interaction between Market Power and Returns to Scale," *European Review of Agricultural Economics*, 28, 143–159.

Meyer, J. and S. von Cramon-Taubadel (2004): "Asymmetric Price Transmission: A Survey," *Journal of Agricultural Economics*, 55, 581–611.

Miller, D. J. and M. L. Hayenga (2001): "Price Cycles and Asymmetric Price Transmission in the U.S. Pork Market," *American Journal of Agricultural Economics*, 83, 551–562.

Nakamura, E. and J. Steinsson (2008): "Five Facts About Prices: A Reevaluation of Menu Cost Models," *Quarterly Journal of Economics*, 123, 1415–1464.

Nakamura, E. and D. Zerom (2010): "Accounting for Incomplete Pass-Through," *Review of Economic Studies*, 77, 1192–1230.

Peltzman, S. (2000): "Prices Rise Faster than They Fall," *Journal of Political Economy*, 108, 466–502.

Pick, D. H., J. Karrenbrock, and H. F. Carman (1990): "Price Asymmetry and Marketing Margin Behavior: An Example for California–Arizona Citrus," *Agribusiness*, 6, 75–84.

Trochim, W. (1984): *Research Design for Program Evaluation: The Regression-Discontinuity Design*, Beverly Hills, CA: Sage Publications.

——— (2001): "Regression-Discontinuity Design," in *International Encyclopedia of the Social and Behavioral Sciences*, ed. by N. J. Smelser and P. B. Baltes, Amsterdam: North Holland, vol. 19, 12940–12945.

Ward, R. W. (1982): "Asymmetry in Retail, Wholesale, and Shipping Point Pricing for Fresh Vegetables," *American Journal of Agricultural Economics*, 64, 205–212.

Ward, R. W. and T. Stevens (2000): "Pricing Linkages in the Supply Chain: The Case for Structural Adjustments in the Beef Industry," *American Journal of Agricultural Economics*, 82, 1112–1122.

Weldegebriel, H. T. (2004): "Imperfect Price Transmission: Is Market Power Really to Blame?" *Journal of Agricultural Economics*, 55, 101–114.

Wolffram, R. (1971): "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches – Some Critical Notes," *American Journal of Agricultural Economics*, 53, 356–359.

Young, T. (1980): "Modeling Asymmetric Consumer Responses with an Example," *Journal of Agricultural Economics*, 31, 175–186.

Zhang, P., S. M. Fletcher, and D. Carley (1995): "Peanut Price Transmission Asymmetry in Peanut Butter," *Agribusiness*, 11, 13–20.

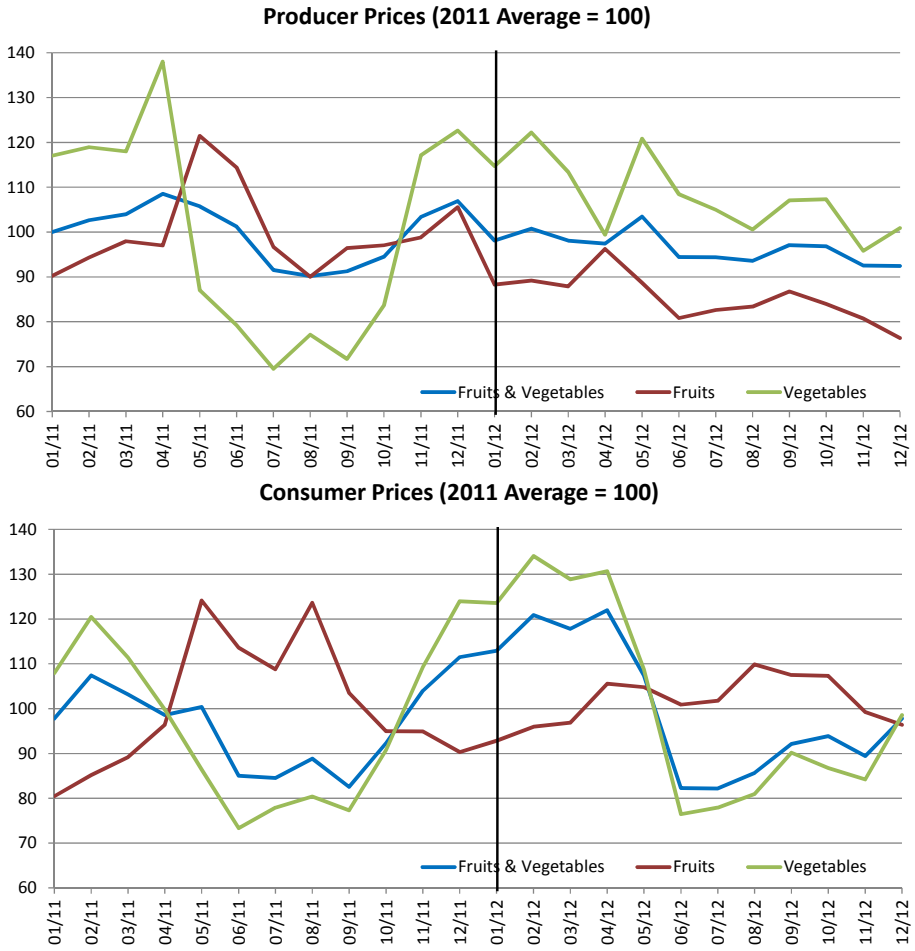


Figure 3: **Price developments.** These figures plot the general trends in the producer and consumer prices of fresh fruits and vegetables in Turkey between January 2011 and December 2012.

	Dec 2011–Jan 2012		
Item	**Mean**	**Std.Dev**	**# of Obs.**
Sweet pepper	3.015	0.820	52
Bell pepper	1.693	0.368	52
Red pepper	2.491	0.639	52
Chili pepper	2.000	0.256	52
Long green pepper	2.576	0.309	52
Broccoli	2.665	1.375	52
Dill	0.540	0.138	52
Tomato	2.798	0.355	52
Green bean	3.185	0.590	52
Cucumber	1.922	0.240	52
Spinach	1.802	0.291	52
Pumpkin	1.058	0.224	52
Zucchini	1.906	0.491	52
Cauliflower	2.420	1.350	52
Cabbage	0.902	0.201	52
Red cabbage	1.044	0.158	52
Iceberg	2.087	0.569	52
Lettuce	1.305	0.245	52
Curly lettuce	1.249	0.271	52
Parsley	0.500	0.158	52
Peppermint	0.604	0.124	52
Beetroot	1.083	0.273	52
Potato	0.853	0.260	52
Eggplant	2.359	0.568	52
Leek	1.205	0.373	52
Arugula	0.549	0.157	52
Purslane	0.624	0.136	52
Onion	0.694	0.250	52
Scallion	3.668	0.614	52
Radish	0.703	0.165	52
Quince	1.340	0.189	52
Apple (golden)	1.552	0.383	52
Apple (starking)	1.525	0.316	52
Grapefruit	0.759	0.303	52
Lemon	0.770	0.220	52
Banana	2.211	0.292	52
Pomegranate	1.308	0.167	52
Total	1.594	0.963	1,924

Table 1: **Summary Statistics – Wholesale prices [Antalya Wholesale Market].** The first column describes the arithmetic average of the daily price levels in Turkish liras for 52 observations (from the beginning of December to the end of January) in 2011–2012. The second column reports the corresponding standard deviations. The third column indicates the total number of price observations for each item.

	Dec 2011–Jan 2012		
Item	**Mean**	**Std.Dev**	**# of Obs.**
Orange	1.482	0.079	2
Pear	2.937	0.178	2
Quince	2.098	0.049	2
Apple	1.993	0.035	2
Lemon	1.583	0.050	2
Tangerine	1.722	0.154	2
Banana	3.530	0.185	2
Banana pepper	3.119	0.227	2
Bell pepper	2.957	0.128	2
Long green pepper	3.609	0.230	2
Tomato	1.935	0.211	2
Carrot	1.200	0.042	2
Spinach	2.270	0.015	2
Zucchini	2.994	0.116	2
Cauliflower	3.313	0.729	2
Onion	0.805	0.008	2
White cabbage	1.228	0.176	2
Red cabbage	1.554	0.218	2
Mushroom	5.872	0.053	2
Curly lettuce	1.764	0.168	2
Parsley	0.552	0.019	2
Eggplant	3.696	0.011	2
Leek	1.642	0.041	2
Cucumber	3.014	0.623	2
Garlic	8.364	0.235	2
Radish	1.289	0.055	2
Scallion	5.641	0.213	2
Potato	1.042	0.013	2
Total	2.614	1.713	56

Table 2: **Summary Statistics – Retail prices [Turkish Statistical Institute].** The first column describes the arithmetic average of the monthly price levels in Turkish liras of two observations (December and January) in 2011–2012, respectively. The second column reports the corresponding standard deviations. The third column indicates the number of price observations for each produce.

Dependent variable: Log Price (Daily price observations)

	2-month window		**1-month window**		**10-day window**	
Variable	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**
Treatment	-0.272***	(0.019)	-0.203***	(0.024)	-0.236***	(0.044)
Linear trend	0.0011	(0.0007)	-0.0034**	(0.0015)	0.0003	(0.070)
Item fixed effects	Yes		Yes		Yes	
Intercept	1.113***	(0.054)	1.417***	(0.109)	1.160**	(0.541)
R^2	0.869		0.908		0.910	
# of Obs.	1,924		1,110		370	

Table 3: **RDD Estimates for Wholesale Prices.** ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. Huber-White (robust) standard errors are reported in parentheses. The window size describes the length of time period for the analysis. The starting day of policy implementation (January 1st) is at the center of the window. For example, if the window size is 1 month, then the period of analysis is December 15th – January 15th. Note that the estimates are reported in terms of "log points" in this table, while they are converted into "percentage points" in the text.

Dependent variable: Log Price (Daily price observations)

	2-month window Linear		**2-month window** Quadratic		**2-month window** Cubic	
Variable	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**
Treatment	-0.272***	(0.019)	-0.272***	(0.019)	-0.186***	(0.026)
Trend	0.0011	(0.0007)	-0.011***	(0.002)	0.008*	(0.004)
Trend^2/100	–	–	0.022**	(0.003)	-0.076***	(0.022)
Trend^3/1000	–	–	–	–	0.012	(0.003)
Item fixed effects	Yes		Yes		Yes	
Intercept	1.113***	(0.054)	1.276***	(0.029)	1.202***	(0.034)
R^2	0.869		0.874		0.875	
# of Obs.	1,924		1,924		1,924	

Table 4: **RDD Estimates for Wholesale Prices – Alternative trend specifications.** ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. Huber-White (robust) standard errors are reported in parentheses. The window size describes the length of time period for the analysis. The starting day of policy implementation (January 1st) is at the center of the window. For example, if the window size is 1 month, then the period of analysis is December 15th – January 15th. Note that the estimates are reported in terms of "log points" in this table, while they are converted into "percentage points" in the text.

Dependent variable: Log Price (Monthly price observations)

	2-month window		4-month window		6-month window	
Variable	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**
Treatment	0.035	(0.117)	-0.045	(0.043)	0.002	(0.047)
Linear trend	omitted		0.080***	(0.023)	0.052***	(0.017)
Item fixed effects	Yes		Yes		Yes	
Intercept	0.375***	(0.058)	0.288**	(0.126)	0.354**	(0.140)
R^2	0.991		0.969		0.939	
# of Obs.	56		112		168	

Table 5: **RDD Estimates for Retail Prices.** ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. Huber-White (robust) standard errors are reported in parentheses. The window size describes the length of time period for the analysis. The starting day of policy implementation (January 1st) is at the center of the window. For example, if the window size is 2 months, then the period of analysis is December 1st – January 31st. Note that the estimates are reported in terms of "log points" in this table, while they are converted into "percentage points" in the text.

Dependent variable: Log Price (2-month window)

	Retail Prices		Wholesale Prices	
Variable	**Coefficient**	**St.Error**	**Coefficient**	**St.Error**
2009–2010	0.021	(0.126)	-0.022	(0.026)
2010–2011	-0.016	(0.123)	0.011	(0.028)
2012–2013	0.011	(0.118)	-0.035	(0.027)
2013–2014	0.031	(0.121)	-0.009	(0.026)
Linear trend	omitted		Yes	
Item fixed effects	Yes		Yes	
# of Obs.	56		1,924	

Table 6: **RDD Estimates for Placebo Treatment Dates.** ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. Huber-White (robust) standard errors are reported in parentheses. The period of analysis is December 1st – January 31st (2-month window) of the corresponding year. The starting day of policy implementation (January 1st) is at the center of the window. The estimates for wholesale and retail prices are performed based on daily and monthly price observations, respectively. Note that the estimates are reported in terms of "log points" in this table, while they are converted into "percentage points" in the text.

Central Bank of the Republic of Turkey
Recent Working Papers
The complete list of Working Paper series can be found at Bank's website
(http://www.tcmb.gov.tr).

Decomposition of Labor Productivity Growth: Middle Income Trap and Graduated Countries
(Gökhan Yılmaz Working Paper No. 15/27 October 2015)

Estimating Income and Price Elasticity of Turkish Exports with Heterogeneous Panel Time-Series Methods
(İhsan Bozok, Bahar Şen Doğan, Çağlar Yüncüler Working Paper No. 15/26 October 2015)

External Shocks, Banks and Monetary Policy in an Open Economy: Loss Function Approach
(Yasin Mimir, Enes Sunel Working Paper No. 15/25 September 2015)

Tüm Yeni Açılan Krediler Eşit Mi? Türkiye'de Konut Kredisi ve Konut Kredisi Dışı Borç ile Özel Kesim Tasarruf Oranı
(Cengiz Tunç, Abdullah Yavaş Working Paper No. 15/24 September 2015)

A Computable General Equilibrium Analysis of Transatlantic Trade and Investment Partnership and Trans-Pacific Partnership on Chinese Economy
(Buhara Aslan, Merve Mavuş Kütük, Arif Oduncu Working Paper No. 15/23 September 2015)

Export Behavior of the Turkish Manufacturing Firms
(Aslıhan Atabek Demirhan Working Paper No. 15/22 August 2015)

Structure of Debt Maturity across Firm Types
(Cüneyt Orman, Bülent Köksal Working Paper No. 15/21 August 2015)

Government Subsidized Individual Retirement System
(Okan Eren, Şerife Genç İleri Working Paper No. 15/20 July 2015)

The Explanatory Power and the Forecast Performance of Consumer Confidence Indices for Private Consumption Growth in Turkey
(Hatice Gökçe Karasoy, Çağlar Yüncüler Working Paper No. 15/19 June 2015)

Firm Strategy, Consumer Behavior and Taxation in Turkish Tobacco Market
(Oğuz Atuk, Mustafa Utku Özmen Working Paper No. 15/18 June 2015)

International Risk Sharing and Portfolio Choice with Non-separable Preferences
(Hande Küçük, Alan Sutherland Working Paper No. 15/17 June 2015)

A Theory of Intra-Firm Group Design
(Semih Tümen Working Paper No. 15/16 June 2015)

Government Spending Multiplier in Turkey
(Cem Çebi Working Paper No. 15/15 June 2015)

Kayıt Dışı Ekonomide Beceri Edinme ve Okul Eğitimi: Yükselen Ekonomilerden Kanıtlar
(Semih Tümen Working Paper No. 15/14 May 2015)

Türkiye için Finansal Koşullar Endeksi
(Hakan Kara, Pınar Özlü, Deren Ünalmış Çalışma Tebliği No. 15/13 Mayıs 2015)

The Dynamic Relationship Between Stock, Bond and Foreign Exchange Markets
(S. Hilmi Kal, Ferhat Arslaner, Nuran Arslaner Working Paper No. 15/12 April 2015)

Anticipated vs. Unanticipated House Price Movements and Transaction Volume
(Yavuz Arslan, Birol Kanık, Bülent Köksal Working Paper No. 15/11 April 2015)

Türkiye'de İhracatın İthalatı Karşılama Oranı Üzerine Ampirik Bir Analiz
(Mustafa Faruk Aydın, Yusuf Soner Başkaya, Ufuk Demiroğlu Çalışma Tebliği No. 15/10 Nisan 2015)