Do Consumers Benefit from Supply Chain Intermediaries? Evidence from a Policy Experiment in Edible Oils Market in Bangladesh

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ABSTRACT

Commodity traders are often the focus of popular resentment. Food price hikes in 2007-2008 resulted in protests and food riots, and spurred governments to regulate traders. In March 2011, the Bangladesh Government banned Delivery Order traders (DOTs) in the edible oils market, citing cartelization, and replaced them with a dealer's network appointed by upstream refiners. The reform provides a natural experiment to test alternative models of marketing intermediaries. We develop three models and derive testable predictions about the effects of the reform on the intercept of the margin equation and pass-through of international price. Using wheat as a comparison commodity, a difference-of-difference analysis of high frequency price data shows the reform led to (i) an increase in domestic prices and marketing margins, and (ii) a weakening of the pass-through of imported crude prices. The evidence is inconsistent with the standard double-marginalization-of-rents (DMR) model wherein intermediaries exercise market power while providing no value-added services, or with a model where DOTs provide credit to wholesalers at below-market interest rates. The evidence supports a model where DOTs relax binding credit constraints faced by the wholesale traders.

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1 Introduction

Throughout history, monopoly power of marketing intermediaries has been identified as one of the most important sources of high food prices; commodity speculators are often condemned as evil agents who add no value to society, but destroy the stability of the market.[2] Many governments have implemented measures to curb the market power of the traders, and, in some cases, banned them or particular trades they frequently make. For example, in USA Chicago onions futures were banned in 1958, which remains in place to date. In Berlin wheat futures in Germany were prohibited in 1897. Distrust of private traders led to the establishment of marketing boards in many developing countries in 1950s and 1960s. However, disappointing results with the marketing boards and other parastatals in commodity markets led to agricultural market liberalization starting from the late 1970s. Lack of trust in middlemen traders in commodity markets nevertheless remains widespread and deeply ingrained; the price spiral in international commodity markets in 2007-2008 brought their role back into focus.[3]

Although market power among traders has been the dominant explanation for price increases in food markets among politicians and people in general, there is little rigorous evidence on the industrial organization of food markets in developing countries that can test this view. While traders may exercise market power (owing to concentration and/or collusion), they may also play a variety of efficiency-enhancing roles in the supply chain. These could include provision of trade credit to downstream distributors, supply assurance via inventory holdings and quality inspections, reducing consumer search costs, or absorbing price risks, which can lower distribution costs and consumer prices. Trading off these costs and benefits requires detailed evidence-based analyses.

To this end, we study the effects of a policy reform which banned a particular layer of middlemen called the Delivery Order traders (DOTs) in the edible oils market in Bangladesh during the second half of 2011. The 2007-2008 food price shock reignited popular resentment against the traders in Bangladesh. This included edible oils which constitute a significant fraction of household expenditures. The government subsequently identified DOTs in the edible oils market as responsible for the price rise

[2]The sentiments were shared by most, from Aristotle to Lincoln to Lenin. For example, Abraham Lincoln said "For my part, I wish every one of them (speculators) had his devilish head shot off. (as quoted in Carpenter (1866, p. 84)), and Lenin concluded: "For as long as we fail to treat speculators the way they deserve—with a bullet in the head—we will not get anywhere at all. ((Lenin, 1964, p. 311).)

[3]It is a widely held belief among politicians, bureaucrats and general population in developing countries that collusion especially among the traders and the resulting market power are largely responsible for such price spirals in the food markets. For example, in a seminar organized by Bangladesh Institute of Development Studies in February 2010, both the finance minister and commerce minister of Bangladesh Government identified monopoly power and price fixing by cartels (called "syndicate) as the salient factors behind the observed rise in prices of food essentials such as edible oil, sugar and onion ("Minister Blames Price Hike on Syndicates, Daily Star, February 24, 2010). Similarly, Kaushik Basu, the then chief economic advisor to Government of India, pointed out monopolistic practices (cartels) and speculative storage (hoarding) as drivers of the recent dramatic increase in onion price (Reuters, January 5, 2011).

by exercising undue market power.[4] In a policy move in March 2011, DO trading was prohibited, and was replaced by a Sale Order (SO) system, whereby edible oil refiners would bypass DO traders, and directly sell to newly appointed dealers among wholesale traders. We exploit this policy experiment to discriminate among alternative models of the role of marketing intermediaries.

A standard model of the vertical supply chain involving double marginalization of rents (DMR) provides a rationale for the regulation adopted by the Bangladesh Government. In this model, refiners and DOTs exert market power, and the DOTs are pure intermediaries between refiners and wholesalers who do not provide any value-addition services. Using a Bulow-Pfleiderer (1983) demand specification, wholesale prices end up being a convex combination of the demand intercept and cumulative upstream costs (sum of crude import and refining costs of the refiner, and the costs incurred by the DOTs and the wholesalers). Higher market power at each layer results in a higher weight assigned to the demand intercept, resulting in higher price levels and lower pass-through of upstream costs. In this model, elimination of the DOT layer from the market leads to a reduction in the prices, and increases the pass-through of costs (imported crude Palm oil). Although common in the existing theoretical literature on cost pass-through in a vertical chain (see, for example, Adachi and Ebina (2014a, 2014b), the assumption that the marketing intermediaries such as DOTs do not provide any services is not consistent with the available evidence. Based on extensive and intimate knowledge of the edible oils market in Bangladesh, we develop two models where the primary role of DOTs is provision of supplier credit to the wholesale traders. In the first model, apart from exercising market power, the DOTs provide a valuable service: credit to the wholesalers at below-market interest rates. When DOTs are eliminated, wholesalers borrow from alternative market sources at higher interest rates, while not being subject to any credit rationing. The second model focuses on the credit rationing faced by wholesale traders, and the DOTs help relax binding credit constraints. The models deliver sharp predictions regarding the effects of the policy experiment on the intercept and slope of the price (and marketing margin) equation.[5]

To test these predictions, the empirical analysis focuses on prices of palm oil, which accounts for more than 75 percent of domestic edible oils consumption in Bangladesh. We use a difference-in-difference (DID) approach examining how the relation between wholesale prices of refined palm oil and

[4] A DO is a sales receipt issued by the refiner with the quantity of oil specified on it (30-45 drums of oil, each drum containing 150 maunds), to be deliverable after a specified time period (usually 2 weeks). However, most of the DOs in recent years did not have a specified delivery date, only the quantity was specified.

[5] The DOTs do not play a significant role in quality inspection and assurance, as they do not take physical delivery of the oil. The reputation for quality is associated with a refiner. Note that the reform may have reduced the search costs of the wholesale traders, as it is easier to search for better price among 9 refiners than among 300 DOTs. We discuss later that the possible changes in search costs of the wholesale traders is not a plausible alternative explanation of the empirical findings.

import prices of crude oil differed before and after the reform, with wheat as a comparison commodity. Wheat is chosen as a basis of comparison for at least three reasons. First, both wheat and palm oil are primarily imported into Bangladesh with little or no domestic production; thus the international market plays an important role in both. Second, both palm oil and wheat are easily storable, because they do not need cold storage. Third, they are bulky, necessitating substantial transport charges. Hence fluctuations in transport or storage costs would apply in a similar way to the distribution costs of Palm oil and wheat.[6] The availability of long time series data before the policy intervention allows us to test the validity of the parallel trend assumption by using a placebo policy reform date. Taking advantage of the rich time series data from the pre-intervention period, we take into account the implications of the world market cycle for our difference-in-difference design, because the marketing margin depends on the phase of the international market (upswing vs. downswing) in a way consistent with imperfect pass-through into the domestic prices.

The results of the empirical analysis definitively contradict the predictions of the basic DMR model: pass-through of imported crude oil costs to wholesale prices fell significantly following the reform, while the intercept term increased. Overall, controlling for the imported crude prices, wholesale palm oil prices were significantly higher following the reform, contrary to the expectations of the policy makers and the observers of Bangladesh economy.

While the increased financing costs of wholesalers in the second model can explain the higher *level* of wholesale prices resulting from the reform, it turns out to be inconsistent with the pass-through results observed. The third model builds in an additional role for DOTs wherein they relax credit constraints faced by wholesalers when borrowing from alternative sources. The predictions of this model are consistent with the empirical results if these credit constraints are strong enough. The intuitive explanation is that the reform sharply limited the amount of oil that wholesalers could purchase and offload onto the market, raising the price level. Pass-through of crude oil prices to wholesale prices fell as the buyer credit limits reduced the effective price elasticity of the residual demand curve faced by refiners, thereby raising their effective market power. This explanation is also consistent with anecdotal accounts of how the reform disrupted flows through the supply chain, as well as evidence of a decline in crude oil imports following the reform (at a time when crude oil prices were dropping), as also the fact that the reform could not be sustained beyond six months as refiners sought out previous DOTs to help relieve these supply disruptions.

This paper makes three contributions to the literature. First, it provides a credible test of a standard

[6]One might argue that wheat is more transport and storage 'intensive' in the sense that storage and transport costs constitute a larger fraction of the price for wheat. We discuss the implications of this later in the paper.

model of marketing intermediaries based on market power which is popular in many developing countries among the policy makers and press. Second, it suggests that a better understanding of the functioning of the markets in developing countries needs to take the role of credit rationing and supplier credit seriously. Third, the results in this paper are relevant for proper micro-foundations for incomplete pass-through of world prices analyzed in a large literature in international finance and macroeconomics.

Section 2 reviews related literature to place the contributions of this paper in perspective, followed by Section 3 which explains the nature of the palm oil supply chain in Bangladesh and the 2011 reform. Section 4 presents alternative models of the vertical chain in the edible oil market with a focus on the financing role of DOTs. A benchmark DMR model is used to provide a theoretical rationale for the reform. Section 5 develops the empirical strategy based on a difference-in-difference design, and the next section discusses the data sources. Section 7 then reports the estimates of the effects of the reform on the world-wholesale margin. The results on the effects on consumer price are presented in the following section. Finally, Section 9 concludes.

2 Related Literature

The theoretical and empirical analysis presented below in this paper intersects a number of important strands of economic literature. While it clearly belongs to a small but active research agenda that focuses on understanding the role of marketing intermediaries in product markets in developing countries (see, for example, Banerji and Meenakhshi (2004, 2008)), it also informs the micro foundations for pass-through of international prices to domestic consumers which has been analyzed by a large literature in international finance and macroeconomics. The traditional focus of the theoretical and empirical literature in Development Economics has been on the imperfections in factor markets, especially the effects of imperfect or missing credit and insurance markets for efficiency and equity.[7] There is a substantial literature that analyzes interlinkage between factor markets (Bardhan (1980)). Our analysis focuses on the role played by upstream marketing intermediaries in product market when credit market imperfections constrain the downstream traders in the vertical chain.

A recent literature deals with the effects of transport infrastructure on the marketing of agricultural commodities and the prices received by the producers in developing countries (Casaburi et al. (2013), Fafchamps and Hill (2008), Minten and Kyle (1999)). In an interesting analysis, Casaburi et al. (2013) find that improvements in road quality reduced market prices of local crops in Sierra Leone, which contradicts models of bilateral bargaining, Bertrand competition, or Cournot oligopsony, but is

[7] A famous exception is Akerlof (1970), which was partly motivated by quality problems in rice market in India.

consistent with the predictions of a search model.[8] Their focus on discriminating among alternative models of intermediaries is, in spirit, similar to ours, but there are also important differences between the two studies. First, Casaburi et al. (2013) rely on the the reductions in transport costs arising from road improvements as a policy experiment. In contrast, the policy experiment in our application is a drastic regulation that affected the whole market. Our results are thus relevant for the country as a whole. Second, while search costs are important when farmers are trying to find better prices for their crops, as found by Casaburi et al (2013), search costs are unlikely to be an important part of the explanation in our context. As noted earlier, the policy reform we exploit might have reduced the search costs faced by the wholesalers, and thus our finding of an increase in the prices following the reform cannot be explained in terms of search costs. More important, the search costs are likely to be very small in this market for wholesale traders, which usually involves nothing more than a couple of phone calls. Third, given that crude Palm oils are imported to Bangladesh with very little domestic production, we can ignore many possible confounding factors that can arise from domestic production shifts of a commodity.

The evidence and analysis present in this paper are relevant for a rich literature on imperfect pass-through of international prices and exchange rate variations to domestic producer and consumer prices (for recent contributions, see, among others, Goldberg and Hellerstein (2008), Nakamura and Zerom (2010), Berman et al. (2012), Bonnet et al. (2013), and for recent surveys, see Burstein and Gopinath (2013), and Campa and Goldberg (2008)). However, most of the literature focuses on developed countries, and uses the double marginalization model with pure intermediaries as the work-horse. The degree of pass-through of world prices in these models depends on two factors: the degree of market power of the marketing intermediaries in the supply chain, and the second-order curvature of the demand function (see Adachi and Ebina (2014a, 2014b), Weyl and Fabinger (2013)). There has also been an increasing emphasis on the role played by domestic distribution costs (transport and storage) in explaining imperfect pass-through. To the best of our knowledge, the role played by the supplier credit and, in particular, the implications of credit rationing have largely been ignored in the existing literature. In an interesting paper, Atkin and Donaldson (2014) use the Bulow and Pfleiderer (1983) demand function as we do in this paper, and show that it is possible to uncover the trade costs from spatial price differences, because the pass-through rate provides a sufficient statistic for the indirect effect of a change in the trade costs on varying mark-ups. Their model differs from ours in two important ways. First, consistent with the existing literature, the traders are "pure intermediaries" in their model, they transport goods from the production (or import) point to a destination market

[8] They adapt the search model of Chau et al. (2009) to their application.

incurring "trade costs" (transport costs), and the prices charged by the traders reflect both mark-ups and marginal trade costs. In our case, the DOTs play an explicit credit provision role for the downstream wholesale traders. Second, the trade costs they consider are unit costs, i.e., the costs that vary with the quantity. This is appropriate in their context where the focus is on spatial differences in prices, assuming that access to credit and interest rates do not vary significantly across locations. In contrast, our basic model incorporates both per unit (transport and storage) and advalorem trading costs (financing costs). More important, we explore the implications of binding credit constraints faced by wholesale traders for pass-through and marketing margins.

Although there has been a renewed interest in the domestic food markets in developing countries in response to the price shocks in the international market, most studies estimate the effects of higher international prices on domestic prices (pass-through) in reduced form regressions, and the focus is usually on the implications of higher consumer prices for poverty.[9] To the best of our knowledge, none of the recent studies spurred by the international price rise in 2007-2008 rigorously examined the impacts of policy interventions in the marketing chain on the marketing margin, or made an attempt to understand the role played by the intermediaries. As these types of policy interventions are being considered or implemented by other developing countries, a careful study of the Bangladesh case will be useful to the policy makers and analysts in other developing countries.

There is a substantial literature on the functioning of commodity markets in developing countries in general, and also in the specific context of Bangladesh. The literature on food markets in developing countries has traditionally focused on the spatial integration (see, for example, Ravallion (1986), Baulch (1997)), and on the effects of government stabilization policy such as procurement, and price and non-price interventions at the domestic and international levels (see, for example, Newbery and Stiglitz (1981), Islam, and Thomas (1996), Byerlee et al. (2006)).

In the context of Bangladesh, the focus of the research and policy analysis has been on the functioning of the rice market and price stabilization (see, for example, Ahmed and Bernard (1989), Goletti et al. (1995), and Chowdhury (1992), Murshid (2011)). Mahmud et al. (1994) analyze constraints on crop diversification in Bangladesh agriculture. Among the available studies, Chowdhury (1992) and Farid and Rahman (2002) discuss the marketing chain in the rice market, and indicate the presence of market power on the basis of descriptive statistics. Rahman et al. (2008) and CPD (2007) provide descriptive analysis of the food price inflation and suggest possible market power exerted by the millers, refiners and large wholesalers. However, they do not provide any formal analysis of the market structure and do not present any rigorous test for the existence of market power or collusion.

[9] See, for example, Ivanic et al. (2012), Wodon and Zaman (2010), and Minot and Dewina (2013).

The evidence on the functioning of the edible oils market in Bangladesh is limited; we are aware of only two studies that discuss the role of marketing intermediaries in the edible oils market in Bangladesh (Uddin and Taslim (2010), and Choudhury and Clara Costa (2012)). Helal and Taslim (2010) provides a discussion on the operation of the different layers of the edible oil market, and attempt to provide evidence on collusion among intermediaries using cointegration and a test of equality of variances of prices between world and domestic markets. However, they are aware of the limitations of such tests for identifying market power and collusion. They characterize the refiner layer of the market as an oligopoly with potential for anti-competitive practices. Choudhury and Clara Costa deal with the effects of 2011 policy reform on the refiners by analyzing two case studies; they provide preliminary evidence on the effects of the policy reform on two refiners: Nurjahan Group and Bangladesh Edible Oils Limited. They find that both refiners had difficulties in establishing a network of dealers as required by the reform and they also curtailed the import of crude oil following the reform.

3 The Marketing Chain in the Bangladesh Palm Oil Market and the 2011 Reform

3.1 Marketing Chain of Palm Oil Before the Policy Reform

Here we provide a brief description of the marketing chain in the palm oil market in Bangladesh before the policy intervention in June 2011 (for a more detailed discussion, see Uddin and Taslim (2010)). The palm oil market consists of four layers: the refiners, the delivery order traders (the DOTs), the wholesalers, and retailers. The refining segment is highly concentrated, there are only 9 refinery groups, and observers believe that there is excess capacity (Uddin and Taslim (2010)). The refiners import crude palm oil from Malaysia and Indonesia and refine it. Most of the refined palm oil goes through the DOTs, although wholesalers can buy directly from the refiners with cash payments.[10] It is attractive for the wholesalers to buy oil from the DOTs for two reasons: (i) DOTs buy in bulk and get price discounts from the refiners, part of which they can share with the wholesalers, and (ii) a significant proportion of sales by DOTs to the wholesalers are on credit. In fact, estimates from a recent survey of the edible oils market in Bangladesh shows that about 30 percent of transactions between the DOTs and wholesalers are on credit with little or no collateral; relational credit is thus an important aspect of the marketing network.

The DOTs buy the DOs for oil deliverable by the refiner after a stipulated period of time (usually

[10] A small proportion of palm oil (super palm) is bottled and sold through a separate network of agencies primarily used for soybean oil distribution. Our focus is on the loose palm oil that consists of about 95 percent of the palm oil market.

2 weeks). It is important to appreciate that the DOTs do not own any storage and thus do not take delivery of the oil. The DO layer of the market interacts vertically with the refiners upstream and the wholesalers downstream, and also horizontally with other DOTs (relatively smaller DOTs buy from the large DOTs). The horizontal transactions among the DOTs have evolved into something like an organized commodity exchange in Moulovibazar in Dhaka and Khatunganj in Chittagong where speculators operate with the help of brokers. However, note that the DO system is not a futures market, because there is no "settlement at the end of the day (it is not marked to market). Also, unlike a futures contract, the payment is made at the time of the contract, not at the delivery date. The fact that the DOTs pay ahead of the physical delivery implies that the refiners effectively get short-term loans at zero interest rate. It is common for a refiner to sell DOs as soon as the letter of credit for import of the crude palm oil is opened, although it takes 4-6 weeks to get the oil from Malaysia and Indonesia. The DO is also not a standard forward contract, because the stipulated delivery date is almost never enforced. Thus the DO contract resembles something like an American call option. In some cases, a DO may not be executed for more than a year. This implies that the DOTs or other DO holders bear less price risk compared to a standard forward contract.

3.2 The Policy Reform

The policy reform focused on the DO layer of the market. The law banning DO (Delivery Order) transactions and instituting SO (Sales Order) dealers in its place (i.e., Essential Commodities Marketing and Distributor Appointment Order 2011) was passed in March 23 2011, and 90 days were allowed to implement the policy change, implying that the directive implementing the law came into effect on June 21, 2011.

It was argued by the government and popular media that in the DO system a few big players exert market power and manipulate the market by strategically buying, holding and selling DOs. Under the SO system, dealers are appointed for each "marketing area" (for example, upazilla or municipality) selected by the refiners, and a dealer is allowed to buy oil "commensurate with" the size of the market. This is expected to break the "large player" problem. In total, 7388 dealers for edible oil were appointed by different refiners; City group playing a dominant role with 3796 dealers. A refiner was allowed to demand 200,000 taka as 'security money' for accepting a trader as its dealer, but the City Group which appointed more than half of all dealers waived the security deposit. The fact that the City Group had to waive the deposit may indicate the difficulties faced by the refiners in establishing a network of dealers to distribute the oil to the wholesalers and retailers.

The law also made the SO non-transferable, in an attempt to stop the development of lateral

transactions which may become something like an embryonic organized commodity exchange similar to the DO-Broker system. The dealer (SO holder) is supposed to take delivery of oil from refiner within 15 days and sell it to the retailers. The requirement that the SO dealers need to take delivery of the oil implies that the dealers need storage facilities, unlike the DOTs who never had to take the delivery of the oil from the refiner.[11]

The newspaper reports and discussions with the DO traders (who became SO after the policy reform) in the two most important markets in Dhaka and Chittagong indicate that the refiners faced difficulties with the distribution of oil following the reform. Since the DOTs who became dealers after the reform did not own any storage before the reform, they might have faced difficulties in taking delivery of the oil. More importantly, the ability to get oil from the refiners may have been limited for many dealers because of a lack of credit availability. As noted above, a major function of the DOTs were that they provided oil on credit based on their accumulated information about the wholesalers. The reform over-night destroyed these long-standing credit arrangements. As a result the dealers were unable to pay for the required oil, and the refiners began to accumulate stock beyond their desired level of inventory. This prompted the refiners to look for alternative distribution channels, and naturally, they went back to some of the large DOTs to sell the oil effectively undermining the new system. The government did not take any action against it, and this passivity on part of government might have set into motion forces to push back the marketing system towards the old DO system after the first six months of the policy implementation.

4 Models of the Marketing Chain

The expressed goal of the reform was to eliminate the market power of the DOTs and was intended to reduce middlemen margins and ultimately the prices faced by the consumers. Although the government did not put forth any explicit model to justify the policy reform, a plausible model that rationalizes government's policy can be constructed where both the refiners and DOTs enjoy significant market power resulting in double marginalization and higher consumer prices. There are only 9 refiners of edible oils in Bangladesh, and the refining technology exhibits increasing returns, owing to large fixed costs. In fact, observers believe that there is excess refining capacity in the edible oils sector in Bangladesh. Given the technology, it may be difficult to introduce competition at the refiner level, and collusion may also be easier with such a small number of players (Helal and Taslim (2010)). It is thus understandable for the government to focus on the DO layer. This was also politically expedient given the general

[11] One might rationalize this as an attempt to reduce hit and run entry and exit by increasing the fixed costs of operation.

distrust of middlemen in Bangladesh.

The government's argument that the replacement of DOTs by the SOTs would result in lower prices seems plausible because the reform was expected to deconcentrate the market. The number of dealers appointed by the refiners after the reform was more than 7300, while the number of DOTs were about 300 (summing over both Dhaka and Chittagong markets). Thus purely in terms of number of dealers, the reform was successful in reducing concentration in the market. More important, most of the dealers (more than 7000) were wholesalers themselves before the reform, so it amounted to removing an intermediate layer of traders between refiners and wholesalers. The following model captures the argument that this ought to lower middlemen margins and consumer prices.

In this section, we develop two models of the vertical chain of the edible oils market in Bangladesh where DOTs are not pure intermediaries, but provide services to the downstream wholesale traders. In the first model, the DOTs provide low cost credit to the wholesale traders, and the traders are not credit rationed when they have to borrow from the credit market such as banks. The standard double marginalization model with pure marketing intermediaries is a special case of this model (called the policy model here after), and it can provide an expost rationale for the policy reform implemented by the government. The DOTs in the second model not only provide low cost credit, they also relax binding credit constraints faced by the wholesale traders when borrowing from banks.

4.1 DOTs as Providers of Low Cost Credit

We build a model of vertical chain with three layers in the market: refiners, DOTs and traders (wholesalers). Although the edible oil supply chain also includes retailers, we ignore them as the focus is on the effects of the elimination of the DOTs on wholesalers. This simplifies the algebra. We shall assume that there are sufficiently many wholesalers that they effectively have no market power. All the conclusions would remain intact in a model that includes a competitive retail sector and the wholesalers exercise some market power. Besides, we shall see in the next section that most of the effects of the reform were on the margin between the crude import price and the wholesale price.

The inverse demand function is assumed to be that of Bulow and Pfleiderer (1983):

$$P^T = \alpha - \eta Q^{\delta}; \;\; \alpha, \eta, \delta > 0 \tag{1}$$

where P^T is the price charged by the traders to the consumers. There is a fixed number ($N_r \geq 1$) of refiners who import crude palm oil from the world market at an exogenous price P^w and produce edible oil with a Leontief production function; for simplicity, we assume that 1 unit crude is transformed into

1 unit of refined oil. The refiners incur per unit cost of C^r for labor and other intermediate inputs in addition to the crude oil cost. Refiners engage in Cournot competition; prior to the reform they sell to DOTs. The case where the refiners collude with one another is captured by a value of N_r smaller than the true number of refiners.

There is a fixed ($N_d \geq 1$) number of DOTs in the market. The DOTs buy DOs for the refined oil from the refiner at price P^r, and sell these to wholesalers. DOTs do not take physical delivery of the oil, so incur no storage or transport costs themselves. DOTs engage in Cournot competition with one another in selling DOs to wholesale traders. As with the refiners, the case where the DOTs collude is represented by a value of N_d smaller than the actual number of DOTs.

Evidence from a recent survey of wholesalers and dealers indicates that an important role of the DOTs is to provide supplier credit to the wholesalers (Emran et al. (2015)). DOTs are usually quite wealthy, with access to short tern capital at lower costs than is available to most wholesalers. The DOTs sell oil to the wholesale traders on credit. They bear an interest cost of i^d, smaller than i^b which either wholesalers or refiners would bear.

The DOTs purchase DOs from the refiners at per unit price P^rat the beginning of the period. Upon selling DOs at price P^d at the end of the period, the effective price received by the DOTs discounted back to the beginning of the period is $\frac{P^d}{1+i^d}$. After the reform, wholesalers buy oil directly from the refiners at the beginning of the period by taking a loan from the market at interest rate $i^b > i^d$, and they sell the oil to retailers at the end of the period. Thus they pay an effective price (inclusive of finance costs) per unit of oil equal to $P^r\left(1+i^b\right)$ after the reform. The key assumption in this version of the model is that the wholesale traders are not subject to any credit rationing. The consequence of the DOT ban is to raise the interest costs borne by suppliers, besides removing the market power of the DOT layer. The effect of the ban on wholesale prices thus depends on the relative importance of these two effects.

As mentioned above, we assume that the wholesale layer of the market is competitive, hence wholesalers have no market power and earn zero profits. Each wholesale trader incurs unit cost of C^T for transport and storage of oil.

To ensure that the market exhibit some activity, we assume that

$$\alpha > P^w + C^r + C^T \tag{2}$$

for if this condition were not satisfied it would be impossible for a positive quantity of oil to supplied to consumers at a price that covers total unit costs.

The zero profit condition at the wholesaler segment implies that:

$$P^T = P^d + C^T \tag{3}$$

Equations (1) and (3) combined gives the demand curve faced by the DOTs:

$$P^d = \left(\alpha - C^T\right) - \eta Q^\delta \tag{4}$$

The optimization problem of DOT k facing a refiner price P^r and given quantity chosen by other DOTs (Q_{-k}) is:

$$Max_{q_k^d}\Pi_k^d = \left[\frac{P^d}{1+i^d} - \left(P^r + C^d\right)\right] q_k^d$$

Using the inverse demand function above (see equation 1 above), the DOT optimization problem can be stated as

$$Max_{q_k^d}\Pi_k^d = \left[\frac{\alpha - C^T}{1+i^d} - P^r - C^d - \frac{\eta}{1+i^d}(Q_{-k}+q_k)^\delta\right] q_k^d$$

This generates the following first order condition which is necessary and sufficient:

$$\left[\frac{\alpha - C^T}{1+i^d} - P^r - C^d - \frac{\eta}{1+i^d}(Q_{-k}+q_k)^\delta\right] + q_k^d \frac{\eta\delta}{1+i^d} Q^{\delta-1} = 0$$

In a symmetric equilibrium, $q_k^d = q^d = \frac{Q}{N_d}$, and we obtain the following expression for the price at which wholesalers purchase DOs:

$$P^d = \frac{\delta}{N_d+\delta}(\alpha - C_T) + \frac{N_d}{N_d+\delta}(1+i^d)\left(P^r + C^d\right) \tag{5}$$

The equilibrium price is a convex combination of the demand intercept $\alpha - C_T$ and the unit cost $\left(1+i^d\right)\left(P^r + C^d\right)$ incurred by DOs (including the financing cost), where the weight on the latter which represents the rate at which cost increases are passed through to wholesalers, is increasing in the number of DOTs. As N_d increases the DOT layer becomes more competitive, raising the pass-through rate, and lowering the level of the price paid by wholesalers (given (2)). The wholesale price converges to the DOT cost $\left(1+i^d\right)\left(P^r + C^d\right)$ as N_d tends to infinity. Note also that the pass-through of refiner price (P^r) or other components of unit costs such as transport and storage depends on the interest rate in this model.

Given the way P^d depends on P^r, we can now determine the outcome of Cournot competition

among refiners. Using equations (1) and (3) above, we get the inverse demand function facing refiners:

$$P^r = \left[\frac{\alpha - C^T}{1+i^d} - C^d\right] - \frac{(\delta + N_d)}{N_d\,(1+i^d)}\eta Q^\delta \tag{6}$$

Hence the optimization problem for refiner j is as follows:

$$Max_{q_j^r}\Pi_j^r = \left[P^r - (P^w + C^r)\right] q_j^r$$

where P^w is the world market price of crude palm oil. In a symmetric equilibrium, analogous calculations as in the case of the DOT layer yields the following expression for the price at which DOs are sold to DOTs:

$$P^r = \left(\frac{\delta}{N_r + \delta}\right)\left[\frac{\alpha - C^T}{1+i^d} - C^d\right] + \left(\frac{N_r}{N_r+\delta}\right)\left[P^w + C^r\right] \tag{7}$$

The equilibrium price is a convex combination of refiner cost and the demand intercept, with a cost pass-through rate which is increasing in N_r the measure of competition at the refiner level. A higher financing cost does not affect the pass-through of world price to the price charged by the refiners, but it lowers the price level by reducing the intercept of the demand curve faced by the refiners.

The eventual outcome on the price charged by wholesalers is obtained by combining (3, 5, 7):

$$P_{DO}^T = \left[1 - \frac{N_r}{N_r+\delta}\frac{N_d}{N_d+\delta}\right]\alpha + \frac{N_r}{N_r+\delta}\frac{N_d}{N_d+\delta}\left[(1+i^d)\left(P^w + C^d + C^r\right) + C^T\right] \tag{8}$$

where P_{DO}^T denotes equilibrium wholesale price before the reform (i.e., with DOTs operating in the market), and it is again a convex combination of the demand intercept α and cumulative supply cost $\left(1+i^d\right)\left(P^w + C^r + C^d\right) + C^T$, with a cost pass-through rate that is the product of competition measures at the refiner and DOT layers. The pass-through of world price to the wholesale price also depends on the interest rate faced by the DOTs.

After the DOT ban, the market power of the DOTs is eliminated, while the unit costs decline to $(P^w + C^r)$, and interest factor rises from $(1+i^d)$ to $(1+i^b)$:[12]

$$P_{NDO}^T = \left[1 - \frac{N_r}{N_r+\delta}\right]\alpha + \frac{N_r}{N_r+\delta}\left[(1+i^b)\left(P^w + C^r\right) + C^T\right] \tag{9}$$

where P_{NDO}^T is the wholesale price without the DOTs after the reform. Denoting the marketing margin between the world market and wholesale level by M^T, we have $M_{DO}^T = P_{DO}^T - P^w$, and

[12] As noted earlier, the unit costs incurred by DOTs are likely to be very small, because they do not incur transport or storage costs.

$M^T_{NDO} = P^T_{NDO} - P^w$. Note that the standard double marginalization model where DOTs are pure intermediaries is a special case of the above model, with $i^d = i^b = 0$, which provides us with a benchmark.

A comparison of equations (8) and (9) above yield sharp predictions about the effects of the policy reform on the slope and intercept of the wholesale price. *If the DOTs are pure intermediaries, the reform is expected to reduce the intercept of margin equation and increase the passthrough rate of world price P^w, thus reducing the wholesale margin of the traders as claimed by the government.* The reform in this benchmark model increases competitiveness, because the term $\frac{N_d}{N_d+\delta}$ is replaced by 1 in the post-reform price equation. *When the DOTs provide low interest credit to the wholesale traders, the reform would increase the passthrough of crude oil price, but it can also increase the intercept if i^b is sufficiently large compared with i^d. As a result, the level of wholesale price may go up following the elimination of DOTs from the market.* Not only is there an increase in competitiveness as a result of the ban, the interest cost on financing the time-lag between crude imports and acquisition of refined oil by wholesalers has increased.

4.2 DOTs Role in Alleviating Credit Limits of Wholesalers

In this section, we analyze a model in which the The absence of DOTs following the reform led not only to an increase in the cost of borrowing by wholesale dealers, but also imposition of quantitative credit limits by alternative financiers. This is based on the assumption that wholesalers faced no credit rationing prior to the reform, owing to long-term relationships with DOTs. As noted earlier, recent survey evidence indicates that about 30 percent of transactions between the DOTs and the wholesalers are on credit. The reform constrained the use of the information capital accumulated by the DOTs (and brokers) over more than six decades. Unlike the DOTs, refiners had little or no information about the credit-worthiness of a wholesaler (dealer) and were therefore reluctant to provide oil on credit.[13] This forced the dealers to finance their purchases from other sources, possibly resulting in binding credit limits which restricted their ability to purchase oil from refiners. The resulting disruption in oil supply to downstream retailers would then raise the price at which the wholesalers would be selling to retailers. In order to derive implications for pass-through rates, we now work out an extension of the preceding model.

Prior to the reform, we suppose the analysis of the earlier section applies, with the wholesale price determined according to (8). After the reform, wholesale dealers have to borrow at an interest rate of $(1+i_b)$ and are subject to a credit limit of B (aggregating across all the dealers). We assume the number

[13] Recall that the wholesalers could buy oil from refiners directly before the reform, but they had to pay cash.

of wholesalers is fixed at its pre-reform level, which is not going to be able to adjust as a consequence of the reform. As we shall see, incumbent wholesalers will end up earning positive profits following the reform owing to the oil 'shortage' which is going to emerge, which will create pressure for entry of new wholesale dealers. In the short run — which seems a reasonable description of the six months for which the reform was in place — such entry may not materialize even if there are potential dealers waiting in the wings, as the process of entry can take some time to implement. It is also possible that credit constraints limit the supply of new entrepreneurs: incumbents have some access to credit to finance working capital needs, whereby potential entrants do not.

We will not, however, need any explicit notation for the number of wholesalers, as we will continue to assume that all incumbent wholesale dealers are identical and thereby focus on symmetric equilibria. We can then focus on the behavior of a single representative wholesaler that has no independent market power, and is subject to a credit limit of B in value terms.[14] To study when this can impose a binding limit on oil purchases from refiners, consider first what working capital requirements would be in the absence of any credit limit. If refiners set price P^r and dealers borrow at interest rate i_b after the reform without being subject to any quantitative limits, the wholesale price would be

$$P^T = (1 + i_b)P^r + C^T = \alpha - \eta Q^\delta \tag{10}$$

as a result of competition among wholesalers. This generates the inverse demand equation faced by refiners

$$P^r(Q) = \frac{\alpha - C^T - \eta Q^\delta}{1 + i_b} \tag{11}$$

implying a wholesaler working capital requirement of

$$W(Q) \equiv QP^r(Q) = \frac{Q(\alpha - C^T) - \eta Q^{1+\delta}}{1 + i_b} \tag{12}$$

This function is increasing over the range $Q \in [0, Q^*]$ and decreasing thereafter, where $Q^* \equiv [\frac{\alpha - C^T}{\eta(1+\delta)}]^{\frac{1}{\delta}}$ (see Figure 1). If the credit limit B is smaller than $W(Q^*)$, the credit limit will be binding over some range (Q_1, Q_2), where Q_1, Q_2 are the two solutions of the equation $W(Q) = B$.

[14] One might wonder whether a model where some of the wholesalers are not credit rationed after the reform may yield substantially different results. Note that the wholesalers are geographically dispersed across the country, and have little or no information about the wholesalers (and retailers) in market areas not served by them before the reform. Even if some wholesalers have excess funds after meeting the demand in their segment, they will face the same informational constraint when considering selling oil to wholesalers from other regions who are credit rationed. Thus we can at best have some isolated cases where the wholesaler may not be credit rationed given the demand faced in their local market. But as long as the proportion of wholesalers who are credit rationed is not too small, so that the credit limit B is small enough, the results derived below continue to hold.

The assumption of a binding credit limit then amounts to imposing the condition

$$Q_1 < Q_u < Q_2 \tag{13}$$

where Q_u denotes the quantity of oil that would be purchased in equilibrium by wholesalers if they were not subject to credit rationing, i.e.,

$$\frac{1}{1+i_b}\left[\alpha - C^T - \eta(1+\frac{\delta}{N_r})Q_u^{\delta}\right] = P^w + C_r \tag{14}$$

Over the intermediate range (Q_1, Q_2), the inverse demand function facing refiners will become a rectangular hyperbola

$$\tilde{P}^r = \frac{B}{Q} \tag{15}$$

instead of (11) above, thereby resulting in a change in the price elasticity of demand. This implies an interior equilibrium with credit rationing will involve quantity sold Q_c by refiners in the interval (Q_1, Q_2) which will satisfy

$$\frac{B}{Q_c}(1-\frac{1}{N_r}) = P^w + C^r \tag{16}$$

while the refiner price (using (15)) will become:

$$\tilde{P}^r = \frac{N_r}{N_r - 1}(P^w + C^r) \tag{17}$$

This will be the unique symmetric equilibrium if

$$\frac{B}{Q_2}(1-\frac{1}{N_r}) < P^w + C^r < \frac{B}{Q_1}(1-\frac{1}{N_r}) \tag{18}$$

If this condition is not satisfied, the equilibrium will be at either corner: Q_1 if $\frac{B}{Q_1}(1-\frac{1}{N_r}) \geq P^w + C^r$, and Q_2 if $P^w + C^r \geq \frac{B}{Q_2}(1-\frac{1}{N_r})$. The above discussion assumes $N_r > 1$, it is easy to check that if the refiner layer behaves like a monopoly, the solution is at the corner Q_1.

Note that if the credit limit B is small enough, $\frac{B}{Q_1} \equiv \frac{\alpha - \eta Q_1^{\delta} - C^T}{1+i_b}$ will be large, and $\frac{B}{Q_2} \equiv \frac{\alpha - \eta Q_2^{\delta} - C^T}{1+i_b}$ will be small, implying that the equilibrium will be interior. The refiner price is then given by (17), with a pass-through from P^w to $\tilde{P}^r$ which exceeds unity, in contrast to the model without any credit rationing. The resulting price at which wholesalers sell oil is given by

$$\tilde{P}^T = \alpha - \eta\left[\frac{B\frac{N_r-1}{N_r}}{P^w + C^r}\right]^{\delta} \tag{19}$$

The pass-through of P^w to the wholesale price is

$$\frac{\partial \tilde{P}^T}{\partial P^w} = \delta \eta B^\delta \left[1 - \frac{1}{N_r}\right]^\delta \frac{1}{(P^w + C^r)^{1+\delta}} \tag{20}$$

which is small if B is small. Hence *the model predicts a lower pass-through rate from P^w to the wholesale price after the reform if the resulting credit rationing is strong enough, in contrast to the models in the earlier section where the reform must increase the pass-through rate.* Binding credit limits restrict the volume of oil that wholesalers can purchase; given refiners price set according to (17), we obtain

$$Q = B[1 - \frac{1}{N_r}]\frac{1}{P^w + C^r} \tag{21}$$

which implies that the effect of higher P^w on equilibrium quantity (and hence the price at which it is sold by wholesalers) is small when the credit limit B is small.

Finally, the level of the wholesale price will approach α as B approaches zero, so will rise as a result of the reform with sufficiently binding credit limits. Setting $P^w = 0$ in equation (19) above , we obtain the intercept of the margin (and wholesale pricing) equation:

$$\tilde{P}^T\,(P^w = 0) = [\alpha - \eta B^\delta (1 - \frac{1}{N_r})^\delta\,(C^r)^{-\delta}] \tag{22}$$

and the intercept term tends to α as B approaches zero. So severe supply disruptions resulting from credit rationing of wholesalers can result in higher intercept and the lower pass-through rate of crude oil prices to the wholesale price, besides a lower volume of crude oil imports. The supply disruptions would cause profits of refiners to decrease as a result of the reform, since their profit margin per unit volume of oil sold $\frac{1}{N_r - 1}(P^w + C^r)$ does not vary with the quantity sold. In fact wholesalers are the ones who profit from the disruption, as they purchase oil from the refiners at a price which does not vary with the volume of oil sold, and sell it at a price which is higher the greater the disruption (lower B) . Hence an important implication of the credit rationing model is that the refiners would have a strong interest in dismantling the reform and bringing back the old DOTs into the supply chain.

5 Empirical Strategy

In this section, we develop an empirical strategy for estimating the effects of the policy reform on the marketing margins. To capture the policy reform we define two dummies :

$$S_{at} = \begin{cases} 1 \text{ if } t \geq \text{ March 23, 2011} \\ 0 \text{ otherwise} \end{cases} \quad \text{(Announcement Effect)}$$

$$S_{ft} = \begin{cases} 1\text{if } t \geq \text{ June 21, 2011} \\ 0 \text{ otherwise} \end{cases} \quad \text{(Implementation Effect)}$$

As discussed above, the government allowed the refiners to go back to their large DOTs to off-load accumulating stocks after approximately six months of policy implementation. We report estimated effects of the policy reform in the short-term (up to six months after policy implementation) and long-term (after six months of policy implementation). As noted before, the focus of our empirical analysis is on the effects of the policy change on the marketing margin between the world market and the wholesale traders, as the DOTs were situated in the middle.

5.1 Before-After Comparisons

A simple way to estimate the effects of the policy reform is a before-after approach that estimates the following equation:

$$M_t = \lambda_0 + \lambda_1 S_{at} + \lambda_2 S_{ft} + \varepsilon_t \tag{23}$$

where M_t is the marketing margin at period t, and the policy dummies S_{at} (announcement), and S_{ft} (actual policy effect) were defined above. However, a before-after approach may yield a biased estimate of the effects of the policy reform, when time varying factors influence significantly the price of palm oil in the domestic market. For example, we would expect the price to go up if there is significant inflation in the country with all commodity prices rising because of macroeconomic factors. If the exchange rate adjustments do not reflect the rising prices adequately (because of imperfect pass-through), one might find that the marketing margin of palm oil defined as the difference between the world price and wholesale price has gone up. Other factors common across different commodities that can affect the marketing margin of different food commodities include transport and storage costs, changes in taxes etc. For example, if the transport costs decline due to better transport infrastructure, the wholesale price of palm oil is expected to decline assuming that there is reasonable degree of competition at the wholesale level. On the other hand, a higher marketing margin observed in the data may reflect higher

fuel costs for transporting the oil. If we look at the margin between the world price and wholesale price of palm, it may become higher over time simply because fuel costs have increased. Changes in ad valorem import tariff rate or value-added tax may also be incorrectly be attributed as changes in marketing margins. To address such omitted common factors, we develop a difference-in-difference approach using a comparison commodity to net out the effects of the common time varying factors.

5.2 Difference-in-Difference Approach

5.2.1 Choice of the Comparison Commodity and Control Variables

As noted before, the comparison commodity chosen for our DID strategy is wheat. This choice is based on the following considerations. First, almost all Palm oil consumed in Bangladesh is imported from Malaysia and Indonesia; the domestic supply is virtually non-existent.[15] Similarly, wheat is also primarily imported into Bangladesh, with about 80 percent of domestic consumption met from imported wheat. Thus both palm oil and wheat are highly dependent on international markets, and respond to the world price fluctuations. Second, palm oil and wheat are easily storable. Note that both the storage and transport cost of wheat is likely to be higher. In other words, the proportion of transport and storage costs in the price of wheat is higher when compared to that of palm oil. This implies that if we find that the marketing margin for palm oil has increased compared to that for wheat, it cannot be because the fuel price has gone up, or storage space has become more scarce. In the empirical analysis, we are able to control for the variations in the fuel price in the DID specification. A potentially relevant issue in understanding if any observed changes in the marketing margins are due to policy changes in the organization of the market at the world to wholesale segment of the marketing chain is that the producers (refiners) may be facing increasing marginal costs when expanding production. If the marginal cost curve slopes sharply upward, a higher marketing margin between the world market and wholesale levels may be partly due to higher marginal cost of refining when there is a demand shift. It is, however, extremely difficult to get the required data for estimating the marginal cost curves faced by different refiners (it is likely to depend on their scale and the type of machines used).[16]

In the absence of direct estimate of the marginal cost curve faced by the refiners, we use an indicator that captures movements along the marginal cost curve of the refiners. To this end, we include the relative international price of palm compared to soybean as a control in the DID specification. The rationale is that the imports of palm and soybean by the refiners respond quickly to the changes in

[15] According to one estimate, there are only 500,000 oil palm trees in Bangladesh in 2011, with most of them concentrated in hill tracts of Chittagong (Rahman, 2012).

[16] The Chinese made machines are relatively small scale and incur higher variable costs due to high consumption of Hexane.

relative prices in the international market. When the relative price of palm increases in international market, the refiners import less palm and more soybean, thus the refiner climbs down the marginal cost curve for the production of palm. However, note that the most important component of the variable cost for the refiner is the price of crude palm in the international market; when the taxes are added to the import price, the price of crude palm constitutes about 85 to 90 percent of the variable production costs. This also means that the cost of crude palm oil is a reliable proxy for the marginal cost faced by the refiners and movements along the marginal cost curve due to other factors may be limited at best.

The above discussion leads to a DID specification of the following form:

$$M_{it} = \mu_0 + \mu_1 S_{at} + \mu_2 S_{ft} + \mu_3 T + \mu_4 (T * S_{at}) + \mu_5 (T * S_{ft}) + \Gamma' X_t + \xi_{it} \tag{24}$$

where T is a dummy that equals 1 for palm and zero for wheat, and X_t is a vector of time varying controls such as transport fuel price and relative price of crude palm compared to soybean in the international market. The focus of this paper is on estimating parameters μ_4 and μ_5, which are the DID estimates of the announcement and implementation of the policy reform.

5.2.2 Issues Related to Time Series Data

Our data are different from the panel data-sets used in many studies with DID design. While most of the data-sets have a large number of cross-section units a subset of which is affected by the treatment, they are also limited in the temporal dimension: only a few time series observations, usually only 2, baseline and post-treatment surveys, are available. In contrast, the main variations in our data come from the time series dimension. We thus need to carefully understand the time series behavior of the prices, and more importantly, of marketing margins and their implications for the DID design. As we discuss in more detail below, we do not need to worry about non-stationarity in our analysis, because our focus is on the marketing margins, which are defined as the difference of two price series. Thus the price data may be $I(1)$, the marketing margin equation involves a linear combination of two $I(1)$ price variables which can be $I(0)$. Formal tests for unit roots in the residual of the estimating equation cannot reject the null of stationarity (results available from the authors).

Even though unit roots are not an issue in our analysis of marketing margins, a close inspection of the data shows that the time series behavior of the prices require careful considerations for a credible DID design in our application. The reason is that the marketing margin in palm oil depends on the price trend in the international market. Figure 1 plots the world market and domestic retail prices in our sample. It is clear that the gap between the retail and world prices moves counter-cyclically; the

marketing margin tends to decline when the international market price is on an increasing trend, and the margin increases when the international price is on a declining path. This can be seen clearly by comparing the price trends and the margin before and after July 2009 in figure 2. The behavior of domestic retail price is consistent with widely discussed incomplete pass-through of international prices in the literature; the domestic prices do not transmit the full extent of the changes in the international market prices, both at the upswing and downswing of the international market. A straight-forward implication of incomplete pass-through is that the marketing margin declines when international market price goes up, and it increases when international market price goes down. This dependence of the margins on the phase of the international market makes the standard DID specification as in equation (2) above potentially misleading. For example, it is likely that a sustained increase in international price will strengthen the political resolve for a policy reform, and we are more likely to see a policy reform to be implemented after such a period of persistent price increase in the international market. This also implies that it is more likely to observe a declining international price following the policy intervention, for example, when policy is implemented at the height of the international market cycle, as was the case with the banning of DOTs in Bangladesh. Since the marketing margins increase during the downturn because of incomplete pass-through irrespective of the policy regime, one might incorrectly attribute this increase in the margins to the policy reform if one compares margins from periods immediately before and after the policy reform.

We address the issue of the dependence of the marketing margins on the world price trend in two ways. First, we include a dummy that takes on 1 when the international price is rising. Second, we provide additional evidence on this issue by taking advantage of the long time series data available before the policy intervention. For the "before sample", we identify a time period that matches closely the international market phase observed after the policy intervention, and exclude the observations from the other pre-intervention periods. This strategy uses a subset of the pre-intervention sample, but may be more satisfactory in dealing with the counter-cyclical margins issue.

We provide formal evidence on the validity of the DID design. We test the validity of the parallel trend assumption between palm and wheat markets in two ways. First, we look at trends graphically (see Figures 2 and 3) and present nonlinear nonparametric estimates of the trends in marketing margins for these two commodities before the policy reform in March 23 2011 (see Figures 4 and 5). Figure 3 plots the marketing margin (world to wholesale) for palm and wheat for the pre-intervention sample; the marketing margin for wheat seems to track the changes in the marketing margin for palm reasonably well. Figures 3 and 4 present the nonparametric estimates of the evolution of marketing margins for palm oil and wheat over the pre-reform sample period. It is reassuring that the shapes of the both

curves are broadly similar. As a more formal test of the parallel trend assumption we use a placebo policy implementation date that bisects the pre-reform sample (before the enactment of the law in March 23 2011). If the DID identifying assumption is incorrect, we should find significant DID effect for the fictitious policy reform date.

6 Data

Several data sets are utilized in the empirical analysis. The daily price data came from the Department of Agricultural Marketing (DAM) unit of Ministry of Agriculture. The Trading Corporation of Bangladesh (TCB) also reports daily price data from major urban centers. We compared daily price data from both sources. The price trends in both data sets are nearly indistinguishable. The price data from DAM however are available for one additional year (2008) compared with the TCB data. Moreover DAM reports price data for a wider range of commodities compared to TCB. We thus use the DAM data for our empirical analysis. The daily international price data of wheat are derived from the data stream of Chicago Board of Trading.[17] Crude palm oil price data are taken from the Malaysian Palm oil Board. Lentil import unit values are taken from the National Bureau of Revenue daily import data. Our sample extends from January 24, 2008 to October 4, 2012. There are however some data gaps due to lack of price data during weekends and holidays as well as some missing data in the DAM original data set. Our total sample sizes for most commodities (palm oil and wheat) are 966 days spread over 57 months.

To provide a feel of the data used in the analysis, Table 1 reports summary statistics for key prices and the margins for palm oil and wheat during pre and post-intervention periods. For palm oil, the world-wholesale margin, the focus of our analysis, has increased in the post-reform period. In contrast, the margin has declined for wheat marketing in the post-reform period. Note that the world to wholesale value chain includes not only transport and storage costs but also milling costs.[18] None of the data sources reported mill gate prices so it is not possible to examine the world to mill gate, and mill gate to wholesale price margins separately. In the following, we present the estimates of the policy effect on the marketing margin from formal econometric analysis.

[17] Crude palm oil was listed in the TCB in January 2009. We compared TCB data with MPB data on daily palm oil prices, there are again nearly identical.

[18] The milling loss for palm oil is about 4-6% whereas for wheat (to flour) it is much larger: 10-15% weight loss due to impurity and moisture and 20-22% bran.

7 Empirical Results on Wholesale Margin and Pass-through

Since our data-set consists mainly of time series data for each commodity, we start by checking the time series properties. The correlogram analysis indicates the presence of an AR (1) process in the residuals. All regressions in this paper thus correct standard errors for the presence of AR(1) in residuals as well as heteroskedasticity using the Newey-West (1987) procedure. The results presented in the following used one period lag as indicated by correlogram analysis but the central conclusions of this paper are robust to inclusion of higher order lags. The null hypothesis of unit root in the residual is rejected at the 1 percent level for all the margin regressions.

7.1 Preliminary Results: Before-After Comparison

We start by presenting the simple before-after comparison of the marketing margin as an estimate of the effects of the policy intervention in the palm oil market. The first two columns in Table 2 present results from the full sample. Columns 1 reports estimates for our simplest specification with year and quarter fixed effects without any other controls, while column 2 presents the regression results when we add a number of control variables in addition to year and quarter fixed effects. The specification in column 2 includes dummies that take the value of unity during ramadan month and zero otherwise to control for the observed tendency for price of palm oil to rise during ramadan period. We also add diesel price to control for possible changes in the transportation and processing costs. Note that the fuel prices in Bangladesh are controlled by government and changes infrequently over time. Thus it is appropriate to treat the fuel price as exogenous in the marketing margins regressions. Since the margins tend to vary over world price cycles reflecting imperfect pass-through, and an upward cycle of palm price is contained in the pre-intervention sample of our data-set, we add a dummy indicating the upswing phase of palm price in the international market as a regressor.

As discussed before in the empirical strategy section above, the volume of crude palm imported by the refiners depends on its relative price to soybean oil in the world market. [19] We include the relative international price of palm compared to soybean as a proxy for possible changes in the costs as the refiners move along the marginal cost curve. Note that the relative price of palm also captures the consumer substitutions in so far as it reflects the movements in the relative prices faced by the consumers at the retail level. It is important to appreciate that, for a small country such as

[19] Between 2007 and 2008, prices of crude palm oil increased substantially. Import of crude palm oil also increased substantially between these two years because rise in crude soybean oil price was much sharper compared with crude palm oil. To the extent such substitution affects marginal costs of palm production, it will also affect the world-retail and world-wholesale margins.

Bangladesh, the international prices are parametrically given from the world market, and thus the relative international price is exogenous for the determination of the marketing margins at different interfaces of the domestic marketing chain.[20]

The estimates in Columns 1 and 2 for the full sample show statistically significant and numerically substantial effect of both policy announcement and implementation. More importantly, the estimates indicate that both the intercept and the absolute slope of the margin equation increased following the reform which contradicts the predictions of the benchmark model with DOTs as pure intermediaries.[21] To check if the results depend on the pre-intervention sample period, we present results based on a restricted sample that compares post-intervention with the two immediate preceding years (please see columns 3 and 4 in Table 2). In a standard before-after design, it is usually better to select a comparison period closer to the intervention date to avoid confounding by long-run structural changes in the economy. In this sense, a shorter pre-intervention sample seems more appropriate for a before-after design instead of the full sample covering a longer time period.[22] The results indicate that if anything, the magnitudes of increases in the intercept and the absolute slope of marketing margin following the announcement and implementations of the reform are much larger in this case compared with those in columns 1 and 2 in Table 2.

The before-after estimates of the reform are striking in that they consistently reject the predictions of the standard double marginalization model with pure intermediaries, and thus suggest that the effects of the reform might be opposite to what the policy makers had in mind. Instead of reducing the marketing margin and improving the pass-through of international prices, the reform seems to have resulted in higher margins and lower pass-through. Note that the estimates also contradict the model where DOTs provide low cost credit to wholesale traders, because a lower pass-through rate following the reform is consistent only with a model of credit rationing. In rest of this section, we provide an array of evidence that this conclusion is very robust.

[20] In contrast, relative consumer prices would be better controls for demand shifts, but they are clearly endogeneous. Note also that there were no significant difference between aggregate growth or macroeconomic stability in pre and post reform period, thus it is unlikely that positive demand shifts can explain the results reported below. The GDP growth rate for the period 2006-2010 was 6.2 percent, and 6.5 percent over 2011-2012. In fact, the agricultural growth rate was lower in the post reform period, which may cause a negative demand shock as low income households in villages constitute the bulk of the demand for Palm oil.

[21] Recall that the benchmark model predicts a higher pass-through of crude oil price after the reform, thus implying a lower absolute slope of the margin equation.

[22] One can argue, plausibly, that the same argument is valid for the DID design later.

7.2 Estimates from Difference-in-Difference (DID) Approach

In this sub-section, we present the DID results from alternative specifications and samples. As discussed in the empirical strategy section, wheat is our comparison commodity for the DID design. We discussed a set of a priori reasons to expect that the marketing margin for wheat provides us with a credible comparison commodity. We also provide visual evidence supporting our DID design in section (4) above. Later in the paper, we will report formal results on the validity of the DID design.

Table 3 presents the results from the DID estimation for three different samples. In addition to the "full" and "restricted" samples discussed before, we also use a sample where the pre-reform period is selected in a way to match the international market phase with that observed during the post-reform period. We call this third sample the "matched sample". A close inspection of crude palm prices at the world market identifies one matching sample period during the pre-reform period. Consistent with post intervention price trends, prices in 2008 and the first half of 2009 continued to decline from a high in early 2008. The "matching sample" restricts our pre-intervention sub-sample to this matched period, and thus takes out the period of palm price rise in the international market from the pre-intervention sample. Since the margins become smaller in the upswing phase of the international market reflecting imperfect pass-through, a point discussed earlier, a pre-intervention sample that includes such a phase can bias the estimated policy effects upward, especially because there is no similar sustained increase in international price in the post-intervention sample.

Similar to Table 2, we present results from two specifications of the regressions; the first specification only controls for year and quarter dummies, and the second adds the set of controls used in the second specification in Table 2 above. Regardless of the sample and the set of controls used, the results suggest statistically and numerically significant and positive effects of both policy implementation and policy announcement on the intercept of the world-wholesale margin equation (please see the coefficient of "Policy Implement*Palm" and "Announcement*Palm" in Table 3). The effects of policy implementation seems statistically stronger, in all of the six cases in Table 3 estimates are significant at the 1 percent level. The effect of announcement is less significant, in three out of 6 cases, the effect is not significant at the 1 percent level, and in one case (column 6), the effect is not significant at the 10 percent level. The evidence thus provides strong support to the conclusion based on the before-after approach that instead of reducing the marketing margin, the reform actually increased it.

The evidence on the effects of policy implementation on the slope of the margin equation in Table 3 is also consistent with the conclusion reached earlier on the basis of before-after estimates in Table 2. In contrast, the significant effect of policy announcement on the slope of margin found in Table 2 is

not supported by the evidence from DID estimates in Table 3. Although the effect of announcement on the slope is negative which is consistent with the evidence in Table 2, none of the six estimates are significant at the 5 percent level. The evidence from the DID approach thus provides strong evidence that the implementation of the reform increased the intercept of the margin equation, and also increased the absolute slope with respect to the world price of crude Palm oil. As noted before, this evidence contradicts both the pure intermediary model of double marginalization and the financing costs model without any credit rationing. The evidence thus strengthens the conclusion that the DOTs seem to enhance the efficiency of intermediation in the marketing chain by relaxing binding credit constraints faced by the wholesale traders.

The estimates in the last column of Table 3 imply that the wholesale margin was 4.16 Taka higher because of the reform, which is about 34 percent of the average wholesale margin in post reform period (12.00 Taka), and 5.12 percent of the average world price in that period (81.00 Taka).

7.3 Short-term vs. Long-term Effects

The empirical analysis so far provides robust evidence in favor of a positive effect of policy change on the intercept and slope of the marketing margin of palm oil. In this sub-section, we examine if the effects of policy intervention changes overtime. To distinguish the short-term effects from the longer-term effects, we divide the post implementation sample into two parts: short-term sample consists of the first six months period after the policy implementation and the 'long-term' is the rest of the post-reform sample. We define a dummy which takes the value of unity during the first 6 months following implementation date (June 21, 2011). Coefficient of this dummy (interacted with palm dummy) captures the immediate effects of implementation. To capture the long term effect, we define another dummy which takes the value of unity for the rest of the period after first 6 months and zero otherwise. We repeat our estimation with these new policy variables using the matched sample, as this is likely to be the most credible estimate of the counterfactual, and gives us the most conservative estimates of the policy effect on the marketing margin. The results are reported in Table 4. Columns denoted as '1' include all regressors except the relative international prices. The evidence shows that the largest effect of policy on the margin is found during the first six months of the implementation of the reform. After six months, the effects decline substantially and also become statistically insignificant. This result holds regardless of the regression specification. The results in Table 4 suggest that the effects of policy interventions were concentrated mostly during the first six months of implementation of the reform. This is consistent with the discussion before that in the face of perverse effects of the reform, the refiners went back to large DOTs and the dealers were not getting oil delivery which most likely reflects the credit constraint

faced by them. The government also chose not to enforce the SO Law that banned the DOTs. Our results show that after approximately six months, the market largely reverted back to the old DOT system.

7.4 Validity of the DID Design

Note that changes in two important components of marketing costs: transport and storage cannot result in spurious policy effect in our DID design for two reasons. First, wheat price depends much more on the changes in transport and storage costs than palm oil, a point noted earlier. Thus wheat price at the wholesale and retail levels increases much more when transport and storage costs go up. Thus our DID design would give us lower bound estimates if both transport charges and storage costs were increasing during the sample period.[23] The available evidence shows that the fuel price, although controlled by the government, has increased over time in discrete fashion, and the price of storage space has increased significantly over time, as to be expected in a high population density country such as Bangladesh. Second, even if the traders face increasing marginal cost (for example, when they have to rent in additional space) of storage, our results showing an increase in the margins cannot be explained by such rising marginal cost faced by traders. Because, as we discuss below, the total imports of palm oil declined in the post-intervention period, thus the traders did not need to rent in new spaces during this time period. In what follows, we provide formal evidence on the validity of the DID design.

Testing the Parallel Trend Assumption with Placebo Policy Reform Date

We perform a placebo policy test to check if the parallel trend assumption between palm and wheat is valid in the pre-intervention sample. We implement this test by defining a fictitious policy intervention during pre-intervention period. For this exercise, we take the matched pre-intervention sample. We divide this sample roughly into two halves. We then define a policy intervention dummy which takes a value of unity during the first half of the sample and zero otherwise. We then estimate the effect of this fictitious policy intervention on palm trading margins. The results are reported in Table 5. The interaction of policy and palm dummies have positive coefficients in regressions for both world-retail and world-wholesale margins, but they are small in magnitude and are not statistically significant at the conventional level.

[23] This also implies that our estimates may overestimate the margin between palm and wheat if transport and storage costs decline significantly over time.

7.5 Additional Evidence

The theory and evidence presented so far in this paper contradict the widely held view that the DOTs are the cause of higher market prices in edible oils market in Bangladesh, and suggest that they provide valuable services to the wholesale traders by relaxing their credit constraints. In this section, we provide additional evidence that supports this conclusion. If the wholesalers faced difficulties in buying oil from the refiners because of lack of credit, then the refiners would not be able to sell the expected volume of oil consistent with a declining world price, and consequently cut back the import of crude Palm oil as they accumulate excessive inventory. In fact, the newspaper reports indicate that, in fact, the refiners had difficulties in offloading oil after the reform, as many newly appointed dealers were not buying oil from them. More important, we can look at the effects of the reform on the imports of crude oil. The available data on the quantity of crude Palm oil imported to Bangladesh is, however, limited, and not suitable for a formal difference in difference analysis. Since imports are lumpy and there may not be any imports in some weeks of a month, we aggregate the data at the monthly frequency. We report regression results on the effects of reform using the monthly import data in Table 6. It is reassuring that even with a small sample size (46 observations), there is a clear negative effect of the reform on quantity of crude Palm imported by the refiners; the reform implementation dummy is negative and statistically significant at the 5 percent level. This is striking evidence because one would have expected higher imports in post reform period when the world price was falling.

Although the quantity of imports went down, it does not necessarily follow that the refiners were adversely affected by the reform. If the reform increased the market power of the refiners (for example, if they were better able to coordinate and collude), then the reduction in quantity may reflect a move towards the monopoly quantity after the reform. If this in fact is the case, then the refiners would try to protect their monopoly profit by cooperating with the government to make the ban on DOTs permanent. In contrast, the model based on credit rationing faced by the wholesalers when DOTs were banned implies that the refiners earn lower profit after the reform, because per unit profit of refiners does not depend on the quantity sold (see equation (17) above), and the available reports strongly suggest that the DOTs were unhappy with the reform, and surreptitiously went back to the DOTs to offload their accumulated inventory as the dealers were reluctant to take oil delivery. This suggests that the refiners' profit was adversely affected by the reform, consistent with the prediction of the credit rationing model.

The final piece of evidence comes from a survey we conducted in 2013 in the edible oils market in Bangladesh to estimate the prevalence of suppliers credit provided by the DOTs in the market. Based

on the data on 6176 transactions between DOTs and wholesalers in Dhaka and Chittagong markets, 30 percent of transactions between DOTs and wholesalers is on credit. In terms of quantity, the supplier credit from the DOTs accounted for 32 percent of the volume. Thus credit provided by the DOTs plays a vital role in the market.

8 Estimated Effects on the Consumer (Retail) Prices

The focus of our analysis has been on the margin between wholesale and world market because the reform eliminated the DOT layer which was situated in between them. In this section, we report estimates of the effects of the reform on consumer (retail) prices. The specification used for estimation is similar to that in Table 5 above, where the short- and long-run effects are separately estimated in a difference in difference set-up with wheat as the comparison commodity.[24]

The evidence reported in Table 7 is broadly similar to the effects we found earlier for the wholesale price; the reform increased the retail price by increasing the intercept of the margin equation and lowering the pass-through of world price, as predicted by the credit rationing model. The long-term effects on retail price is, however, somewhat different; while for wholesale margin we found earlier that the effects of the reform became statistically insignificant after six months, the corresponding effects on the retail margin is significant at the 1 percent level. However, the effects are numerically much smaller, about one third of the magnitude found for the first six months. Thus the results suggest that most of the effects of the reform was concentrated in the first six months, consistent with the estimates on wholesale price discussed earlier. However, the fact that the effects of the reform were felt even after six months at the retail level, but not at the refiner to the wholesale level suggests that the price adjustments at the retail level lag behind the adjustments at the refiner and wholesale levels.

9 Concluding Comments

There is a widely held view that the presence of marketing intermediaries in commodity markets ends up raising consumer prices, owing to the effects of their market power in the supply chain exceeding the value of cost-reducing distribution services they provide. The Bangladesh 2011 policy experiment provides a rare opportunity to test this view, as it attempted to eliminate an entire layer of such intermediaries. Using high frequency data for the prices of imported crude besides wholesale and retail prices of refined oil relative to wheat which is also imported in bulk and incurs similar storage and

[24]The results from a specification similar to that in Table 4 where the post-reform period takes on a single dummy are available from the authors.

transport costs, we showed that the reform increased the average margin between the crude import and the wholesale price. In particular the data firmly rejects the predictions of the standard double marginalization model which formalizes the hypothesis that the presence of intermediaries with significant market power who do not provide concomitant distribution-cost-reducing services ends up raising consumer prices. The model predicts the reform should have lowered the intercept and increased the pass-through rate of the crude oil price to wholesale prices, whilst the precise opposite was observed.

An extension of the basic double marginalization model to allow the intermediaries to provide cost-reducing services (such as financing dealers at below-market interest rates) is also incapable of explaining the lower pass-through of imported crude prices observed following the reform. This suggests the DOTs played a more fundamental role in the supply chain. One possible role is alleviating credit limits that wholesalers are subjected to when borrowing from alternative sources. Such credit rationing could have severely disrupted volumes in the supply chain, resulting in higher average wholesale prices and lower pass-through rates from imported crude prices. Note that this does not deny the possibility that the DOTs exercised significant market power. The point is that the consequences of such market power were outweighed by their financing role within the supply chain.

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Table 1: Summary Statistics

	Before Intervention		After Intervention	
	Mean	Stnd Deviation	Mean	Stnd Deviation
Palm				
Wholesale price	70.39	14.95	93.15	4.50
Retail price	73.66	14.97	98.43	4.21
World Price	59.85	16.18	81.04	6.49
World-Retail Margin	13.81	5.13	17.39	4.88
World-W'sale Margin	10.54	5.03	12.11	4.82
W'sale-Retail Margin	3.27	1.07	5.28	1.95
Wheat				
Wholesale price	21.89	5.68	23.53	2.12
Retail price	24.89	5.98	26.17	2.57
World Price	15.49	3.97	18.72	2.95
World-Retail Margin	9.40	3.43	7.44	3.04
World-W'sale Margin	6.40	2.95	4.81	2.75
W'sale-Retail Margin	3.00	0.95	2.63	0.91

Table 2: Before and After for Wholesale Margin in Palm Oil

	Trading Margins (World-Wholesale)			
	Full Sample		Restricted Sample	
Announcement Dummy	41.63***	36.90***	48.65***	42.95***
	(2.983)	(2.772)	(3.429)	(2.824)
Announcement*World price	-0.486***	-0.454***	-0.564***	-0.533***
	(-2.796)	(-2.743)	(-3.195)	(-2.809)
Policy Implement. Dummy	11.68***	8.454	22.84***	17.72***
	(2.845)	(1.565)	(4.491)	(2.894)
Policy*World Price	-0.0968**	-0.0843	-0.220***	-0.164**
	(-1.975)	(-1.296)	(-3.711)	(-2.118)
World Price	-0.349***	-0.301***	-0.255***	-0.348***
	(-15.09)	(-10.29)	(-8.150)	(-7.764)
Observations	966	966	687	687
Lag Length	1	1	1	1
Controls				
Year and Quarter dummies	Yes	Yes	Yes	Yes
Ramadan Dummies	No	Yes	No	Yes
Relative Prices	No	Yes	No	Yes
Fuel Price	No	Yes	No	Yes
Dummy if World Price rising	No	Yes	No	Yes

Note: Standard errors corrected for heteroskedasticity and Auto-correlation using Newey and West (1987) procedure
t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Difference in Difference Results (comparison: wheat margin)

	Wholesale-World Price Margins					
	Full Sample		Restricted Sample		Matched Sample	
Effect of Announcement	(1)	(2)	(1)	(2)	(1)	(2)
Announcement Dummy	-5.879***	-4.999***	-6.703***	-4.582***	-5.769***	-4.762***
	(-10.70)	(-8.188)	(-11.85)	(-10.45)	(-9.787)	(-8.537)
Announcement*Palm	36.48**	24.84*	38.84**	24.73*	34.00**	22.33
	(2.390)	(1.668)	(2.480)	(1.683)	(2.235)	(1.515)
Announcement*Palm world Price	-0.316*	-0.221	-0.318	-0.232	-0.327*	-0.188
	(-1.668)	(-1.197)	(-1.634)	(-1.277)	(-1.730)	(-1.030)
Effect of Implementation						
Policy Implement. Dummy	-2.610***	-3.156***	-3.623***	-1.670***	-1.461**	-2.493***
	(-4.565)	(-5.063)	(-6.186)	(-2.730)	(-2.548)	(-3.768)
Policy Implement.*Palm	24.84***	21.88***	28.78***	19.85***	24.33***	26.84***
	(7.474)	(5.789)	(8.452)	(4.936)	(7.240)	(6.675)
Policy Implement.*Palm world price	-0.212***	-0.221***	-0.233***	-0.210***	-0.247***	-0.281***
	(-4.997)	(-4.675)	(-5.291)	(-4.300)	(-5.742)	(-5.454)
World Price	-0.338***	-0.379***	-0.317***	-0.386***	-0.336***	-0.385***
	(-17.79)	(-19.57)	(-16.53)	(-20.65)	(-13.78)	(-10.39)
Observations	1,932	1,932	1,374	1,374	1,312	1,312
Lag Length	1	1	1	1	1	1
Year and Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ramadan Dummies	No	Yes	No	Yes	No	Yes
Relative Prices	No	Yes	No	Yes	No	Yes
Fuel Price	No	Yes	No	Yes	No	Yes
Dummy if World Price rising	No	Yes	No	Yes	No	Yes

Note: Standard errors corrected for heteroskedasticity and Auto-correlation using Newey and West (1987) procedure
t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Placebo Tests: Fictitious Policy Intervention during pre-intervention period

	Wholesale-World Price Margins
Policy Dummy	-0.438
	(-0.184)
Policy*Palm dummy	-1.568
	(-0.365)
Policy*Palm World Price	0.0115
	(0.217)
World Price	-0.361***
	(-7.967)
Observations	626
Lag Length	1
Year and Quarter dummies	Yes
Ramadan Dummies	Yes
Relative Prices	Yes
Fuel Price	Yes
Dummy if World Price rising	Yes

Note: Standard errors corrected for heteroskedasticity and Auto-correlation using Newey and West (1987) procedure
t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Difference in Difference Results - Short-run vs. long-run effects

	Wholesale-World Price Margins	
Announcement Effects	(1)	(2)
Announcement Dummy	-5.815***	-4.911***
	(-9.997)	(-8.640)
Announcement*Palm	21.61	14.71
	(1.391)	(0.981)
Announcement*Palm*World Price	-0.175	-0.0913
	(-0.905)	(-0.491)
Effects of Policy Implementation		
Effects during first 6 months		
Policy Implementation	-2.257***	-3.487***
	(-3.357)	(-4.913)
Policy*Palm	57.65***	58.69***
	(7.322)	(7.249)
Policy*Palm*World Price	-0.691***	-0.705***
	(-6.396)	(-6.345)
Effects after first 6 months		
Policy Implementation	-3.985***	-5.627***
	(-3.042)	(-3.946)
Policy Implement.*Palm	1.863	7.580*
	(0.461)	(1.865)
Policy*Palm*World Price	0.0170	-0.0458
	(0.330)	(-0.895)
World Price*palm	0.159***	-0.0292
	(2.727)	(-0.396)
World Price	-0.406***	-0.208***
	(-7.757)	(-2.763)
Diesel Price	10.63***	15.29***
	(4.002)	(5.448)
Dummy if World Price was rising (DW)	0.0348	-0.0403
	(0.608)	(-0.668)
DW*palm	0.0838	0.872
	(0.0579)	(0.607)
Palm	-3.148**	-3.739***
	(-2.378)	(-2.727)
Relative world prices of palm/soy		-4.496***
		(-2.664)
Relative world prices of wheat/rice		1.453***
		(4.912)
Intercept	18.66***	15.09***
	(6.032)	(4.786)
Observations	1312	1312
Lag Length	1	1
Controls		
Year, Quarter, Product Fixed effects	Yes	Yes
Ramadan Dummies	Yes	Yes

Note: Standard errors corrected for heteroskedasticity and Auto-correlation using Newey and West (1987) procedure
t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Effects of Reform on Crude Palm Oil Imports

VARIABLES	(1)	(2) q
Annoucement	-23.18	-16.43
	(-1.566)	(-1.115)
Policy	**-20.77****	**-20.15****
	(-2.021)	(-2.026)
Import unit value for palm	0.0107***	0.0110***
	(10.98)	(11.52)
Import unit value for soy	-0.00129	-0.000844
	(-0.844)	(-0.565)
Wholesale rice price		-1.613*
		(-1.954)
Constant	40.75***	77.55***
	(5.015)	(3.801)
Observations	46	46
R-squared	0.752	0.774

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Effects on Retail-World Market Trading Margin

Announcement Effects	(1)	(2)
Announcement Dummy	-6.574***	-5.655***
	(-10.33)	(-8.902)
Announcement*Palm	26.60	20.04
	(1.358)	(1.075)
Announcement*Palm*World Price	-0.232	-0.154
	(-0.957)	(-0.669)
Effects of Policy Implementation		
Effects during first 6 months		
Policy Implemt.	-3.356***	-4.591***
	(-5.047)	(-6.426)
Policy*Palm	61.94***	62.94***
	(10.67)	(10.33)
Policy*Palm*World Price	-0.717***	-0.730***
	(-8.961)	(-8.708)
Effects after first 6 months		
Policy Implement.	-4.248***	-5.941***
	(-3.963)	(-4.973)
Policy Implement.*Palm	21.07***	26.59***
	(5.304)	(6.626)
Policy*Palm*World Price	-0.185***	-0.245***
	(-3.700)	(-4.911)
World Price*palm	0.0877	-0.120
	(1.533)	(-1.619)
World Price	-0.359***	-0.134*
	(-6.967)	(-1.771)
Diesel Price	12.37***	17.36***
	(5.242)	(6.836)
Dummy if World Price was rising (DW)	0.157***	0.0902
	(2.983)	(1.646)
DW*palm	0.0177	0.819
	(0.0124)	(0.577)
Palm	-3.150***	-3.645***
	(-2.625)	(-2.950)
Relative world prices of palm/soy		-5.358***
		(-3.136)
Relative world prices of wheat/rice		1.375***
		(4.261)
Intercept	16.07***	12.29***
	(5.567)	(4.085)

Figure 1

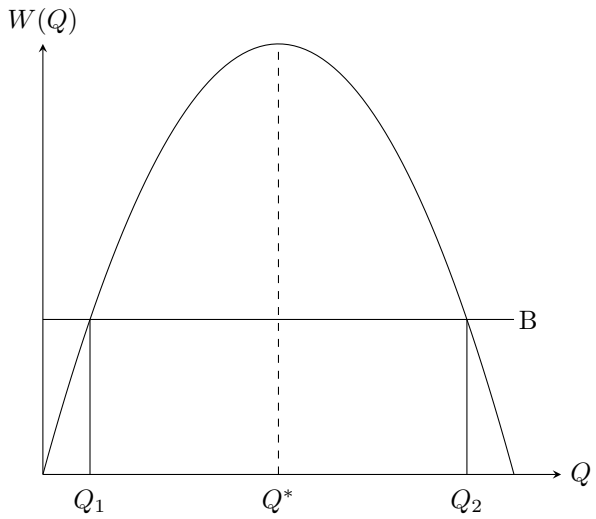


Figure 2: World and Wholesale Prices: Palm and Wheat

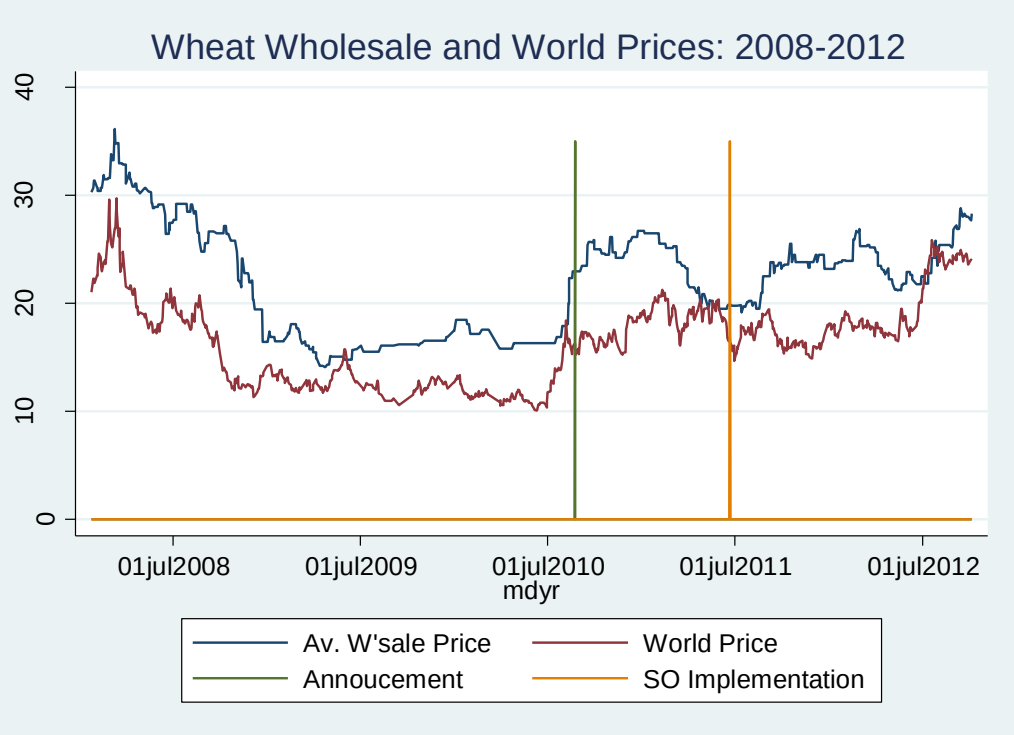


Figure 3: World and Wholesale Price Margins: Palm and Wheat

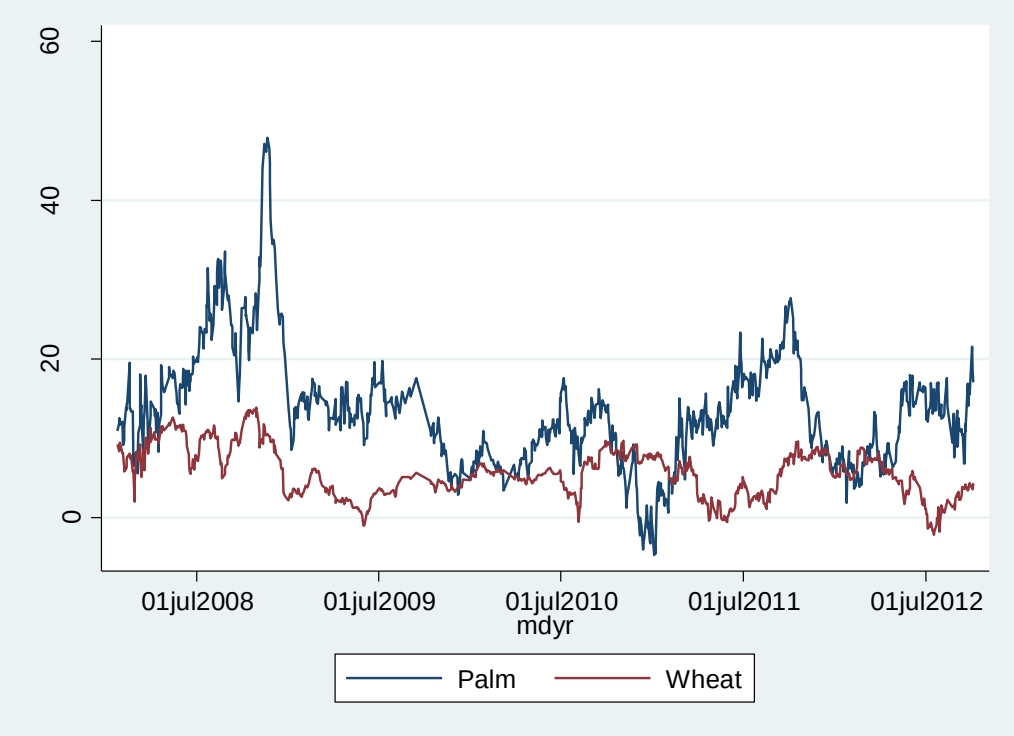


Figure 4: Palm Oil World-Wholesale Price Margins during pre-intervention

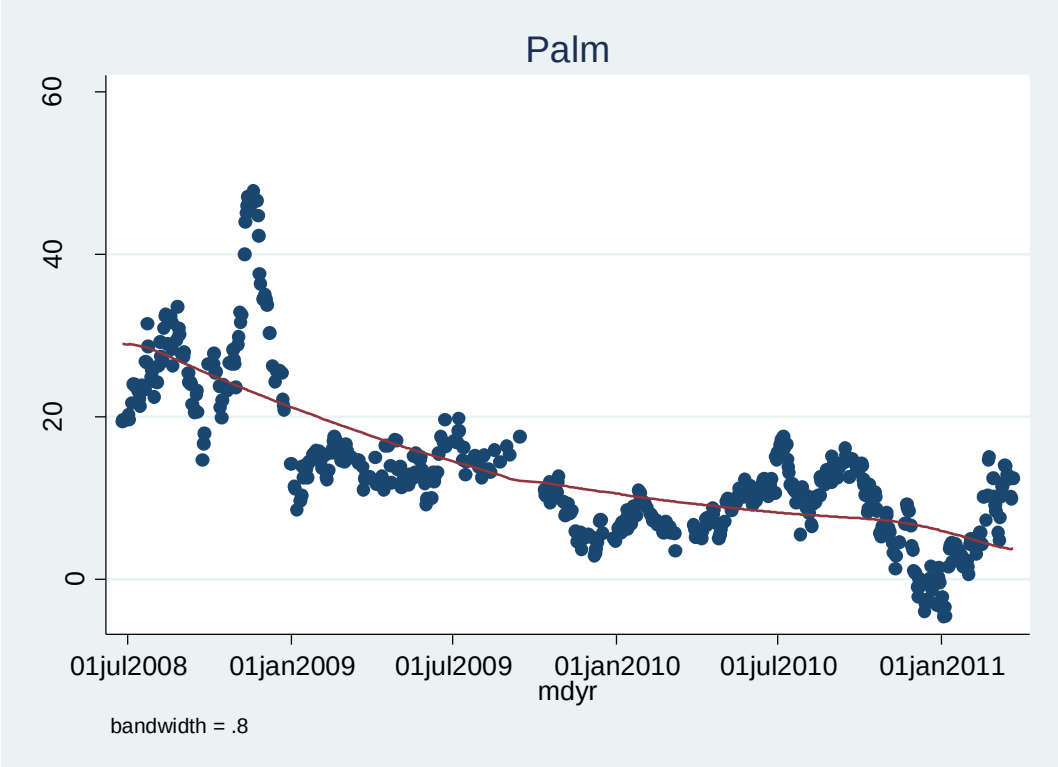
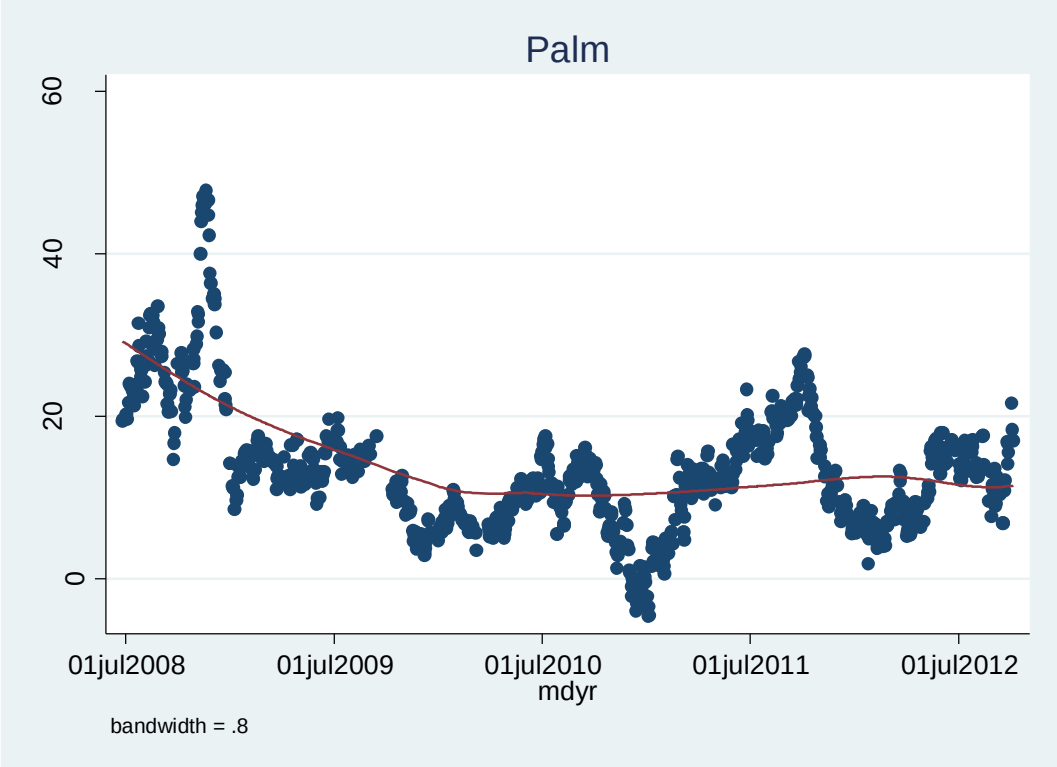


Figure 5: Wheat World-Wholesale Price Margins during pre-intervention



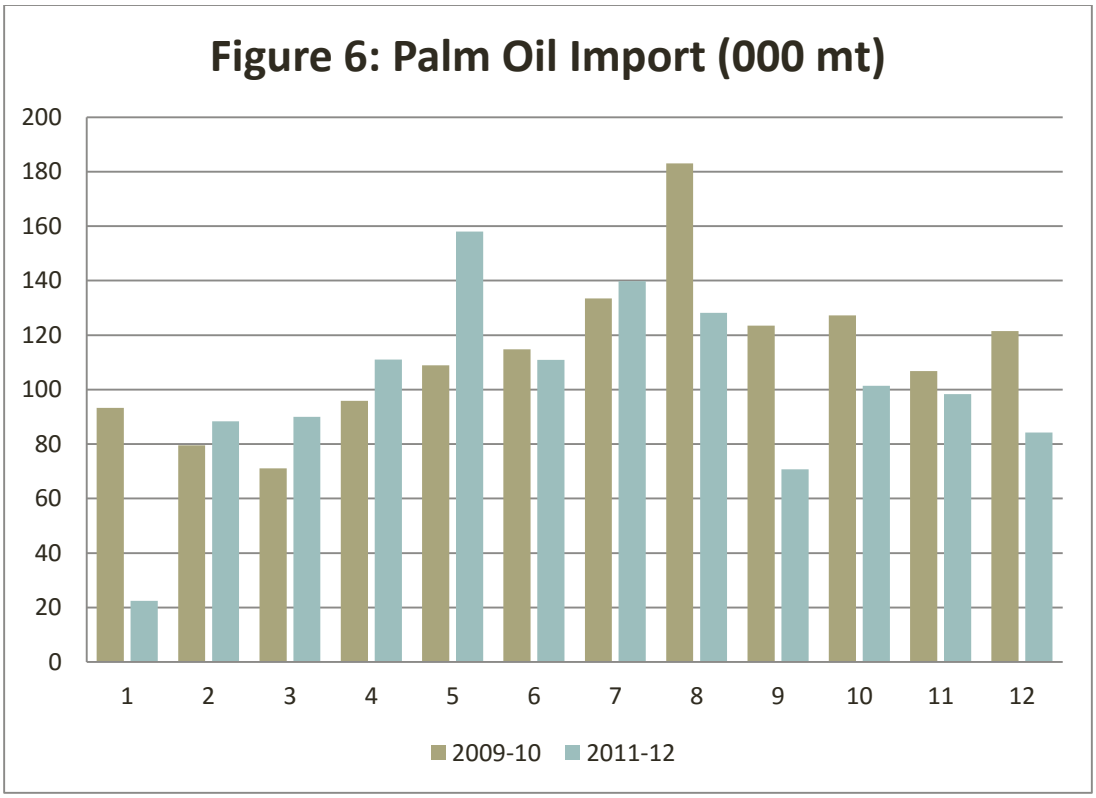


Figure 6: Palm Oil Import (000 mt)
200
180
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
2009-10
2011-12