Credit Rationing and Pass-Through in Supply Chains: Theory and Evidence from Bangladesh

M. Shahe Emran[1]
IPD at Columbia University

Dilip Mookherjee
Boston University

Forhad Shilpi
World Bank

M. Helal Uddin
Dhaka University

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ABSTRACT

The standard model of pass-through in imperfectly competitive markets focuses on double marginalization of rents and highlights the importance of the curvature of demand curve. We develop a model of equilibrium prices in a supply chain with financing intermediaries to incorporate credit rationing faced by wholesale traders. The financing intermediaries help relax the quantitative credit limits faced by the wholesalers by reducing moral hazard through informal enforcement mechanisms not available to formal banks. To discriminate between models with and without credit rationing, we exploit a policy experiment in Bangladesh in 2011 which banned financing intermediaries called Delivery Order Traders (DOTs) from edible oils market. The elimination of DOTs from the market leads to higher pass-through rate and a lower intercept of the wholesale price equation in the standard double marginalization model. A model of financing intermediaries where DOTs provide low-interest credit, and the wholesalers do not face quantity constraints also yields the same conclusions. In contrast, a model with quantitative credit rationing yields sharply different predictions: the ban on DOTs raises the intercept and reduces the pass-through rate. The pass-through rate falls as the elimination of DOTs tightens the credit constraints faced by the wholesalers and the effective wholesale demand curve becomes a rectangular hyperbola with a lower (unit) elasticity. We test the predictions using a difference-in-difference design with wheat as the comparison commodity, and provide evidence on the credibility of the research design using a placebo reform date and a placebo treatment commodity (lentil). Contrary to the expectations of the policy-makers, prices were higher in post-reform period when world prices of crude oils were declining, because the ban resulted in lower pass-through rate but a higher intercept in the wholesale price equation. The evidence contradicts the standard models, and is consistent with the model of quantitative credit rationing.

Keywords: Pass-through rate, Financial Intermediary, Supply Chain, Market Power, Credit Rationing, Edible Oils, Bangladesh

JEL Codes:O12, L13, Q13

1 Introduction

The role of market power of trade intermediaries in earning high margins that unduly raise consumer prices has frequently been a matter of public concern. Such concerns underlie arguments for regulations, often taking extreme forms of outright bans on some intermediary layers, and even jail term and execution of traders. For example,

> "For my part, I wish every one of them (speculators) had his devilish head shot off. (Abraham Lincoln, quoted in Carpenter (1866, p. 84))

> "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. ((Vladimir Lenin, 1964, p. 311).)

In 1958 private trades in onions futures were banned in Chicago; 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 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. In 2011, the Bangladesh government banned a layer of intermediaries called Delivery Order Traders (DOTs) in edible oils distribution trade, out of a concern that their market power was primarily responsible for the rising consumer prices since 2008.

However, there is relatively little systematic evidence on the effects of such policy actions. More generally, there is a paucity of literature on the

role of middlemen and price pass-through with imperfect competition in the context of developing countries. A better understanding of the role played by intermediaries in a supply chain is needed to understand the nature of international price transmissions and to evaluate the efforts to regulate the activity of the traders.

In this paper we argue that the standard models of pass-through in the literature pay insufficient attention to the financing role of intermediaries. Specifically, if the financing intermediaries help relax quantitative credit constraints faced by downstream traders, banning them can have dramatically different implications for pass-through and price margins when compared to a standard model of double marginalization of rents. We show this in the context of a model of symmetric Cournot competition with given concentration at each layer. As in the recent work of Atkin and Donaldson (2016), a Bulow-Pfleiderer (1983) specification of downstream consumer demand generates explicit linear recursive expressions for prices at each layer in the absence of any credit rationing.[2] Pass-through rates are independent of cost levels, and depend only on concentration at successive layers and the curvature of the demand function. Removing an intermediate layer is equivalent to eliminating market power at that layer, which raises pass-through and lowers the intercept term in the downstream price equation. Extending the model to incorporate credit constrained downstream traders, and the role of upstream intermediaries in alleviating these credit constraints, we show that the effects of regulations can get reversed: if the credit rationing effect is strong enough, the pass-through rate falls while the intercept term rises as a result of removing the financing intermediary layer.

[2]Our baseline model is, however, different from that of Atkin and Donaldson (2016) as we incorporate the financing intermediaries that provide low interest loans compared to the banks without any credit rationing.

We test these contrasting predictions using daily wholesale and retail palm oil price data in Bangladesh spanning 2008-2013. We compare estimated pass-through of shocks to import prices of crude palm (which constitutes 80% of oil refining costs) before and after the reform (which lasted approximately one year starting July 2011). The main econometric issue is that the estimated pass-through rates may be biased owing to omission of other sources of distribution costs when they are correlated with the oil import price. We deal with this problem in two steps. (a) The direction of the change in the pass-through rate is unbiased under the assumption that the correlation between the omitted distribution costs and imported crude price did not change as a result of the reform (heceforth called B-A approach). This enables us to provide a simple and transparent test of the leading prediction of the 'standard' model without any credit-rationing.[3] (b) However, the direction of the bias on the estimated effect on the intercept term cannot be assessed without making assumptions regarding the changes in the average distribution costs before and after the reform, even when the assumption of stable correlation is valid. We develop a difference-in-difference strategy and compare changes in oil price margins with the changes in the margin for wheat, which is also imported and incurs similar transport and storage costs. We test and do not reject the parallel trend assumption underlying the validity of the DID approach.

In the B-A analysis, we find a substantial fall in the pass-through rate (from 80% to 68%), statistically significant at the 5% level. Moreover, the estimated intercept term nearly doubled (the difference being significant at the 1% level). The increase in the intercept was large enough to make the

[3]We test the plausibility of the stable correlation assumption using estimates of the correlations of crude palm oil import price with diesel price and interest rate.

net effect on consumer price positive. Consistent with the assumption of positive correlation of distribution costs and crude import prices due to factors unrelated to the reform, the estimated DID effects are larger than the B-A estimates. We check subsequently that the DID results are robust with respect to alternative specifications of oil import lags, duration of the reform and the pre-reform period. The credibility of the DID results is strengthened by placebos for the timing of the reform and the affected commodity.

These results reject the standard model where there is no credit rationing, and are consistent with the model with credit rationing. The intuitive explanation provided by the latter is that the DOT ban resulted in more severe credit constraints faced by downstream wholesale and retail traders, resulting in a contraction in trade volumes which raised downstream prices. Moreover, the credit constraints effectively lowered price elasticity of derived demand functions faced by upstream refiners, resulting in higher refiner markups. These disruptions overwhelmed whatever reductions in market concentration resulted from the elimination of the DOTs from the market. This explanation is consistent with evidence from case-studies, as well as data on aggregate crude import volumes which contracted sharply (at a time when import prices were falling). It also helps explain why the reform was reversed, following pressure from palm oil refiners who were struggling to offload their accumulating inventories.

The paper is structured as follows. Section 2 provides details of the institutional setting of the palm oil supply chain in Bangladesh and the nature of the reform. Section 3 develops the theoretical analysis, followed by a discussion of estimation strategy in Section 4. Section 5 then describes the data and presents the empirical results. Section 6 discusses possible competing explanations, while Section 7 discusses related literature. Finally

Section 8 concludes.

2 The Palm Oil Marketing Chain in Bangladesh and the 2011 Reform

2.1 Pre-Reform

We start with a brief description of the Bangladesh palm oil marketing chain before the DOT ban in 2011; a more detailed discussion is provided in Uddin and Taslim (2010). As the reform was effectively suspended by mid-2012, the current structure of the supply chain resembles the way it was organized prior to the reform. The chain consists of four layers: refiners, delivery order traders (DOTs), wholesalers and retailers. The refining segment is highly concentrated, with only 9 refiners many of whom have considerable excess capacity. The refiners import crude palm oil from Malaysia and Indonesia and then refine it. While wholesalers can pick up refined oil directly from the refiners upon paying cash, they mostly furnish a delivery order (DO), a paper document representing an entitlement to a defined quantity. DOs are purchased by DOTs from refiners, sometimes immediately after the crude oil is imported, and sold later to wholesalers. There are approximately 300-400 DOTs divided between two principal cities Dhaka and Chittagong, forming an intermediate layer between refiners and over 7000 wholesalers. Wholesalers mostly prefer to purchase through a DOT rather than directly from a refiner for two reasons: the credit implicitly provided by a DOT, and DOTs buy in bulk and get price discounts from the refiners part of which they can share with the wholesalers. Estimates from a trader survey we conducted in 2013 shows that about 32 percent of quantity transacted between the

DOTs and wholesalers was on credit without collateral, based on long-term relationships.

The DOTs buy DOs for oil deliverable by the refiner after a stipulated period of time (usually 2 weeks). It is important to note that DOTs never take physical delivery of the oil: they are pure financial intermediaries. This is important for our empirical analysis, as it implies that the reform did not affect the distribution costs such as storage and transport costs directly. The DOT layer interacts vertically with the refiners upstream and the wholesalers downstream. In effect, they purchase refined oil from the refiners and re-sell it after a time lag to wholesalers, thereby providing credit to the latter.

There are also horizontal transactions amongst DOTs, representing arbitrage, speculation or purchase by smaller DOTs from the large DOTs. The horizontal transactions among the DOTs have evolved into something like an embryonic commodity exchange in Moulovibazar in Dhaka and Khatunganj in Chittagong where speculators operate with the help of brokers, primarily during upswings in the market. Our post-reform data period however coincided with a downswing in the international market when activities in the secondary (horizontal) DOT market were almost nonexistent.[4] In our analysis we focus on market power and pricing implications across vertical layers in a static framework, and thus abstract from price dynamics, risk, or heterogeneity across traders within any layer.

[4]The DO layer is not a futures market, because there is no settlement at the end of the day. Also, unlike a futures contract, payment is made at the time of the DO 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. In return, the refiners provide storage for the oil, as the DOTs do not own any storage facilities. Thus the cost of storage can be thought of as implicit interest rate on the short-term loan a refiner gets from the DOT. 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.

2.2 The 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 on March 23 2011. 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. This layer was sought to be entirely eliminated in the new system, in which wholesalers were expected to purchase directly from refiners In the SO system, new dealers were 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. In total, 7388 dealers for edible oil were appointed by different refiners. While wholesalers were principally expected to become the new dealers, it would have been difficult to prevent previous DOTs from acquiring dealerships. This was the logic underlying the quantity restrictions on how much oil could be purchased by a dealer, so that even if an ex-DOT became a dealer he would not be able to engage in bulk purchases and sales of SOs. Hence the intent was to reduce market concentration within the supply chain.

However elimination of DOTs also meant disappearance of an important source of credit for wholesalers. Refiners were reluctant to step in to fill this gap because they lacked the information accumulated by the DOTs over four decades. Accordingly, the wholesalers had to turn to banks to finance dealership deposits and purchase of SOs. Many faced difficulty in

obtaining sufficient credit. This made it difficult for the refiners to set up a new network of SO dealers. City Group, one of the largest refiners which accounted for nearly half of all new dealerships created, was forced to waive required security deposits. A related problem was lack of storage among wholesalers, who were expected to pick up refined oil earlier in the new system in the absence of the DOTs.

As a result of these problems, the wholesale-traders-turned-dealers were increasingly unable to pay for the required oil, and refiners began to accumulate stock beyond their desired level of inventory. This prompted the refiners to look for alternative distribution channels; eventually they went back to some of the large DOTs to return into the business and undermine the new system. After approximately six months of the reform, the DOTs started to circumvent the quantity restrictions imposed, with the government taking little initiative to enforce these restrictions (presumably owing to pressure from refiners). This passivity set into motion forces that pushed back the marketing system towards the old DO system; within a year or so the old system was back in play.

3 Theory

We model a vertical chain with three layers: refiners, DOTs and wholesale traders (depicted below respectively by $i \in \{r, d, T\}$). 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 wholesale prices. So we assume that wholesalers sell directly to final consumers. Owing to its recursive structure, it is easy to extend the model to incorporate an additional fourth layer of retailers who sell to final consumers. Indeed, the model with a retail layer

reduces to the one developed below when there are sufficiently many retailers that the market power at that layer is negligible.

We also abstract from product heterogeneity and horizontal asymmetries across traders at each layer.[5] Concentration i.e., the number of (identical) traders at each layer is exogenously given: the number of traders in layer i is denoted as N_i. They engage in Cournot competition, taking as given prices of the intermediate input they purchase from the layer above (which determine their unit costs). We normalize units so that one unit of crude oil is used to produce one unit of refined oil. Besides oil costs, traders at level i incur costs C_i per unit: for refiners this includes refining and storage costs; for wholesalers this includes transport, storage and other distribution costs.

Production decisions and distribution flow vertically downwards. First, the crude oil import price P_m is determined in the international market. Then refiners decide how much to import and refine, taking the import price as given, but incorporating the effect of their quantity decisions on the price at which they sell to traders one level below. This determines total unit costs of traders at the next layer, who then decide their quantities, and so on.

The inverse demand function among consumers is assumed to be take the Bulow and Pfleiderer (1983) form:

$$P_T(Q) = \alpha - \eta Q^{\delta}; \;\; \alpha, \eta, \delta > 0 \tag{1}$$

where P_T denotes the price at which wholesale traders sell to consumers.

We now explain the role of credit, which arises from a time-lag associated with the refining process. There are two dates: $t = 0$ when the crude oil is imported and DOs are sold by the refiners, and $t = 1$ when the crude oil

[5]This is a reasonable assumption in our empirical context because there is little product differentiation in the Palm oils market.

has been refined and is sold to the consumers. Distribution costs of DOTs and wholesalers are also incurred at $t = 0$.[6] DOTs are not constrained with respect to the amount of credit they have access to, and incur the lowest borrowing costs compared to refiners and wholesalers.[7] Being informal lenders with specialized expertise in financing, they can lend at a cost of i_d per taka, which is lower than (or equal to) the rate i_b charged by banks. This difference arises owing to lower transaction costs (screening and loan collection expenses) they incur compared with formal financial institutions. Hence DOTs provide loans to wholesalers to cover the time-lag between $t = 0$ and 1. All relevant economic decisions take place at $t = 0$: refiners sell DOs to DOTs at price P_r, who in turn sell them (on credit) to wholesalers at price P_d. Wholesalers finance their working capital needs at $t = 0$ by borrowing from DOTs. They need to borrow P_d+C_T for per unit of oil purchased. These loans are repaid at $t = 1$ after they receive cash payments from consumers.

Loans are subject to moral hazard: a wholesaler could decide not to repay a loan at $t = 1$. Loan default is punished by lenders with a severity depending on who the lender is. DOTs are able to impose more punitive sanctions on defaulters than banks, owing to their access to punishments not limited to purely legal routes. The maximal pecuniary cost of sanctions imposed by DOTs and banks respectively are denoted by R_d, R_b with $R_d > R_b$. We treat these sanctions as given.[8] Consequently the borrowing of any given

[6]For instance, these include worker wages which need to be paid in advance at $t = 0$; transport charges can also be payable in advance. The only role of this assumption is to simplify the notation; the cost expressions need to be adjusted if distribution costs are incurred at $t = 1$.

[7]This is consistent with the evidence from the survey of the edible oils market in Dahaka and Chittagong in 2013? reported in Emran et al (??). See also the discussion in Taslim and Uddin (??).

[8]It is easy to extend the model to settings where sanctions are endogenous, e.g., in a dynamic setting where sanctions involve cutting off access to credit and the oil market in future. DOTs could engage in such collective punishments as in Kandori (199?) or

wholesaler has to satisfy the constraint that the amount of repayment due to a DO trader cannot exceed R_d.

DOTs compete with one another (and with banks) in the market for lending to wholesalers. For simplicity we assume they compete over loan contracts in Bertrand fashion, thereby ending up earning zero profits in equilibrium. This implies that wholesalers would be able to borrow at an interest rate of i_d. However, owing to the moral hazard problem the size of their loan would be subject to a ceiling given by $\frac{R_d}{1+i_d}$. This in turn translates into a ceiling on how many DOs the wholesaler can purchase; q DOs generate a need to borrow $[P_d + C_T]q$. Hence the ceiling on q is given by

$$q \leq \frac{R_d}{(1+i_d)(P_d + C_T)} \tag{2}$$

Taking the price of DOs (besides conjectured aggregate quantity Q_- of other wholesalers) as given, each wholesaler decides q, how many DOs to purchase. This is chosen to maximize profit

$$P_T(Q_- + q)q - (1+i_d)(P_d + C_T)q \tag{3}$$

subject to (2).

We can then solve for an equilibrium in the game played between wholesalers, taking DO price P_d as given. This generates the demand function for DOs from wholesalers. The DO price is determined by equating aggregate demand from wholesalers with aggregate supply from DOTs.[9]

Greif (1993): all DOTs could refuse to sell DOs or lend to any wholesaler who defaults on a loan with any DOT. If prices are stationary, the cost of these sanctions imposed on defaulters will depend on prices, which will alter the expression for credit ceilings derived below. This complicates the analysis without affecting the results qualitatively.

[9]This is based on the standard assumption underlying the Cournot model that an auctioneer clears the market (for DOs between DOTs and wholesalers). We speculate

To ensure that the market does not shut down, we assume

$$\alpha > (1 + i_b) [P_m + C_r + C_d + C_T] \tag{4}$$

3.1 The Standard Model without Credit Rationing

If loan default sanctions (R_d, R_b) are large enough, the credit ceilings will not be binding. Then each wholesaler maximizes profit (3) without being subject to any quantity constraint. A symmetric equilibrium among wholesalers results in consumer price

$$P_T = \alpha \left[1 - \frac{N_T}{N_T + \delta} \right] + \frac{N_T}{N_T + \delta} (1 + i_d) (P_d + C_T) \tag{5}$$

implying a pass-through rate of $\frac{N_T}{N_T+\delta}$ which is rising in N_T, and converging to 1 as N_T approaches ∞.

Having solved for the equilibrium at the wholesaler level resulting from any given DO price, we can roll back to the earlier stage where DOTs make quantity decisions. Combining (5) and (3) we obtain the derived demand function facing DOTs:

$$P_d(Q) = \frac{1}{1 + i_d} \left[\alpha - \frac{N_T + \delta}{N_T} Q^{\delta} \right] - C_T \tag{6}$$

The profit of a representative DOT selecting DO quantity q when the remaining DOTs select a total of Q_- when P_r is the price at which DOs can be bought:

$$[P_d(Q_- + q) - P_r - C_d]q \tag{7}$$

that the same equilibrium will result in the absence of an auctioneer, as in Kreps and Scheinkman (1983) where DOTs choose their capacity first, and then engage in Bertrand competition in selling DOs in conjunction with loans to wholesalers.

Routine calculations yield the following expression for the symmetric equilibrium selling price of DOs

$$P_d = \left[\frac{\alpha}{1+i_d} - C_T\right]\left[1 - \frac{N_d}{N_d+\delta}\right] + \frac{N_d}{N_d+\delta}[P_r + C_d] \tag{8}$$

Using (5), this in turn implies a downstream price of

$$P_T = \alpha\left[1 - \frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\right] + \frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\left(1+i_d\right)\left(P_r + C_d + C_T\right) \tag{9}$$

if P_r is the price at which DOTs buy DOs.

Proceeding in similar fashion back to the refiner level, we can solve for the equilibrium P_r and end up with the following expression for wholesale (and also retail) price as a function of oil import price:

$$P_T = \alpha\left[1 - \frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\frac{N_r}{N_r+\delta}\right] + \frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\frac{N_r}{N_r+\delta}(1+i_d)(P_m + C_r + C_d + C_T) \tag{10}$$

The pass-through of oil import price to the consumer price is the product of c_i across successive layers, where $c_i \equiv \frac{N_i}{N_i+\delta}$ is a measure of competitiveness in layer i. The downstream price is a convex combination of the demand intercept α and total unit cost (aggregating import, refining, distribution and financing costs). Rising competitiveness at any layer raises the pass-through rate and lowers the consumer price (given (4).

What does this model predict about the effects of a reform which bans the entire DOT layer from functioning? Then wholesalers will buy directly from refiners, financing their purchase by borrowing from banks instead of the DOTs.[10] Under the assumption of no credit rationing (i.e., wholesalers face

[10]The underlying assumption is that following the ban DOTs are not just unable to trade in oil, but also lend to wholesalers. This is plausible as a large part of the loanable funds of DOTs are funded by their profits from buying and selling DOs. Moreover, in a

no credit ceilings in borrowing from banks, as R_b is large enough), wholesaler per unit costs rise owing to a rise in the borrowing interest rate from i_d to i_b. This tends to raise the wholesale price. On the other hand, the reduction in concentration at the DOT layer has an opposite effect of lowering P_T. Moreover, DOT costs C_d are no longer incurred.[11] The net effect on the wholesale (and consumer) price is ambiguous, depending on the relative strength of either effect (i.e., the size of $i_b - i_d$ compared with N_d and C_d). The post-reform price is given by

$$\hat{P}_T = \alpha\left[1 - \frac{N_T}{N_T+\delta}\frac{Nr}{Nr+\delta}\right] + \frac{N_T}{N_T+\delta}\frac{N_r}{N_r+\delta}(1+i_b)(P_m + C_r + C_T) \quad (11)$$

Note however that the standard model yields unambiguous predictions regarding the changes in both the intercept of the price equation and the pass-through rate following the reform. The intercept term becomes smaller while the pass-through rate of the oil import price to P_T must go up as a result of the reform, as concentration declines and the interest cost of wholesalers rise ($i_b > i_d$). Post-reform the pass-through rate equals $\frac{N_T}{N_T+\delta}\frac{N_r}{N_r+\delta}(1+i_b)$, as against $\frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\frac{N_r}{N_r+\delta}(1+i_d)$ prior to the reform, and the intercept declines from $\alpha\left[1 - \frac{N_T}{N_T+\delta}\frac{N_d}{N_d+\delta}\frac{N_r}{N_r+\delta}\right]$ to $\alpha\left[1 - \frac{N_T}{N_T+\delta}\frac{N_r}{N_r+\delta}\right]$ following the reform. These predictions can be tested empirically.

dynamic setting the sanctions DOTs impose on defaulting wholesalers involved refusing to sell them any DOs. Such sanctions cannot be used if DOTs are banned from functioning in the oil market.

[11] Since the DOTS do not take physical delivery of oils, transport and storage costs incurred by them is zero. Thus the magnitude of C_d is likely to be small.

3.2 The Model with Binding Credit Constraints

When default sanctions R_d, R_b are low enough, the credit constraint (2) is likely to bind. Then the best response of a representative wholesaler to DO price P_d and aggregate quantity Q_- of all other wholesalers in the pre-reform situation is

$$q(Q_-, P_d) = \min\{\bar{q}(P_d), q^*(Q_-, P_d)\} \tag{12}$$

where

$$\bar{q}(P_d) = \frac{R_d}{(1+i_d)(P_d + C_T)} \tag{13}$$

is the constrained demand where the credit constraint binds, while $q^*(Q, P_d)$ denotes the corresponding unconstrained demand, which is the value of q that solves the first order condition

$$\alpha - (1+i_d)\,(P_d + C_T) = \eta\big[(Q_- + q)^\delta + \delta q(Q_- + q)^{\delta-1}\big] \tag{14}$$

The credit constraint does not bind in the symmetric equilibrium if

$$\frac{N_T}{N_T + \delta}\frac{1}{\eta}[\alpha - (1+i_d)(P_d + C_T)] \leq \left[\frac{N_T R_d}{(1+i_d)(P_d + C_T)}\right]^\delta \tag{15}$$

while if this condition is violated, the symmetric equilibrium with a binding credit constraint involves each wholesaler selecting

$$\bar{q} = \frac{R_d}{(1+i_d)(P_d + C_T)} \tag{16}$$

so the derived demand at the per wholesaler level resembles a unit price-elastic rectangular hyperbola. The residual demand curve facing DOTs is

now

$$P_d(Q) = \frac{1}{Q}\frac{N_T R_d}{1+i_d} - C_T \tag{17}$$

instead of (6). The resulting Cournot equilibrium among DOTs given P_r is

$$P_d = (1 - \frac{1}{N_d})^{-1}(P_r + C_d) - C_T \tag{18}$$

which yields a Cournot equilibrium among refiners that ultimately results in consumer price

$$P_T = \alpha - \eta\left[\left(1-\frac{1}{N_r}\right)^{-1}\left(1-\frac{1}{N_d}\right)^{-1}\frac{N_T R_d}{(1+i_d)\,(P_m + C_r + C_d)}\right]^{\delta} \tag{19}$$

In contrast to the case where the credit constraint does not bind, this is nonlinear, with the pass-through rate no longer independent of the crude import price.

The marginal pass-through rate equals

$$\frac{\partial P_T}{\partial P_m} = \eta\delta\left[\left(1-\frac{1}{Nr}\right)^{-1}\left(1-\frac{1}{N_d}\right)^{-1}\frac{N_T R_d}{(1+i_d)}\right]^{\delta}[P_m + C_r + C_d]^{-(1+\delta)} \tag{20}$$

which is increasing in R_d, and converges to 0 as R_d approaches zero. A decline in credit limit (i.e., R_d) shifts the residual demand curve facing DOTs inward, and reduces the sensitivity of the consumer prices to changes in oil refining costs.

Following the DOT ban, wholesalers borrow from banks at a higher interest rate i_b and are subject to lower credit limit $\frac{R_b}{1+i_b}$. If credit constraints were binding in the pre-reform situation, they will continue to bind following

the reform. The resulting equilibrium will involve

$$\hat{P}_T = \alpha - \eta \left[\left(1 - \frac{1}{N_r} \right)^{-1} \frac{N_T R_b}{(1+i_b)(P_m + C_r)} \right]^{\delta} \quad (21)$$

and a marginal pass-through rate

$$\frac{\partial \hat{P}_T}{\partial P_m} = \eta\delta \left[\left(1 - \frac{1}{N_r} \right)^{-1} \frac{N_T R_b}{(1+i_b)} \right]^{\delta} [P_m + C_r]^{-(1+\delta)} \quad (22)$$

The greater severity of credit constraints ($\frac{R_b}{1+i_b} < \frac{R_d}{1+i_d}$) now reduces the pass-through rate, which counters the increase owing to lowered concentration (equivalent to $N_d \to \infty$) and reduction in dealer costs ($C_d \to 0$). If the former effect is strong enough, the pass-through rate can now decline. The intensification of credit constraints also tends to raise the general level of P_T, i.e., the estimated intercept term, by shifting the oil supply curve inwards. The predictions about the effects of the reform on the intercept of the price equation and the the pass-trough rate are thus opposite to the standard model when credit contraction due to DOT ban is strong enough: the intercept goes up while pass-through declines after the reform.

4 Estimation Strategy

We utilize daily data on crude palm import price and domestic wholesale price to estimate the pass-through equation and how it changed following the reform. In order to test the standard model, we seek to estimate are

$$P_t^k = \gamma_k + \beta_k P_{tm} + \beta_k C_t + \epsilon_t \quad (23)$$

analogous to equations (10, 11), where $k = b, a$ refers to the regime (before and after the reform respectively), t denotes the date, the dependent variable P_t^k is the wholesale price during regime k, the regressor P_{tm} is the crude palm import price, and C_t denotes the sum of refining and distribution costs. The pass-through rate β_k equals the product of competition variables $\frac{N_i}{N_i+\delta}$ across various stages, and the interest rate at which wholesalers borrow. The key prediction of the standard model is that $\beta_a > \beta_b$, owing to a rise in competition and the interest rate following the DOT ban. The change in the intercept $\gamma_a - \gamma_b$ is of independent interest, as it helps estimate the effect of the reform on the level of downstream prices. Hence we are interested in running a regression of the form

$$P_t = \theta_0 + \theta_1 d_R + \theta_2[P_{tm} + C_t] + \theta_3 d_R*[P_{tm} + C_t] + \epsilon_t \tag{24}$$

where d_R is a regime dummy (1 after the reform, 0 before), and identifying the signs of coefficients of the dummy (θ_1) and its interaction (θ_3) with the import price. We refer to this as the before-after (B-A) regression.

The key difficulty is that we do not have data on costs of refiners, financing and distribution costs of wholesalers. If these costs are correlated with the import price, the estimated pass-through rate will be biased. However, our main interest is to infer the direction of *change* in the pass-through rate, i.e., the sign of θ_3. Denoting the coefficient on oil import price in a regression of c_t on p_{tm} by ρ_k in regime k, the estimated pass-through rate is$\hat{\beta}_k = \beta_k(1 + \rho_k)$. Under the assumption that the correlation between c_t and p_{tm} did not change (or became weaker) as a result of the reform, i.e., $\rho_a = \rho_b$, then clearly we can infer the direction of change in pass-through rate from a before after comparison. More generally, when $\rho_a \leq \rho_b$, we have $\hat{\beta}_a > \hat{\beta}_b$ if and only

if $\beta_a > \beta_b$. In contrast, when $\rho_a \geq \rho_b$, we have $\hat{\beta}_a < \hat{\beta}_b$ if and only if $\beta_a < \beta_b$. The bias in the B-A estimate of the intercept term in regime k equals $\beta_k {c^0}_k$ where ${c^0}_k = \left(\bar{c}_k - \rho_k \bar{P}_{mk}\right)$ denotes the intercept term in the regression of distribution costs c_t on the crude oil import price P_{tm} in regime k. Inferring the direction of change in the intercept term is therefore not possible, without making assumptions regarding the before-after difference in average distribution costs.

Assumptions and prior information concerning the sign and magnitude of ρ across policy regimes can thus be helpful in understanding the extent of bias in the BA estimates. There are reasons to believe that $\rho > 0$, i.e., refining and distribution costs are positively correlated with the palm import price, e.g., both being driven by collinear movements in international crude palm oil prices, fuel prices (diesel), interest rate and exchange rates within Bangladesh. Using data on diesel price and interest rates, we find evidence in favor of the assumption that $\rho_a > \rho_b \geq 0$. For example, the correlation between diesel price and crude oils import price was virtually zero in pre-reform period as government controls decoupled the domestic diesel price, but the correlation was 0.40 in the post-reform period as government allowed more flexibility in price setting in the gas stations. In this case, the change in pass-through rate as a result of the reform is overestimated by a B-A regression. The implied direction of bias in the intercept term is, however, not unambiguous. While $\rho_a > \rho_b$ implies ${c^0}_a < {c^0}_b$, ceteris paribus; the bias in the estimated intercept in general would depend on the average import prices and the average distribution costs across policy regimes. In our data, the average import prices of crude palm oils is higher in the post reform period, which suggests that any increase in the intercept in the post-reform period may be underestimated by a B-A regression. We would expect ${c^0}_a < {c^0}_b$

especially because the reform did not affect the storage or transport costs directly. This implies that if the average price of oils is higher because of the reform, the intercept of the distribution costs regression equation becomes smaller. However, it is not possible to pin it down exactly as we do not have information on average distribution costs $\bar{c}_k$, and, given $\rho > 0$, higher crude Palm prices will be associated with higher distribution costs on average due to factors unrelated to the reform.

One way of dealing with the bias in the B-A estimates is to add variables that proxy for refining and distribution costs, such as the diesel price.[12] A second approach is to compare price movements in palm oil with another commodity such as wheat which, in Bangladesh, is primarily imported from abroad, and is subject to similar transport and storage costs. This would amount to a DiD regression using data which pools oil and wheat:

$$P_t = \theta_0 + \theta_1 d_R + \theta_2 P_{tm} + \theta_3 (d_R * P_{tm}) + \gamma_1 d_O + \gamma_2 (d_O * P_{tm}) + \gamma_3 (d_O * d_R * P_{tm}) + \epsilon_t^* \tag{25}$$

where d_O denotes an oil dummy. Then γ_2 and γ_3 would provide estimates of the reform effect on the intercept and pass-through rates in oil. Since the storage rental rates and transport rates do not vary across palm oil and wheat, the distribution costs in oil and wheat will be positively correlated over time, and the estimates from the DID design will be less biased than the before-after regression using data on oil alone.

A final issue in understanding the effects of the reform on pass-trough rate is that, according to our benchmark model without credit rationing, the pass-through rate in post-reform period depends on the interest rate charged

[12]Diesel price is an important factor as most of the trucks run on diesel and the privately owned electricity generators also use diesel. Electricity outage and load shading were common in Bangladesh during the study period.

by the banks, as the wholesalers deprived of the credit from DOTs turn to them for financing their purchases. If the bank interest rate changes after the reform due to central bank policy independent of the policy reform in the edible oils market, we may incorrectly attribute the changes in the pass-through rate due to changes in interest rate to the effects of reform, under the null hypothesis that there is no quantitative credit rationing in post-reform period. Using data on interest rates on short-term bank loans, we will provide evidence that the conclusions in this paper are not due to changes in interest rates due to central bank policy.

5 Data and Empirical Results

We use daily price data for palm oil and wheat at various stages of the supply chain from the Department of Agricultural Marketing (DAM) unit of Ministry of Agriculture. These data are very similar to daily price data reported by The Trading Corporation of Bangladesh (TCB) for major urban centers. We utilize the DAM data owing to longer coverage and across a wider range of commodities. Daily international prices of wheat are derived from the data stream of Chicago Board of Trading.[13] Crude palm oil price data is obtained from the Malaysian Palm oil Board. Lentil import prices 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.

[13]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 nearly identical.

Table 1 provides summary statistics for wholesale, retail and import prices of palm oil and wheat prior to the reform. Figure 1 plots retail price data for palm oil along with the crude import price over the sample period. The close co-movement between the two series is apparent, with a margin that moves counter-cyclically, suggesting a pass-through rate between 0 and 1. The two vertical lines in the middle of 2011 correspond to dates of announcement and implementation of the reform. The international price was rising continuously from late 2008 onwards, until a few months prior to the onset of the reform. This was reversed thereafter immediately for a few months following the reform. Despite this the retail price remained stationary, resulting in an increase in the margin, and suggesting that the pass-through rate had declined following the reform.

Figure 2 compares movements in palm oil and wheat margins prior to the reform: the two tend to move together with the wheat margin tending to lead. Table 2 provides average wholesale and retail margins for the two commodities both before and after the reform. Margins are computed either using the current or 4-week lagged import price. We see a 25% or higher rise in oil margins while the wheat margin fell slightly.

Table 3 presents the results of the BA and DID regressions for the margin (using the 4-week lagged import price) as the dependent variable , which include year and quarter dummies, and a dummy for the Ramadan period when food prices tend to spike. We exclude data for the few months between the date of announcement and implementation of the reform. Data for two years prior to the announcement are compared with data following policy implementation. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) procedure. The B-A regression shows a significant fall in the pass-through rate, and a significant rise in the

intercept term. The pass-through rate declines from a point estimate of 0.81 to 0.62, while the point estimate of the intercept term rises from 22 to 41. This is inconsistent with the model of the supply chain without credit rationing, and consistent with predictions of the credit rationing model. The results are reinforced in the DID regression: the fall in the pass-through rate and the rise in the intercept are both larger. The evidence that the fall in pass-through rate after the DOT ban is underestimated in B-A regression is consistent with the assumption that . The fact that the increase in intercept is underestimated in the B-A on the other hand suggests that the combined effect of a higher crude import price and a higher ρ after reform is strong enough to make ${c^0}_a < {c^0}_b$.

Table 4A shows that the results are robust with respect to alternative lags for the oil import price. These correspond to alternative hypotheses concerning the way refiners set prices for refined oil, based on historic or current cost, and alternative specifications of the lag between the time of import of crude oil and sale of refined oil. Longer lags weaken the BA regression results (which nevertheless remain statistically significant), while the DID estimates are comparatively unaffected. The first two columns of Table 4B shows that the results continue to hold when the pre-reform sample is expanded to include three rather than two years. Columns 3 and 4 show they also hold when we include the 'announcement' period between the announcement and implementation dates, with separate intercept and pass-through interaction dummies for the announcement period included in the regression (estimated coefficients of these are not shown in the table).

The exact period for which the reform lasted is unclear, as the ban on operation of DOTs unraveled gradually a few months after implementation. According to informal accounts, the reform was in place for slightly less

than a year. Table 5A thus separates the post-reform period into the first 9 months following the reform, from the post-9 month period. Both B-A and DID results show that the effects were concentrated in the first 9 months; the post-9 month period is statistically indistinguishable from the pre-reform period. Not surprisingly, the first 9-month effects are larger in magnitude compared to previous tables which pooled all post-reform dates into a single post-reform period. Table 5B separates the first 6 months following the reform with the post-6-month period. The BA results are similar to those in Table 5A, while the DID results show some effects on the intercept term lingering even during the post-6-month period.

Table 6A tests the parallel trend assumption underlying the analysis. We move the reform date to one year prior to the actual reform, whereupon the significant effects in both BA and DID regressions in Table 3 disappear. Table 6B carries out an alternative placebo test, replacing oil with lentil, a different commodity whose supply chain was not affected by the reform. The corresponding DID results show no effect of the oil reform.

Our analysis predicts that the reform affected the wholesale margin but did not directly affect the wholesale-retail margin, since it affected DOTs who intermediated between the refiners and the wholesalers. This would imply that the effects on the retail margin (retail price less the oil import price) would be similar to those of the wholesale margin. Table 7A presents results for the retail margin. These are very similar to the results in Table 3 for the wholesale margin. Table 7B shows that the effects for the first 9 months following the reform had similar but larger effects on the retail margin (compared with the effects on the wholesale margin shown in Table 5A).

6 Supplementary Evidence and Alternative Explanations

In this section, we provide additional evidence consistent with our finding of an increase in the wholesale price of palm oil resulting from the DOT ban which intensified credit constraints of wholesalers. Choudhury and Clara Costa (2012) provide case studies of the experience of two refiners (Nurjahan Group and Bangladesh Edible Oils Limited) following the reform. Owing to a drop in demand from wholesalers, these two refiners accumulated excess inventory, and thereafter lowered their imports of crude oil by 39% between 2010 and 2011. Consistent with this account, aggregate imports of crude oil for Bangladesh as a whole fell following the reform: see Figure 3 which plots monthly imports for 2009-10 and 2010-11. A simple before-after regression indicates a statistically significant decline following the reform. It is striking that this happened during a period when world oil prices were declining, reversing the trend for the previous three years (see Figure 1).

In 2013, two years following the reform, we conducted a survey of edible oil traders in the Dhaka and Chittagong markets (Emran et al. (2015)). Data on 6176 transactions between DOTs and wholesalers revealed 30% of transactions between DOTs and wholesalers were on credit, and supplier credit from DOTs accounted for 32 percent of the volume. A retrospective survey we conducted in February 2016 of a sub-sample of 50 wholesalers in these markets indicated that wholesalers buying on credit from DOTs prior to the reform experienced a 45% reduction in volumes. This suggests aggregate supply at the wholesale level dropped by approximately 15% after the reform owing to the difficulties faced by wholesale traders in obtaining credit following the reform. There are no reliable estimates of the price elasticity of retail

demand for palm oil in Bangladesh, the estimate for USA is 1.24 (Kojima et al. (2014)), and 1.62 for India (Srinivasan (2005). The evidence is consistent with the idea that elasticity is higher in poorer countries. A plausible estimate for the elasticity in Bangladesh is 2.0. This yields a back-of-the-envelope estimate of a price increase of 7.5% owing to the reform, which is somewhat but not much higher than the estimated 5% increase implied by Table 2. A price elasticity of 3.0 would exactly match the survey estimate of the quantity reduction with our estimate of price increase from the DID design.

A possible alternative explanation of the lower pass-through rate estimated after the reform is that the wholesalers always rely on the banks for credit and the interest rate charged by banks declined after the reform because of central bank policy shift. A lower interest rate would reduce the pass-through estimate according to our benchmark model without credit rationing. The evidence on bank interest rate rejects this explanation; the average bank interest rate was higher in the post reform period.

Another alternative explanation of the rise in wholesale price is that the reform increased the market power of refiners who were selling directly to wholesalers, rather than indirectly through the DOTs prior to the reform. This would have implied an increase in profits earned by refiners, who would have an interest in ensuring that the reform was not reversed. Interviews with refiners and traders, as well as the retrospective survey of 50 traders we conducted in February 2016 instead report that refiners who were unhappy with the reform (owing to the limited take up from wholesale dealers) surreptitiously went back to the DOTs to offload their accumulated inventory. This indicates that the refiners' profit was adversely affected by the reform, consistent with the prediction of the credit rationing model.

Explanations based on increased search costs are also unlikely to account for a price increase resulting from the reform. These search costs did not seem significant prior to the reform, as DOTs operate within a very narrow market area in Dhaka and Chittagong, and wholesalers could find out prices quoted by DOTs by making a telephone call to their contacts in these market areas. Following the reform, there were only nine refiners from whom they could purchase; knowing what prices they were charging would have been even easier than checking prices charged by the 300-400 DOTs previously.

7 Related Literature

The evidence and analysis presented in this paper is most closely related to a large literature on imperfect pass-through of international prices and exchange rate variations to domestic producer and consumer prices (e.g., recent contributions by Goldberg and Hellerstein (2008), Nakamura and Zerom (2010), Berman et al. (2012), Bonnet et al. (2013), and recent surveys by Burstein and Gopinath (2013), Campa and Goldberg (2008)). Weyl and Fabinger (2013) presents a unifying framework for incidence with imperfect competition. This framework has been fruitfully utilized in the context of a developing country by Atkin and Donaldson (2016). Analogous to our approach, they use the Bulow-Pfleiderer (1983) specification of demand to derive a constant pass-through rate that depends only on market concentration and demand curvature. They use this to recover trade costs from spatial price differences. As in the standard model, intermediaries in their model play a role in trade and physical distribution rather than financing, and contract frictions such as credit constraints play no role.

The literature in development economics has paid more attention to con-

tracting frictions, resulting from adverse selection, moral hazard and enforcement problems. Models of interlinked trade-credit relationships have appeared in Braverman and Stiglitz (1984), Bardhan (1984, 1989). Burkart and Ellingsen (2004) show that relative illiquidity of commodities implies that it is easier to provide trade credit compared to a pure credit contract. This argument is relevant for our application, because a DO is considerably less liquid than money, as it may not be easy for a wholesaler to find a DO buyer willing to pay cash without offering significant discounts. More important, the DOTs rely on accumulated information about the wholesalers to minimize adverse selection and moral hazard, and default information is shared quickly among the DOTs in a market, similar to multilateral punishment scheme a la Greif (1993). Information and monitoring advantages have been identified as important factors for supplier credit (see, for example, Smith (1987)).

Recent empirical work in developing countries on intermediaries and commodity supply chains have examined pass-through of international or retail prices to farmgate prices when trade intermediaries operate as middlemen between farmers and retail or foreign buyers (Casaburi et al. (2013), Fafchamps and Hill (2008), Minten and Kyle (1999)). Many of these focus on search frictions to explain pass-through patterns, while Mitra et al (2013) consider implications of asymmetric price information. The role of intermediaries in providing trade credit does not appear in these papers. Our paper therefore provides an interesting complement to this literature.

Although there has been a renewed interest in the domestic food markets in developing countries in response to price shocks in the international market, most studies (e.g., Ivanic et al. (2012)) estimate the effects of higher international prices on domestic prices (pass-through) in reduced form regres-

sions without a theoretical model, and the focus is usually on the implications of higher consumer prices for poverty. These studies do not attempt to understand the role of intermediaries or the effects of efforts to regulate their activities.

8 Concluding Comments

This paper extends the model of vertical supply chain with imperfect competition to incorporate financing intermediaries who relax binding quantitative credit constraint faced by downstream traders. We show that quantitative credit constraint faced by downstream traders reduces the price elasticity of the demand curve for upstream market agents. More stringent credit constraint lowers the pass-through rate of international prices to domestic wholesale prices.

To discriminate between the models of supply chain with and without quantitative credit rationing, we take advantage of a policy experiment in Bangladesh where the government banned a layer of financial intermediaries in edible oils market called Delivery Order Traders (DOTs) in 2011. The reform was motivated by widely held belief that these intermediaries exert market power and keep the prices paid by consumers high even when the international prices are falling, by lowering the pass-through rate. The reform is expected to increase the pass-through rate and reduce the marketing margin of traders in the standard double marginalization model without quantitative credit rationing. In sharp contrast, the reform is likely to reduce pass-through rate and increase the marketing margins if the role played by the DOTs before the reform is to provide credit to wholesalers and relax their binding credit constraints.

The empirical analysis based on a difference-in-difference design with wheat as the comparison commodity shows that, contrary to the expectations of the policy makers, the reform raised the consumer prices; it reduced the pass-through rate of falling international prices after the reform, and also increased the intercept of the marketing margin equation. The evidence of a lower pass-through and higher intercept rejects the standard double marginalization model of pass-through in imperfectly competitive marketing chain widely used in the literature, and is consistent with the predictions from the extended model with quantitative credit rationing. The evidence and analysis presented here suggest that credit market frictions and quantitative credit rationing are important for a better understanding of the transmission of international prices to domestic wholesale and retail prices.

Table 1: Summary Statistics

	Main Sample		Full Sample	
	Mean	Standard Deviation	Mean	Standard Deviation
Palm				
Wholesale price	80.07	15.31	77.85	16.23
Retail price	84.27	16.19	82.05	16.77
World Price (4 week lagged)	68.54	15.50	64.20	18.03
World Price (Current)	69.31	15.26	64.44	17.93
Wheat				
Wholesale price	21.62	3.90	22.41	4.91
Retail price	24.22	3.97	25.29	5.19
World Price (4 week lagged)	16.06	3.48	16.34	3.85
World Price (Current)	16.39	3.73	16.51	3.98

Notes: (1) The Main Sample Includes 2 years from pre-reform period, full sample spans 3 year and 2 months before reform period. (2) Unit for Palm is Litre, and for Wheat Kg. All prices and margins are in Taka.

Table 2: Wholesale and Retail Trading Margins for Palm Oils and Wheat

	Palm Margins				Wheat Margins			
	Before Intervention	After Intervention	Difference	T-stat	Before Intervention	After Intervention	Difference	T-stat
	4-week Lagged World Price (taka/kg/litre)							
World-Retail Margin								
Mean	13.57	18.31	4.74	13.76	8.43	7.84	-0.59	3.08
Standard Dev.	4.24	4.39			2.22	2.56		
World-Wholesale Margin								
Mean	10.42	12.86	2.44	6.41	5.86	5.21	-0.65	3.51
Standard Dev.	4.37	5.19			2.34	2.27		
	Current World Price (taka/kg/litre)							
World-Retail Margin								
Mean	11.74	18.81	7.07	16.67	8.16	7.44	-0.72	3.50
Standard Dev.	4.72	5.92			2.11	3.04		
World-Wholesale Margin								
Mean	8.59	13.36	4.77	11.45	5.59	4.81	-0.78	4.10
Standard Dev.	4.77	5.69			2.02	2.75		

NOTE: Unit for Palm is Litre, and for Wheat Kg. All prices and margins are in Taka.

Table 3: Main Results: 4 weeks lagged world price for crude palm oil

	Before- After	Difference in Difference
	(1)	(2)
Effect of Implementation		
Policy Implement. Dummy	**18.92*** **	
	(3.113)	
Policy Implement.* World price	**-0.179** **	
	(-2.459)	
Palm world price	-0.195***	
	(-4.302)	
Policy Implement. Dummy		-3.150***
		(-4.633)
Policy Implement.*Palm		**24.38*** **
		(7.348)
Policy Implement.*Palm * World Price		**-0.217*** **
		(-5.039)
World price*palm		0.105**
		(2.066)
World Price		-0.357***
		(-6.269)
Palm		14.30***
		(13.19)
Intercept	21.88***	14.42***
	(5.126)	(9.544)
Observations	631	1262
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg.
Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 4A: Robustness to Alternative Lags in Crude Palm Oil Price
(Dependent Variable: Wholesale Margin)

	No Lag		8 Week Lag	
	Before-After	Difference in Difference	Before-After	Difference in Difference
	(1)	(2)	(3)	(4)
Effect of Implementation				
Policy Implement. Dummy	**23.95*** **		**13.64***	
	(4.333)		**(1.940)**	
Policy Implement.* World Price of Palm	**-0.237*** **		**-0.168***	
	(-3.686)		**(-1.887)**	
World Price of Palm	-0.258***		-0.355***	
	(-7.734)		(-5.066)	
Policy Implement. Dummy		-4.013***		-4.352***
		(-5.749)		(-5.710)
Policy Implement.*Palm		**29.28*** **		**26.06*** **
		(7.748)		**(5.415)**
Policy Implement.*Palm* World Price		**-0.245*** **		**-0.269*** **
		(-5.097)		**(-4.253)**
World Price*Palm		0.132**		0.285***
		(2.109)		(4.626)
World Price		-0.455***		-0.554***
		(-6.636)		(-8.250)
Palm		15.98***		14.35***
		(13.47)		(7.580)
Intercept	25.79***	16.41***	40.77***	20.23***
	(8.095)	(9.334)	(6.717)	(11.86)
Observations	631	1,262	631	1,262
Year and Quarter dummies	Yes	Yes	Yes	Yes
Ramadan Dummies	Yes	Yes	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation.t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 4B: Robustness with respect to Sample Used for Estimation
(Dependent Variable: Wholesale Margin)

	Full Sample (3 yrs before pre-reform subsample)		**Including Announcement in Sample**	
	Before-After	Difference in Difference	Before-After	Difference in Difference
	(1)	(2)	(3)	(4)
Effect of Implementation				
Policy Implement. Dummy	**19.68*** **		**22.76*** **	
	(3.646)		**(3.846)**	
Policy Implement.* World Price of Palm	**-0.184*** **		**-0.221*** **	
	(-2.834)		**(-3.123)**	
World Price of Palm	-0.318***		-0.183***	
	(-8.212)		(-4.192)	
Policy Implement. Dummy		-1.083		-3.128***
		(-1.461)		(-5.854)
Policy Implement.*Palm		**25.18*** **		**26.15*** **
		(7.239)		**(7.980)**
Policy Implement.*Palm* World Price		**-0.240*** **		**-0.233*** **
		(-5.232)		**(-5.474)**
World Price*Palm		0.0513		0.104**
		(1.046)		(2.360)
World Price		-0.342***		-0.353***
		(-5.797)		(-7.435)
Palm		18.79***		14.22***
		(14.28)		(13.17)
Intercept	37.67***	16.31***	20.42***	14.02***
	(14.00)	(12.38)	(5.160)	(11.95)
Observations	890	1,780	687	1374
Year and Quarter dummies	Yes	Yes	Yes	Yes
Ramadan Dummies	Yes	Yes	Yes	Yes

Notes: (1) World Price Denotes the World Market Prices of Palm Oil and Wheat.
(2) The "Full Sample" Excludes the Announcement Period.
(3) The Announcement Sample Includes 2 years from pre-reform period.
(4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation.t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 5A: Effects of the Reform in the first 9 Months and Afterward
(Dep. Variable: Wholesale Margin)

	Before- After	Difference in Difference
	(1)	(2)
Effects during first 9 months		
Policy Implementation	**28.24*** **	
	(3.783)	
Policy Implement.*World Price of Palm	**-0.338*** **	
	(-3.765)	
Policy Implement. Dummy		-5.318***
		(-8.656)
Policy*Palm		**33.48*** **
		(7.684)
Policy*Palm*World Price		**-0.328*** **
		(-5.691)
Effects after first 9 months		
Policy Implementation	**-8.065**	
	(-1.008)	
Policy Implement.*World Price of Palm	**0.0450**	
	(0.502)	
Policy Implement. Dummy		-8.374***
		(-8.432)
Policy*Palm		**7.003**
		(1.128)
Policy*Palm*World Price		**-0.0162**
		(-0.218)
World Price of Palm	-0.222***	
	(-4.839)	
World Price*Palm		0.133***
		(2.616)
World Price		-0.396***
		(-7.092)
Palm		14.43***
		(13.41)
Intercept	29.38***	18.48***
	(6.818)	(13.64)
Observations	631	1262
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 5B: Effects of the Reform Before and After the First 6 Months
(Dep. Variable: Wholesale Margin)

	Before- After	Difference in Difference
	(1)	(2)
Effects during first 6 months		
Policy Implementation	**31.77*** **	
	(3.248)	
Policy Implement.*World Price of Palm	**-0.348*** **	
	(-2.891)	
Policy Implement. Dummy		-4.428***
		(-7.496)
Policy*Palm		**19.47*** **
		(2.980)
Policy*Palm*World Price		**-0.129**
		(-1.459)
Effects after first 6 months		
Policy Implement.	**9.927**	
	(1.493)	
Policy Implement.*World Price of Palm	**-0.126**	
	(-1.603)	
Policy Implement. Dummy		-5.231***
		(-4.836)
Policy*Palm		**11.85** **
		(2.307)
Policy*Palm*World Price		**-0.0820**
		(-1.315)
World Price of Palm	-0.189***	
	(-3.960)	
World Price*Palm		0.193***
		(3.810)
World Price		-0.460***
		(-8.173)
Palm		13.76***
		(12.69)
Intercept	26.02***	18.95***
	(5.305)	(11.25)
Observations	631	1262
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 6A: Test of the Validity of Parallel Trend in Pre-reform Period: Fictitious Policy Date (Dep. Variable: Wholesale Margin)
(DID Estimates: Treatment = Palm, Control = Wheat)

	Before- After	Difference in Difference
	(1)	(2)
Effect of Implementation		
Policy Implement. Dummy	**6.619**	
	(0.475)	
Policy Implement.*World Price of Palm	**-0.0163**	
	(-0.0890)	
World Price of Palm	-0.249***	
	(-5.015)	
Policy Implement. Dummy		1.968***
		(2.802)
Policy Implement.*Palm		**-2.689**
		(-0.334)
Policy Implement.*Palm* World Price		**0.0939**
		(0.823)
World Price*Palm		0.00553
		(0.0927)
World Price		-0.252***
		(-3.764)
Palm		15.48***
		(13.79)
Intercept	27.13***	11.30***
	(6.366)	(8.617)
Observations	471	942
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 6B: The Effects of the Reform on a Placebo Commodity
(Dep. Variable: Wholesale Margin)
(Treatment = Lentil, and Control= Wheat)

	Difference in Difference
	(1)
Policy Implement. Dummy	-1.002
	(-1.156)
Policy Implement.*Lentil	**-11.12**
	(-1.506)
Policy Implement.*Lentil*World Price	**0.134**
	(1.049)
World Price*Lentil	-0.450***
	(-2.647)
World Price	-0.00731
	(-0.0823)
Lentil Dummy	34.20***
	(4.854)
Intercept	7.208***
	(3.539)
Observations	1,239
Year and Quarter dummies	Yes
Ramadan Dummies	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Units for Lentil and Wheat are both Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7A: Effects of the Reform on Retail Trading Margin (Dep. Variable: Retail Margin)

	Before-After	Difference in Difference
	(1)	(2)
Effects of Implementation		
Policy Implement. Dummy	**14.01*** **	
	(2.606)	
Policy Implement.*World Price of Palm	**-0.119***	
	(-1.853)	
World Price of Palm	-0.225***	
	(-5.853)	
Policy Implement. Dummy		-4.263***
		(-7.013)
Policy Implement.*Palm		**26.13*** **
		(9.594)
Policy Implement.*Palm* World Price		**-0.213*** **
		(-5.924)
World Price*Palm		0.145***
		(3.038)
World Price		-0.396***
		(-7.557)
Palm		14.31***
		(13.99)
Intercept	29.15***	18.94***
	(8.107)	(14.14)
Observations	631	1,262
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7B: Effects on Retail Margin in the First 9 Months and After
(Dep. Variable: Retail Margin)

	Before- After	Difference in Difference
	(1)	(2)
Effects during first 9 months		
Policy Implementation	**32.53*** **	
	(4.872)	
Policy Implement.*World Price of Palm	**-0.384*** **	
	(-4.703)	
Policy Implement. Dummy		-5.558***
		(-8.976)
Policy Impl.*Palm		**45.46*** **
		(10.32)
Policy Impl.*Palm*World Price		**-0.463*** **
		(-7.851)
Effects after first 9 months		
Policy Implementation	**-11.80***	
	(-1.793)	
Policy Implement.*World Price of Palm	**0.121***	
	(1.699)	
Policy Implement. Dummy		-8.106***
		(-7.893)
Policy*Palm		**6.379**
		(1.453)
Policy Implement.*Palm* World Price		**0.0241**
		(0.461)
Palm world price	-0.231***	
	(-5.793)	
World Price*Palm		0.152***
		(3.020)
World Price		-0.407***
		(-7.393)
Palm		14.37***
		(14.03)
Intercept	33.66***	21.67***
	(8.789)	(15.96)
Observations	631	1,262
Year and Quarter dummies	Yes	Yes
Ramadan Dummies	Yes	Yes

Notes: (1) The sample consists of 2 years from the pre-reform period, and the announcement phase is excluded. (2) World Price Includes Both Palm and Wheat. (3) Unit for Palm is Litre and for Wheat Kg. (4) Standard errors are corrected using Newey-West (1987) procedure for heteroskedasticity and autocorrelation correction and assuming 1 period lag in autocorrelation. t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Figure 1: World and Wholesale Prices: Palm oil

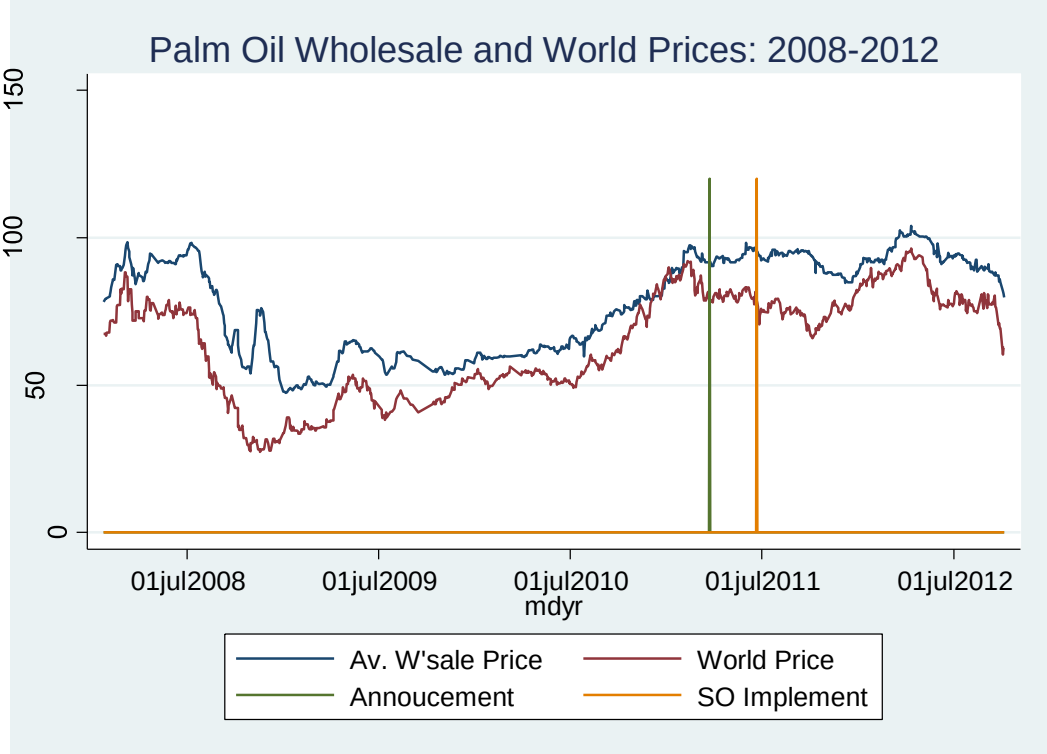

Figure 2: World -Wholesale Trading Margins: Palm and Wheat

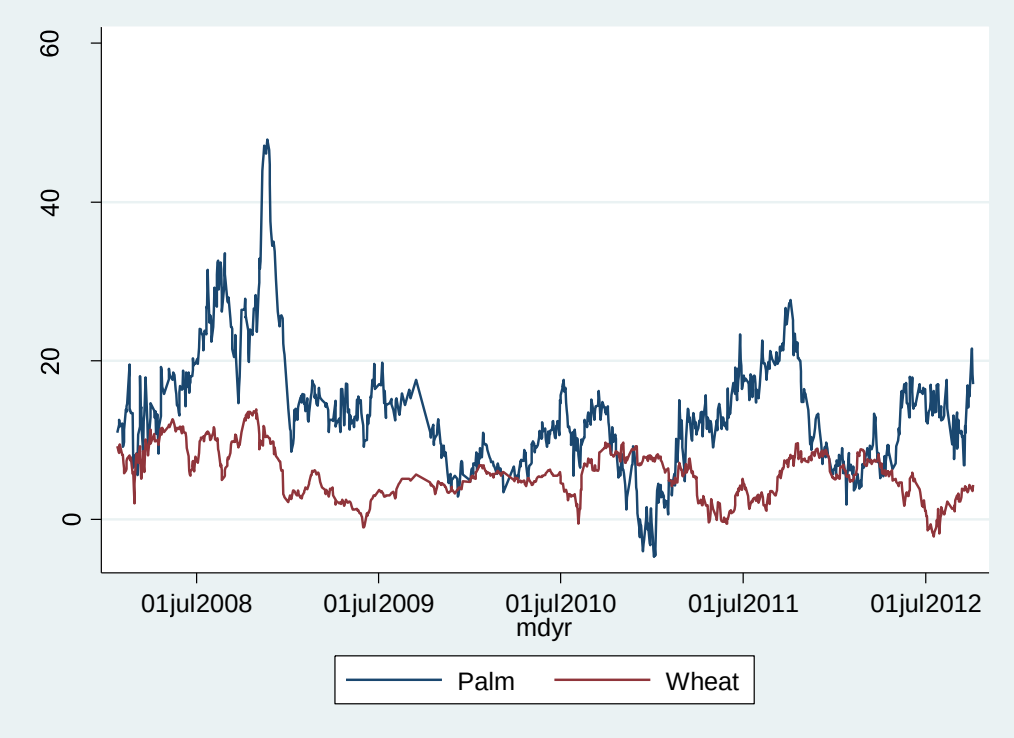

Figure 3: Palm Oil Import ('000 mt)