How do commodity derivatives markets impact farmers' welfare? The Indian experience

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Abstract

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1 Introduction

Recent discussions on agricultural commodity markets have, more often than not, centered around the growing financialization of commodity markets. In particular, ever since the food inflation crisis worldwide in 2007-08, there have been concerns that speculation in futures markets attracted players who did not have a direct interest in these commodities and transmitted to commodity markets, greater volatility and inflation (Kalkuhl *et al.*, 2016; UNCTAD, 2011). Yet, a large number of theoretical and empirical works in developed and developing countries alike emphasize the role of futures markets in enabling price discovery, under the premise that it would benefit farmers.

In this paper we explore the relationship between operations of futures markets and farmer welfare in the context of India. In what ways do futures markets benefit farmers, if at all? One argument that is often made in favour of futures markets is that farmers have opportunities to hedge by participating in these markets. However, this may not always be a tenable proposition, especially in emerging economies such as India, where farmers are not well equipped to become direct participants on the futures market platform. However, the futures market might still have a positive impact on the farmers by reducing the asymmetries involved in market transactions. The underlying hypothesis is that the commodities' exchanges provide price benchmarks that aid not only price transmission to the farmers (upstream) but also market integration, spatially. The beneficial effects of these may accrue to farmers as benefits in terms of higher and less volatile prices even if farmers do not use the futures market directly for the purpose of hedging. To the extent that farmers are risk averse, information on prices can help farmers take decisions to help smooth their returns and enable them to be better off.

The view that information can increase market efficiency is well established. The absence of market infrastructure and institutions especially information exacerbates spot market price risk for most producers (Barett, 2008), that may in turn lead to underinvestment (Sandmo, 1971). Theoretical literature in economics suggests that the absence of information could lead to spatial dispersion of prices and costly search which lowers competition and results in inefficient allocation of goods (Stigler, 1961; Schroeder and Goodwin, 1991; Salop and Stiglitz, 1977; Pratt *et al.*, 1979). In principle, knowledge of market information tends to reduce the risks and lowers the transaction costs for farmers participating in the market (Giovannucci and Shepherd, 2001). These efficiency gains can contribute to larger markets (by expanding participation and volumes), wherein prices begin to reflect/signal demand and supply conditions. This would then result in supply responsiveness and greater stability in prices and supply. Information helps farmers negotiate favorably with traders, assisting in equitable distribution of gains from market participation across actors (Giovannucci and Shepherd, 2001). On a longer term basis, improved information enables farmers to plan their production, harvesting, and sale according to market demand and in some cases to choose the optimal marketing channel (i.e. selling at one or a combination of: the farm gate, local market, wholesaler, processor, and retailer). Market information has the potential for improving efficiency

along the entire chain. Just as it helps producers participate in markets, traders, especially smaller ones benefit from better information in making efficient allocation decisions to hold products in storage or ship them to the most lucrative markets. To the extent that these efficiency gains are transferred to consumers through lower prices (or more stable and reliable supplies) consumers too become indirect beneficiaries.

Most of the existing empirical work has focused on the impact of market information systems (MIS) or information and communication technologies (ICTs) on price dispersion between markets and sellers (Aker and Fafchamps, 2015; Jensen, 2007), price asymmetry between traders and farmers (Svensson and Yanagizawa, 2009), traders' search behavior (Aker and Tack, 2014), farmers bargaining power and selling prices (Mitchell, 2011) , consumption expenditures (Labonne and Chase, 2009), and farmers' marketing choices (Tadesse and Bahiigwe, 2015), among others (see Nakasone *et al.* (2014) for a recent review). Ample anecdotal evidence exists on the potential welfare gains of MIS and ICTs. Examples of these in the Indian context include the effect of e-Chaupal on soyabean markets (Goyal, 2010) and the impact of mobile telephones for price information in the fishery sector in Kerala (Jensen, 2007).

But information does not always seem to matter. For example, studying potato farmers in West Bengal, Mitra *et al.* (2017) find that information provision resulted in no change in average margins, but caused farm-gate prices and traded quantities to shrink (respectively expand) significantly in villages with low (respectively high) wholesale prices. Fafchamps and Minten (2012) find in a randomized control experiment (RCT) that Reuters Market Light SMS-based information system did not make a difference to the prices farmers received. One constraint was the low cost of adoption and low uptake of services that provide information; another reason is structure of local markets that prevent farmers from commanding a higher share of value in the supply chain. Thus, market structures and costs associated with access to information can undermine or hinder the translation of informational interventions to farmer welfare, implying that this is an empirical question.

In general, therefore, despite evidence of the role of information in improving market quality, its implications specifically for farmer welfare are more complex and are a function of a number of contextual conditions like spot market structure, existing infrastructure for market information and storage, among others. This paper asks whether futures markets impact the welfare of the farmers by acting as a medium for information dissemination in the spot markets for agriculture commodities, focussing on the Indian experience with agri-commodity futures markets over the period 2003-15. For this purpose, we focus on select commodities, coriander, mustard, maize, soyabean and turmeric, traded on the largest agricultural commodity exchange in India, the National Commodity Derivatives Exchange (NCDEX) of India. Rather than attempting to assess the ultimate impact on farmer earnings, a challenging task given the paucity of data, we focus on intermediate outcomes in the spot market. We examine three potential consequences: Does the operation of futures markets lead to reduced spatial price differentials? Do futures markets smoothen arrivals

of a commodity across seasons and consequently, does this support a smoothening of prices across seasons. These latter aspects are potentially important in contexts such as India, where spot market trade dominates and cash-poor farmers are forced to sell soon after harvest when prices are the lowest.

We use a regression framework that identifies the relationship between the scale of operations of futures markets for a specific commodity to the metrics of interest. We find that the main effect of futures markets varies across commodities - with spatial dispersion decreasing for maize and soyabean while increasing for turmeric, mustard and coriander. All effects while statistically significant are fairly small. For maize, mustard and soybean, we find that there has been a decline in variation in daily arrivals across the year and a decline in the variation of spot prices for maize and turmeric. The patterns of interaction effects likewise differ across commodities. We offer some possible reasons for these findings based on the structure of agricultural markets in India. Our findings suggest that there are potential gains from the operations of futures market. However, the pattern of results also suggest that complementary reforms of spot markets are required to ensure the translation of these benefits.

The rest of paper is structured as follows. Section 2 provides a background of agricultural commodity futures in India and of existing evidence of the links between futures markets and spot markets as well as the more general issue of impacts of information on prices for agricultural commodities. This provides the context against which we define our research questions. In Section 3 we describe the data and empirical strategy used in the paper.Section 4 discusses the findings, taking up one hypothesis at a time. Section 5 concludes the paper.

2 Agricultural Commodity Futures in India

Futures markets for agricultural commodities have had a long but chequered history in India. Several exchanges at the national and regional level dealing with single or multiple commodities have operated for long. At the same time, the policy environment has not always been conducive to the operation of agricultural commodity futures on account of the perception that futures markets are inimical to farmer interests. Consequently, successive governments have frequently banned futures trading in commodities. The broader policy environment too has largely thwarted the growth of agricultural futures markets. Likewise, the Essential Commodities Act (1955) provides a framework for controls on stocks domestically to manage prices and is used frequently to curtain inflationary pressures. International trade policy too entails frequent changes in the form of export restrictions (bans, minimum export prices and so on) and import controls to ensure that prices for the consumers are managed. On the production side, heavy government intervention in some markets (notably wheat and rice), through a combination of price supports and procurement, have thwarted the development of spot and derivatives markets for these commodities.

Yet, many committees formed in the past two decades to look specifically into the issue of the impact of futures markets on commodity markets have either explicitly supported the development of futures markets or have declared that there is not adequate evidence to suggest that futures markets are inimical to farmer interests. For example, the National Agricultural Policy 2000 (NAP), sought to "enlarge the coverage of futures markets to minimize the wide fluctuations in commodity prices as also for hedging their risk. The endeavour ought to be to extend futures trade to all agri-commodities in course of time." The Guru Committee (2001) emphasized the role of futures trading for price risk management and marketing of agricultural produce. The Abhijit Sen Committee (2008)[1] that was mandated to look specifically at the impact of the futures markets on commodity spot markets declared that the evidence was not clear about whether the futures markets had any role to play in aggravating inflation or volatility. Academic research in India too has found ambivalent evidence to suggest that futures markets exacerbate volatility in prices.

Although farmer participation in futures markets in India is historically low, at the same time, participants are no longer based exclusively in large metropolitan areas and increasingly come from small towns. Even as early as in 2007, it was reported that the major cities in the country —Delhi, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad and Jaipur accounted for 68% of total clients on the futures market exchange, implying that the rest came from smaller towns —that a fair share of futures markets' participants were located closer to farmers and consequently, the benefits of this market may be percolating to actual producers also, though indirectly. Several anecdotal examples supporting this proposition find mention in the Abhijit Sen Committee Report (2008). For instance, farmers of guar seed and menthol reportedly received a higher proportion of the final price due to incremental bargaining power brought by transparency of futures prices on exchange platforms. It is also reported that some farmers in Punjab held back their produce of wheat during harvest season in April-May, 2006 on the basis of signals of higher futures prices on NCDEX platform and sold at higher prices during October-November, 2006.

Against this context, our research seeks to investigate the consequences of commodity futures markets on aspects of farmers' welfare. Measuring farmer welfare directly is a challenging exercise and owing to paucity of such data, we focus on intermediate outcomes measured at the market level that correlate with farmer welfare. Our research is built specifically around a set of three hypotheses.

- Do futures markets reduce the spatial price dispersion across spot markets by serving as a single credible source of information in a context where information is scattered and markets are fragmented?

- Does the presence of a futures markets reduce seasonal variation in market transactions within a year so that arrivals are more evenly spread over the year?

[1] See `http://www.fmc.gov.in/showfile.aspx?lid=180`

- Does such smoothening of arrivals also reduce the price variation over the year?

For farmers who are risk averse, an affirmative confirmation of the latter two hypotheses could smoothen the farmers' incomes enhancing welfare by reducing volatility of returns. Greater spatial integration of prices imply that on average farmers who hitherto obtained lower prices on account of information asymmetry are perhaps now able to command a higher price, therefore earning more on average than in the absence of futures markets. Reduction in spatial dispersion could also lead to farmers earning a price lower than before, which would then represent a correction of sorts. In theory, essentially farmers should be able to direct their produce to markets where price reign higher.

We test each of these hypothesis in the context of five heavily traded commodities on the largest agriculture commodities' exchange in India —the National Commodities and Derivatives Exchange (NCDEX). Our choice of commodities includes soybean, rapeseed and mustard (RM seed), maize, turmeric, coriander. These commodities represent different groups —oilseed, cereals, spices and pulses —are typically grown in different seasons across large parts of the country. Our research spans the years 2003 to 2015. The futures contracts traded for these commodities are the most traded contracts on the exchange that did not undergo any major policy intervention including bans on trading ever since their inception and have maintained relatively high liquidity during the life of the contract. This enables us to focus on the effects of the emergence of futures markets that are not muddied by bans and responses to these bans.

3 Data and Empirical Strategy

3.1 Data

Our data come from multiple sources. Spot market prices pertain to those from the network of regulated market places or *mandis* where most of the spot market trade takes place. We use daily prices published by the Department of Agricultural Cooperation.[2] These prices are collected on daily basis and reported to a centralized database system. The database collects three prices —minimum, modal, and maximum price. For the purpose of our analysis, we use the minimum price instead of the modal or the maximum price. The reason for choosing the minimum price over the modal price is that more often, the modal price is only a ballpark estimate of the mode rather that the actual value. In some markets it is recorded as a linear combination of maximum and minimum, and is mode only in name. The maximum price, in contrast will indicate the price of the

[2] *Agmarknet* is a portal set up by Government of India on agricultural marketing. The portal provides static and dynamic information relating to agricultural marketing in India. The static information is about infrastructure-related (storage, warehousing, cold Storage, grading and packing facilities), market related (market fee, weighment, handling, market functionaries, market laws, etc) and promotion-related information (standards, grades, labelling, pledge financing, marketing credit and new opportunities available). The dynamic part comprises of price-related information, that includes maximum, minimum and modal prices of varieties, and total arrivals.

highest quality, for which the quantity traded may be very small. Hence, we restrict our analysis to the minimum price.

This database also records the total arrivals in a regulated market place (*mandi*) on daily basis for each commodity, and in many cases disaggregated by quality. The *mandi* is the dominant space for price discovery and offers a benchmark for most bilateral outside *mandi* trades (for example, contract farming, direct purchases by supermarket retailers and so on). Therefore, the price in these market places reflects best the prices that farmers likely get. While a *mandi* is the principal site for trade, these are often differentiated informally as producer-mandis and consumer-mandis to distinguish between upstream mandis where the farmer interfaces with a trader and the latter to denote those where intermediary-aggregators sell to consumers downstream.

For the analysis, we focus on five most heavily traded commodities on the largest agricultural commodities exchange in India – the National Commodities and Derivatives Exchange (NCDEX). These include soybean, mustard, turmeric, maize and coriander. These commodities represent different commodity groups —oilseed, cereals and spices, and are typically grown in different seasons across large parts of the country (Figure 1). Apart from being the most liquid contracts relatively, these commodities did not see any policy intervention such as ban on trading. Table 1 provides details of the sample commodities.

Table 1 Details of commodities analysed

The table presents a brief description for the set of underlying commodities used in the analysis. It lists the date of introduction of futures contracts, commodity groups, and cropping season for each of these commodities. The two major cropping seasons in India are *Kharif* (summer season from June to September) and *Rabi* (winter season from October to March).

Commodity	**Date of futures introduction**	**Commodity group**	**Cropping season**
Mustard	December, 15^{th}, 2003	Oil seed	Rabi (winter)
Soybean	December, 15^{th}, 2003	Oil seed	Kharif (summer)
Maize	January, 5^{th}, 2005	Cereal	Kharif & Rabi
Turmeric	July, 27^{th}, 2004	Spice	Kharif (summer)
Coriander	August, 11^{th}, 2008	Spice	Rabi (winter)

At the time of the launch of futures contract, the exchange specifies details of the quality of the commodity acceptable for physical delivery (such as percentage of foreign matter, moisture) as well as the basis and the delivery center. Basis centers are *mandis* from where the exchange takes spot price information to price the futures contract. These *mandis* are usually the one with highest volumes amongst all *mandis* in the country. Delivery centers are the *mandis* which are accredited by the exchange to accept physical delivery of the commodity at the time of final settlement. The exchange reviews the commodity specifications as well the basis (and the delivery centers) from time to time, and modify them as per the changing demand patterns as well as market conditions.

Table 2 provides names of polling and delivery centers that were announced by NCDEX for sample commodities during 2003-15. In the analysis, we do not distinguish between polling and delivery centers, and refer to these collectively as reference centers.

Table 2 Polling and delivery centers for sample commodities during 2003-15

The table below presents the NCDEX accredited polling and delivery centers that were announced during 2003-15 for sample commodities. The accredition of a mandi as an NCDEX center depends on the supply and demand for that commodity in a particular geographical region.

Commodity	Polling centers	Delivery centers	
Soybean	Indore, Madhya Pradesh Kota, Rajasthan Nagpur, Maharashtra Akola, Maharashtra	Itarsi, Madhya Pradesh Shujalpur, Madhya Pradesh Vidisha, Madhya Pradesh	Sagar, Madhya Pradesh Latur, Maharashtra Mandsaur, Madhya Pradesh
Turmeric	Nizamabad, Andhra Pradesh	Sangli, Maharashtra Duggirala, Andhra Pradesh Cuddapah, Andhra Pradesh	Erode, Tamil Nadu Warangal, Andhra Pradesh
RM seed	Jaipur, Rajasthan Alwar, Rajasthan	Kota, Rajasthan Hapur, Uttar Pradesh Narnaul, Haryana Morena, Madhya Pradesh Agra, Uttar Pradesh	Sri Ganganagar, Rajasthan Hisar, Haryana Rewari, Haryana Bikaner, Rajasthan Bharatpur, Rajasthan
Cumin	Unjha, Gujarat	Jaipur, Rajasthan Delhi, Delhi	Jodhpur, Rajasthan
Coriander	Kota, Rajasthan Gondal, Gujarat	Ramganjmandi, Rajasthan Guna, Madhya Pradesh	Jaipur, Rajasthan Baran, Rajasthan
Maize (industrial)	Davengere, Karnataka Sangli, Maharashtra Jalgaon, Maharashtra Delhi, Delhi	Nizamabad, Andhra Pradesh Shimoga, Karnataka	Karimnagar, Andhra Pradesh Warangal, Andhra Pradesh

In certain cases, the exchange also modifies the futures contract in terms of the underlying commodity. Amongst the sample commodities analysed in this study, the maize contract underwent such changes. As specified in Table 1, the exchange first introduced the maize futures contract on January 5, 2005. The underlying commodity that was traded was *yellow/red* maize which is used as a food grain. On May 21, 2010, the exchange launched a new contract *feed/industrial grade* maize which is used as cattle feed or industrial purposes. Alongside, the exchange discontinued the old yellow/red maize contract from September 20, 2010.[3] Later, with the growth of two different production centers across *kharif* and *rabi* seasons, in February 2013, the exchange modified the contract to vary across two seasons, namely maize-rabi contract and maize-kharif contract, with two different basis centers, *Gulabbagh* and *Nizamabad*, respectively.[4]

[3]See Circular No. NCDEX/TRADING-049/2010/130, NCDEX, `https://www.ncdex.com/Downloads/Circulars/PDF/4130.pdf`

[4]See Circular No.: NCDEX/TRADING-011/2013/033, NCDEX, `https://www.ncdex.com/Downloads/Circulars/PDF/Modification_in_contract_specifications_of_Maize_Feed_Industrial08022013.pdf`

The exchange also made changes to contract details of soybean and mustard. In the case of soybean, the exchange initiated an additional contract with a smaller delivery unit of 2 metric tonnes from February 2015 onwards.[5] The earlier contract that was launched in December 2003 had a delivery unit size of 10 metric tonnes. A smaller delivery size contract could potentially widen participation from traders with low capital or lower exposure to commodity price risk. For mustard, in November 2010, the exchange introduced a new contract with lower tick size of Re. 1 (as opposed to the old tick size of 5 paise) and changed the quotation value from the old Rs. per 20 kg to Rs. per Quintal.[6] The old contract was suspended in January 2011. The exchange also introduced an additional contract of smaller delivery size of 2 metric tonnes in January, 2015.[7] The dates of these changes in contracts are summarized in Table 3.

Table 3 Dates of changes in futures contract for sample commodities during 2003-15

The table provides dates of major contract changes in sample commodities during 2003-15. 'Launch' indicates date of launch of the new or modified contract, and 'End' indicates the date of suspension of the old contract.

Commodity	**Initial contract**		**Modification I**		**Modification II**
	Launch	End	Launch	End	Launch
Coriander	2008-08-11	NA	NA	NA	NA
Maize	2005-01-05	2010-09-20	2010-05-21	2013-01-01	2013-02-08
Mustard	2003-12-15	2011-01-20	2010-11-10	NA	2015-01-01
Soybean	2003-12-15	NA	2015-02-02	NA	NA
Turmeric	2004-07-24	NA	NA	NA	NA

Figure 2 shows monthly volumes on NCDEX for sample commodities during the period of analysis. The dashed lines indicate launch / modifications in existing contract as described earlier. Amongst the commodities analysed, we see that soybean and mustard are traded the most.

3.2 Empirical strategy

We use a regression framework to test the hypotheses described in Section 2. To estimate the impact of futures market on spatial price dispersion (hypothesis 1), we estimate the following regression for each sample commodity:

[5]See Ciruclar No.: NCDEX/TRADING-011/2015/028, `https://www.ncdex.com/Downloads/Circulars/PDF/Launch_futures_contracts_Soybean_30012015.pdf`

[6]See Circular No.: NCDEX/TRADING-108/2010/284, `https://www.ncdex.com/Downloads/Circulars/PDF/4441.pdf`

[7]See Circular No.: NCDEX/TRADING-197/2014/417, `https://www.ncdex.com/Downloads/Circulars/PDF/Launch_futures_contracts_Rapeseed_Mustard_Seed_RMSEED2MT_29122014.pdf`

$$
\begin{aligned}
|\text{price-diff}_{i-s,t}| \;=\; & \alpha_0 + \alpha_y + \alpha_{\text{state}} + \alpha_m + \beta_1 \times \log(\text{arrivals})_{i,t} + \beta_2 \times \text{distance}_{i-s} + \beta_3 \times \log(\text{NCDEX volumes})_t \\
& \beta_4 \times \text{market share}_{i,t} + \sum_{l=1}^{12} \beta_{5,l} \times \text{rainfall deficit}_{i,l,t} + \sum_{lag=1}^{12} \beta_{6,l} \times \text{rainfall surplus}_{i,l,t} + \beta_7 \times \text{ref.} \\
& \beta_8 \times \mathbb{1}_{\text{ref. center}_i} \times \log(\text{NCDEX volumes})_t + \beta_9 \times \text{ref. center market share}_{i,t} + \\
& \sum_{d=1}^{3} \beta_{10,d} \times \mathbb{1}_{\text{contract change}_{d,t}} + \sum_{d=1}^{3} \beta_{11,d} \times \mathbb{1}_{\text{contract change}_{d,t}} \times \log(\text{NCDEX volumes})_t + \epsilon_{i,t}
\end{aligned}
$$

where i indexes *mandis*, t indexes time, and s indexes NCDEX reference centers (polling and delivery). $|\text{price-diff}_{i-s,t}|$ measures spatial price dispersion by capturing price difference between mandi, i, and its closest *reference center,* s[8] on day t, α_y indicates year effects, α_s indicates state effects, α_m indicates month effects. $\log(\text{arrivals})_{i,t}$ indicates logarithmic values of arrivals in mandi i on day t and capture the size of trading in the mandi, distance indicates distance between mandi, i, and its closest center s. This serves as a proxy for cost of transportation that cannot arbitraged away. The term $\log(\text{NCDEX volumes})_t$ indicates logarithmic values of NCDEX traded volumes for that commodity on day, t, and is our focal variable of interest. The term $\text{marketShare}_{i,y}$ indicates market share of mandi i in year, y, corresponding to date t, and controls for the size of the mandi. These market shares are computed annually to ensure that seasonality effecs and idiosyncratic shocks to mandi arrivals do not distort the relative importance of these mandis. We define year as the agricultural crop year, which runs from July to June. We control for rainfall using rainfall surplus or deficit in that month-year in the district of the mandi. For this purpose, each mandi was mapped to its district. ref. center is a dummy variable that takes value 1, for the period during which the center remained as a polling or delivery center by NCDEX, 0 otherwise. We include interactions of center dummy with NCDEX volumes (capture by $\mathbb{1}_{\text{ref. center}} \times \log(\text{NCDEX volumes})_{c,t}$). We also add a control for market share of the center, to capture the changing importance of the reference center. We expect that the larger the share of the mandi i, the larger its role in driving prices relative to the reference center r and vice versa. We include $\mathbb{1}_{\text{contract change}_{d,t}}$; these are dummy variables for commodities that underwent contract changes. It takes value 1, for the period for which one contract traded, and zero when it was not launched / suspended. If, for example, there are two contracts in place contemporaneously, both

[8]For each mandi, we determine the distance between that mandi and all reference centers declared by NCDEX at any point of time in the sample period using Google maps. We pick the center that was closest to that mandi and use it as that mandi's reference center. The mandi-reference center pair remains fixed, but the the value it takes can vary depending on whether on day t the reference mandi is a reference center or not

C1 and C2 would be deemed to have the value 1. We also include an interaction term between contract change dummies and NCDEX volumes.

We try several specifications by excluding various variables specified in the above equation. In one specification, we also add state-year dummies to capture the effect of policy changes that may have occurred in an year in a state. This is critical because in India, agricultural markets is a state subject and states make laws and policies on how markets function within a state. Moreover, different states have embarked on market reforms and have progressed at different speeds.

The coefficient that captures the impact of futures market are the term associated with NCDEX volumes, with the main effect captured by the coefficient on the variable $\log(\text{NCDEX volumes})_{c,t}$. A negative and significant coefficient value will indicate that higher NCDEX volumes on that commodity lower the price dispersion across mandis, on average, which implies information transmission across different mandis after the start of futures trading on that commodity and better spatial integration, overall proving beneficial to the farmer. All terms that involve NCDEX volumes interacted with other variables are modifiers of futures markets impacts. The term that interacts center dummy and NCDEX volumes capture how after the declaration of a mandi as a reference center impacts the price-differential for mandis closer to that center. A negative and significant coefficient will indicate that there are smaller mandis or mandis closer to the center also gain once a center gets declared by NCDEX as a polling or a delivery center. In some sense this captures the incremental effect of declaration of delivery and polling centers, conditioned on the scale of operations of futures markets.

We test our second hypothesis of whether futures trading reduce seasonal variation in arrivals by using the following specification:

$$\begin{aligned}\frac{|\mathrm{A}_{i,t} - \bar{\mathrm{A}}_{i,y}|}{\sigma_{A_{i,y}}} = {} & \alpha_0 + \alpha_y + \alpha_{\text{state}} + \alpha_m + \gamma_1 \times \text{distance}_{i-s} + \gamma_2 \times \log(\text{NCDEX volumes})_t + \\ & \gamma_3 \times \text{market share}_{i,t} + \sum_{l=1}^{12} \gamma_{4,l} \times \text{rainfall deficit}_{i,l,t} + \sum_{lag=1}^{12} \gamma_{5,l} \times \text{rainfall surplus}_{i,l,t} + \\ & \gamma_6 \times \text{ref. center}_i + \gamma_7 \times \mathbb{1}_{\text{ref. center}_i} \times \log(\text{NCDEX volumes})_t + \gamma_8 \times \text{ref. center market share}_{i,t} + \\ & \sum_{d=1}^{3} \gamma_{9,d} \times \mathbb{1}_{\text{contract change}_{d,t}} + \sum_{d=1}^{3} \gamma_{10,d} \times \mathbb{1}_{\text{contract change}_{d,t}} \times \log(\text{NCDEX volumes})_t + \epsilon_{i,t}\end{aligned} \tag{2}$$

The term $\frac{|\mathrm{A}_{i,t} - \bar{\mathrm{A}}_{i,y}|}{\sigma_{A_{i,y}}}$ indicates standardized daily arrivals, and capture the variation in arrivals throughout the year vis-a-vis the yearly average. We use the same control variables as described for Hypothesis 1 in Equation 3.2, except that we do not include logarithmic arrivals in this hypothesis. As before, the value of the coefficients associated with NCDEX volumes terms capture the effect of

futures trading on variation in arrivals. A negative and significant value will indicate that futures trading smoothen the arrivals to a mandi in an year. This would imply that as futures trading on a commodity increases, farmers take hints from futures prices and make a decision of whether to hold their produce or sell it.

Finally, the third hypothesis regarding the impact of futures trading on spot price variation is tested using the following regression specification:

$$\begin{aligned}\frac{|\mathrm{P}_{i,t} - \bar{\mathrm{P}}_{i,y}|}{\sigma_{P_{i,y}}} = {} & \alpha_0 + \alpha_y + \alpha_{\text{state}} + \alpha_m + \gamma_1 \times \text{distance}_{i-s} + \gamma_2 \times \log(\text{NCDEX volumes})_t + \\ & \gamma_3 \times \text{market share}_{i,t} + \sum_{l=1}^{12} \gamma_{4,l} \times \text{rainfall deficit}_{i,l,t} + \sum_{lag=1}^{12} \gamma_{5,l} \times \text{rainfall surplus}_{i,l,t} + \\ & \gamma_6 \times \text{ref. center}_i + \gamma_7 \times \mathbb{1}_{\text{ref. center}_i} \times \log(\text{NCDEX volumes})_t + \gamma_8 \times \text{ref. center market share}_{i,t} + \\ & \sum_{d=1}^{3} \gamma_{9,d} \times \mathbb{1}_{\text{contract change}_{d,t}} + \sum_{d=1}^{3} \gamma_{10,d} \times \mathbb{1}_{\text{contract change}_{d,t}} \times \log(\text{NCDEX volumes})_t + \epsilon_{i,t}\end{aligned} \tag{3}$$

where $\frac{|\mathrm{P}_{i,t} - \bar{\mathrm{P}}_{i,y}|}{\sigma_{P_{i,y}}}$ captures variation in spot prices in mandi i on day t using standardized prices. Higher is the value, higher is the variation in spot prices. We include arrivals in this specification as that is a key determinant of spot prices. The coefficients associated with NCDEX volumes capture the impact of futures trading on spot price variation.

We try alternative specifications for each of the three hypothesis. In the analysis, we truncate minimum prices and arrivals value at 0.5%. We also winsorize the spatial price dispersion values at 1% level to remove the effect of outliers. We do not winsorize the dependent variables for hypothesis 2 and 3 as the possible outlier effect is already omitted after truncation of data at 0.5% for prices and arrivals. In the next section, we discuss the results.

4 Results

4.1 Hypothesis 1: Impact of futures trading on spatial price dispersion

We first examine the impact of futures trading on spatial price dispersion. Figure 3 shows spot prices at the reference centers along with the futures prices for sample commodities. We see that for all the sample commodities, futures price move in tandem with the spot price. Some deviations emerge in the case of maize for a short period in 2013-15, however, the overall trend seems to be similar between spot and futures prices.

Table 7-11 present the regression results for various specifications described in Section 3.2. Model 1 represents regression results for specification without month effects, and with selected control variables. Model 2 indicates the results for selected control variables along with month effects. Model 3 utilizes the change in contract specification during the period of analysis. Model 4 uses interaction terms of center dummy and contract changes with logarithmic values of NCDEX volumes. Model 5 presents results with market share of the center as an additional explanatory variable. Model 6 represents Model 5 along with state-year interaction dummies. Model 2-6 include month effects.

As expected, for all commodities, we find a positive and significant coefficient with distance of mandi from its nearest reference center. This indicates, higher is the distance to a major market, higher is the price difference, which can be explained in terms of higher costs of transportation for a mandi that's located far away from the nearest reference center. The sign of the coefficient with arrivals also turns out to be negative and significant for all commodities except maize.The sign of the coefficient with market share of the mandi is also consistent with the expectation that higher is the market share, higher is the importance of the mandi in determining the spot price, and hence lower is the spatial price dispersion.

We now discuss the coefficients of interest, that is, the terms related to NCDEX volumes. The net impact of NCDEX futures trading could be assessed by the coefficients associated with, NCDEX volumes ln(NCDEX Volumes), and the interaction terms associated with NCDEX volumes which includes Center NCDEX Volumes Intrn, C1 NCDEX Volumes Intrn, C2 NCDEX Volumes Intrn and C3 NCDEX Volumes Intrn. The terms C1, C2 and C3 capture contract changes described in Section 3. We find that the net average impact of NCDEX volumes on coriander is *positive*. For a 10% increase in futures trading, the spatial price dispersion increases on an average by 0.01 relative to the nearest center.[9] This indicates that contrary to our hypothesis, futures trading increased the spatial price dispersion for coriander. We next turn to maize. Our results suggest that maize futures trading, *reduced* spatial price dispersion. A 10% increase in futures trading reduced local price differences relative to the nearest center by an average 0.01-0.02 points.

In the case of mustard, when we do not control for changes in contract, we find that an increase in futures trading by 10% increases spatial price difference by less than 0.01 points. However, once we account for changes in contract, we find that even in the case of mustard, when the first contract was in place between 2003-10, the net impact of higher futures trading on local price differences was *negative* though very small, about 0.001 (in case of an increase in futures trading by 10%). The introduction of the new contract in 2010, took away this small reduction, and the overall impact of 10% increase in futures trading on mandi prices for mustard turns out to be positive, though small in magnitude (0.001-0.004). The net impact of futures trading on soybean also turns out to be a *reduction* in spatial price differences, but very small in terms of magnitude, less than 0.003

[9]This is based on the sum of coefficients with ln(NCDEX Volumes) and Center NCDEXVolumes Intrn, multiplied by 0.10.

for a 10% increase in futures trading after inclusion of contract changes. The results for turmeric indicate a *positive* impact on spatial price difference in the range of 0.008-0.0012 points for every 10% increase in futures trading. However, when we control for state-year effects (as in Model 6), we find that 10% increase in futures trading reduces price differences by 0.002.

Table 4 Impact of futures trading on spatial price dispersion

The table provides a summary of the impact of futures trading on spatial price difference across sample commodities. The impacts have been estimated based on regression equations described in Section 3.2.

Commodity	**Impact**	**Magnitude**
Coriander	Increase	< 0.01
Maize	Decrease	< 0.02
Mustard	Increase	< 0.004
Soybean	Decrease	< 0.003
Turmeric	Increase	< 0.002

Table 4 summarizes our findings. In general, we find that higher futures trading reduces spatial price dispersion for maize. The impacts are rather negligible for mustard and soybean. Coriander and turmeric see a rise in spatial price difference with higher futures trading by less than 0.01 points.

4.2 Hypothesis 2: Impact of futures trading on variation in arrivals

We now turn to Hypothesis 2, which examines if higher futures trading reduces seasonal variation in arrivals so that they are more evenly spread through the year. Figure 4 shows plots of daily arrivals for sample commodities during our sample period. Interestingly, coriander arrivals indicates some smoothening during 2012-14. The arrivals also appear to be more spread across the year in the years from 2011 onwards. We see similar smoothening in the other three commodities, soybean, mustard and turmeric in the later years from 2010 onwards. However, whether this can be attributed to futures trading or not, we test using our regression framework.

As described in Section 3.2, we examine smoothness in arrivals by taking deviation in daily arrivals from yearly average, and we standardize these values by the standard deviation of daily arrivals over the crop year. Tables 12-16 provide regression results. The coefficient with distance turns out to be negative and statistically significant across all specification for all our sample commodities. However, the magnitude of these coefficients is as small as 0.01% or lower. These are economically insignificant. The reason for such low magnitudes could be that the variation in arrivals in a mandi during the year is most likely to be due to seasonal patterns, rather than the distance from the nearest center. The variation due to seasonal patterns is accounted for by month effects in our regression framework. The coefficient with market share of the *mandi* is positive

and significant across all specifications for all commodities. This indicates that mandis with higher market share experience greater variation in arrivals during the year.

We now turn to the coefficients associated with explanatory variables related to NCDEX volumes. After controlling for seasonal variation in Models 2-5, we find that higher futures trading does not have any impact on daily arrivals for coriander. Coefficients with NCDEX volumes terms are statistically insignificant. The net impact on variation in daily arrivals for maize is *negative*, but very small in magnitude. A 10% increase in futures trading reduces variation in maize arrivals by less than 0.001 standard deviations. Similarly, for mustard, we find that the net impact of higher futures trading is a reduction in daily variation in arrivals. A 10% increase in futures trading brings down volatility in arrivals by 0.0001 standard deviations. The introduction of mini-contract in 2015 further brought down the variation in arrivals by 0.0003 standard deviations.

We also find evidence of reduction in variation in arrivals of soybean with higher futures trading. A 10% increase in soybean futures trading reduces the variation in daily arrivals of soybean by 0.0001 standard deviations. We do not find a statistically significant impact of futures trading on turmeric daily arrivals variation.

Table 5 Impact of futures trading on variation in daily arrivals

The table provides a summary of the impact of futures trading on variation in daily arrivals of sample commodities. The impacts have been estimated based on regression equations described in Section 3.2.

Commodity	**Impact**	**Magnitude** (standard deviation units)
Coriander	No impact	-
Maize	Decrease	< 0.001
Mustard	Decrease	< 0.0001
Soybean	Decrease	< 0.0001
Turmeric	No impact	-

Overall, our results suggest that higher futures trading smoothen mandi arrivals for soybean, maize and mustard. Although, the magnitude of the impacts is minuscule, it is statistically significant. We do not find any evidence of any impact of futures trading on coriander and turmeric.

4.3 Hypothesis 3: Impact of futures trading on variation in spot price

Our final hypothesis asks if futures trading reduces spot price variation over the year. Smoothening of arrivals is likely to smoothen the prices as well. We test this hypothesis using the regression specification given in 3.2. Tables 17-21 provide detailed regression results.

We do not find any evidence of impact of futures trading on spot price variation for coriander. This is consistent with our findings in the previous section were we did not find any impact of futures on coriander arrivals variation as well. If arrivals did not get impacted, by no means can

we expect a reduction in spot price variation across seasons. In the case of maize, we do find evidence of *reduction* in spot price variation through the year with higher futures trading. Our estimates suggest that a 10% increase in futures trading reduce spot price variation in the range of 0.002-0.004 standard deviation units. This finding holds across different specifications, and is again consistent with reduction in maize daily arrivals variation with higher futures trading as found in the previous section.

In contrast to the findings of maize, we find that higher futures trading has negligible to positive impact on price variation for mustard. During the period when the first contract was launched on mustard, we find that a 10% increase in futures trading *increased* the variation in spot prices by 0.0003 standard deviation. This positive impact vanished when the contract was modified in 2011. However, from 2015 onwards, with the introduction of the additional mini-contract in mustard, we see a positive impact on spot price risk with higher futures trading. Similar is the case with soybean, where we see minor positive impact of higher futures trading on spot price variation. Interestingly, we find that that higher futures trading reduce spot price variation in the case of turmeric. A 10% increase in futures trading of turmeric *reduces* spot price variation turmeric by close to 0.001 standard deviation units.

Table 6 Impact of futures trading on variation in spot price variation

The table provides a summary of the impact of futures trading on variation in spot prices of sample commodities. The impacts have been estimated based on regression equations described in Section 3.2.

Commodity	**Impact**	**Magnitude** (standard deviation units)
Coriander	No impact	-
Maize	Decrease	< 0.004
Mustard	Increase	< 0.0003
Soybean	Increase	< 0.0001
Turmeric	Decrease	< 0.001

Overall, our findings for hypothesis 3 suggests that higher futures trading reduce spot price variation in maize and turmeric, has no impact on coriander, and have minor positive impacts on mustard and soybean.

5 Conclusion

This paper sets out to establish the implications of the operations of futures markets on aspects of farmer welfare. Through a set of regression models, we tested three hypotheses. The first is to test if the scale of futures markets operations in India reduces spatial variation in prices. An affirmative finding would suggest that markets now link to the futures-relevant markets, via information flows, and this gets reflected in a closer alignment of prices. A second and third question of interest was

to see if the transmission of futures prices results is a more even spread of arrivals over the year and consequently smoothens prices over the year. While the paper does not test the specific pathways through which futures markets influences aspects of farmer welfare, overall we find that there is a variation in evidence based on the nature of the crop.

We find that the main effect of futures markets varies across commodities - with spatial dispersion decreasing for maize and soyabean while increasing for turmeric, mustard and coriander. All effects while statistically significant are fairly small. For maize, mustard and soybean, we find that there has been a decline in variation in daily arrivals across the year and a decline in the variation of spot prices for maize and turmeric. The patterns of interaction effects likewise differ across commodities. Given the variations across commodities and within commodities, the difference in main and interaction effects, how can we better understand these results? Specifically why is the economic significance of these results so small. We discuss a few possible reasons below.

One issue with agricultural futures markets in India is that the size of futures markets is still extremely small relative to the spot markets and deliveries on contract tend to be fairly low. It is possible that there are threshold effects so that it is only when futures markets grow to larger than a certain threshold that they begin to have the presumed hypothesized impacts.

There could also be several reasons for the difference in results across commodities. For many commodities, the production areas are scattered across the country, in very different agro-climatic regions with large variation in product quality and characteristics. In our analysis we include data from all regions and markets. It is possible that on account of this, the futures markets and the prices it transmits are relevant for a subset of these centers, those that may be closer as well as those that grow the commodity whose characteristics match most with those traded in the futures markets. The fact that for some commodities, the reference centres are clustered in a few states even when the production areas are widespread could mean that the impacts in terms of spatial differences are heterogenous. It is also the case that given limited infrastructure with farmers on storage and pressures to sell immediately after harvest due to cash constraints, even if farmers sense that storing to sell later makes economic sense they may be unable to do so. Product characteristics might matter as well. Turmeric for example is more perishable than say soybean so that there is no smoothening of arrivals. Another reason could be that the local market structure. Mediated trade with intermediaries between farmers and buyers, could prevent the percolation of market information to the farmers so that the benefits of the futures markets are not fully transferred to farmers or has not percolated completely.

Our findings point to potential gains to farmers from the operations of futures markets. However the patterns of results also suggest that complementary reforms of domestic markets and infrastructure are required to ensure the translation of these benefits.

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Figure 1 Geographical coverage of NCDEX centers and *mandis*

The geographical maps show the coverage of market places (*mandis*) and NCDEX polling and delivery centers within the country.

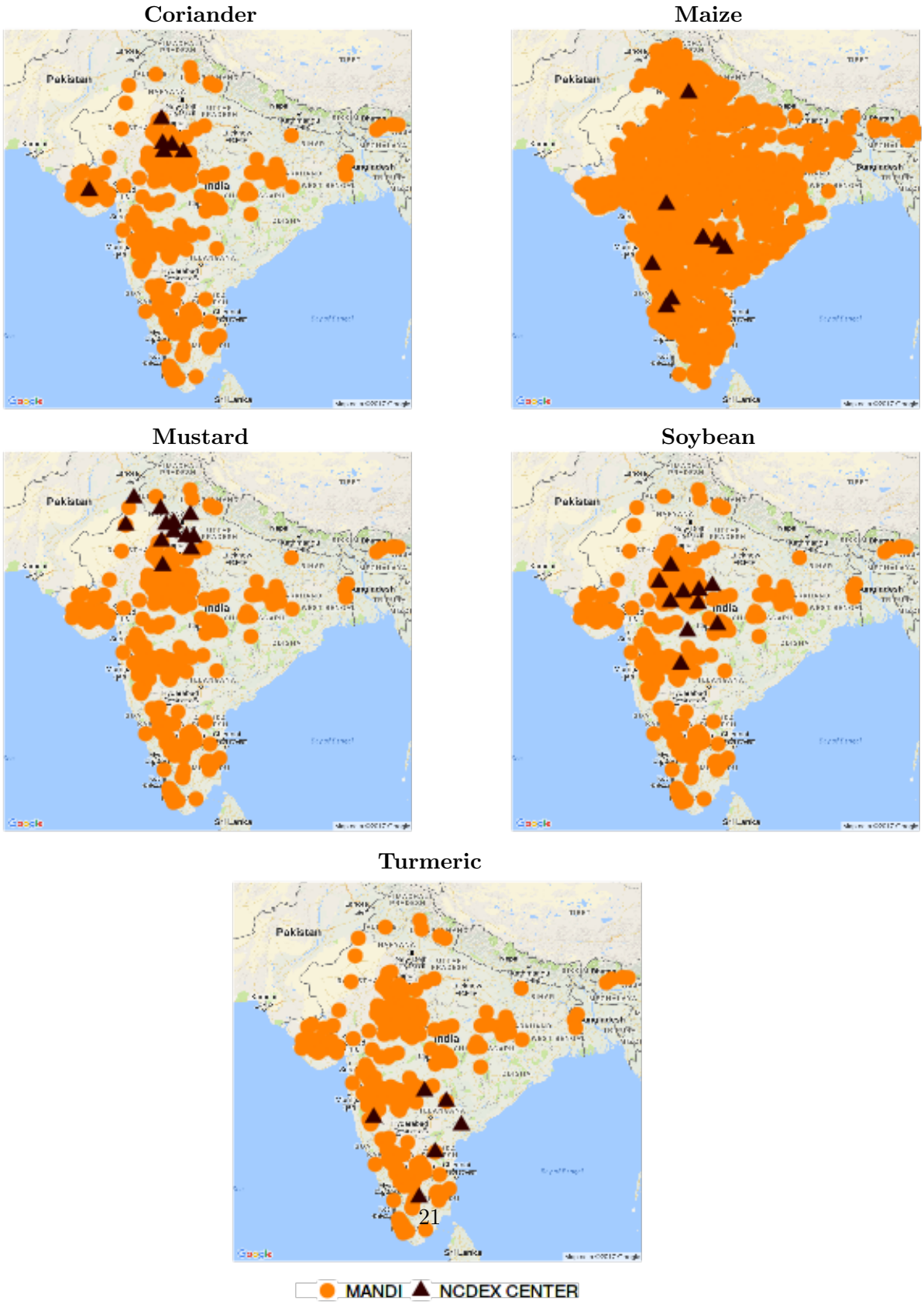

Figure 2 Traded volumes at futures exchange platform

The graphs below present the monthly trading volumes in futures contracts traded at the Exchange over the period from 2003 to 2015. The orange lines in the graphs mark the introduction of different contracts over the period of analysis.

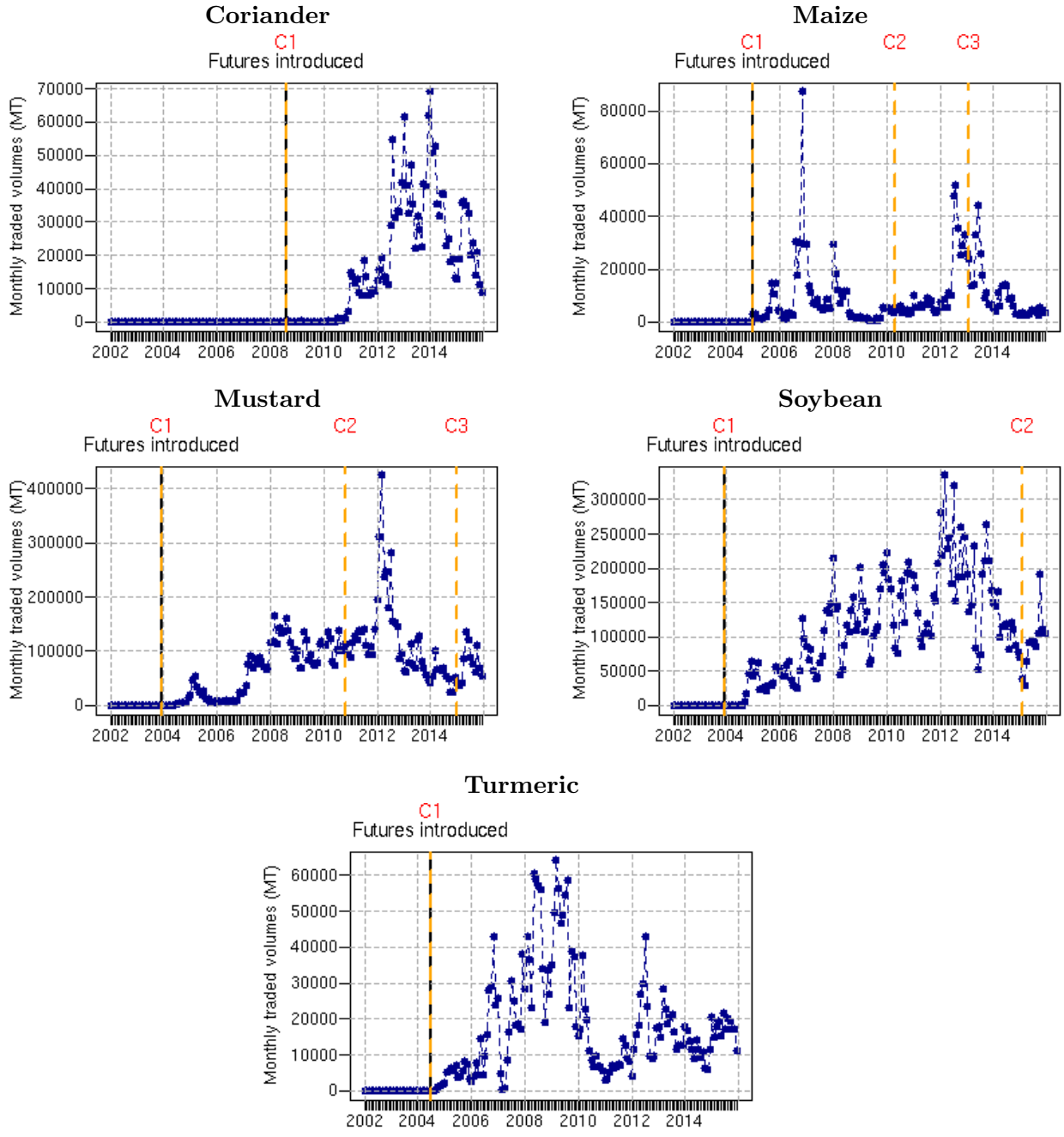

Figure 3 Price movements: Spot prices in NCDEX reference centers and futures prices

The graphs below show the movement in prices for near-month futures contracts traded at NCDEX and spot prices at which commodities are traded in the reference centers.

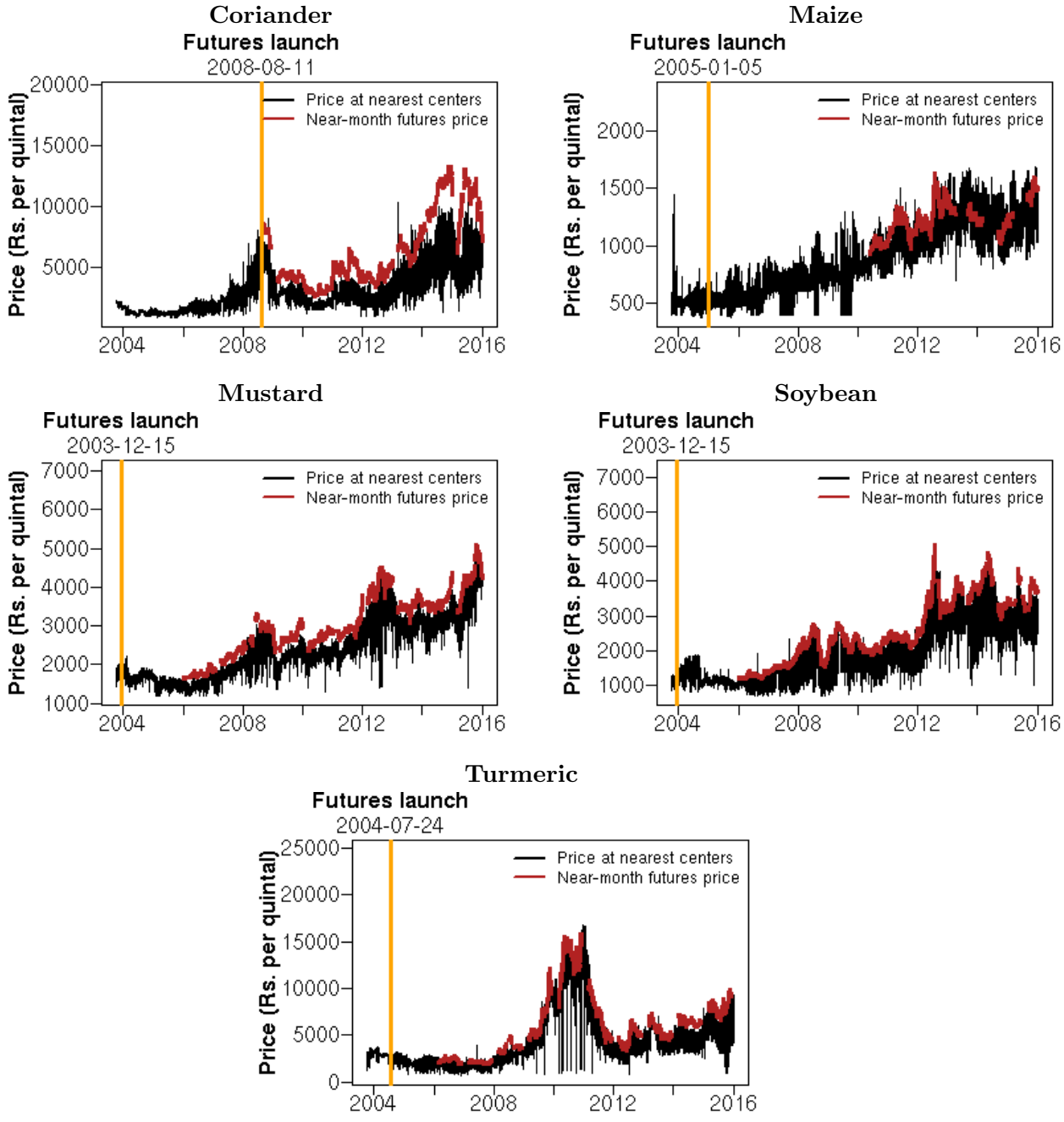

Figure 4 Daily aggregated arrivals across mandis for sample commodities

The graphs below aggregated daily arrivals across mandis for the period between 2003 to 2015 for sample commodities.

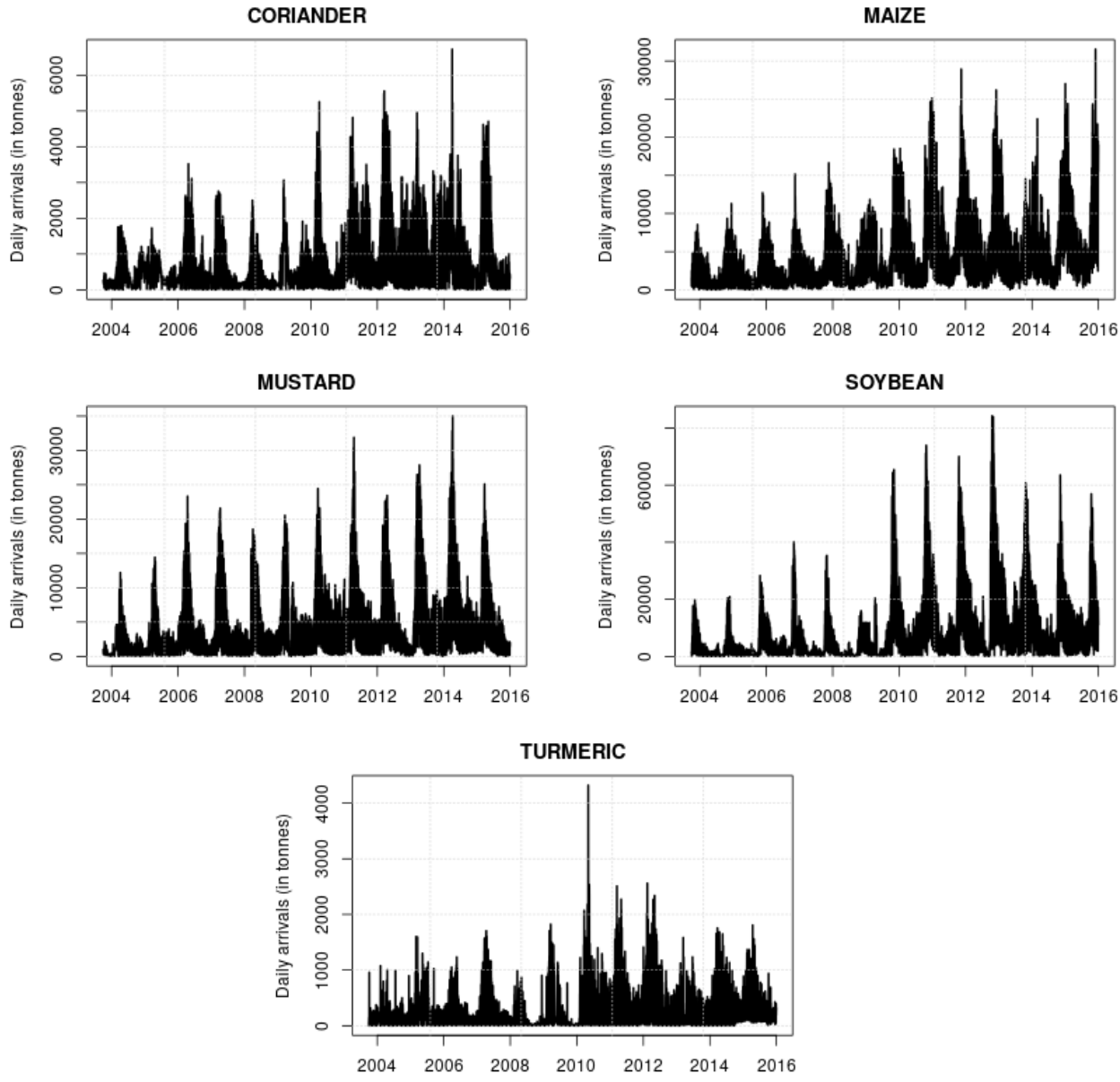

Table 7 H1: Regression results for commodity, CORIANDER

	Price differential from the nearest center					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.048***	0.047***	0.047***	0.047***	0.046***	0.046***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(Arrivals)	−2.538***	−2.638***	−2.638***	−2.674***	−2.405***	−2.024***
	(0.066)	(0.070)	(0.070)	(0.070)	(0.071)	(0.072)
ln(NCDEX Volumes)	0.095**	0.028	0.028	−0.429***	−0.321***	−0.407***
	(0.048)	(0.049)	(0.049)	(0.071)	(0.070)	(0.074)
Market share mandi	−0.260***	−0.242***	−0.242***	−0.238***	−0.518***	−0.646***
	(0.013)	(0.014)	(0.014)	(0.014)	(0.021)	(0.023)
Market share center					0.453***	0.472***
					(0.023)	(0.024)
Center dummy	6.481***	6.596***	6.596***	2.713***	2.271***	10.476***
	(0.342)	(0.342)	(0.341)	(0.557)	(0.556)	(0.631)
Center NCDEXVolumes Intrn				0.546***	0.421***	0.481***
				(0.065)	(0.064)	(0.073)
C1 dummy			−0.003	2.254	1.681	−0.579
			(1.371)	(1.378)	(1.392)	(1.523)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.51	0.52	0.52	0.52	0.52	0.56
FStat pval	0	0	0	0	0	0
Obs. C1	55303	55303	55303	55303	55303	55303
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	40390	40390	40390	40390	40390	40390
No. of Obs.	69848	69848	69848	69848	69848	69848

Table 8 H1: Regression results for commodity, MAIZE

	Price differential from the nearest center					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.006***	0.006***	0.006***	0.006***	0.007***	0.006***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ln(Arrivals)	−0.037***	0.197***	0.191***	0.191***	0.174***	0.199***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
ln(NCDEX Volumes)	−0.101***	−0.064***	−0.068***	0.244***	0.242***	0.182***
	(0.009)	(0.009)	(0.009)	(0.024)	(0.024)	(0.025)
Market share mandi	−0.942***	−1.227***	−1.225***	−1.225***	−1.139***	−1.191***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.025)
Market share center					−0.314***	−0.216***
					(0.014)	(0.015)
Center dummy	0.008	−0.115**	−0.110**	1.256***	1.220***	2.817***
	(0.054)	(0.055)	(0.055)	(0.129)	(0.129)	(0.135)
Center NCDEXVolumes Intrn				−0.177***	−0.177***	−0.159***
				(0.015)	(0.015)	(0.015)
C1 dummy			−1.801***	−0.541***	−0.557***	−0.974***
			(0.099)	(0.136)	(0.136)	(0.139)
C2 dummy			−1.495***	−0.238	−0.209	−0.783***
			(0.113)	(0.245)	(0.246)	(0.259)
C3 dummy			−1.880***	0.702**	0.723**	−0.172
			(0.137)	(0.284)	(0.284)	(0.292)
C1 NCDEXVolumes Intrn				−0.304***	−0.304***	−0.249***
				(0.021)	(0.021)	(0.022)
C2 NCDEXVolumes Intrn				−0.148***	−0.151***	−0.122***
				(0.026)	(0.026)	(0.026)
C3 NCDEXVolumes Intrn				−0.273***	−0.274***	−0.216***
				(0.027)	(0.027)	(0.027)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.11	0.14	0.14	0.14	0.14	0.19
FStat pval	0	0	0	0	0	0
Obs. C1	167123	167123	167123	167123	167123	167123
Obs. C2	106550	106550	106550	106550	106550	106550
Obs. C3	102162	102162	102162	102162	102162	102162
Obs. center dummy	66465	66465	66465	66465	66465	66465
No. of Obs.	390737	390737	390737	390737	390737	390737

Table 9 H1: Regression results for commodity, MUSTARD

	Price differential from the nearest center					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.008***	0.008***	0.008***	0.008***	0.008***	0.008***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ln(Arrivals)	−0.132***	−0.201***	−0.201***	−0.201***	−0.197***	−0.221***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ln(NCDEX Volumes)	0.053***	0.031***	0.030***	−0.033**	−0.035**	0.0002
	(0.003)	(0.003)	(0.003)	(0.016)	(0.016)	(0.016)
Market share mandi	−0.379***	−0.316***	−0.316***	−0.316***	−0.325***	−0.326***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Market share center					0.018***	0.087***
					(0.004)	(0.005)
Center dummy	0.335***	0.161***	0.157***	−0.053	−0.059	0.923***
	(0.035)	(0.035)	(0.035)	(0.076)	(0.076)	(0.080)
Center NCDEXVolumes Intrn				0.024***	0.025***	−0.028***
				(0.008)	(0.008)	(0.008)
C1 dummy			−0.041	−0.297**	−0.305**	−0.326**
			(0.071)	(0.142)	(0.142)	(0.144)
C2 dummy			−0.982***	−1.485***	−1.489***	−1.676***
			(0.079)	(0.169)	(0.169)	(0.171)
C3 dummy			−0.021	−0.051	−0.047	−0.252***
			(0.065)	(0.090)	(0.090)	(0.090)
C1 NCDEXVolumes Intrn				0.029**	0.029**	0.034**
				(0.014)	(0.014)	(0.014)
C2 NCDEXVolumes Intrn				0.048***	0.048***	0.056***
				(0.015)	(0.015)	(0.015)
C3 NCDEXVolumes Intrn				−0.0005	−0.0005	0.004
				(0.007)	(0.007)	(0.007)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.17	0.18	0.18	0.18	0.18	0.22
FStat pval	0	0	0	0	0	0
Obs. C1	185638	185638	185638	185638	185638	185638
Obs. C2	224319	224319	224319	224319	224319	224319
Obs. C3	44055	4405527	44055	44055	44055	44055
Obs. center dummy	343542	343542	343542	343542	343542	343542
No. of Obs.	402122	402122	402122	402122	402122	402122

Table 10 H1: Regression results for commodity, SOYBEAN

	Price differential from the nearest center					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.012***	0.011***	0.011***	0.011***	0.011***	0.012***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ln(Arrivals)	0.040***	−0.066***	−0.061***	−0.061***	−0.066***	−0.121***
	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
ln(NCDEX Volumes)	0.030***	0.034***	0.032***	0.087***	0.094***	0.112***
	(0.007)	(0.007)	(0.007)	(0.010)	(0.010)	(0.010)
Market share mandi	−0.277***	−0.150***	−0.153***	−0.156***	−0.089***	−0.084***
	(0.028)	(0.029)	(0.029)	(0.029)	(0.030)	(0.029)
Market share center					−0.313***	−0.582***
					(0.022)	(0.025)
Center dummy	−0.826***	−0.779***	−0.796***	0.110	0.232**	0.408***
	(0.043)	(0.043)	(0.043)	(0.102)	(0.102)	(0.102)
Center NCDEXVolumes Intrn				−0.090***	−0.107***	−0.132***
				(0.009)	(0.009)	(0.009)
C1 dummy			2.107***	2.010***	1.925***	1.808***
			(0.228)	(0.226)	(0.225)	(0.217)
C2 dummy			−0.797***	−0.797***	−0.841***	−0.681***
			(0.124)	(0.168)	(0.168)	(0.166)
C2 NCDEXVolumes Intrn				0.005	0.008	0.014
				(0.012)	(0.012)	(0.012)
State Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.12	0.13	0.13	0.13	0.13	0.16
FStat pval	0	0	0	0	0	0
Obs. C1	339689	339689	339689	339689	339689	339689
Obs. C2	43690	43690	43690	43690	43690	43690
Obs. C3	0	0	0	0	0	0
Obs. center dummy	222766	222766	222766	222766	222766	222766
No. of Obs.	341479	341479	341479	341479	341479	341479

Table 11 H1: Regression results for commodity, TURMERIC

	Price differential from the nearest center					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.074***	0.074***	0.074***	0.074***	0.067***	0.071***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(Arrivals)	−2.040***	−2.072***	−2.075***	−2.069***	−1.622***	−0.862***
	(0.083)	(0.085)	(0.085)	(0.085)	(0.086)	(0.084)
ln(NCDEX Volumes)	0.104*	0.125*	0.125*	0.350*	0.582***	0.359*
	(0.063)	(0.064)	(0.064)	(0.194)	(0.194)	(0.201)
Market share mandi	−0.200***	−0.187***	−0.187***	−0.187***	−0.484***	−0.594***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.025)	(0.029)
Market share center					0.451***	0.508***
					(0.027)	(0.032)
Center dummy	−7.144***	−6.838***	−7.302***	−6.121***	−6.275***	−6.280***
	(0.948)	(0.956)	(0.988)	(1.116)	(1.115)	(1.444)
Center NCDEXVolumes Intrn				−0.241	−0.500***	−0.374*
				(0.191)	(0.191)	(0.200)
C1 dummy			6.226***	5.582***	5.610***	6.513***
			(1.589)	(1.616)	(1.519)	(1.405)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.43	0.43	0.43	0.43	0.44	0.53
FStat pval	0	0	0	0	0	0
Obs. C1	34012	34012	34012	34012	34012	34012
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	32574	32574	32574	32574	32574	32574
No. of Obs.	34650	34650	34650	34650	34650	34650

Table 12 H2: Regression results for commodity, CORIANDER

	Arrivals variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.0001***	−0.0002***	−0.0002***	−0.0002***	−0.0002***	−0.0002***
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
ln(NCDEX Volumes)	0.008***	−0.0002	−0.0001	−0.002	−0.003	−0.005**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Market share mandi	0.003***	0.004***	0.004***	0.004***	0.004***	0.005***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)
Market share center					−0.001	−0.002***
					(0.001)	(0.001)
Center dummy	−0.029***	−0.043***	−0.042***	−0.062***	−0.061***	−0.098***
	(0.009)	(0.009)	(0.009)	(0.015)	(0.015)	(0.019)
Center NCDEXVolumes Intrn				0.003	0.003	0.006***
				(0.002)	(0.002)	(0.002)
C1 dummy			−0.016	−0.005	−0.004	0.032
			(0.037)	(0.037)	(0.037)	(0.038)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.07	0.07	0.07	0.07	0.07
FStat pval	0	0	0	0	0	0
Obs. C1	55303	55303	55303	55303	55303	55303
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	40390	40390	40390	40390	40390	40390
No. of Obs.	69848	69848	69848	69848	69848	69848

Table 13 H2: Regression results for commodity, MAIZE

	Arrivals variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.00003***	−0.00003***	−0.00003***	−0.00003***	−0.00003***	−0.00003***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(NCDEX Volumes)	−0.006***	−0.002***	−0.002***	−0.009***	−0.009***	−0.009***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Market share mandi	0.031***	0.034***	0.034***	0.034***	0.034***	0.034***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.002*	−0.002
					(0.001)	(0.001)
Center dummy	0.020***	0.014***	0.013***	0.001	0.001	−0.003
	(0.004)	(0.004)	(0.004)	(0.009)	(0.009)	(0.010)
Center NCDEXVolumes Intrn				0.002	0.002	0.002*
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.024***	−0.047***	−0.047***	−0.046***
			(0.007)	(0.009)	(0.009)	(0.010)
C2 dummy			0.007	−0.046***	−0.046***	−0.036**
			(0.008)	(0.018)	(0.018)	(0.018)
C3 dummy			−0.037***	−0.113***	−0.113***	−0.106***
			(0.010)	(0.020)	(0.020)	(0.020)
C1 NCDEXVolumes Intrn				0.006***	0.006***	0.006***
				(0.001)	(0.001)	(0.001)
C2 NCDEXVolumes Intrn				0.006***	0.006***	0.005***
				(0.002)	(0.002)	(0.002)
C3 NCDEXVolumes Intrn				0.008***	0.008***	0.008***
				(0.002)	(0.002)	(0.002)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.02	0.02	0.02	0.02	0.02
FStat pval	0	0	0	0	0	0
Obs. C1	167123	167123	167123	167123	167123	167123
Obs. C2	106550	106550	106550	106550	106550	106550
Obs. C3	102162	102162	102162	102162	102162	102162
Obs. center dummy	66465	66465	66465	66465	66465	66465
No. of Obs.	390737	390737	390737	390737	390737	390737

Table 14 H2: Regression results for commodity, MUSTARD

	Arrivals variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.00001	−0.00001	−0.00001	−0.00001	−0.00000	0.00001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(NCDEX Volumes)	0.003***	−0.001*	−0.001**	−0.007***	−0.006***	−0.007***
	(0.0004)	(0.0004)	(0.0004)	(0.002)	(0.002)	(0.002)
Market share mandi	0.016***	0.022***	0.022***	0.022***	0.023***	0.023***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.002***	−0.003***
					(0.001)	(0.001)
Center dummy	0.0001	−0.015***	−0.015***	−0.018*	−0.017*	−0.034***
	(0.005)	(0.004)	(0.004)	(0.009)	(0.009)	(0.010)
Center NCDEXVolumes Intrn				0.0002	0.0001	0.002**
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.021***	−0.074***	−0.074***	−0.069***
			(0.008)	(0.013)	(0.013)	(0.014)
C2 dummy			−0.021***	−0.080***	−0.080***	−0.067***
			(0.008)	(0.017)	(0.017)	(0.017)
C3 dummy			−0.009	0.010	0.010	0.008
			(0.007)	(0.011)	(0.011)	(0.011)
C1 NCDEXVolumes Intrn				0.006***	0.006***	0.005***
				(0.001)	(0.001)	(0.001)
C2 NCDEXVolumes Intrn				0.006***	0.006***	0.005***
				(0.001)	(0.001)	(0.002)
C3 NCDEXVolumes Intrn				−0.002**	−0.002**	−0.002**
				(0.001)	(0.001)	(0.001)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.06	0.06	0.06	0.06	0.06
FStat pval	0	0	0	0	0	0
Obs. C1	185638	185638	185638	185638	185638	185638
Obs. C2	224319	224319	224319	224319	224319	224319
Obs. C3	44055	44055	44055	44055	44055	44055
Obs. center dummy	343542	343542	343542	343542	343542	343542
No. of Obs.	402122	402122	402122	402122	402122	402122

Table 15 H2: Regression results for commodity, SOYBEAN

	Arrivals variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.00002	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(NCDEX Volumes)	−0.001*	0.003***	0.003***	0.002***	0.002***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share mandi	0.021***	0.032***	0.032***	0.032***	0.034***	0.034***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.008***	−0.008***
					(0.001)	(0.001)
Center dummy	0.010***	0.016***	0.015***	0.008	0.011	0.012*
	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)	(0.007)
Center NCDEXVolumes Intrn				0.001	0.0002	0.0001
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.115***	−0.115***	−0.117***	−0.121***
			(0.025)	(0.025)	(0.025)	(0.026)
C2 dummy			−0.137***	−0.136***	−0.137***	−0.137***
			(0.008)	(0.011)	(0.011)	(0.011)
C2 NCDEXVolumes Intrn				−0.0002	−0.0001	−0.0003
				(0.001)	(0.001)	(0.001)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.13	0.13	0.13	0.13	0.13
FStat pval	0.03	0.02	0.02	0.02	0.02	0.02
Obs. C1	339689	339689	339689	339689	339689	339689
Obs. C2	43690	43690	43690	43690	43690	43690
Obs. C3	0	0	0	0	0	0
Obs. center dummy	222766	222766	222766	222766	222766	222766
No. of Obs.	341479	341479	341479	341479	341479	341479

Table 16 H2: Regression results for commodity, TURMERIC

	Arrivals variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001**
	(0.00005)	(0.00005)	(0.00005)	(0.00005)	(0.0001)	(0.0001)
ln(NCDEX Volumes)	0.003*	−0.0004	−0.0004	−0.006	−0.007	−0.016***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.005)
Market share mandi	0.005***	0.005***	0.005***	0.005***	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.001**	−0.004***
					(0.001)	(0.001)
Center dummy	−0.003	−0.020	−0.033	−0.064*	−0.063*	−0.145***
	(0.022)	(0.022)	(0.022)	(0.034)	(0.034)	(0.047)
Center NCDEXVolumes Intrn				0.006	0.007	0.015***
				(0.004)	(0.004)	(0.005)
C1 dummy			0.176***	0.193***	0.192***	0.228***
			(0.059)	(0.061)	(0.061)	(0.060)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.02	0.03	0.03	0.03	0.03	0.04
FStat pval	0.54	0.54	0.54	0.54	0.54	0.53
Obs. C1	34012	34012	34012	34012	34012	34012
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	32574	32574	32574	32574	32574	32574
No. of Obs.	34650	34650	34650	34650	34650	34650

Table 17 H3: Regression results for commodity, CORIANDER

	Spot price variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	0.00000	−0.00002	−0.00002	−0.00001	−0.00001	−0.00001
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
ln(Arrivals)	−0.0005	−0.004**	−0.004**	−0.004**	−0.004**	−0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(NCDEX Volumes)	0.003**	0.001	0.001	0.007***	0.007***	0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Market share mandi	0.002***	0.002***	0.002***	0.002***	0.003***	0.003***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)
Market share center					−0.0003	−0.001
					(0.001)	(0.001)
Center dummy	−0.034***	−0.029***	−0.027***	0.019	0.020*	0.003
	(0.007)	(0.007)	(0.007)	(0.012)	(0.012)	(0.014)
Center NCDEXVolumes Intrn				−0.006***	−0.006***	−0.008***
				(0.001)	(0.001)	(0.002)
C1 dummy			−0.069**	−0.096***	−0.095***	−0.097***
			(0.032)	(0.032)	(0.032)	(0.036)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.03	0.03	0.03	0.03	0.03
FStat pval	0.02	0.02	0.02	0.02	0.02	0.02
Obs. C1	55303	55303	55303	55303	55303	55303
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	40390	40390	40390	40390	40390	40390
No. of Obs.	69848	69848	69848	69848	69848	69848

Table 18 H3: Regression results for commodity, MAIZE

	Spot price variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.00004***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(Arrivals)	−0.011***	−0.002***	−0.003***	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln(NCDEX Volumes)	−0.005***	−0.003***	−0.004***	0.013***	0.013***	0.015***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Market share mandi	0.017***	0.007***	0.007***	0.007***	0.009***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Market share center					−0.007***	−0.005***
					(0.001)	(0.001)
Center dummy	0.008**	−0.002	−0.005*	−0.002	−0.003	0.002
	(0.003)	(0.003)	(0.003)	(0.008)	(0.008)	(0.009)
Center NCDEXVolumes Intrn				−0.001	−0.001	−0.0004
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.191***	−0.124***	−0.124***	−0.119***
			(0.006)	(0.009)	(0.009)	(0.009)
C2 dummy			0.105***	0.268***	0.269***	0.288***
			(0.008)	(0.017)	(0.017)	(0.017)
C3 dummy			−0.022***	0.115***	0.116***	0.139***
			(0.008)	(0.018)	(0.018)	(0.018)
C1 NCDEXVolumes Intrn				−0.017***	−0.017***	−0.018***
				(0.001)	(0.001)	(0.001)
C2 NCDEXVolumes Intrn				−0.019***	−0.019***	−0.021***
				(0.002)	(0.002)	(0.002)
C3 NCDEXVolumes Intrn				−0.015***	−0.015***	−0.017***
				(0.002)	(0.002)	(0.002)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.04	0.04	0.04	0.04	0.05
FStat pval	0	0	0	0	0	0
Obs. C1	167123	167123	167123	167123	167123	167123
Obs. C2	106550	106550	106550	106550	106550	106550
Obs. C3	102162	102162	102162	102162	102162	102162
Obs. center dummy	66465	66465	66465	66465	66465	66465
No. of Obs.	390737	390737	390737	390737	390737	390737

Table 19 H3: Regression results for commodity, MUSTARD

	Spot price variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.00001	−0.00002**	−0.00001**	−0.00001**	−0.00001*	−0.00001*
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(Arrivals)	0.008***	0.007***	0.008***	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln(NCDEX Volumes)	0.006***	0.003***	0.004***	−0.0002	−0.0002	−0.001
	(0.0003)	(0.0003)	(0.0003)	(0.002)	(0.002)	(0.002)
Market share mandi	−0.001	0.001	−0.0002	−0.0003	−0.0002	−0.00003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.0002	0.0001
					(0.0004)	(0.0005)
Center dummy	−0.031***	−0.042***	−0.039***	−0.077***	−0.077***	−0.080***
	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)	(0.008)
Center NCDEXVolumes Intrn				0.004***	0.004***	0.004***
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.254***	−0.280***	−0.280***	−0.290***
			(0.008)	(0.017)	(0.017)	(0.017)
C2 dummy			0.020**	0.044**	0.044**	0.037*
			(0.008)	(0.019)	(0.019)	(0.020)
C3 dummy			0.192***	0.163***	0.163***	0.164***
			(0.006)	(0.009)	(0.009)	(0.009)
C1 NCDEXVolumes Intrn				0.003*	0.003*	0.004**
				(0.002)	(0.002)	(0.002)
C2 NCDEXVolumes Intrn				−0.002	−0.002	−0.002
				(0.002)	(0.002)	(0.002)
C3 NCDEXVolumes Intrn				0.003***	0.003***	0.003***
				(0.001)	(0.001)	(0.001)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.03	0.04	0.04	0.04	0.04
FStat pval	0.02	0.02	0.02	0.02	0.02	0.02
Obs. C1	185638	185638	185638	185638	185638	185638
Obs. C2	224319	224319	224319	224319	224319	224319
Obs. C3	44055	44055	44055	44055	44055	44055
Obs. center dummy	343542	343542	343542	343542	343542	343542
No. of Obs.	402122	402122	402122	402122	402122	402122

Table 20 H3: Regression results for commodity, SOYBEAN with month effects

	Spot price variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.0001***	−0.00005***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
ln(Arrivals)	−0.018***	−0.013***	−0.013***	−0.013***	−0.014***	−0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln(NCDEX Volumes)	−0.005***	−0.002***	−0.002***	−0.005***	−0.005***	−0.005***
	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)	(0.001)
Market share mandi	0.022***	0.016***	0.016***	0.016***	0.017***	0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.004***	−0.004***
					(0.001)	(0.001)
Center dummy	0.006**	0.005**	0.003	−0.037***	−0.036***	−0.033***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)
Center NCDEXVolumes Intrn				0.004***	0.004***	0.004***
				(0.001)	(0.001)	(0.001)
C1 dummy			−0.293***	−0.288***	−0.290***	−0.299***
			(0.015)	(0.015)	(0.015)	(0.016)
C2 dummy			−0.153***	−0.171***	−0.172***	−0.178***
			(0.008)	(0.010)	(0.010)	(0.011)
C2 NCDEXVolumes Intrn				0.002**	0.002**	0.002**
				(0.001)	(0.001)	(0.001)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.09	0.1	0.1	0.1	0.1
FStat pval	0	0	0	0	0	0
Obs. C1	339689	339689	339689	339689	339689	339689
Obs. C2	43690	43690	43690	43690	43690	43690
Obs. C3	0	0	0	0	0	0
Obs. center dummy	222766	222766	222766	222766	222766	222766
No. of Obs.	341479	341479	341479	341479	341479	341479

Table 21 H3: Regression results for commodity, TURMERIC

	Spot price variation through the year					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	−0.00003	−0.00003	−0.00003	−0.00003	−0.00002	−0.0001*
	(0.00004)	(0.00004)	(0.00004)	(0.00004)	(0.00004)	(0.00004)
ln(Arrivals)	−0.0005	−0.005**	−0.006**	−0.006**	−0.007***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
ln(NCDEX Volumes)	−0.006***	−0.008***	−0.008***	−0.014***	−0.014***	−0.023***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.005)
Market share mandi	0.001	0.002***	0.002***	0.002***	0.002***	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Market share center					−0.001*	−0.001
					(0.0005)	(0.001)
Center dummy	−0.072***	−0.053***	−0.084***	−0.117***	−0.116***	−0.184***
	(0.020)	(0.020)	(0.020)	(0.028)	(0.028)	(0.041)
Center NCDEXVolumes Intrn				0.007*	0.007*	0.015***
				(0.004)	(0.004)	(0.005)
C1 dummy			0.405***	0.423***	0.423***	0.458***
			(0.056)	(0.057)	(0.057)	(0.055)
State Effects	YES	YES	YES	YES	YES	YES
Year Effects	YES	YES	YES	YES	YES	YES
Weekday Effects	YES	YES	YES	YES	YES	YES
Month Effects	NO	YES	YES	YES	YES	YES
State Year Interaction	NO	NO	NO	NO	NO	YES
Adj. R2	0.01	0.03	0.03	0.03	0.03	0.04
FStat pval	0.01	0.01	0.01	0.01	0.01	0.01
Obs. C1	34012	34012	34012	34012	34012	34012
Obs. C2	0	0	0	0	0	0
Obs. C3	0	0	0	0	0	0
Obs. center dummy	32574	32574	32574	32574	32574	32574
No. of Obs.	34650	34650	34650	34650	34650	34650