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Do Agricultural Contracts Affect Grain Prices? Evidence from Mexico*

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Abstract: In the late 80's and early 90's Mexico eliminated minimum price policies of main agricultural commodities and substituted those policies by government operated contract markets. Contracts can help smooth price variations and facilitate risk-sharing but their impact on price levels is uncertain. We simultaneously estimate the impacts of quantity supplied sold via contracts and the cash market on cash prices for grains participating in contracts: wheat, corn, soybeans and sorghum. By doing so we estimate an inverse grain demand function using supply shifters and other exogenous variables as exclusion restrictions. Our findings show that quantity supplied sold via contracts is a more important determinant of prices than quantity supplied in the cash market. A 10 % increase of volume sold via contracts is estimated to reduce cash market prices by 2.5 %. Additionally, we find no evidence that more contracts affect prices by reducing quantity supplied in the cash market.
Keywords: Contracts, Inverse Demand, Three Stage Least Squares, Grains, Supply Shifters.
JEL Classification: Q11, Q14, Q18.

Resumen: A finales de los 80's y principios de los 90's México eliminó las políticas de precios de garantía de bienes agrícolas y substituyó dichas políticas por contratos agrícolas operados por el gobierno. Los contratos ayudan a suavizar cambios en precios y esparcen el riesgo entre varios agentes pero su impacto en los niveles de precios es incierto. En este trabajo estimamos los impactos de la cantidad vendida vía contratos y vía el mercado libre en los precios del mercado libre de los granos que participan en los contratos: trigo, maíz, soya y sorgo. Así, estimamos una demanda inversa de granos utilizando factores impulsores de oferta (*supply shifters*) y otras variables exógenas como variables de exclusión. Nuestros resultados muestran que la cantidad ofrecida vía contratos es un determinante de precios más importante que la cantidad ofrecida en el mercado libre. Estimamos que un incremento en 10 % del volumen vendido en contratos reduce los precios de mercado libre en 2.5 %. Adicionalmente, no encontramos evidencia de que los contratos afecten los precios debido a que reducen la cantidad de oferta disponible en el mercado libre.
Palabras Clave: Contratos, Demanda Inversa, Mínimos Cuadrados en Tres Etapas, Granos, Factores Impulsores de Oferta.

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1 Introduction

Before the North American Free Trade (NAFTA), prices of main grains and other agricultural commodities in Mexico were regulated by the government through price support programs where the government purchased them at a minimum price (*precio de garantía*). After NAFTA went into effect in 1994, minimum prices of most agricultural commodities were gradually eliminated and, for some grains (corn, wheat, soybeans and sorghum), a new form of price regulation emerged: agricultural contracts.

Under the contract market regulation, the Mexican government operated a contract market of grains, where farmers and buyers contracted with each other. Contracts specified the price, quantities, quality, date and form of delivery of the commodity. The price was set by the government at an "indifference" rate before harvest time: it was the price at which buyers were indifferent between acquiring the grain in Mexico and importing it from the US (the main import market for Mexico). In order to promote the participation of both farmers and buyers, the government subsidized the costs of put and call options purchased in the Chicago Board of Trade (CBOT) market to insure market participants from price changes and also compensated either farmers or buyers from changes in local basis (transportation costs) that could have occurred from the date the contract was signed to the time of delivery specified in the contract. From 2005 to 2012, agricultural contracts were the main commercialization policy of the Mexican government. In June of 2012, the government announced a reduction of 40% of the budget allocated the support of contracts, as well as a new program called "Price Risk Management through Financial Intermediaries". In the new scheme, contracts remain but financial institutions work as the intermediaries.[1]

Little is known from the effects of contracts on cash market prices. On the one hand, more contracts induce lower cash market prices for two main reasons. First, the price of contracts is, on average, lower than the cash market price given they lower price risk, which

[1]Contracts will still operate but in a more efficient environment and under much lower government support.

induces lower prices in the cash market because contract market prices are usually used as reference prices in the cash market. We assume, as a result of the interview with ASERCA's officials, that contract prices are used as reference prices when the share of contracts to total production increases, so the channel contract prices affect cash market prices is assumed to only be via volume contracted. This was confirmed by a government official in charge of operating the contract market in Jalisco, one of the main corn production regions in Mexico. According to the interviewed, when more contracts are signed, it is more likely that the prices set in the contracts are used as reference prices in cash market deals. Second, contracts give incentives to producers to maintain and even expand their production since they know it is possible for them to sell their production in the contract market at a certain price (MacDonald 2006). This effect happens *exante*, at sowing time, since contracts are signed before harvest. Since not all production can be sold in the contract market due to public funds availability, part of the quantity supplied expansion induced by contracts is sold in the cash market. On the other hand, they have an indirect impact on prices via a decrease of quantity supplied and quantity demanded available in the cash market given that part of the cash market quantity supplied is sold via contracts, which may induce higher prices in the cash market.

There are at least three main reasons for which knowing the impact of contracts on cash market prices is relevant. First, contracts are a large percentage of total grain production. In 2010, the share of volume contracted to total grain production was 50% for corn, 60% for sorghum, 80% for wheat and 100% for soybeans. Hence, we could expect that movements in the volume contracted will impact prices of these basic grains. Second, if contracts tend to reduce cash market prices, that has direct benefits to grain consumers and also to final consumers. Changes in producer prices (grain prices) have direct impacts on inflation rates.[2] Finally, if contracts induce lower cash market prices, profits of farmers that do not participate in contracts are also reduced. In my sample, only 10% of farmers participate in the contract

[2]For Mexico, Sidaoui et. al. (2009) find evidence of long-run Granger causality going from the Producer Price Index (PPI) to the Consumer Price Index (CPI).

market and these farmers account for almost half of total grain production; they are large enough to sell their production in main markets (Mexico City for example). Not participating farmers are mostly low income farmers that sell their product locally and are more exposed to fluctuations in local cash market prices. Hence, reductions in cash market prices may contribute to increased poverty rates and income disparities. This is important mainly because poverty is concentrated in the rural sector: in 2010, 64% of the rural population were poor and 53% of the total population living in extreme poverty lived in rural areas (CONEVAL, 2010).

Additionally, recent increases in the international commodity prices ignited the public debate regarding the effectiveness of contracts in Mexico since public costs per contract supported were also increasing. Knowing if this support program has impacts on prices will help to inform future policies and to guide the current debate.

This paper intends to estimate effect of agricultural contracts on grain prices in Mexico. We do so by estimating the impacts of agricultural contracts on the level of cash market prices farmers obtain from the four crops that participate in contracts: corn, soybeans, sorghum, and wheat. We make at least three contributions to the existing literature. First, to our knowledge, this is the first empirical study conducted for a developing country. This is important given the share of the population that depend on agricultural activities in developing countries. Second, in developing countries the weight of agricultural products on inflation is larger than in developed countries. Hence, understanding price drivers of agricultural products contributes to the overall understanding of inflation. Finally, the empirical approach is novel, since this is the first study that jointly estimates the effects of quantity supplied sold via contracts and via cash market on prices, controlling for fixed effects.

In our empirical approach we break down the effect of quantity produced on the cash market price in two elements: quantity contracted and quantity sold in the cash market. By doing so, we estimate the relative contribution of contracted and not contracted quantities to the cash market price function. Additionally, we test for the indirect effect of contracts

on prices via a reduction of the quantity sold in the cash market. Effectively, our estimation approach allows us to identify an inverse demand function of grain using supply shifters and other exogenous variables for both quantity contracted and not contracted.

We construct a comprehensive database of volume contracted, prices and production of corn, wheat, sorghum and soybeans for all producing states of those crops in Mexico during the period 2008-2010, using not publicly available data on contracts. Data on quantity contracted, prices and production was obtained from the Secretary of Agriculture (SAGARPA) and data on precipitation by climate station was obtained from the Water National Commission (CONAGUA). Our dataset is a panel by grain, year, production cycle and state.

One of the main challenges we face is that we do not have a separate measure of cash market prices. The price SAGARPA reports is an average of the price that farmers reported they received for their crop in a given year. Hence, this price is composed by contract and cash market prices. However, we posit that changes in quantity contracted and quantity not contracted only impact the cash market component of the average price. This is because contract prices are set by the government using the international price and transportation costs, which do not respond to local supply conditions.[3] We show evidence consistent with this argument and proceed by estimating the average price farmers received for each crop in each cycle as a function of two variables: quantity produced that was contracted and quantity produced that was not contracted (sold in the cash market). Since quantity produced (contracted and not contracted) is jointly determined with prices, we simultaneously estimate three equations: average price, quantity contracted and quantity not contracted, via 3SLS. To identify the system of equations we include an exclusion restriction variable in each of the supply equations. Given we are mostly interested in estimating the impacts of contracts on grain supply, our exclusion restriction variables are supply shifters and other exogenous variables. To control for time-invariant unobserved shocks, we adapt the model

[3]Domestic markets for these grains are integrated to the international market: for most of the four grains analyzed, Mexico imports at least half of its total domestic production with no tariffs from the US market, the main source of Mexican grain imports.

to allow for fixed effects in each equation. Our empirical strategy allows us to estimate the two main channels in which contract quantity may affect cash market prices: 1) direct, via lower contract prices and production incentives and 2) indirect, via a reduction in the cash market supply.

Results show that quantity contracted is the most significant factor explaining grain cash market prices. Increasing quantity contracted reduces the cash market price farmers obtain for their crops. We find no evidence of impacts of contracts on cash market prices via a reduction in the cash market supply. According to our preferred estimate, a 10% increase in the quantity contracted decreases the cash market price by 2.5%, whereas a 10% increase in the quantity not contracted reduces the cash market price by 0.9%. In monetary terms, the effect of contracting 10% percent more tons of grain decreases the cash market price by $75.85 pesos per ton (around $5.5 dollars per ton).

Although we do not obtain welfare measures from our results (we do not estimate a supply curve since data on production demand by grain consumers is not available), we posit that producers that did not participate in the contract market were the ones that lost more from the contract support program, whereas consumers and producers that participated in the contract market were the ones that benefited more from the subsidized contract market.

The paper is structured as follows: Section 2 presents an overview of the Mexican contract market, Section 3 summarizes the literature on contracts, Section 4 presents the data and data sources, Section 5 describes the empirical strategy, Section 6 summarizes the results and Section 7 concludes.

2 The Mexican Contract Market

In the period 1960-1980, minimum support prices for agricultural products was one of the main development policies followed by the Mexican government (Yúnez and Barceinas, 2000).

Prices of 12 agricultural products were regulated by the government through CONASUPO,[4] the government agency that was in charge of buying those products from producers, transporting, storing and selling them to consumers. It was thought that, by controlling the commercialization of those products, the government would promote their production and ensure producers would make a minimum profit (Appendini and Almeida, 1980).

By the end of 1980, the government significantly reduced the minimum price of those commodities and the deregulation of the farming sector was intensified.[5] In 1991, minimum support prices of all products except corn and beans were eliminated and, in 1998, four years after Mexico's accession into NAFTA, CONASUPO ceased to exist along with the minimum support prices of beans and corn. CONASUPO was replaced by ASERCA, which is the agency that, until the first semester of 2012, was in charge of managing the grains contract market. Since the elimination of minimum support prices, prices of main agricultural products became more responsive to international prices. Mexico is a net importer of sorghum, yellow corn, wheat and soybeans, which makes their domestic price more responsive to international price fluctuations compared to other products. To protect consumers and producers of sorghum, corn (white and yellow), wheat and soybeans from market fluctuations and to give certainty to producers regarding the selling of their harvest, the government created a contract market (*Agricultura por Contrato*) where farmers and buyers contracted with each other with ASERCA working as the intermediary.

The operation of the contract market worked the following way: first, at sowing time, ASERCA called for market participants to register. Second, buyers presented to the regional offices of ASERCA a list with potential sellers that they had contacts with detailing the amounts they wanted to buy from each seller. Third, producers presented to ASERCA officials their harvest estimates based on cultivated area and current market conditions and

[4]The 12 products were white rice, palay rice, wheat, sorghum, soybeans, corn, copra, safflower, barley (two types), beans, sesame, sunflower and cotton seed.

[5]The process of deregulation of all economic sectors started in the mid 80's with the accession of Mexico into the GATT, the reduction of import tariffs of some products and the privatization of state-owned companies.

showed proof that they had planted the necessary amount to produce the estimated quantity they intended to contract. Fourth, ASERCA validated both databases and matched producers and buyers according to the list presented by the buyers. Producers could be switched from the matched list if they did not fulfill the requirements specified by ASERCA. Fifth, contracts were signed by both parties.

Contracts specified price, quantities, quality, date and form of delivery of the commodity. The price specified in the contract was set at an indifference price: it was the price at which grain buyers would be indifferent between buying the grain in Mexico and importing it from the US. Therefore, to set the price of contracts, ASERCA used a formula that had two elements: 1) the futures market price at the time the contract was signed, 2) the cost of importing the commodity from the US to the consumer zone (this varied by state) minus the costs of transporting the commodity from the production zone in Mexico to the consumer zone. The second element is the basis, which was calculated by ASERCA two times during the production cycle: at the time contracts were announced and after they were honored. This is because ASERCA also had a basis compensation program to compensate either producers or consumers participating in the contract market from changes in transportation costs (basis) between the time the contract was signed and the time of delivery of the commodity. The main purpose of the price formula used for contracts was to increase domestic production of grains in a context of international competitiveness (Echanove, 2009).

Finally, ASERCA purchased options from the CBOT market to cover producers and consumers from changes in the international prices of grains. Since the price was fixed before harvest time, ASERCA purchased call options for producers and put options for buyers. A call option gives the opportunity to the buyer to purchase a given good at the strike price, so it appreciates with increases in the price of the good. A put option gives the opportunity to the buyer to sell a good at the strike price so it appreciates with decreases in the price of the good. Hence, if the price of the commodity increased from the time the contract was signed to harvest time, the producer requested ASERCA to sell her call option

to compensate her loses from having received a lower price for her production specified in the contract. Similarly, if the price of the commodity decreased from the time the contract was signed and harvest time, the buyer requested ASERCA to sell her put option and she compensated the higher price (established in the contract) she paid with the return from the option. To ensure compliance with contracts, returns from the options were supposed to be transfered only when parties showed proof of having complied with contract terms.[6]

The government support of put and call options started operating in 2003 (Echanove, 2012). However, data on contracts was obtained since 2005, when only two products, yellow corn and sorghum, were supported by the government in the contracts. After 2005, the contract market expanded to cover white corn, wheat and soybeans.

In the following section we summarize some of the literature that analyzes how agriculture contracts may impact cash market prices.

3 Literature Review

The few studies that analyze the contract market in Mexico are descriptive, mostly based on interviews to key participants to elicit their perceptions on the functioning of the market (Echanove y Stefen, 2005; Steffen y Echanove , 2007; Echanove, 2009 y Echanove 2012).

According to Steffen y Echanove (2007), the contract market for yellow corn was initiated to increase total cultivated area of yellow corn in Mexico in order to reduce the dependency of this product from the US market.[7] The authors document that, as a result of contracts, production of yellow corn increased from 420,000 tons in 2004 to 700,000 tons in 2005.

To our knowledge, all economic studies conducted on the impacts of contracts on cash market prices have analyzed contracts in the US, with special emphasis on the cattle and the hog markets. In contrast to the Mexican case, contracts in the US are not operated by the government, and the reasons that are often cited regarding the impacts of contracts on cash

[6]Despite ASERCA's efforts to make sure participants honored their contracts, there were several complaints from both producers and consumers regarding the lack of enforcement of contracts.

[7]Most of the consumption of yellow corn in Mexico, used to feed chicken, comes from the US.

market prices in the US are related to power market that upstream meatpacking processors exert on producers (hog and cattle growers) and on quality differences in the contract and cash markets (Elam, 1992; Shroeder, et al., 1993; Ward, et al., 1998; Hayenga, et al., 2000; Xia and Sexton, 2004; MacDonald, 2006 and Wang and Jaenicke, 2006).

The few econometric studies that intend to study the impact of contracts on cash market prices point to a negative association between both variables.

Among the studies that focus on the packers market power hypothesis, Elam (1992) investigates the differences between cash forward contract prices and the futures hedge prices for fed cattle from a sample of contracts from Texas feedlots and finds that, on average, cash forward contract prices are lower than cash market prices, mainly because the former eliminates the basis risk (growers are willing to pay a premium for being able to sell their cattle at a certain price). Additionally, the author correlated contract cattle shipments in Kansas, Colorado, Nebraska and Texas for the period 1988-1991 with the cash market price of cattle and found negative associations, indicating that contracts may have reduced cash market prices for cattle in those states. According to his results, a 10% increase in cattle shipments decreases the cash market price of fed cattle by 0.12%.

Ward, et al. (1998) study the effect of captive supplies (contracts) on fed cattle prices. Captive supplies are cattle supplies obtained through three types of contracts: forward contracts, packer-fed cattle contracts and marketing agreements. In forward contracts, packers bid for a basis (cash price minus futures price), which becomes a fixed price before slaughter. In packer-fed cattle contracts, cattle are delivered to a slaughter plant and the price is determined at the time of delivery. In marketing agreements the cattle feeder agrees to supply a fixed number of cattle to a buyer at a formula-based price.[8]

Using a detailed dataset at the plant level from the largest meat-packers in the US containing all contracts, types of contracts, purchases in the cash market and the characteristics of the purchases (prices, delivery costs, transportation costs and cattle characteristics) from

[8]Marketing agreements are the most similar to Mexican contracts, although no government intervention takes place.

1992 to 1993, Ward, et al. (1998) estimate the effects of contracts on transaction prices and also test differences between cash market prices and contract prices. Their results point to a weakly negative association between cash market prices and the quantity of captive supplies and marketing agreements. Their results are smaller than those estimated by Elam (1992): a 10% increase in captive supplies reduce transaction prices by 0.004%, whereas a 10% increase in marketing agreements decrease transaction prices by 0.03%. Consistent evidence across specifications and models of this negative association was found for forward contracts whereas mixed evidence was found for packer-fed cattle contracts and marketing agreements. Also in the context of cattle contracts, Xia and Sexton (2004) analytically show that when buyers obtain cattle from contracts and the spot market they have no incentives to compete in the spot market, which reduces cash market prices.

Regarding the quality hypothesis, Wang and Jaenicke (2006) analytically derive the effects of three types of contracts in the hog industry: fixed-price contracts, market-price contracts and formula-price contracts. The authors build a principal-agent model to study the relationship between processors and producers, where they account for quality differences that are imperfectly observable in the contract market. They show that, given asymmetric information regarding hog's quality sold in the contract market, growers are the most benefited from contracts: under both fixed price and formula price contracts, the cash market price increases with quantity contracted.

In the following section we describe our data and data sources.

4 Data

Data on contracts was obtained from SAGARPA and it contains average contract price and quantity contracted by state, grain, cycle and year. It is important to note that quantity contracted refers to the volume contracted *exante*, i.e. before harvest (we do not have other data). Any deviations from this volume to what actually was sold via contracts due to climate

shocks for example will not be considered in our estimates. Daily data on precipitation were obtained from CONAGUA at the climate station level. There are more than 2000 climate stations distributed across the country. Many of the stations have missing values for several consecutive periods. Therefore, there is a trade-off between selecting stations with consistent data and the geographic fineness of the data. Eliminating stations with inconsistent data leads us to discard climate stations that could potentially be closer to those municipalities that produce a given grain. Keeping those stations leads us to having large periods with missing values. Since we are more interested in capturing weather impacts on production (supply shifters), we prioritized consistency of climate variables over geographic detail. Our rule for selecting climate stations consisted on choosing those stations that have at least 26 days of non-missing data within a month for all months in a given year. For the years 2005-2007, a large proportion of climate stations do not satisfy our selection criterion, so we focus on the period 2008-2010.

In order to match climate stations to municipalities that produce a given grain in a given cycle (Autumn-Winter or Spring-Summer) we first identified those municipalities that, for the period 2008-2010, cultivated a given grain every year during that period. Then, by selecting those climate stations that have consistent data, we spatially matched climate stations to municipalities. A municipality was assigned multiple climate stations if more than one climate station was contained into its territory and the average measure of a given climate variable was computed. If no climate station was contained in a municipality, we assigned it the climate station that was closer to its gravity center.[9]

We construct an unbalanced panel at the grain-state-cycle level. Summary statistics for our variables are presented in Table 1. The data contains production of corn, wheat, soybeans and sorghum contracted and sold in the cash market in 28 states. We also have data on average salary of employees in the formal sector, manufacturing GDP, average fertilizer price, average precipitation during growing season for each grain, quantity produced contracted and

[9]The gravity center is the point in a surface where the weighted relative position of the distributed mass sums to zero.

quantity produced not contracted (sold in the cash market).

We have two types of prices for each grain-cycle-state: the average price received by farmers and the contract price. The average price (denoted by Price in the Tables) is a function of the contract price and the cash market price. One difference between the average price and the contract price is that the latter is lower: Table 2 shows t-test of the average differences between contract prices and the average prices in different years for the four grains we analyze and shows that, on average, average prices are statistically higher than contract prices.[10] This is mainly because, on average, international prices, the reference prices for contracts, are lower than domestic prices for all grains (see Figure 1). Correlations of average prices and the share of production contracted are negative for corn and soybeans and positive for sorghum and wheat (see Figures 2a to 3b). Additionally, since contracts started operating in 2005, grains that participate in contracts (managed by ASERCA) present lower correlations between the coefficient of variation of their yearly prices and the coefficient of variation of their yearly production compared to the same correlation for grains that do not participate in contracts (see Figures 4a to 5b). Unfortunately data on prices is only available on a yearly basis, which impedes us from testing the impact of contracts on price volatility.

In the next section we discuss the empirical strategy followed to identify the impact of contracts on cash market price levels.

5 Empirical Model

In this section we attempt to estimate the impacts of grain quantity supplied on the cash market price of corn, sorghum, wheat and soybeans in states that had agricultural contracts. We exclude states that did not have contracts or periods when states did not register con-

[10]To obtain a cleaner estimate of the mean differences between the contract price and the average price, for the average price we used states for which no contracts were registered for a given grain. Since we do not have cash market prices, we cannot test for differences between cash market prices and contract prices within the same state.

tracts. The reason we do this is because we do not have an adequate variable to capture selection into the contract market. In this regard, our estimates should be read as follows: conditional on having contracts, what is the effect of increasing quantity supplied in one percentage on cash prices?[11] Despite this omission we cover 28 out of the 32 states in Mexico, which account for most of the domestic production of corn, wheat, sorghum and soybeans. Figures 7 to 10 show quantity contracted by state and production cycle for each grain from 2005-2011. The graphs show that the number of states participating in the contract market increased over the period analyzed. They also show that state contract market shares vary over time. This last source of variation is what we exploit in our analysis.

We breakdown grain quantity supplied in two elements: quantity supplied from agricultural contracts and supplied from the cash market. This decomposition allows us to evaluate the relative impact of each supply component on the cash market price. Since we have data on contracts established pre-harvest (*exante*), we interpret the effect of contracts on cash market prices as impacts of *exante* contracted quantity on cash market prices, rather than actual contracted quantity (hereafter we omit the *exante* term in our discussion). To identify the impacts of quantity supplied on cash market prices we exploit time and cross-section variation of quantity contracted and quantity sold in the cash market, and use supply shifters and other exogenous variables for each component. Although most of the expansion of contracts occurred between 2006 and 2007, we still capture a large proportion of the variation in contracts across time and grains (see Figure 6).

We face two main complications when estimating the contribution of quantity supplied changes on cash market prices. The first is that our measure of price is composed by the cash market price and the contract price, provided it is an average of the price reported by different producers in every state. The second is that both price and quantity supplied are market equilibrium conditions that are jointly determined. We handle the first complication by exploiting the fact that the contract price is arbitrarily set by the government. As such, none

[11] Considering this interpretation of the estimated effects, attrition should not be an issue of concern.

of the supply or demand shifters should impact this price. We show evidence that this is the case. Hence, although our price measure combines contract prices and cash market prices, our empirical strategy captures changes in the cash market component of the average price. We address the second complication estimating three equations simultaneously: average price, quantity contracted and cash market quantity using exclusion restriction variables for each of the supply components. Empirically, we are interested in estimating the effects of quantity contracted and quantity not contracted on the cash market price. We are also interested in estimating the direct and the indirect effects of quantity contracted on the cash market price. The direct effect is given by the effect quantity supplied sold in the contract market has on cash market prices (via increased quantity supplied and lower reference prices),[12] whereas the indirect effect is given by the effect contracted quantity has on quantity sold in the cash market: more quantity contracted reduces the quantity available in the cash market, which may induce higher prices, depending on the relative elasticities of cash market supply and demand.

Since we are interested in estimating changes in the quantity supplied components of the cash market price function, we instrument quantity contracted and not contracted using supply shifters and other exogenous variables. Essentially, our empirical approach allows us to estimate an inverse demand function for grains.

Given contracts are established during sowing time, quantity sold in the cash market is more likely to be impacted by unanticipated shocks - such as weather conditions - than quantity sold in the contract market. In contrast, quantity contracted is more likely to be affected by structural factors, since producers need to estimate their total production before harvest time as a requirement for participating in the contract market. For quantity not contracted (sold in the cash market) we use precipitation during the growing season as an exclusion restriction. We also experimented adding more complex temperature variables such as Chebysheb polynomials of temperature (see Schlenker and Roberts, 2006) and regular

[12] As explained in the introduction, contract prices are used as reference prices when the share of contracts to total production increases.

temperature and precipitation polynomials, however, in all those models we rejected the null hypotheses of no over identification, which raised serious concerns on the appropriateness of the exclusion restriction variables. In the quantity not contracted equation, we do not control for any price because we do not have more variables available. However, we indirectly control for fertilizer and contract prices via the impact they have on quantity contracted. Since the quantity contracted that we use is the *exante* contracted volume, we posit that it is not influenced by climate shocks and show evidence accordingly. Although *expost* contracted quantity will be affected by climate shocks, our analysis focuses on *exante* contracted volume. We argue *exante* contracted volume has an impact on cash market prices because the way they affect producer's expectations: the more quantity the producer is expected to sell via contracts the more likely she will invest in production for, at least, produce enough to honor the contract. In the reduced form estimations we show that precipitation does not impact quantity contracted, but that it significantly influences the quantity sold in the cash market. For quantity contracted we use fertilizer prices and contract prices as the exclusion restriction. We consider fertilizer prices as an exogenous variable since Mexico is a net importer of fertilizers and, as such, it is a price-taker in the fertilizer market. In the reduced form estimations we also show that fertilizer prices have a negative and significant effect on quantity contracted whereas they do not have significant impacts on quantity sold in the cash market, reinforcing our intuition that structural factors are more likely to impact contracts than contingent factors. To control for demand shocks we include the average state salary reported by the Ministry of Social Security (IMSS by its Spanish acronym) as well as state manufacturing GDP.

We construct three equations: average price, quantity contracted and quantity not contracted as a function of supply shifters, exogenous variables and demand components. To test for the indirect effect quantity contracted can have on quantity not contracted, we allow for quantity not contracted to depend on quantity contracted.

The equations we estimate are given by:

$$Price_{cgst} = \beta_0 + \alpha_{1cgs} + \beta_1 QContract_{cgst} + \beta_2 QCashMkt_{cgst} + B'\mathbf{Z}_{st} + u_{1cgst} \quad (1)$$

$$QCashMkt_{cgst} = \delta_0 + \alpha_{2cgs} + \delta_1 QContrac_{cgst} + \delta_2 Precip_{cgst} + D'\mathbf{Z}_{st} + u_{2cgst} \quad (2)$$

$$QContrac_{cgst} = \gamma_0 + \alpha_{3cgs} + \gamma_1 ContracPrice_{cgst} + \gamma_2 FertPrice_{st} + G'\mathbf{Z}_{st} + u_{3cgst} \quad (3)$$

where c represents cycle, g grain, s state and t represents year. $Price$ is the average price received by farmers (composed of contract and cash market prices), $QContract$ is the quantity sold via contracts, $QCashMkt$ is the quantity sold in the cash market, $\mathbf{Z}$ is a vector that contains the average wage of workers in the formal sector and manufacturing GDP, $Precip$ is the average precipitation during the growing season registered in the municipalities where a given grain is produced, $ContracPrice$ is the contract price and $FertPrice$ is the average price of fertilizers in a given state. The term u_{jcgst} is the error of equation jth and α_{jcgs} represents a fixed effect which we allow to be correlated with u_{jcgst} (we assume no cross-equation correlation between the fixed effects and the error terms). All variables but precipitation are in logs. Given our price variable in equation (1) is a function of current contract prices, we need to instrument for it. Even though contract prices are not supply shifters *per se*, we instrument them using one period lagged prices of agricultural contracts. Lagged contract prices are correlated with current contract prices, but not correlated with average prices (except through current contract prices).

We estimate equations (1) to (3) via 2SLS and 3SLS. The later produces more efficient estimates and is conducted in two steps: first, each equation is estimated via two-stage least

squares (using the instruments) and the covariance matrix of the estimated errors is calculated. Second, a generalized least squares estimation is performed on the complete system using the covariance matrix obtained in the first step. In order to remove the individual time invariant components, α_{jcgs}, that may be correlated with the error term in each equation, we demeaned all variables. In the next section we discuss the results of the estimates.

6 Results

First stage estimates are presented in Table 3. Column (1) in Table 3 confirms our intuition that our empirical specification captures changes in the cash market prices only (not contract prices): except for one period lagged contract prices, none of the instruments we use are significant at explaining current contract prices. Also from Table 3 we can observe that instruments are significant at explaining the endogenous variables. Most of the exogenous variables are significant in the price equation (Column (2)). In the quantity not contracted equation, precipitation is positive and significant at the 5% level, whereas for quantity contracted, both, lagged contract price as well as fertilizer price are significant.

Results of 2SLS and 3SLS estimations are reported in Table 4. These support the use of our exclusion restriction variables: fertilizer prices are negative and significant in the quantity contracted equation and precipitation is positive and significant in the quantity not contracted equation. Two tests provide further support for the use of our proposed exclusion restrictions: 1) we reject the null of all exclusion restrictions equal to zero (P-Value>0.00 in 3SLS estimates) and 2) we cannot reject the Hansen-Sargan Tests of no over-identification (Prob.>Chi2=0.39 in 3SLS estimates). Contract price is significant in the quantity contracted equation but negative. This could be explained by the fact that the government faces a budget constraint and, when contract prices are higher, it can only support part of the demand for contracts.

As expected, both models show negative associations between quantity supplied and

price, as well as positive associations between price and wage, the demand control.[13] Moreover, our estimates are stable across methods: 2SLS and 3SLS estimates are similar in magnitude and identical in the direction they impact the dependent variables. According to the results, quantity contracted is the most important driver of cash market prices: a 10% increase in the quantity contracted is estimated to reduce the cash market price in 2.5%, whereas a 10% increase in the quantity not contracted is estimated to reduce the cash market price between 0.9% and 1%. The relative impacts of our estimates are larger by 2.38 percentage points compared to Elam's (1992) estimate and by 2.47 percentage points compared to Ward's estimate (1998). However, one should be cautious when comparing these effects since our estimates are for the grain market in Mexico and theirs are for the cattle market in the US.

The most important channel in which contracts impact cash market prices is direct. The reasons contracts may induce lower cash market prices may be: they provide producers with incentives to increase quantity supplied since they know they can participate in the contract market and sell their product at a given price. Contract prices can also be used as benchmark prices in cash market deals as more quantity is sold via contracts. We find no evidence of an indirect channel by which quantity contracted impacts prices: the coefficient of quantity contracted on the quantity not contracted equation is negative, but not significant. The direction of the estimate of the indirect effect suggests that the cash and the contract market may be substitutes.

Although conducting a cost-benefit analysis of the operation of the contract market by the Mexican government is beyond the objectives of this paper, we at least identify potential winners and losers from this market. In terms of economic value, a 10% increase in the quantity contracted traduces to a price decrease of $75.85 pesos per ton (around $5.5 dollars per ton). In the same period, 2008-2010, the Mexican government spent $7,650 million pesos

[13] Although manufacturing GDP was not significant in any of the specifications we decided to keep it as a control for demand shocks, that were specially intense during the time period of our study. Results without this variable do not change in any significant way our estimates.

per year (around $554 million dollars) in the operation of this market (this cost excludes staff payments and only involves direct subsidies), where it subsidized 22 million tons of grains directed at 206,440 producers per year. Hence, operational costs per ton were 334 pesos per ton ($24.6 dollars per ton).

Net gains to producers from the operation of the contract market are mixed and depend on producer's participation: on the one hand, producers that participated in the contract market gained from having the certainty that their production would be sold at harvest time and from selling the option. On the other hand, producers that did not participate in this market were the ones who lost more since they were excluded from the benefits producers participating in the forwards market obtained and also faced lower cash market prices. Grain buyers gained from the contract market from two sources: 1) the price they faced was lower and 2) volatility may have been lower for grains that participated in the contract market. Cost savings for consumers from facing lower prices had an upper bound of $75.85 pesos less per ton consumed (around $5.5 dollars less per ton) depending on the degree of pass-trough from producer prices to consumer prices.

Therefore, we conclude that most of the benefits generated by the operation of the contract market reached producers that participated in the market and consumers via lower prices and lower price volatility.

7 Conclusion

Contracts in Mexico expanded rapidly since 2005 and their operation cost rose accordingly. Given the lack of evidence on the impacts of these markets on prices, public opinion questioned their effectiveness and the public debate focused on the possibility of replacing such markets with a formal commodity market operated privately (*bolsa agropecuaria*). This paper shows evidence on the effect of contracts on the cash market price levels of soybeans, corn, wheat and sorghum in Mexico. We empirically test the effects of quantity contracted

and quantity not contracted on cash market price levels and show that quantity contracted is the main driver of cash market prices. Our results indicate that increasing the volume of contracts by 10% decreases the cash market price by 2.5%. We find no evidence of an indirect impact of contracts on the cash market, via a reduction on the available quantity supplied in the cash market.

Winners from the contract market were producers that participated in contracts and consumers. The first ones won from having certainty that their products would be sold at a minimum price at harvest time. The second ones won from facing lower prices and from facing lower price volatility. Losers from these policies were producers that did not participate in contracts (about 90% of producers). We conclude that contracts were effective at reducing cash market price levels.

One of the questions that remains is if the subsidy was needed to incentivize contracts. If, for some participants, it was not needed (they could have purchased options without the need of the subsidy), then, they could have been getting information rents (rents from the government's lack of information of participant types). The new contract scheme, "Price Risk Management through Financial Intermediaries", announced in July of 2012, reduces the subsidy and increases the efficiency of the market operation, which will reduce information rents and reduce the public cost of supporting contracts.

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9 Annex

Table 1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Log (Price)	123	7.9974	0.1964	7.6088	8.6056
Log (Contract Price)	123	8.0059	0.2529	7.5759	8.6505
Log (Quantity Contracted)	123	10.7259	2.0523	5.5373	15.1817
Log (Quantity not Contracted)	123	11.1597	2.2849	2.4214	14.4323
Log (Fertilizer Price)	123	2.2508	0.6271	0.8856	5.0118
Log (Wage)	123	5.4393	0.1360	5.2364	5.7306
Log (Manufacturing GDP)	123	17.9980	0.8874	16.2062	19.4997
Price (MXN Pesos 2011 per ton)	123	3034.0610	657.3946	2015.9120	5461.9350
Contract Price (MXN Pesos 2011 per ton)	123	3104.5500	906.7823	1950.5250	5712.7920
Quantity Contracted (Tons)	123	286514.90	671626.50	254	3920545
Quantity not Contracted (Tons)	123	589473.30	893037.20	1020.80	4963195
Precipitation (Liters per square meter)	123	3.0912	2.5375	0.0466	11.4447
Fertilizer Price (2011 MXN Pesos per kg.)	123	13.5757	23.1868	2.4244	150.1705
Average Wage (2011 MXN Pesos per month)	123	232.4515	32.7399	187.9889	308.1492
Manufacturing GDP (2011 MXN Mill. Pesos)	123	92.6	73.2	10.9	294

Table 2: Price differences (Price-Contract Price)

Grain	2005	2006	2007	2008	2009	2010
Corn	527.9380***	672.3560***	595.4120***	367.7790***	724.6470***	647.8460***
Sorghum	34.2880	130.0410*	144.0170**	-328.2190***	531.992***	187.407*
Wheat		206.6370**	323.2560*	-1289.8410***	-100.6250	141.7620
Soybeans			-510.5800**	-1557.2520*	-1081.9020	-82.1870

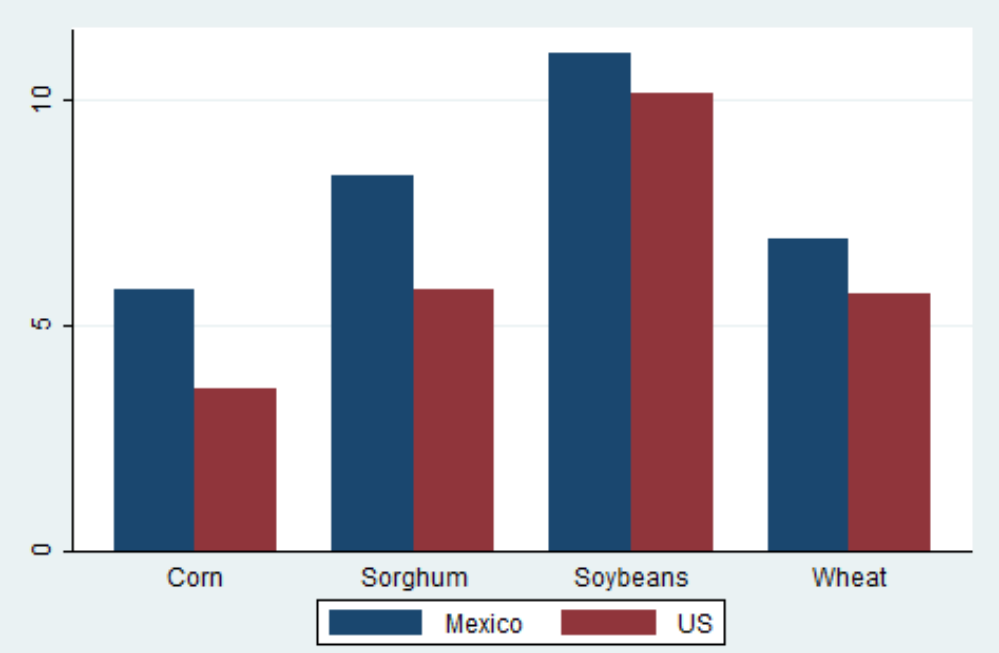
Note: * significant at 10%, ** significant at 5%, *** significant at 1%. T-test differences of average prices in states with contracts and states without contracts.

Table 3: Reduced form estimates

Dependent Variable	Contract Price	Price	Quantity Not Contracted	Quantity Contracted
Wage	1.1161	3.3331***	-3.5724	-4.6640
	(1.0663)	(1.0565)	11.6755	(6.8924)
Manufacturing GDP	0.1015	0.0088	-0.0161	-0.3273
	(0.2340)	(0.1941)	1.4243	(1.1785)
Precipitation	0.0070	-0.0296**	0.3812**	-0.0263
	(0.0144)	(0.0119)	(0.1567)	(0.0904)
Lagged Contract Price	-0.6021***	-0.3013***	-0.4088	0.7799*
	(0.0702)	(0.0813)	(1.0338)	(0.4613)
Fertilizer Price	-0.0386	0.0056	0.0186	-0.1839**
	(0.0373)	(0.0136)	(0.1787)	(0.0835)
Constant	5.0848	-7.7535	32.8566	36.2487
	(7.5029)	(5.3292)	(56.0989)	(42.3176)
Observations	123	123	123	123
Prob.>F	0.00	-	0.01	0.03
Adj. R-2	0.67	0.44	0.11	0.11

Note: * significant at 10%, ** significant at 5%, *** significant at 1%. Price denotes the average price reported by SAGARPA, which is a function of contract prices and cash market prices. It is our dependent variable in the following estimates. Prob.>F is the p-value of the F-test on the significance of the exclusion restriction variables.

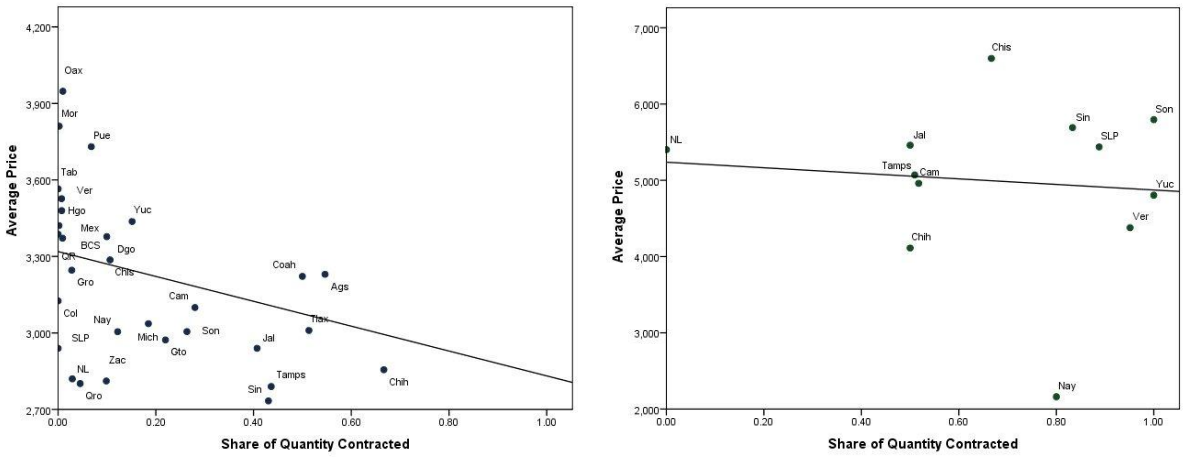
Figure 1: Average prices for selected grains in Mexico and the US (2008-2010)



Source: US Department of Agriculture

Note: All prices are in dollars per bushel, except for sorghum which is in dollars per hundredweight (cwt)

Figure 2: Negative correlation between prices and the share of production contracted by state (2008-2010)

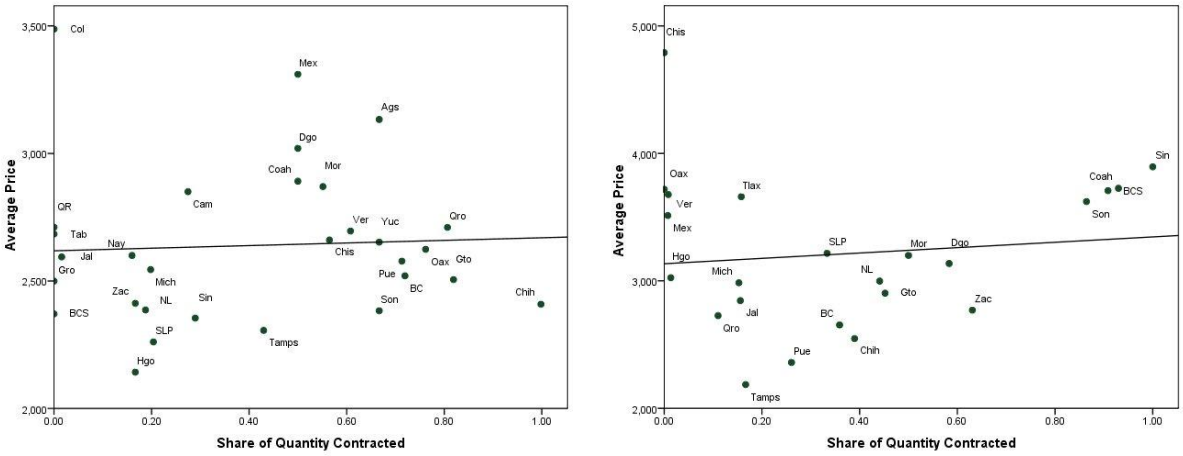


(a) Corn

(b) Soybeans

Source: SAGARPA

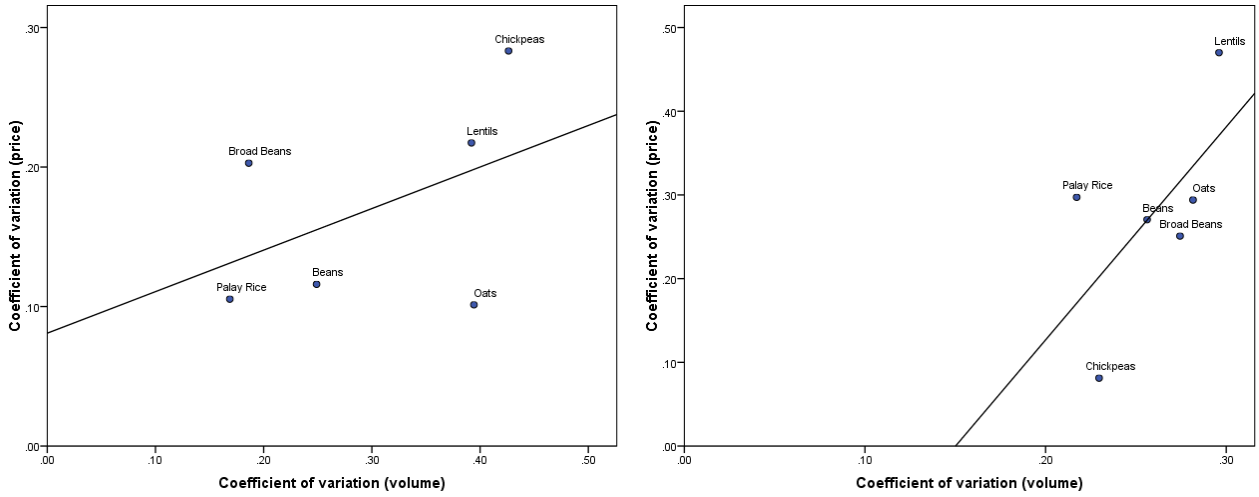
Figure 3: Positive correlation between prices and the share of production contracted by state (2008-2010)



(a) Sorghum (b) Wheat

Source: SAGARPA

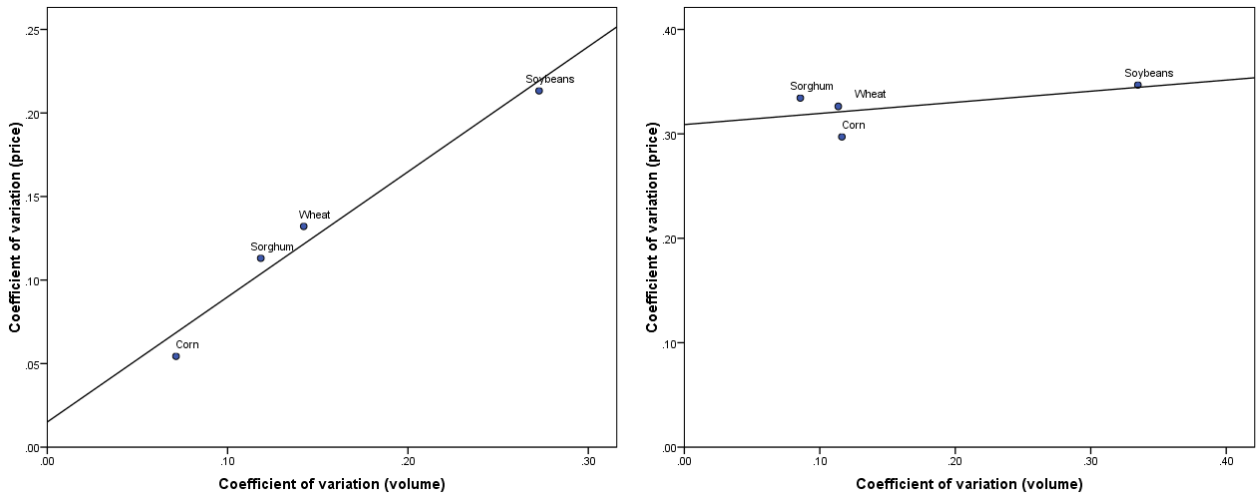
Figure 4: Coefficient of variation of production vs. Coefficient of variation of prices of grains not in ASERCA



(a) 2000-2005 (b) 2005-2011

Source: SAGARPA

Figure 5: Coefficient of variation of production vs. Coefficient of variation of prices of grains in ASERCA

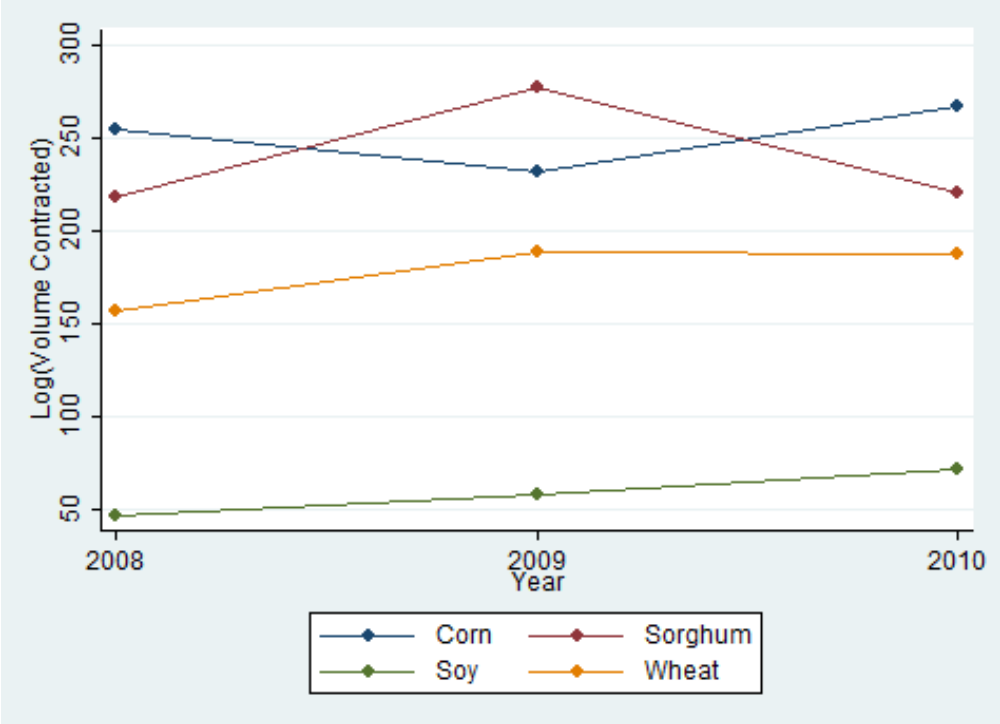


(a) 2000-2005

(b) 2005-2011

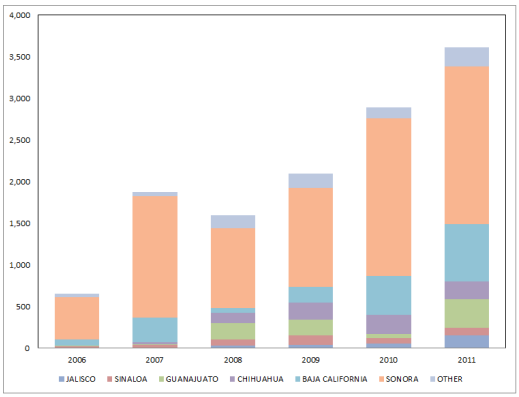
Source: SAGARPA

Figure 6: Contracts

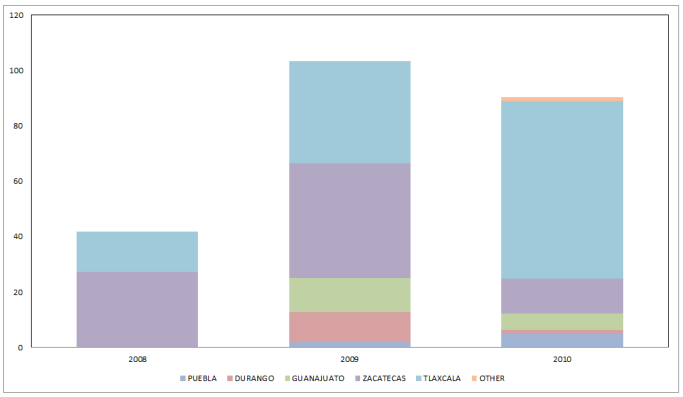


Source: ASERCA

Figure 7: Wheat contracts by state 2006-2011 (1'000 Tons)



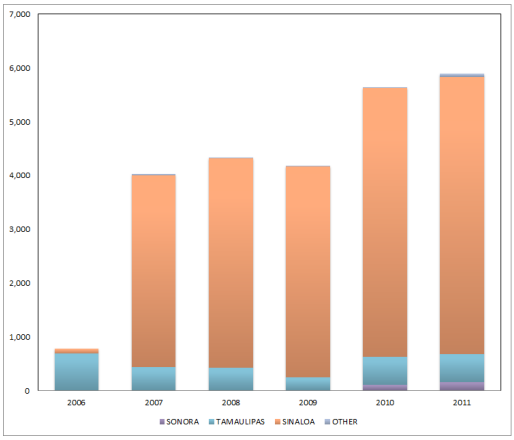
(a) Autumn-Winter Cycle



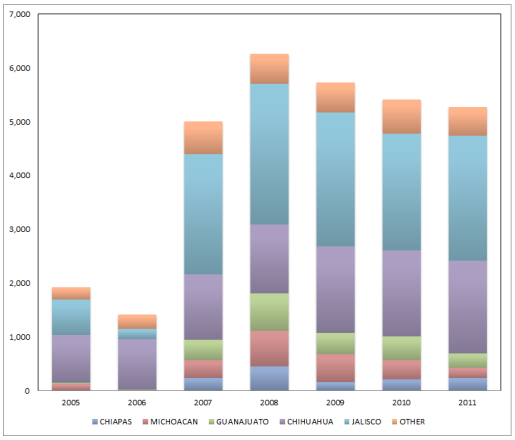
(b) Spring-Summer Cycle

Source: ASERCA

Figure 8: Corn contracts by state 2006-2011 (1'000 Tons)



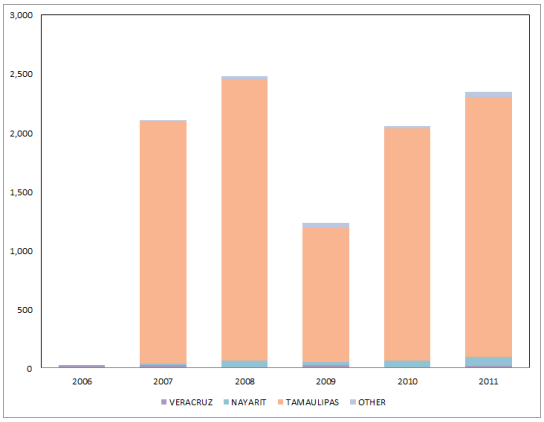
(a) Autumn-Winter Cycle



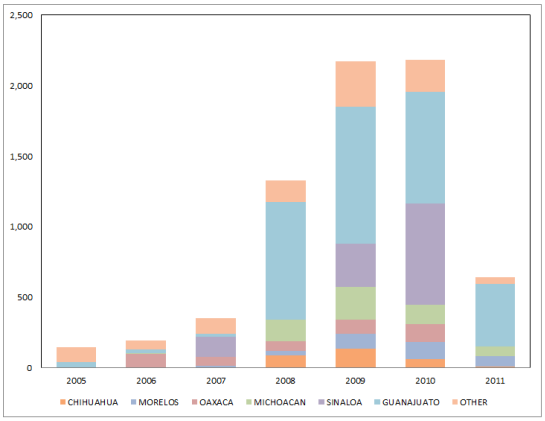
(b) Spring-Summer Cycle

Source: ASERCA

Figure 9: Sorghum contracts by state 2006-2011 (1'000 Tons)



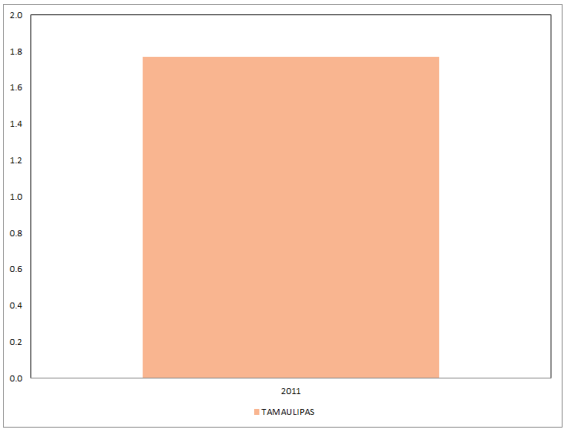
(a) Autumn-Winter Cycle



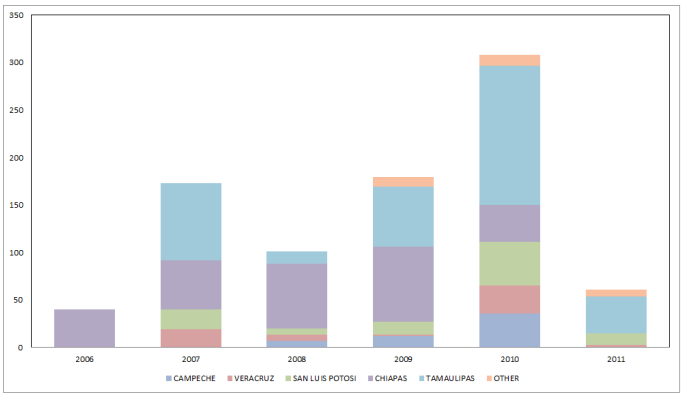
(b) Spring-Summer Cycle

Source: ASERCA

Figure 10: Soybeans contracts by state 2006-2011 (1'000 Tons)



(a) Autum-Winter Cycle



(b) Spring-Summer Cycle

Source: ASERCA

Table 4: 2SLS and 3SLS estimates

	2SLS			3SLS		
Dependent Variables	Price	Quantity Not Contracted	Quantity Contracted	Price	Quantity Not Contracted	Quantity Contracted
Quantity Not Contracted	-0.0992**			-0.0881**		
	(0.0372)			(0.0310)		
Quantity Contracted	-0.2536***	-0.3294		-0.2494**	-0.3245	
	(0.0832)	(0.8389)		(0.1061)	(0.6379)	
Wage	2.2099**	-4.6414	-3.5041	2.2125***	-4.6841	-1.6026
	(0.9002)	(9.4624)	(5.8727)	(1.5407)	(9.4807)	(4.7066)
Manufacturing GDP	0.0157	-0.0281	-0.2007	0.0180	-0.0227	0.1214
	(0.1939)	(1.4242)	(1.2339)	(0.2582)	(1.5840)	(0.8224)
Precipitation		0.3688**			0.3743***	
		(0.1573)			(0.1017)	
Contract Price			-1.2688*			-1.9375***
			(0.7345)			(0.5035)
Fertilizer Price			-0.2354**			-0.1541*
			(0.1019)			(0.0852)
Constant	-0.4131	39.2550	44.2054	-0.6394	39.3192	33.3570
	(5.1727)	(45.6085)	(37.3808)	(9.7663)	(59.3896)	(26.3517)
Observations		123			123	
P-Value from joint test		0.01	0.03		0.00	
Prob.>Chi2					0.39	

Note: Hetersokedasticity-robust standard errors clustered at the cycle-grain-state level in parenthesis: * significant at 10%, ** significant at 5%, *** significant at 1%. Instrumented in 2SLS models. All variables are in logs except for Precipitation. All estimates include time dummies. The P-Value of the Hansen-Sargan Tests of over-identification is reported in Prob.>Chi2.