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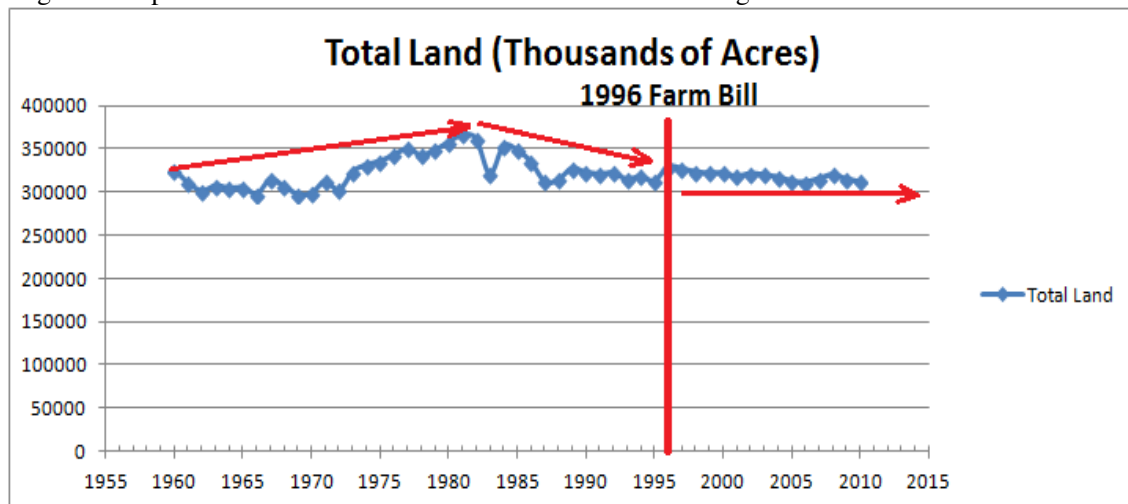
Effect of Relative Price Changes of Top Principle Crops on U.S. Farm Land Allocation

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1. Introduction

The twentieth century has witnessed extraordinary population growth. The population has crossed the seven billion mark in 2011 (USCB 2013), and, according to the United Nations (UN), world population will cross the eight billion mark in 2028 (UN 2011). At the same time, according to the UN research, the grain land per person has diminished by more than 50%, from 0.23 hectares in 1950 to 0.10 hectares in 2007 (UN 2011). Thomas Hertel, a distinguished professor and past president of Agricultural and Applied Economics Association (AAEA), in his presidential address to the AAEA in 2010 points out that, as a consequence of population growth, the farming industry faces significant pressure to expand agricultural production, especially for the staple grains sector (Hertel 2011). Figure 1 lends support to Hertel's argument; the land in production remains relatively flat just before and after the 1996 Farm Bill, whereas, it expands a bit in the period prior to the 1996 Farm Bill. However, it also can be seen that the expansion and the contraction of land can hardly be attributed to the 1996 Farm Bill because land in production stabilizes relative to the previous period right around 1989.

Figure 1. Expansion and Contraction of Land in Production during 1960-2010.



Source: National Agricultural Statistical Service, 2012

Hertel points out that in the United States (U.S.) even if marginal land is pulled into production (e.g., from the Conservation Reserve Program) it would not be enough to sustain the expansion needed (Hertel 2011). Thus, it is likely that various grains will have to compete for the existing grain acreage. This could in turn destabilize the dynamics of grain supply and their prices. For instance, in the New York Times article “Crop Rotation in the Grain Belt,” Barrionuevo (2006) points out that Kansas, traditionally known as the Wheat State, to the surprise of all produced 23% more corn than wheat in the year 2000. Interestingly, in the same newspaper just two years later in an article named “In Price and Supply, Wheat Is the Unstable Staple” states that due to the soaring demand from abroad and droughts, the world’s wheat stocks are at the lowest levels in 30 years while U.S. stocks of wheat have dropped to the levels of 1948 (Streitfeld 2008).

Furthermore, since demand for food is inelastic (Seale et al. 2003), prices for the grains that are in most demand go up more than those of other crops. Therefore, the problem is two-edged. First, the farmers’ challenge is the allocation of already existing land resources amongst the key types of grains to maximize their profits per acre as the prices of the produced crops change. Second, the consumer’s challenge is to navigate through the elevated prices for certain commodities and food. Both issues are components of the efficient resource allocation, one of the core problems of economic theory, described as reaching an objective of most effective allocation of given resources while minimizing costs (Barten 1993). As pointed out by Barten (1993): “Allocation models are being formulated not only for consumer demand but also for demand for inputs into production, composition of imports by country of origin, investment portfolio’s and agricultural acreage allotment.” The interest of this paper is the latter.

Land-allocation dynamics among the top five crops in the U.S. are investigated for the time period of 1960 to 2010. The crops are: corn, wheat, soy beans, hay and cotton – these five comprise 95% of all principle crop acreage grown in the U.S. To find the effect of relative price changes of the top crops on land allocation amongst these crops in the U.S., two parameterizations of the differential model are used: Rotterdam and Central Bureau of Statistics (CBS) model.

This paper is unique in four ways. First, the analysis applies the differential framework to a problem of land allocation from a production point of view. Second, the modeling for the farming industry, specifically for the top staple crops, is performed on a nationwide scale and spans 50 years. Third, it econometrically assesses whether the 1996 Farm Bill introduces structural changes to the production dynamics whereas previously for this type of analysis only simulations have been possible (Lence and Hayes 2002; Alston and Sumner 2007; Robinson et. al. 2003). Fourth, this study is distinct because the differential model allows us to establish a production model without controlling for technological changes occurring during the investigated period. Especially this is important due to the adoption of the GMO technology that occurs also in 1996 (Fernandez-Cornejo 2012). Therefore, the methodological choice of the differential model allows us to accomplish the main goal of the study: assessing the effect of the relative price changes on farm land allocation over the 50-year study period.

2. Methodology

The differential approach is a method of approximation in parametric space. Its key attribute is its flexibility to accommodate different technologies in the same model because it does not require a defined technology function. This advantage allows the approach to model multiproduct multi-factor firms, industry, and even perform multi-sectoral analysis. Even though the differential approach is first proposed in consumer theory by Barten (1964) and Theil (1965), Theil (1977) bridges the approach to producer theory by developing an input-demand system of a one-product firm, where he derives both demand and supply equations in terms of the price changes and quantities. Laitinen and Theil (1978) extend the model to the long-run version of a perfectly competitive multiproduct firm by relaxing the assumptions of input-output separability, constant elasticities of scale, and substitution. Theil (1979) utilizes differential production theory to an input-output production system under the homotheticity and input independence assumptions of a cost-minimizing firm. Clements (1980) develops a short-run differential multiproduct-supply model parameterized in terms of the log-changes under the assumption of separability in the quasi-fixed inputs. Under the same assumption, Rossi (1984) estimates the parameters of the aggregate multiproduct, multifactor technologies on a short-term basis.

Washington and Kilmer (2002) connect the differential approach in production theory to import demand analysis. Building on the flexibility of the differential models, Livanis and Moss (2006) develop a short-run model for the supply response and input demand of a multiproduct firm where an input is quasi-fixed. This paper utilizes the differential approach to examine the multiproduct U.S. agricultural industry with three inputs: quasi-fixed input, land, and two fertilizer inputs, nitrogen and phosphorous.

Using the differential approach, Barten (1964) and Theil (1965) develop the Rotterdam model (Theil 1975) while Keller and Van Driel (1985) develops a Central Bureau of Statistics (CBS) model, which has Rotterdam-like price coefficients. The drawback of CBS is that it fails preference independence and separability conditions. While testing empirical performance of the differential demand systems, Barten (1993) suggests that the same test framework can be adopted to model allocation in a multiproduct, multifactor firm, for example, agricultural acreage allotment. The theory of the multiproduct firm is employed to achieve this goal as shown by Laitinen and Theil (1978) and is extended to quasi-fixed input demand by Livanis and Moss (2006). We propose to further extend this approach by examining the allocation of the quasi-fixed input factor in production given the impacts of the fluctuating food price on land allocation.

Let the efficient production technology of the multiproduct firm in logarithmic terms be represented by

$$h(q, L) = y_a = a + \sum_{k=1}^n b \ln q_k + \sum_{i=1}^n c \ln L_i \quad (1)$$

where $y_a = [y_1, \dots, y_r]$, $q_k = [q_1, \dots, q_m]$ and $L_i = [L_1, \dots, L_n]$ are the vectors of outputs, variable inputs, and quasi-fixed inputs, respectively. The output prices and variable input prices are represented by p and w which are firmly positive. It is important to mention that profit maximizing conditions are also satisfied (Lau 1972).

The multiproduct firm aims to maximize its profit subject to $(L \cdot I = \bar{T})$ available total land where ' I ' refers to the unit vector. So the maximization problem can be shown by

$$\Pi(p, w, L) = h(q, L) \cdot p - w \cdot q - L \quad (2)$$

From the first and second order conditions of profit maximization and utilizing Barten's (1964) fundamental matrix, one can derive an empirical model for the multiproduct firm with quasi-fixed input. The model obtained is:

$$f_i d(\ln L_i) = \theta_i d(\ln L) + \sum_{j=1}^n \pi_{ij} d(\ln P_{ja}) + \sum_{k=1}^m \xi_i^k d(\ln w_k). \quad (3)$$

$d(\ln L)$ is a Divisia index for land: $d(\ln L) = \sum_i f_i d \ln L_i$, where f_i is an average land share for the crop j for two consecutive years, and $d \ln L_i$ is a log change in acreage for crop i . $d(\ln P_{ja})$ is the log change of output price of crop j , $d(\ln w_k)$ is the log change in the input price of input k , θ_i , π_{ij} and ξ_i^k are parameters to be estimated. To operationally the model, let $\bar{f}_{it} = (f_{i,t} + f_{i,t-1})/2$ and $d(\ln X_t) = \ln X_t - \ln X_{t-1}$ where X represents L , P and W , and ε_t be an error term. The empirical model is then

$$\bar{f}_{it} = \theta_i d(\ln L)_t + \sum_{j=1}^n \pi_{ij} d(\ln P_{ja})_t + \sum_{k=1}^m \xi_i^k d(\ln w_k)_t + \varepsilon_t. \quad (4)$$

Note that, the adding up conditions are: $\sum_i \theta_i = 1$, $\sum_i \pi_{ij} = 0$ and $\sum_k \xi_i^k = 0$, the homogeneity condition is: $\sum_j \pi_{ij} = 0$, and the symmetry condition is: $\pi_{ij} = \pi_{ji}$.

The land volume elasticity and price elasticities (η_{ij}) of the land allocation equations are calculated as:

$$\eta_i = \frac{\theta_i}{f_i} \quad (5)$$

$$\eta_{ij} = \frac{\pi_{ij}}{f_i} \quad (6)$$

3. Data

The data span years 1960 to 2010 and are collected from the National Agricultural Statistical Service (NASS) and Economic Research Services (ERS). The data consist of the annual quantity of produced crops: corn, cotton, hay, wheat, and soy plus 12 other crops whose quantities are summed to the category “other.” This category contains: 1) rice, 2) potatoes, 3) beans, 4) peas, 5) rye, 6) oats, 7) barley, 8) tobacco, 9) flaxseed, 10) peanuts, 11) sweet potatoes and 12) sorghum wheat. In the U.S. the quantity of the crops produced in the category “other” are significantly lower than the top five crops, which allows the aggregation for this category. The annual prices for each crop are also collected from NASS, and prices for 12 crops are aggregated for the category “other.” Fertilizer price indexes’ data are collected from the ERS fertilizer statistics and are used in place of Nitrogen and Phosphorous direct prices. The data on the acreage used for each crop produced are also collected, and the acreage is aggregated for the crops in the category “other.” Thus, in our model, for the years from 1960 to 2010, the American agricultural sector is described by the prices of six outputs and three inputs of production. The outputs are principle crops: wheat, corn, cotton, soybeans, hay, and “other”. The inputs are land and two fertilizers - nitrogen and phosphorus. The quasi-fix input, land, is a share of total farm land allocated to a specific crop as the acreage used in the production of that crop.

4. Results

Since the Federal Agricultural Improvement and Reform Act of 1996 (also referred to as Farm Bill and Freedom to Farm Act) is considered to be one of the most impactful farm bills in the past 50 years, one of the agenda’s of the study is to test whether or not there is a statistically significant structural change to the farming industry after the 1996 Farm Bill. To accomplish that two methodological ways are pursued: 1) pooling data by having dummy variables for two periods interact with the output variables to identify whether any coefficients of the dummy variables are significant; and 2) splitting the sample to two periods, 1960-1995 and 1996-2010, with an objective of comparing significance and the magnitudes of the coefficients and the elasticities between the two periods. The 1996 Farm Bill is meant to allow farmers to plant their acreage without being influenced

by subsidies, direct payment, or land restrictions for certain crop. Paggi and Howe (2000) point out that this Farm Bill increases planting flexibility, ends authority for the annual acreage-reduction programs, and decouples direct cash payments to the farmers by changing payments from the deficiency payments into a fixed payment not linked to the changing market prices or to the planting decision. In addition to the 1996 Farm Bill genetically engineered corn, soybeans and cotton are introduced and widely adopted by commercial markets in the U.S. GMO-technology promises to lower the yield risks for these three key grains (Fernandez-Cornejo 2012). Therefore, it is reasonable to explore the pooled and split models to identify any structural change between the two periods, 1960-1995 and 1996-2010.

The first empirical concern is to determine whether the data may be pooled over the entire sample period of 1960-2009. As discussed above, there are reasons to believe that the policy regimes in the two periods may be different enough to cause a structural change in the estimated parameters in the two periods. The method used to determine whether or not to pool the data is as follows. Respectively, all the estimations are performed with maximum-likelihood estimation. A dummy variable, 0 for years 1996-2010 and 1 for years 1960-1995, is multiplied by all variables in the model also allowing for the difference between the intercepts in the two periods. By doing so, the parameters for the years 1996-2010 are directly obtained via estimation while the parameters of the latter period can be obtained as the sum of the 1960-1995 parameters and the coefficients on the dummy interaction. To determine whether pooling the data in the two periods is possible, a log-likelihood-ratio test is performed by comparing the log-likelihood values of the estimation on the entire sample, one without the dummy variable, and the other with them. The test statistic, 27.94, is chi-square with 30 degree of freedom and the critical value at the 95% level is 43.77. The test clearly fails to reject the hypothesis that the parameters are statistically the same in the two periods. After checking for the significance of the coefficients on the interaction terms, it is clear that the dummy coefficients are not significant. In short, the test shows that pooling is possible, an indication of no structural change due to the different policy regimes between the two periods. Therefore, the analysis can be performed on the entire sample of 1960-2010.

4.1 Parameter Estimation

To ensure concavity in the model, homogeneity and symmetry are imposed. A log-likelihood-ratio test is conducted to identify how well these restrictions perform in the overall model. As shown in Table 1 the log-likelihood-ratio test shows that homogeneity cannot be rejected at 5% significance level. Chi-square test statistics for the Rotterdam model is 6.64, which is much less than the critical value of 11.07 for five degrees of freedom. The next log-likelihood-ratio test gauges how well imposing symmetry works. Chi-square test statistics for the Rotterdam model is 5.43, which is also much less than the critical value of 18.31 for 10 degrees of freedom. It shows that symmetry cannot be rejected at 5% significance level. Thus, the model performs well after homogeneity and symmetry conditions are imposed.

Table 1. Test Results for the Log likelihood within Models

	Unrestricted Model (45 ¹)	Homogeneity Imposed (40 ¹)	χ^2 (95%)	Homogeneity and Symmetry Imposed (30 ¹)	χ^2 (95%)	General Model (31 ¹)	χ^2 (95%)
Rotterdam	910.517	907.195		904.478		904.685	
$-2[L(\theta^*)-L(\theta)]$		6.64	11.07	5.43	18.31	0.41	3.84

¹) Number of free parameters for each model.

In addition, it can be seen from Table 1 that at this stage the log-likelihood-ratio tests indicate that the Rotterdam model is not rejected statistically by comparing it to the general model. The chi-square test statistic for the Rotterdam model is 0.41, which is less than the chi-square critical value of 3.84 for one degree of freedom. This confirms that the model fits the data well.

Table 2 summarizes the results for coefficients in the Rotterdam for the entire sample 1960-2010. The land coefficients are significant for corn, cotton, and soybeans at 1% significance level and for wheat at the 5% significance level. These results indicate that for a one unit increase in total land, corn, cotton, soybeans, and wheat get, respectively, 0.45, 0.07, 0.10, 0.31 units of it. By magnitude corn has the highest land coefficient. Table 2 also shows that the nitrogen coefficient is not significant for any

of the crops, and the phosphorous coefficient is significant only for cotton at the 1% level. Results for the own-price and the crops' cross-price coefficients are also reported in Table 2. All own-price coefficients for outputs are positive as expected and those for corn, cotton, wheat, and soybeans are significantly different from zero at the 1% level.

When it comes to the cross-price coefficients, the corn-soybean combination is significant at 1%, while the corn-wheat and hay-wheat ones are significant at 5%. Corn-cotton and corn-hay combinations are significant at 10%.

Table 2. Coefficients of the Rotterdam model

Crops		Rotterdam Model Coefficients					Other Crops
		Corn	Cotton	Hay	Soybeans	Wheat	
Land Coefficients (θ_i)		0.453*** (0.049)	0.067*** (0.018)	0.022 (0.023)	0.097** (0.041)	0.314*** (0.043)	0.048 (0.036)
N Price Coefficients (θ_{kl})		0.010 (0.014)	0.006 (0.005)	0.002 (0.007)	-0.007 (0.012)	0.004 (0.012)	-0.015 (0.010)
P Price Coefficients (θ_{kl})		-0.013 (0.011)	-0.01*** (0.004)	-0.002 (0.005)	0.009 (0.009)	0.010 (0.010)	0.006 (0.008)
Output Price Coefficients (π_{ab})	Corn	0.042*** (0.016)	-0.009* (0.005)	0.012* (0.007)	-0.035*** (0.010)	-0.022** (0.009)	0.011 (0.010)
	Cotton		0.019*** (0.003)	0.001 (0.003)	-0.007* (0.004)	-0.003 (0.003)	-0.001 (0.004)
	Hay			0.004 (0.006)	-0.003 (0.005)	-0.012** (0.005)	-0.002 (0.006)
	Soybeans				0.059*** (0.010)	-0.005 (0.007)	-0.010 (0.007)
	Wheat					0.047*** (0.009)	-0.004 (0.007)
	Other Crops						0.006 (0.011)

Note: figures in parenthesis are standard deviations.

* - significant at 10% level; ** - significant at 5% level; *** - significant at 1% level.

4.2 Elasticities Estimation

Most interesting are the results of the estimated elasticities estimation reported for the entire sample in Table 3 for the Rotterdam model. All elasticities are computed at the sample mean. The land elasticities are significant for corn, cotton, and wheat at the 1% level and for soybeans at 5%. The results indicate that if land expands (contracts) by 1%, then the land quantity for corn, cotton, soybeans, and wheat goes up (down) respectively by 1.92%, 1.67%, 0.53%, and 1.54%. As is seen, corn is the most responsive to the expansion of total land because its land elasticity is the highest.

The own-price elasticities are positive as the production theory suggests for all the crops. In the Rotterdam model own-price elasticities are significant for corn, cotton, soybeans, and wheat at a significance level of 1%. The results indicate that if the price of corn, cotton, soybeans, and wheat goes up (down) by 1%, the land quantity for the different crops goes up (down) by 0.18%, 0.47%, 0.32%, and 0.23%, respectively. Thus, farmers are more responsive to the prices of cotton than the other crops. Such results make sense since cotton is a crop that has a long history of the favorable policies designed around it like subsidies and land restrictions. Even recently cotton remains of the most subsidized crops (Gokcekus and Fishler 2009).

The own-price elasticity for hay is positive but insignificant. Such a result for hay is not surprising because the data for hay perhaps is not most reflective of the production dynamics since a lot of contracts for hay are private and might not be captured in the data. The own-price elasticity for category “other” is also insignificant since being comprised of 12 crops is bound to be somewhat uninformative due to the high level of the aggregation.

Table 3. Output Price and Land Elasticities of the Estimated Rotterdam Model

Crops	Crop Prices						Land
	Corn	Cotton	Hay	Soybeans	Wheat	Other Crops	
1960-2010							
Corn	0.181*** (0.067)	-0.038* (0.021)	0.052* (0.029)	-0.148*** (0.040)	-0.093** (0.039)	0.046 (0.042)	1.924*** (0.206)
Cotton	-0.225* (0.122)	0.469*** (0.079)	0.030 (0.079)	-0.169* (0.096)	-0.080 (0.085)	-0.025 (0.113)	1.671*** (0.452)
Hay	0.064* (0.035)	0.006 (0.016)	0.020 (0.032)	-0.015 (0.028)	-0.064** (0.025)	-0.011 (0.032)	0.116 (0.122)
Soybeans	-0.190*** (0.052)	-0.037* (0.021)	-0.016 (0.029)	0.324*** (0.053)	-0.028 (0.037)	-0.053 (0.040)	0.530** (0.224)
Wheat	-0.108** (0.045)	-0.016 (0.017)	-0.060** (0.023)	-0.025 (0.033)	0.230*** (0.046)	-0.021 (0.033)	1.540*** (0.211)
Other Crops	0.074 (0.067)	-0.007 (0.031)	-0.015 (0.041)	-0.066 (0.050)	-0.030 (0.046)	0.043 (0.076)	0.328 (0.247)

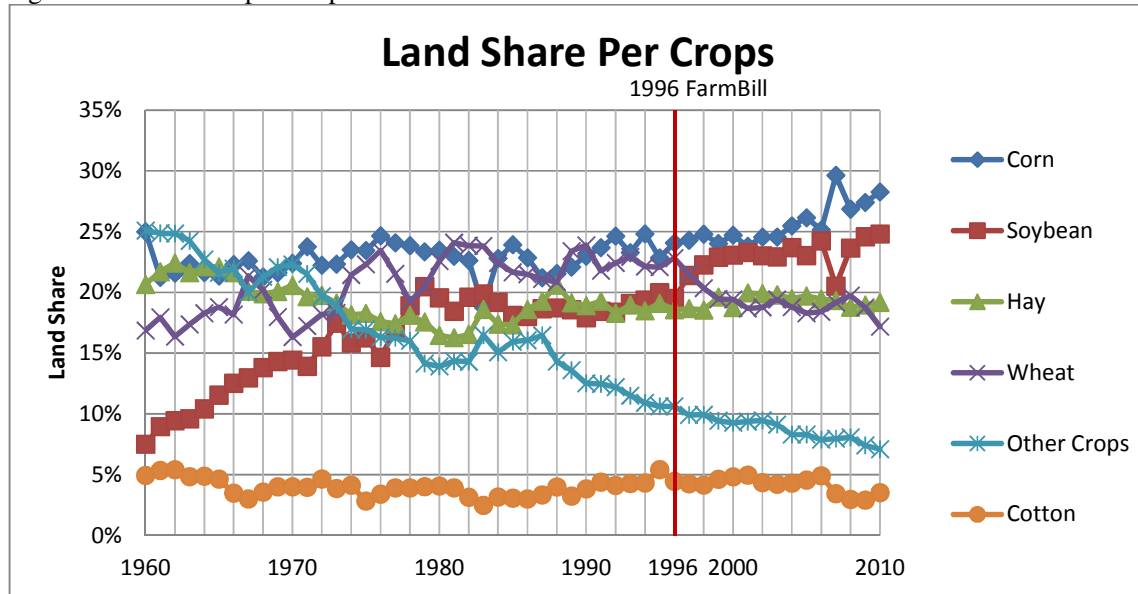
Note: figures in parenthesis are standard deviations.

* - significant at 10% level; ** - significant at 5% level; *** - significant at 1% level.

The cross-price elasticities are significant for the corn-soybean combination at the 1% significance level, for the corn-wheat combination at 5% significance level, and for corn-cotton and corn-hay at 10%. The results mean that if the price of corn goes up by 1%, then land dedicated to cotton, soybeans, and wheat decrease respectively by 0.23%, 0.19%, and 0.11% while the land for hay increases by 0.06%. This indicates that when it comes to land allocation, corn and cotton are substitutes. In addition, pairs like corn and soybeans as well as corn and wheat are also substitutes while corn and hay are actually compliments. Furthermore, the corn and cotton combination has the highest cross-price elasticity (0.23%), thus they compete between each other for acreage more so than other combinations. In addition, for reverse combinations, the results signify that if the price of cotton, soybeans, or wheat goes up by 1%, then the land quantity of corn respectively goes down by 0.04%, 0.15%, and 0.09%. This time the corn and soybean combination has the highest cross-price elasticity (0.15%) meaning that out of these combinations soybeans and corn compete for acreage more so than other combinations. In the reverse combination, as described earlier, corn and soybeans' cross-price elasticity, 0.19%, is still higher than that of soybean and corn. This means that corn's price has a higher influence on soybeans acreage than that of soybeans' on corn's acreage. Thus, corn's price changes have higher impact on other crops' acreages.

This is rather an expected conclusion since the results indicate that the expansion of corn production is happening at the expense of other crops. The expansion of each crop's acreage is depicted in Figure 2, which depicts that corn production historically takes up the most land compared to other crops, so its acreage always seems to be at the highest threshold of the capacity (corn belt) whereas soybeans for instance have increased from a relatively low level on a historical basis.

Figure 2. Land Share per Crops Before and After 1996 Farm Bill



Among other significant cross-price elasticities are wheat and hay as well as soybeans and cotton, at 5% and 10% significance levels, respectively. The wheat-hay cross-price elasticity is the same as that of the reverse combination, meaning that if the price of wheat/hay goes up by 1%, the land quantity of hay/wheat goes down by 0.06%, respectively, which confirms that they are substitutes when it comes to the land being dedicated to it. For soybeans and cotton the picture looks different because the magnitude of the cross-price elasticity increases for the reverse combination, meaning that if the price of soybeans increases by 1% the land quantity of cotton decreases by 0.17%, but if the price of cotton increases by 1% then the land quantity of soybeans goes down by 0.06%, which means that farmers are more sensitive to the price changes of soybeans than those of cotton. The results confirm that soybeans and cotton are also substitutes when it comes to land allocation. This conclusion is confirmed by the USDA's Economic Research Service analyst, Mark Ash, in an email interview where

he points out that cotton acreage has shrunk at a time when soybean prices are increasing (such as in 2007 and in 2008) and sometimes bounces back up in certain states when soybean prices are comparatively low (1998-2001).

5. Conclusion

The study's main goal is to model allocation for agricultural land use in the U.S. for the years 1960 to 2010 to assess the effect of the relative price changes on farm land allocation during these years. The secondary goal is to understand whether one of the most significant Farm Bills, the 1996 Farm Bill, results in statistically significant structural change in terms of farmers' land allocation decision making. The study is important because of several reasons. First, historically U.S. agricultural policy is shaped by the sequence of ongoing Farm Bills, and to design new effective policy it is vital to understand the effects of the previous Farm Bills in retrospect. Second, it is imperative for both global consumers and producers to assess the long-term trends while identifying potentially different land allocation patterns throughout time. Modeling the effects of policy changes is always constrained by the number of years available after a policy change is implemented. The uniqueness of the paper is that for the first time, the number of years after the 1996 Farm Bill, 14 years to be exact, allows for a meaningful analysis. These insights should give an understanding of the robustness of the patterns of U.S. agricultural land in production, which is extremely important especially while facing increasing population, the rising demand for food, global warming, and irregular weather patterns.

The study utilizes the Rotterdam model to trace the land-allocation dynamics among the top five crops in the U.S.: corn, cotton, hay, soybeans, and wheat. Results indicate that the Rotterdam model describes the dynamics of land allocation for this period very well. Econometric analysis concerning pooling the data indicates that there is no statistical evidence that the 1996 Farm Bill policy causes structural change when it comes to the farmer's decisions about land allocation. Lastly, these results indicate that corn's expansion at the expense of other crops is also independent of the 1996 Farm Bill policy changes.

The most interesting results are for the acreage dynamics of corn. No statistically significant evidence over the past 50 years indicates structural change in terms of corn acreage allocation in response to changing prices and the expansion of total land. Corn not only bids away acreage from wheat in the states where both wheat and corn are grown like in Illinois, Missouri, Nebraska, and Texas, but it also takes away the acreage in traditionally only wheat growing areas like a greater swath of the Midwest, Kansas, farther north and west into the Dakotas and central Minnesota. Over the past 50 years corn's competition for land also extends to new territories like some areas in Arizona, California, Mississippi, and Texas, which are historically dedicated to cotton.

The cases of soybeans and cotton are also interesting. The effect of soybeans' price changes on its own acreage remains positive and stable during the entire 50 years. The cross-price elasticities between soybeans and cotton suggest that during this time frame soybeans and cotton are not just substitutes when it comes to land allocation, but soybeans actually expand at the expense of cotton. In other words, cotton's acreage is quite vulnerable and sensitive to the price changes in both corn and soybeans.

In conclusion, the results imply that during the last 50 years the effect of corn price changes is associated with the increase of corn's acreage at the expense of the acreage allocated to other crops such as cotton, soybeans, and wheat. In the case of cotton, not only is new land hardly allocated to this crop, but cotton's acreage has also found new competitors like soybeans, corn, and hay that are bidding away the land previously allocated exclusively to cotton. In addition, there is no statistically significant evidence that these trends are dependent on the 1996 Farm Bill, thus it seems this trend is in place on a long term basis.

The concern still remains that the scarcity of additional arable land is a problem not easily solvable in the near future. We can reasonably assume that in the U.S., the production process is at or close to full "employment" of the immobile factor, land. Therefore, the expansion of acreage of a given crop at some point must come at the expense of production of other crops. So far however, the results in general show that the U.S. farmers have a stable pattern of the land allocation among staple crops that

is not significantly changed even by the major Farm Bills.

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