AN ABSTRACT OF THE THESIS OF

Jason D. Miller for the degree of Master of Science in Applied Economics presented on December 10, 2012

Title: The Economics of Commodity Promotion in the Hazelnut Industry

Abstract approved:

Catherine A. Durham

The objective of this study was to evaluate the effect of commodity promotion activities on the United States' hazelnut farmer's economic welfare. Commodity promotion activities, such as generic advertising and research, are the responsibilities of government mandated commodity commissions, such as the Hazelnut Marketing Board (HMB). The HMB is a state mandated cartel, organized under the Agricultural Marketing Agreement Act of 1937 (i.e. the Marketing Order) and amended in 1981, 1986, and 1989 (7 CFR Part 982, FR Doc. 81-14045 FR Doc. 86-18438, FR Doc. 89-26187). HMB promotion activities are funded by taxes levied on U.S. hazelnut farmers. To ensure that promotion provides a net benefit to these farmers this research uses Cost-Benefit Analysis (CBA) of the assessments under various assumptions about the market's conditions. A non-linear system of equations with Monte Carlo simulation was utilized to produce these estimates.

The Economics of Commodity Promotion in the Hazelnut Industry

by

Jason D. Miller

A THESIS

submitted to

Oregon State Universities

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented December 10, 2012
Commencement June 2013

Master of Science thesis of Jason D. Miller presented on December 10, 2012

APPROVED:

Major Professor, representing Applied Economics

Director of the Applied Economics Graduate Program

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Jason D. Miller, Author

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DEDICATION

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CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Introduction

Promotion is a term used to describe the activities of commodity commissions, which are aimed at maximizing profits and minimizing costs for the industry. To gauge the effectiveness of promotion, commissions recruit econometricians and accountants to determine internal rates of return from promotion activities. The commissions are government mandated, industry funded collectives existing in certain agricultural markets, including, but not limited to, prunes, grapes, almonds, onions, beef, pork, milk, and hazelnuts (which are also known as filberts). The laws establishing these commissions are commonly referred to as "marketing orders" or "marketing agreements", which are administered by the United States Department of Agriculture (USDA).

Marketing orders have been put in place to ensure market stability and the continued domestic production of certain agricultural products such as milk, fruits, vegetables, and specialty crops (USDA Agricultural Marketing Service, 2012). Their promotion activities, as described by the Agricultural Marketing Service (AMS), include the regulation of quality, packaging, supply, reserves, research, and advertising. The Federal Agricultural Improvement and Reform Act (FAIR) of 1996 requires that promotion activities be periodically assessed by outside analysts to determine the effectiveness and economic effects of their promotion. This study was one such assessment. The objective of this study is to determine what, if any, measurable impact promotion has had on farmer's net well-being. Assessments of this nature have been conducted regularly for a number of commodities, including almonds, prunes, strawberries, and many others. Promotion of hazelnuts by the Hazelnut Marketing Board (HMB) has been assessed by past researchers as well (Gopinath & Saito, 2006). The contribution of this research is the use of the most current data (ranging from 1980 to present), a thorough review of the literature to ensure that best practices are being followed, correction of inconsistencies in reports used as primary data, and cleaner identification of the returns to investment in advertising through the use of a theoretically prescribed system of equations, and improved confidence intervals from use of Monte Carlo simulation.

1.2 Background

The market for hazelnut is complex, in part due to its regulation, market power, highly international nature, very limited data, and because it is plagued by challenges in recording data. Data recording challenges include re-exportation and the potential for double-counting products at different points in the supply chain (e.g. recording in-shell, kernel, and processed products). In addition, several features of the supply and demand for hazelnuts are relatively unique among U.S. tree nut crops. One is the dominance of Turkey in worldwide kernel trade. Turkey is the world's largest supplier of hazelnuts, accounting for approximately 75% of world production.

The United States is the third largest producer of filberts and Oregon produces approximately 99% of American's hazelnuts. The U.S. strategy has been to establish a niche as the supplier of the highest quality in-shell hazelnuts by requiring that in-shell nuts are of medium or better grade, with low tolerance for defects, while promoting Oregon as a brand and engaging in other promotional activities (Hazelnut Marketing Board, 2006, 2007a, 2007b, 2008a, 2008b, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b). Spending on promotional activities such as advertising and research began in 1986. Unfortunately, only annual records on promotion have been recorded, thus a mere 25 observations were available for this study, though this represents substantially more data than has been available to prior researchers.

Table 1. Trends in the Domestic Hazelnut Market

Year	Marketable Production in 1,000's lbs	Real Farm Price per MT	Real Promotion
1986	26,528	1,308	9,740
1987	43,680	1,690	334,580
1988	31,732	1,448	271,974
1989	24,487	1,325	341,047
1990	34,170	1,212	377,000
1991	47,306	1,066	379,029
1992	52,647	785	354,388
1993	77,483	873	297,374
1994	39,736	1,121	445,838
1995	71,486	1,194	246,566
1996	34,508	1,093	283,783
1997	78,558	1,112	220,799
1998	29,332	1,172	261,472
1999	76,301	1,064	309,623
2000	43,535	1,034	286,373
2001	95,221	787	257,292
2002	38,156	1,103	218,950
2003	73,724	1,112	206,092
2004	67,974	1,521	224,057
2005	50,057	2,298	291,599
2006	91,113	1,067	328,685
2007	71,420	1,965	226,255
2008	65,433	1,505	85,731
2009	91,917	1,548	425,298
2010	52,017	2,186	202,703
2011	75,866	2,072	209,516

Exporting hazelnuts in-shell rather helps to maintain quality by naturally preserving and protecting the kernels, though end users prefer to purchase kernels (shelled nuts). As a result, most of U.S. exports are in-shell. For consistency, the data used in this study have been converted to an in-shell basis, using an industry and government established weight conversion ratio of 2.5 (Hazelnut Marketing Board, 2011a). Oregonian tree nuts are relatively large in size and as such, U.S. hazelnuts makes them a preferred choice for international confectioners as visible nuts. The export of U.S. in-shell hazelnuts has continued to grow substantially over the last decade, though other sales fluctuated without a clear visual trend (Figure 1). Because of the important role of exports and the natural fixity of supply (since hazelnuts are grown on trees) we follow other agricultural economists in treating the supply of this commodity as residual supply, wherein the domestic market receives the left over supply from the larger international market.

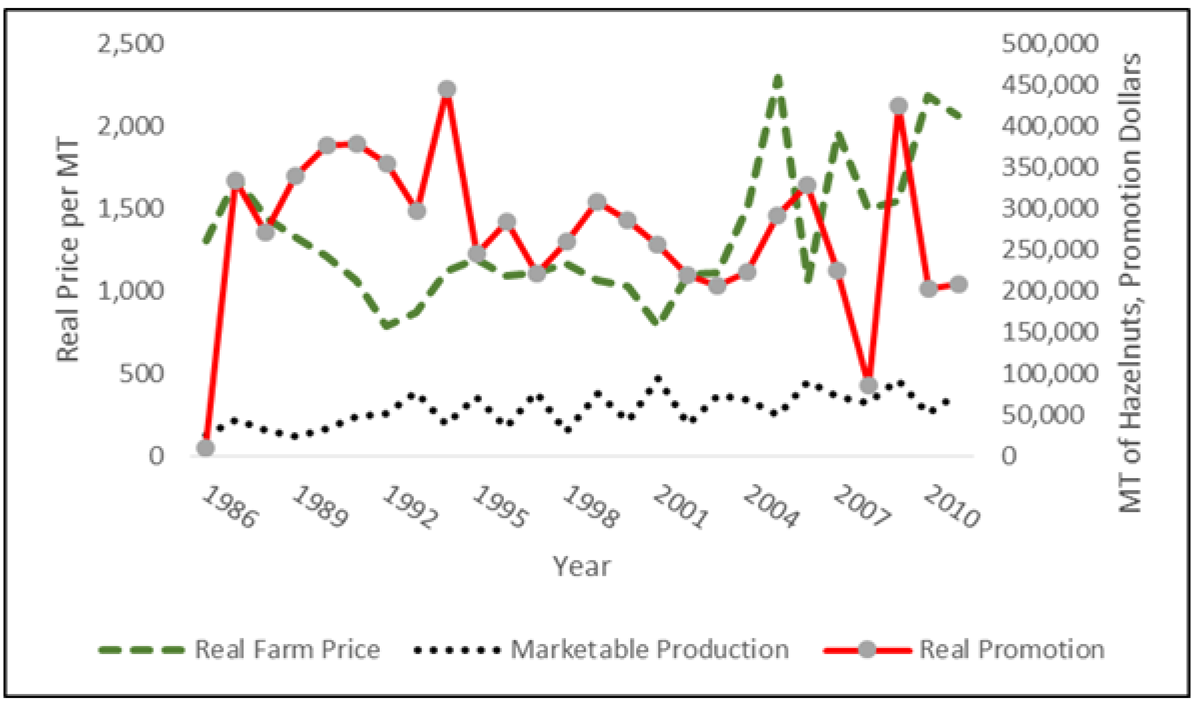

Figure 1: Trends in the Hazelnut Industry (1986 – 2011)

CHAPTER 2

LITERATURE REVIEW

2.1 Seminal Literature

This study makes use of Marshallian partial equilibrium analysis, particularly the seminal work of Marshall, as well as the later contributions of Stigler and Vives (Marshall, 1920; Stigler, 1987; Vives, 1987). Partial equilibrium competitive analysis is a mainstay of economic theory and it allows for the analysis of one market in isolation under a certain set of weak (i.e. easily met) assumptions.

Marshall's requirement for the application of partial equilibrium was that the good being analyzed must be only a small part of the macroeconomy (Marshall, 1920). Vives detailed how the assumption of small market size simplifies the analysis of market equilibrium – given that the good being analyzed is only a small part of a household's expenditure, Engel elasticities will be small (Stigler, 1987; Vives, 1987).

This simplification means that little or no wealth effects will be present in appropriately applied partial equilibrium model. Moreover, if substitution effects must also be relatively minor, then Marshall's theory dictates that the prices of other goods (e.g. almonds) will be virtually unaffected by changes in the small market being analyzed. Thus, the required assumptions for partial equilibrium are easily met in small markets, such as the market for hazelnuts and other tree nuts.

Marshall's theory is rather convenient, because it allows for the analysis of Pareto optimal outcomes without the need for simultaneous consideration of the overall economy, as is required in general equilibrium. In addition, Marshallian partial equilibrium allows for the graphic representation of Marshallian aggregate surplus, which is represented as the vertical area between aggregate supply and aggregate demand (Mas-Colell, Whinston, & Green, 1995).

2.2 Commodity Promotion Literature

Since the establishment of commodity Marketing Orders under the Agricultural Marketing Agreement Act of 1937, a number of economists (as well as accountants) have audited the effectiveness of commodity promotion. In many instances the USDA has mandated that such economic review take place. As a result, there exists a small but growing body of economic literature on the analysis of generic advertising and other forms of commodity promotion and check-off programs.

The literature is somewhat divided between those articles that a construct complex models of international trade, involving any number of equations for foreign markets and price linkage – such as Duffy and Goddard's analysis of promotion in the hog market – and those utilizing simpler residual supply models, such as Alston, Chalfant, Carman, Crespi, Kaiser, Sexton, and others (J.M. Alston et al., 1995; J.M. Alston, Crespi, Kaiser, & Sexton, 2007a; Duffy & Goddard, 1995; H.M. Kaiser, J. M. Alston, J.M. Crespi, & R.J. Sexton, 2005; Harry M. Kaiser, Julian M. Alston, John M. Crespi, & Richard J. Sexton, 2005).

Residual supply has been the most popular framework in recent literature, perhaps because commodity promotion studies often have limited observations (especially in the case of annual data) and these can be estimated with relatively simple econometric models. Of particular interest are a collection of commodity promotion studies published as a booked titled *The Economics of Commodity Promotion Programs* (Harry M. Kaiser et al., 2005).

The collection of studies in that were conducted by the some of the most well published authors in the generic advertising literature. In addition to bringing together experts on the topic, several of these studies developed a shared theoretical and empirical framework, which was adapted to fit the particular nature of the market being studied (J. Alston, Chalfant, Christian, Meng, & Piggot, 2005; Julian M. Alston, Carman, Chalfant, Crespi, & Sexton, 2005; Crespi & Sexton, 2005; Kaiser, 2005). Specifically, these studies developed a residual supply formulation of partial equilibrium, implemented econometrically by linear square root models, instrumental variable regression, and simple simultaneous equation models with Monte Carlo simulations for improved confidence.

Like other commodity commissions with Market Orders, the USDA has mandated that the Hazelnut Marketing Board periodically undergo analysis by economists and accountants (7 CFR Part 982, FR Doc. 81-14045 FR Doc. 86-18438, FR Doc. 89-26187). This thesis is one such analysis, and it was preceded in 2006 by Gopinath and Saito (Gopinath & Saito, 2006). The unique contributions of this thesis to the literature are the use of the most recently available data, the first application of a residual supply approach for the hazelnut industry, and more rigorous econometric diagnostics than in prior studies.

CHAPTER 3

METHODOLOGY

3.1 Data

The data used in this study were drawn from Hazelnut Marketing Board annual reports and major government data sources. The HMB provided data on generic advertising (broken down by advertising objective), research spending, administrative costs, and farm prices. These prices were verified against data obtained from the Oregon Field Office of the USDA's National Agricultural Statistics Service (NASS).

The U.S. Census Bureau provided data on disposable income and population. Data on the prices of alternative tree nuts, quantities of tree nuts, and international trade were obtained from the USDA's Economic Research Service (ERS). International trade data on hazelnuts and other tree nuts were sourced from the USDA Global Agricultural Trade System (GATS) data set.

Recording data on agricultural commodities can be challenging and several inconsistences were found within sources between years of data collection, as well as across sources. These errors led to the rejection of the USDA Foreign Agricultural Service's Production, Supply, and Distribution (PSD) data set from use in this study, and the data sets which were included, shown in Table 1, required adjustments to standardize marketing years and weight basis.

Data recording challenges include re-exportation and the potential for double-counting products at different points in the supply chain (e.g. recording in-shell, kernel, and processed products). Not only do differences in the units recorded by primary data collectors require standardization, but the basis of measurement must also be standardized to allow for valid comparisons and aggregation of the data. In the case of hazelnuts, the "basis" refers the adjustment of price and quantity data to convert data from in-shell (i.e. whole) to shelled (i.e. kernel) equivalency, or visa-versa. For consistency, this study converted all data to an in-shell basis using HMB data on in-shell to shelled weight ratios. Weight ratios for other nuts were obtained from USDA ERS data. All weights were converted to metric tons (MT) and all financial data was converted to 2010 dollars using the Consumer Price Index (CPI).

Table 2: Data Sources

Source	**Description**	**URL**
Bureau of Labor Statistics	CPI	http://www.bls.gov/cpi/
Hazelnut Marketing Board	Data on promotion, research, administrative expenditures, farm prices	http://www.oregonhazelnuts.org
Oregon Field Office of USDA NASS	Price (Farm level)	http://www.nass.usda.gov/Statistics_by_State/Oregon/index.asp
U.S. Census Bureau	Population and consumers' disposable income	http://www.census.gov/
USDA Economic Research Service	Fruit and Tree Nut Yearbook	http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1377
USDA Foreign Agricultural Service's Global Agricultural Trade System	Import and export quantities and values	http://www.fas.usda.gov/gats/default.aspx

The limited sample size is the most serious challenge faced in this study. More observations are necessary and it is recommended that monthly records of HMB spending be kept moving forward.

3.2 Theoretical Framework

This study applies consumer demand and Marshall's partial equilibrium analysis framework to the analysis of changes in market equilibrium under a spectrum of market conditions and levels of commodity promotion. A residual supply approach was taken, and perturbations of promotion were used to simulate shifts in demand (Figure 2).

In partial equilibrium analysis, it is assumed that the good being studied makes up only a small part of the overall economy, as in the case of hazelnuts. All other goods may be considered as a single composite good in a simple two good economy. Let x_i represent the composite good for i individuals, where i = 1,…,I. In this case, x_i is the numeraire and a consumer's utility function may be expressed as:

$$u(m_i, x_i) = m_i + \phi_i(x_i) \tag{1}$$

where,

$$f_i^{\prime}(x_i) > 0 \tag{2}$$

and

$$f_i^{\prime\prime}(x_i) < 0 \tag{3}$$

under the assumption that phi is twice differentiable. This can be normalized by setting:

$$f_i(0) = 0 \tag{4}$$

Given firms (or farms) j = 1,…,J, utilizing level z of an input m, the production function is given by:

$$Y_j = \{(-z_j, q_j) : q_j \geq 0 \text{ and } z_j \geq c_j(q_j)\} \tag{5}$$

for a twice differentiable cost function $c_j(\cdot)$. Give a price of hazelnuts p*, a farm's profit maximizing decision it to choose quantity such that it solves:

$$\underset{q_j \geq 0}{Max}\ \mathrm{p}^* \mathrm{q}_j - \mathrm{c}_j(q_j) \tag{6}$$

with the necessary and sufficient first order condition (FOC):

$$p^* \leq c_j^{/}(q_j^*) \text{ with equality if } q_j^* > 0 \tag{7}$$

By duality, we know that the consumer's utility maximizing problem is:

$$\begin{aligned} &\underset{m_i \in \Re, x_i \in \Re_+}{Max}\ m_i + \phi_i(x_i) \\ &\text{s.t. } m_i + p^* x_i \leq \omega_{mi} + \sum_{j=1}^{J} \theta_{ij}(p^* q_j^* - c_j(q_j{}^* - c_j(q_j^*)) \end{aligned} \tag{8}$$

which can be rewritten by substituting in the constraint as:

$$\underset{x \geq 0}{Max}\ \varphi_i(x_i) - p^* x_i + [\omega_{mi}] + \sum_{j=1}^{J} \theta_{ij}(p^* q_j^* - c_j(q_j{}^* - c_j(q_j^*)) \tag{9}$$

and which has the necessary and sufficient FOC:

$$f_i^{/}(x_i^*) < \mathrm{p}^* \text{ with equality if } x_i^* > 0 \tag{10}$$

Empirically, we will apply these dual optimization decisions in our specification of a simultaneous equation model of residual supply and demand.

3.3 Empirical Framework

Overview

Following approach of Kaiser et al. (2005), the effect of promotion can be estimated by single-equation OLS demand models, instrumental variables with two-stage least squares estimation (2SLS), and a two-equation non-linear simultaneous equations models of supply and demand. A Monte Carlo (MC) simulation was performed with 1,000 replications and up to 32,000 iterations. Cost-benefit analysis (CBA) was used to analyze the results of MC SEM models, by estimating producer surplus and benefit-cost (B-C) ratios for actual levels of promotion compared to zero promotion, as well as for actual promotion compared to a 1% simulated increase in promotion. Following the prior literature, a linear-square root (LSR) model of promotion's effect on demand was specified, though other specifications of promotion were also tested for sensitivity. A 14-equation international SEM of hazelnut supply and demand was also attempted, however it was found that too few observations existed for estimation and the two-equation non-linear SEM approach with residual supply was more appropriate for the data in this study.

Batteries of diagnostic tests were used to ensure instrumental variable relevance and exogeneity, homoscedastic errors, non-autocorrelation, convergence, and to examine other measures of validity. All instruments used not only passed rigorous statistical tests for relevance, but also conceptually avoided the endogeneity that was believe to affect price. For instance, we believe that both price and quantity may be positively associated with cultural trends, such as the growing popularity of "buy local" campaigns in Oregon, which are unmeasured and thus part of the disturbance term. However, our instruments are exogenous because, unlike farm prices in Oregon, they are determined mostly by major macroeconomic and international trade matters, rather than being influenced by local culture. An alternative model with fewer instruments and an alternate dependent variable can be found in Appendix B.

The choice of variables for the single equation and the supply and demand SEM were largely motivated by the past literature and consumer demand theory. The primary dependent variable is marketable production (i.e. production minus culls) in metric tons (i.e. 1,000kg or

2,204.62 pounds), which was chosen because it related directly to the research question that this thesis sought to answer, which was the effect of promotion on U.S. farmers' economic well-being. Adjusted domestic consumption is marketable production less exports, plus exports, adjusted for changes in beginning and ending stocks (see Appendix B). Three additional dependent variables were also tested – marketable production per capita, adjusted domestic consumption, and adjusted domestic consumption per capita.

The goal of this study is to determine the value of assessments that fund promotion to the farmers who pay the assessments. Marketable production is the quantity of hazelnuts actually sold by these farmers and our price variable – real farm price – is the price that they are paid. Adjusted domestic consumption is an alternate, calculated variable used in the model found in Appendix B. Unlike marketable production, it incorporates elements of the international market, because it is calculated as marketable production minus exports, plus imports and the difference between beginning and ending stocks. However, this adjusted domestic consumption does not relate directly to the farmer's economic well-being and also suffers from errors in the data (it was determined mathematically that some re-imports were accidentally recorded). Theory dictates that the farm price should be negatively related to demand in a demand model, while disposable income should be positively related. The price of other goods is also a common factor in demand models, though the expected sign is less clear, since it depends on if the goods are complements or substitutes (which may not be immediately clear *a prior* in the case of tree nuts). We included the prices of almonds and an index of other nuts in some specifications of the OLS model, though they were insignificant and ultimately removed from the preferred OLS and 2SLS models.

Table 3. Descriptions of Key Variables

Variable Name	Description
Q	Marketable production in MT
RPH	Real price of hazelnuts per MT
RPROMO	Real promotion (total dollars)
RADS	Real promotion on advertising only
ROREGON	Real advertising on Oregon branding only
RCULINARY	Real advertising on culinary themes only
RDI	Real disposable income
RPALMONDS	Real price of almonds

3.3.1 Ordinary Least Squares

Quantity dependent least squares (OLS) single equation models of demand were specified as functions of real hazelnut farm prices, real promotion (typically in square root form), real prices of other goods, real disposable income, and a time trend. Alternate specifications of the model were tested for sensitivity, including alternate measures of quantity, substitute prices, functional forms of promotion, and calculation of the promotion variables as total HMB funds collected from farmers and broken down by promotion activity. In particular, HMB funds could be classified as administrative costs, investment in research, regionally themed advertising (i.e. “Oregon brand”), and culinary themed advertising.

A total of 140 OLS models were estimated to test the sensitivity of the models to choice of specification. Factors that were varied were the choice of dependent variable – marketable production, marketable production per capita, adjusted domestic consumption, and adjusted domestic consumption per capita – the specification of promotion, and the inclusion of various potential substitutes. Per capita models were found to offer little or no distinction and are not reproduced here.

Adjusted domestic consumption models were rejected on the basis that they are not conceptually appropriate for the research question. Having reduced the number of regressions considered based on principle, the following were the demand models of key interest. Regardless of specification, the models produced generally similar results.

$$Q_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 RPROMO_t + \varepsilon_t \tag{10}$$

$$Q_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 RADS_t + \varepsilon_t \tag{11}$$

$$Q_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 ROREGON_t + \beta_4 RCULINARY_t + \varepsilon_t \tag{12}$$

$$Q_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 \sqrt{RPROMO_t} + \varepsilon_t \tag{13}$$

$$Q_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 \sqrt{RADS_t} + \varepsilon_t \tag{14}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 RPROMO_t + \varepsilon_t \tag{15}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 RADS_t + \varepsilon_t \tag{16}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 ROREGON_t + \beta_4 RCULINARY_t + \varepsilon_t \tag{17}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 \sqrt{RPROMO_t} + \varepsilon_t \tag{18}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 \sqrt{RADS_t} + \varepsilon_t \tag{19}$$

$$QPC_t = \beta_0 + \beta_1 RPH_t + \beta_2 RDI_t + \beta_3 \sqrt{ROREGON_t} + \beta_4 \sqrt{RCULINARY_t} + \varepsilon_t \tag{20}$$

We ran OLS because it is a standard starting place in econometric analysis, it was conducted in the past literature, and it might have been acceptable if the model performed well and gave no indication of endogeneity or other biases. Due to the endogeneity of price, however, OLS was deemed inappropriate. A two stage least squares model (2SLS) was estimated instead.

3.3.2 Two Stage Least Squares

Prices and promotion were assumed to be endogenous *a priori*. This was later confirmed with Durbin-Wu-Hausman testing. Durbin-Wu-Hausman testing was also conducted on the measures of promotion, which were not deemed to be endogenous. This could have been due to sample size, though the assessment rate has been $10 dollars per ton for several years. But dollars spent has varied widely, thus there may not be a direct connection between promotion and production, thus reducing the need to treat it as endogenous.

To correct for endogeneity, an instrumental variables (IV) model was specified using two stage least squares (2SLS). In order for IV's to be valid they must satisfy two criteria – relevance and exogeneity.

Instrument relevance is established by showing that the instrumental variables are correlated with the instrumented variables. Instrument exogeneity means that they instruments must not suffer from the same bias as the variables for which they are instrumenting (Greene, 2000). The derivation of the instrumental variables estimator rests on these assumption (where bold indicates a matrix):

$$E[\varepsilon_i \mid \mathbf{x}_i] = \eta_i \tag{21}$$

and $$E[\eta_i] = 0 \tag{22}$$

which means that the error terms and the regressors are correlated. This implies that:

$$Cov[\mathbf{x}_i, \varepsilon_i] = Cov[\mathbf{x}_i, E[\varepsilon_i \mid \mathbf{x}_i]] = Cov[\mathbf{x}_i, \eta_i] = \gamma \tag{23}$$

and because the expected value of the disturbance term is zero, this can be rewritten as:

$$E[\mathbf{x}_i, \varepsilon_i] = Cov[\mathbf{x}_i, \eta_i] = \gamma \tag{24}$$

Given Kinchine's theorem, it can be shown that:

$$p\lim \frac{1}{n}\mathbf{X}^{/}\boldsymbol{\varepsilon} = \gamma \tag{25}$$

The disturbance term now has two kinds of variation. One is the variation around the conditional mean Var [ε|**x**] = σ^2. The other is the variance of the conditional mean itself:

$$Var[\eta_i] = \kappa^2 < \infty \tag{26}$$

Given standard assumptions about the instrumental variables, we have that:

$$p\lim \frac{1}{n} Z^{/} Z = Q_{ZZ} \tag{27}$$

$$p\lim \frac{1}{n} Z^{/} X = Q_{ZX} \tag{28}$$

$$p\lim \frac{1}{n} Z^{/}\boldsymbol{\varepsilon} = 0 \tag{29}$$

This leads to the conclusion that, in the general case – not assuming that gamma equals zero – most of the nice properties of OLS have been lost and the lease squares estimator is no longer unbiased:

$$\mathbf{E[b \mid X]} = \boldsymbol{\beta} + \mathbf{(X^{/}X)^{-1}X^{/}}\eta \neq \boldsymbol{\beta} \tag{30}$$

Without that equality, the Gauss-Markov theorem cannot hold. In addition, it is inconsistent:

$$p\lim \mathbf{b} = \boldsymbol{\beta} + p\lim \mathbf{(}\frac{1}{n}\mathbf{X}'\mathbf{X)}^{-1}\, p\lim \mathbf{(}\frac{1}{n}\mathbf{X}'\boldsymbol{\varepsilon}\mathbf{)} = \boldsymbol{\beta} + \mathrm{Q}_{xx}^{-1}\gamma \neq \boldsymbol{\beta} \tag{31}$$

On the other hand, the 2SLS estimator fares better. Since the terms have finite variances and $E[\mathbf{z}_i\varepsilon_i]=0$, it follows that:

$$p\lim \mathbf{(}\frac{1}{n}\mathbf{Z}'\mathbf{y)} = [p\lim \mathbf{(}\frac{1}{n}\mathbf{Z}'\mathbf{X)}]\boldsymbol{\beta} + p\lim \mathbf{(Z}'\boldsymbol{\varepsilon}\mathbf{)} = [p\lim \mathbf{(}\frac{1}{n}\mathbf{Z}'\mathbf{X})]\boldsymbol{\beta} \tag{32}$$

If **X** has the same number of variables as **Z,** then **Z'X** is a square matrix. Accordingly,

$$[\, p\lim \mathbf{(}\frac{1}{n}\mathbf{Z}'\mathbf{X)}\,]^{-1}\, p\lim(\frac{1}{n}\mathbf{Z}'\mathbf{y}) = \boldsymbol{\beta} \tag{33}$$

and finally, we now have the consistent 2SLS estimator:

$$\mathbf{b}_{IV} = (\mathbf{Z}'\mathbf{X})^{-1}\mathbf{Z}'\mathbf{y} \tag{34}$$

In this study, the IV estimator was used to correct for endogeneity in OLS and predicted values of marketable production in MT (i.e. estimated quantity) were retained from this 2SLS model for use in SEM's.

3.3.3 Structural Equation Models

In order to estimate simultaneous (structural) equation models we must specify a supply equation. Given that the decision to grow hazelnut trees is usually a long term choice made prior to the onset of our study, we follow the existing literature in treating overall supply as fixed (i.e., perfectly inelastic) and instead specify a residual supply equation, wherein domestic supply is specified as a function of export elasticity of demand, η, an export ratio (Q_E/Q_{US}), and the assessment rate (τ).

Let

$$\eta_E = \text{assumed price elasticity of export demand} \tag{33}$$

$$\varepsilon = -\eta_E (Q_E / Q_{US}) = \text{price elasticity of residual supply, given inelastic total supply} \tag{34}$$

and

$$\tau_t = \frac{RPROMOMT_t}{RPH_t} \tag{35}$$

This allows us to write the rate of return as:

$$R_t = (1 - \tau_t) RPH_t \tag{36}$$

and we can define A such that:

$$A_t = \frac{\hat{Q}_t}{R_t^{\varepsilon}} \tag{37}$$

which allows for a residual supply function of the form:

$$Q_t = A_t R_t^{\varepsilon} \tag{38}$$

This was the residual supply equation developed in the past commodity promotion literature, which this thesis has adapted for the hazelnut industry (J.M. Alston et al., 1995; J.M. Alston et al., 2007a; J.M. Alston, Crespi, Kaiser, & Sexton, 2007b; J. Alston et al., 2005; J. M. Alston et al., 2005; Angrist & Pischke, 2009; H.M. Kaiser et al., 2005; Harry M. Kaiser et al., 2005). Unlike the prior literature, this thesis estimated eta, however due to the small sample size, it was ultimate decided to follow the past literature in using a range of assumed elasticities (0, 1, 2, and 5).

3.3.4 SEM and Monte Carlo Simulation

This study combined Equation 38 with the OLS demand models to create a simultaneous equation model. Using the specification of supply from Equations 33-38, predicted quantities were forced through actual quantities. Scenarios of no promotion and a 1% marginal increase relative to actual promotion were simulated for values of 0, 1, 2, and 5 for eta. Monte Carlo simulation allowed this study to improve the estimates of the confidence intervals, though the tiny size of the sample remained a major issue. The results of the simulation were used to estimate producer surplus and benefit-cost ratios.

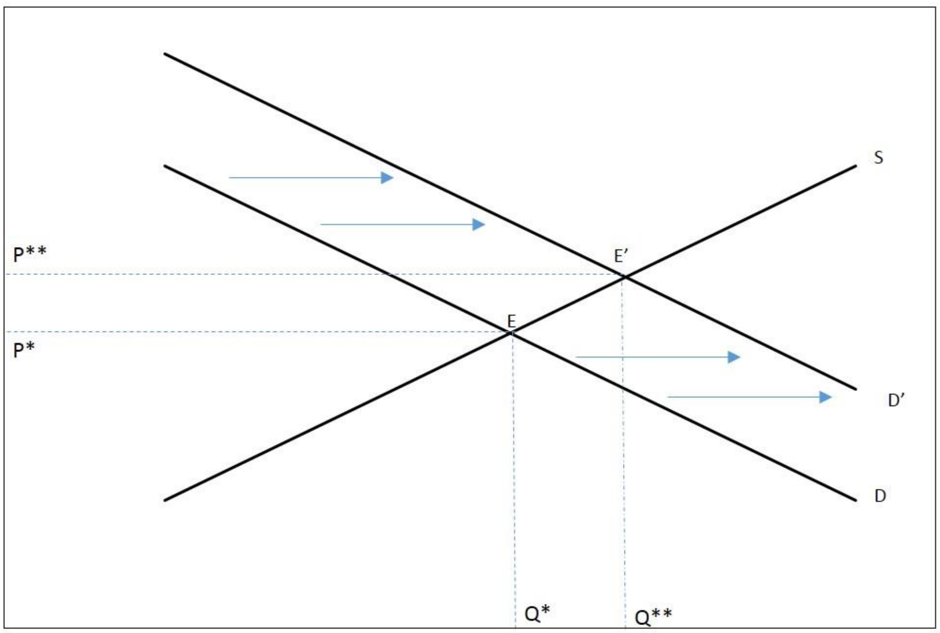

Figure 2. The Ceteris Paribus Effect of Promotion on Demand

CHAPTER 4

RESULTS

The results of the study generally supported the convention wisdom. In accordance with consumer demand theory, in every OLS model from Equations 10-20 and the 2SLS model price had a significant and negative impact on demand. In most models disposable income was positive and significant, though it was insignificant in some specifications (particularly when time was included as a right hand side variable). Promotion was always a positive predictor of demand as expected, though due to sample size and the fixity of supply, it was insignificant.

Table 4: Descriptive Statistics

Variable	n	Mean	σ	Minimum	Maximum
Real Price of Hazelnuts (RPH)	26	1,333.17	413.8801326	785.2897443	2297.58
Marketable Production in MT	26	25,896.37	9921.08	11107.12	43191.52
Real Promotion (total)	26	272,913.95	94864.12	9739.63	445837.88
Real Disposable Income	26	27,839.58	4231.44	22083.00	37078.00
Population	26	276,801,731	22,699,495	22,699,495	311800000

4.1 OLS

Table 5 shows a representative OLS model, wherein an index of tree nut prices available in GATS was used as a substitute price. Promotion was insignificant, though the sign and magnitude of the coefficient was surprisingly consistent across OLS specifications.

Table 5: Simple Linear Single Equation Model of Hazelnut Demand

Variable	Parameter Estimate	t-value	p-value
β_0	-33105	-1.57	0.13
Real Price of Hazelnuts (RPH)	-12.05171	-2.41	0.03
Real Price of Other Nuts (RPS)	3.59425	1.03	0.31
$\sqrt{Real\ Promotion\ (RPROMO)}$	14.10476	0.96	0.35
Disposable Income Per Capita	2.11915	3.99	0.00
Adjusted R^2	**0.3669**		

4.2 Two Stage Least Squares

The 2SLS model accounted for endogeneity of the OLS. While promotion was highly insignificant in this model, the IV estimates of price and income were significant and in step with theoretical predictions. The sign of an insignificant variable (i.e. square root of real promotion) is not meaningful. RPH was assumed endogenous based on theory. Additional instruments are the export price of in-shell hazelnuts, the weighted average domestic farm price of other nuts, and time squared.

Table 6: Two Stage Least Squares Demand Model

Variable	Estimates	Standard Error	t-value	p-value
β_0	-5248.66	16368.62	-0.32	0.75
Real Price of Hazelnuts (RPH)	-8.85464	5.228811	-1.69	0.10
$\sqrt{Real\ Promotion\ (RPROMO)}$	-9.19198	20.31345	-0.45	0.65
Disposable Income Per Capita	1.711240	0.463671	3.69	0.00
Adjusted R^2	**0.31378**			

4.3 SEM

Predicted marketable production and the covariance from the 2SLS model was used to conduct Cost-Benefit Analysis. Producer surplus was estimated and benefit-cost ratios were constructed for actual promotion versus no promotion and actual promotion versus 101% of actual promotion. Unfortunately, due to restrictively small sample size, the estimates were uniformly insignificant. Z1 is the set of instruments without lags, whereas Z2 uses lagged values. Z2 is a theoretically better choice, but exacerbates the lack of observations. Starting seed values were varied, both pre-determined and random, but in all cases the B-C ratios remained insignificant.

Table 7: Y = Marketable Production, Z1, Actual v. 1% Increased Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-29054.8	17628.13	52.34	998.61
Benefit-Cost Ratio with elasticity of 1	25025	-14027.1	2626.18	20.71	100.2
Benefit-Cost Ratio with elasticity of 2	9150	-48.44	146.68	11.34	17.47
Benefit-Cost Ratio with elasticity of 5	25025	-31.78	70.52	4.96	7.88
Producer Surplus with elasticity of 0	25025	-6.4E+07	38730461	137673.8	2492293
Producer Surplus with elasticity of 1	25025	-1226220	3.53E+09	222066.3	22332113
Producer Surplus with elasticity of 2	9150	-113048	424259.2	30443.74	44157.43
Producer Surplus with elasticity of 5	25025	-95956.6	140808.8	13082.57	19097.11

Table 8: Y = Marketable Production, Z1, Actual v. No Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-29111.2	17662.35	52.8	1005.51
Benefit-Cost Ratio with elasticity of 1	25025	-7095.3	1103.87	15.8	54.96
Benefit-Cost Ratio with elasticity of 2	1896	-23.19	82.36	11.12	13.87
Benefit-Cost Ratio with elasticity of 5	17261	-37.41	60.96	4.36	7.33
Producer Surplus with elasticity of 0	25025	-6.4E+09	3.9E+09	13916468	2.52E+08
Producer Surplus with elasticity of 1	25025	-1.8E+09	1.78E+11	12579763	1.13E+09
Producer Surplus with elasticity of 2	1896	-5045505	20295521	2924909	3320503
Producer Surplus with elasticity of 5	17261	-1E+07	12896385	1144284	1762799

Table 9: Y = Marketable Production, Z2, Actual v. 1% Increased Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-19304.4	58860.07	119.84	1278.57
Benefit-Cost Ratio with elasticity of 1	25025	-121.38	312.93	25.38	29.34
Benefit-Cost Ratio with elasticity of 2	25025	-62.47	157.73	14.89	16.7
Benefit-Cost Ratio with elasticity of 5	25025	-26.47	72.93	6.79	7.71
Producer Surplus with elasticity of 0	25025	-3E+07	90514476	250789.8	2522835
Producer Surplus with elasticity of 1	25025	-178469	1667417	52163.74	55608.38
Producer Surplus with elasticity of 2	25025	-106717	256223.1	30084.79	28323.08
Producer Surplus with elasticity of 5	25025	-47802.1	96536.48	13515.29	12474.87

Table 10: Y = Marketable Production, Z2, Actual v. No Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-19341.9	58974.3	120.86	1287.4
Benefit-Cost Ratio with elasticity of 1	25025	-132.97	206.94	21.26	23.65
Benefit-Cost Ratio with elasticity of 2	17248	-68.68	118.73	12.88	14.36
Benefit-Cost Ratio with elasticity of 5	25025	-27.7	64.99	6.36	7.11
Producer Surplus with elasticity of 0	25025	-3E+09	9.11E+09	25365788	2.55E+08
Producer Surplus with elasticity of 1	25025	-2.2E+07	1.17E+08	4309337	4204168
Producer Surplus with elasticity of 2	17248	-1.2E+07	19040399	2580446	2366130
Producer Surplus with elasticity of 5	25025	-5139760	8393093	1263404	1138139

Interestingly, the producer surplus measures in Table 10 are significant with a critical alpha of 0.05 (if barely so). However, the CBA still could not be carried out, since the B-C ratios were insignificant.

Table 11: Y = Adjusted Domestic Consumption, Z1, Actual v. 1% Increased Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-193.04	588.6	1.2	12.79
Benefit-Cost Ratio with elasticity of 1	25025	-1.21	3.13	0.25	0.29
Benefit-Cost Ratio with elasticity of 2	25025	-0.62	1.58	0.15	0.17
Benefit-Cost Ratio with elasticity of 5	25025	-0.26	0.73	0.07	0.08
Producer Surplus with elasticity of 0	25025	-3E+07	90514476	250789.8	2522835
Producer Surplus with elasticity of 1	25025	-178469	1667417	52163.74	55608.38
Producer Surplus with elasticity of 2	25025	-106717	256223.1	30084.79	28323.08
Producer Surplus with elasticity of 5	25025	-47802.1	96536.48	13515.29	12474.87

The pattern is repeated in Table 11.

Table 12: Y = Adjusted Domestic Consumption, Z1, Actual v. No Promotion

Measurement	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-19341.9	58974.3	120.86	1287.4
Benefit-Cost Ratio with elasticity of 1	25025	-132.97	206.94	21.26	23.65
Benefit-Cost Ratio with elasticity of 2	17248	-68.68	118.73	12.88	14.36
Benefit-Cost Ratio with elasticity of 5	25025	-27.7	64.99	6.36	7.11
Producer Surplus with elasticity of 0	25025	-3E+09	9.11E+09	25365788	2.55E+08
Producer Surplus with elasticity of 1	25025	-2.2E+07	1.17E+08	4309337	4204168
Producer Surplus with elasticity of 2	17248	-1.2E+07	19040399	2580446	2366130
Producer Surplus with elasticity of 5	25025	-5139760	8393093	1263404	1138139

Again, all B-C ratios are insignificant, though producer surplus is marginally significant.

Table 13: Y = Adjusted Domestic Consumption, Z2, Actual v. 1% Increased Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25,025	-1,014,759	86,948	59	6,603.39
Benefit-Cost Ratio with elasticity of 1	25,025	-287,570,052,005	60,654,121	-11,491,619	1,817,844,119
Benefit-Cost Ratio with elasticity of 2	4,125	-218	205	19	26
Benefit-Cost Ratio with elasticity of 5	25,025	-231,669,402,752	52,103,082	-9,257,413	1,464,473,991
Producer Surplus with elasticity of 0	25,025	-1,224,114,669	7,184,666,352	26,684,633	171,075,246
Producer Surplus with elasticity of 1	25,025	-32,953,496	60,709,511	4,359,274	4,685,280
Producer Surplus with elasticity of 2	4,125	-10,704,999	13,944,630	2,631,022	2,628,717
Producer Surplus with elasticity of 5	25,025	-5,856,153	10,505,968	1,283,158	1,265,183

Table 13 demonstrates that the producer surplus solutions appear more stable at higher assumed elasticities.

Table 14: Y = Adjusted Domestic Consumption, Z2, Actual v. No Promotion

	N	Minimum	Maximum	Mean	Std. Dev.
Benefit-Cost Ratio with elasticity of 0	25025	-19304.4	58860.07	119.84	1278.57
Benefit-Cost Ratio with elasticity of 1	25025	-121.38	312.93	25.38	29.34
Benefit-Cost Ratio with elasticity of 2	25025	-62.47	157.73	14.89	16.7
Benefit-Cost Ratio with elasticity of 5	25025	-26.47	72.93	6.79	7.71
Producer Surplus with elasticity of 0	25025	-3E+07	90514476	250789.8	2522835
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Producer Surplus with elasticity of 5	25025	-47802.1	96536.48	13515.29	12474.87

The promotion variables in the various models were uniformly insignificant, due to lack of monthly data. Had they been significant, then it would be appropriate to compare the gains from generic advertising with the opportunity cost of the farmers funding the HMB. The simulation results reported in Tables 7 and 8 demonstrate how potential benefits decline with a more elastic supply. There are fewer observations when supply elasticity was set = 2 because the simulation model due to non-convergence.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 Implications of Results

Promotion activities, including advertising and research, have a theoretically positive impact on demand and shift the demand curve out as in Figure 2. When promotion was insignificant it was typically directionally positive, though it was negative in some cases. However, even if promotion is believed to have a significant and positive impact on demand, the critical issue at hand is if the outward movement of the demand curve both fully offsets the inward movement of the supply curve, which occurs due to the effect of taxation, and if any positive internal rate of return exceeds the market rate of return that the farmers could have received by investing the funds used for HMB assessments.

It remains unclear if the activities of the Hazelnut Marketing Board are beneficial to producers. Past reports have lauded the effectiveness of HMB activities using far less data and must be viewed with suspicion. Attempts were made to replicate past studies of commodity promotion, but in each case some critical calculation or data were missing and the studies could not be replicated. It is alarming that other studies on this topic face many of the same challenges yet come to strong conclusions in support of promotion, yet without being easily replicable and while frequently being funded by the commodity councils that they are analyzing.

5.2 Limitations

This analysis suffered considerably from lack of sufficient observations. The primary lesson of this study is that since economic valuation of commodity programs is crucial to ensuring their usefulness, officials at the HMB and USDA must improve the collection of data. Promotion activities should be recorded at least monthly to guarantee that an effective analysis will be possible. This study also suffered from administratively dictated specification search and external pressure to obtain particular results, both of which influenced a large number of decisions throughout the study.

5.3 Ethics and Transparency

Intellectual honesty, transparency, and ethical research should be valued more highly. The full SAS code and datasets used in this study are available in the appendices and the author may be contacted for support in replicating the study. While the data in this study were restrictively limited, this study shall remain a valuable contribution to the literature because it is transparent. Moreover, a “cloud” server (i.e. DropBox) is available to any interested researcher and contains all the data, code – current and dating back to the origins of this study in 2010/2011, and other resources such as electronic copies of prior literature. The URL to access the DropBox folder is:

https://www.dropbox.com/sh/plf0q73hh3v0pr4/g6IpcElvDC

This will enable future researchers to learn and borrow from the exact techniques (and code) used, to engage in a more fruitful evaluation of this study's credibility, to contribute to the hazelnut industry by reporting any errors, and hopefully this thesis will prove to be a catalyst for transparency.

REFERENCES

Alston, J.M., Carman, H.F., Christian, J.E., Dorfman, J., Murua, J.R., & Sexton, R.J. (1995). *Optimal Reserve and Export Policies for the California Almond Industry: Theory, Econometrics and Simulations*. Berkeley, CA: Giannini Foundation of Agricultural Economics, UC Berkeley.

Alston, J.M., Crespi, J.M., Kaiser, H.M., & Sexton, R.J. (2007a). An evaluation of california's mandated commodity promotion programs. *Applied Economic Perspectives and Policy, 29*(1), 40.

Alston, J.M., Crespi, J.M., Kaiser, H.M., & Sexton, R.J. (2007b). An evaluation of california's mandated commodity promotion programs. *Applied Economic Perspectives and Policy, 29*(1), 40-63.

Alston, Julian, Chalfant, James, Christian, Jason, Meng, Erika, & Piggot, Nicholas. (2005). The Benefits and Costs of Promotion Programs for California Table Grapes. In H. M. Kaiser, J. M. Alston, J. M. Crespi & R. J. Sexton (Eds.), *The Economics of Commodity Promotion Programs*. New York, NY: Peter Lang.

Alston, Julian M., Carman, Hoy, Chalfant, James, Crespi, John M., & Sexton, Richard J. (2005). Evaluation of Prune Promotion by the california Dried Plum Board. In H. M. Kaiser, J. Alston, J. Crespi & R. J. Sexton (Eds.), *The Economics of Commodity Promotion Programs*.

Angrist, Joshua D., & Pischke, Jorn-Steffen. (2009). *Mostly Harmless Econometrics*. Princeton, NJ: Princeton University Press.

Champ, P.A., & Boyle, K.J. (2003). *A primer on nonmarket valuation* (Vol. 3): Springer.

Crespi, John, & Sexton, Richard (2005). Evaluating the Effectiveness of California Almond Promotion: How Much Did the Litigation Cost Producers. In H. M. Kaiser, J. Alston, J. Crespi & R. J. Sexton (Eds.), *The Economics of Commodity Promotion Programs*. New York City, NY: Peter Lang.

Duffy, Randy, & Goddard, Ellen. (1995). The Benefits to Canadian Hog Producers of Generic vs. Brand Advertising of Pork *Economic Analysis of Meat Promotion*. Denver, CO: The Research Committee on Commodity Promotion (NEC-63) and The National Institute for Commodity Promotion Resarch and Evaluation.

Gopinath, Munisamy, & Saito, Hisamitsu. (2006). *Evaluation of the Promotion Program of the Hazelnut Marketing Board, Oregon*. Unpublished Report. Agricultural and Resource Economics. Oregon State University. Corvallis, OR.

Greene, William H. (2000). *Econometric analysis* (Vol. 4th). Upper Saddle River, N.J.: Prentice Hall.

Hazelnut Marketing Board. (2006). Preliminary Annual Report: Crop Year 2006. Aurora, OR.

Hazelnut Marketing Board. (2007a). Annual Report: Crop Year 2006. Aurora, OR: Hazelnut Marketing Board.

Hazelnut Marketing Board. (2007b). Preliminary Annual Report: Crop Year 2007. Aurora, OR.

Hazelnut Marketing Board. (2008a). Annual Report: Crop Year 2007. Aurora, OR: Hazelnut Marketing Board.

Hazelnut Marketing Board. (2008b). Preliminary Annual Report: Crop Year 2008. Aurora, OR.

Hazelnut Marketing Board. (2009a). Annual Report: Crop Year 2008. Aurora, OR: Hazelnut Marketing Board.

Hazelnut Marketing Board. (2009b). Preliminary Annual Report: Crop Year 2009. Aurora, OR.

Hazelnut Marketing Board. (2010a). Annual Report: Crop Year 2009. Aurora, OR: Hazelnut Marketing Board.

Hazelnut Marketing Board. (2010b). Preliminary Annual Report: Crop Year 2010. Aurora, OR.

Hazelnut Marketing Board. (2011a). Annual Report: Crop Year 2010. Aurora, OR: Hazelnut Marketing Board.

Hazelnut Marketing Board. (2011b). Preliminary Annual Report: Crop Year 2011. Aurora, OR.

Kaiser, H.M., Alston, J. M., Crespi, J.M., & Sexton, R.J. (Eds.). (2005). *Economics of Commodity Promotion Programs: Lessons from California*. New York City, NY: Peter Lang.

Kaiser, Harry M. (2005). An Economic Analysis of the Walnut Marketing Board's Promotion Programs. In H. M. Kaiser, J. Alston, J. Crespi & R. J. Sexton (Eds.), *The Economics of Commodity Promotion Programs*. New York City, NY: Peter Lang.

Kaiser, Harry M., Alston, Julian M., Crespi, John M., & Sexton, Richard J. (Eds.). (2005). *The Economics of Commodity Promotion Programs: Lessons from California.* New York: Peter Lang.

Marshall, Alfred. (1920). *Principles of Economics*. New York: Macmillian.

Mas-Colell, Andreu, Whinston, Michael, & Green, Jerry. (1995). *Microeconomic Theory*. New York: Oxford University Press.

Stanley, TD, & Rosenberger, R.S. (2009). Are recreation values systematically underestimated? Reducing publication selection bias for benefit transfer. *Bulletin of Economics and Meta-Analysis. Available at: http://www.hendrix. edu/maer-network/default.aspx*.

Stigler, George. (1987). *The Theory of Price*. New York: Macmillian.

USDA Agricultural Marketing Service. (2012, 08/12/2012). Marketing Orders and Agreements. Retrieved 11/12/2012, 2012, from http://www.ams.usda.gov/AMSv1.0/FVMarketingOrderLandingPage

Vives, X. (1987). Small income effects: A Marshallian theory of consumer surplus and downward sloping demand. *The Review of Economic Studies*, *54*(1), 87-103.

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** Hazelnut Commodity Promotion          **
** By Jason Miller                        **
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* This code was created on SAS(R) v9.2 TS, Windows XP;
* Note: this file's formatting is sensitive to your viewer/version;
* Note: this code contains "lock" statements, which were necessary
      at the time of writing but which may result in
      trivial error messages and could potentially be
            removed by future researches
* Note: contains some variables that were not used in the final models;
* Note: for this code to run smoothly you may need to apply
      this hot fix: -SET SAS_USE_LONGFILEEXT 1, for
      an explanation please see http://support.sas.com/kb/8/130.html;

*** TABLE OF CONTENTS ***

Let Y1 = Marketable Production
   Y2 = Adjusted Domestic Consumption
         Z1 = Durham's Preferred Instruments
         Z2 = Buccola's Preferred Instruments

Section    I: Data Import, Cleaning, Calculation
Section   II: Descriptive Statistics, OLS, Diagnostic Testing
Section  III: 2SLS, SEM, Monte Carlo, and B-C with Y1, Z1
Section   IV: 2SLS, SEM, Monte Carlo, and B-C with Y1, Z2
Section    V: 2SLS, SEM, Monte Carlo, and B-C with Y2, Z1
Section   VI: 2SLS, SEM, Monte Carlo, and B-C with Y2, Z2

* End Table of Contents;



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**      Section I: Data Import, Cleaning and Calculation         **
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June;
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GATS Imports and Exports

Quantities and Values Marketing Year July to June Dollars MT.xls"
        DBMS=EXCEL REPLACE;
              RANGE="'export quantities$'";
                 GETNAMES=YES;
                 MIXED=NO;
                 SCANTEXT=YES;
                 USEDATE=YES;
                 SCANTIME=YES;
RUN;

PROC IMPORT OUT= WORK.GATS_EXPORTS_v_dollars
        DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\FAS
GATS Imports and Exports

Quantities and Values Marketing Year July to June Dollars MT.xls"
DBMS=EXCEL REPLACE;
   RANGE="'export values$'";
   GETNAMES=YES;
   MIXED=NO;
RUN;

PROC IMPORT OUT= WORK.GATS_imports_q_mt
        DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\FAS
GATS Imports and Exports

Quantities and Values Marketing Year July to June Dollars MT.xls"
DBMS=EXCEL REPLACE;
   RANGE="'import quantities$'";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;

PROC IMPORT OUT= WORK.gats_imports_v_dollars
        DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\FAS
GATS Imports and Exports
```

```
Quantities and Values Marketing Year July to June Dollars MT.xls"
DBMS=EXCEL REPLACE;
   RANGE="'import values$'";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;


* Marketing Year CPI in 2010 Dollars;
PROC IMPORT OUT= WORK.cpi
        DATAFILE= "C:\Documents and
Settings\millejas\Dropbox\hazelnuts\Data\USCPI.xls"
        DBMS=EXCEL REPLACE;
   RANGE="SAS$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;


* Data from Table F-11 of the 2011 Annual Fruit and Tree Nut Yearbook in Thousands of
Pounds;
PROC IMPORT OUT= WORK.f11
      /*   DATAFILE= "C:\Documents and
Settings\millejas\Dropbox\hazelnuts\Data\Table-E11.xls" */
  DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\Table-F11
replacing E11.xls"
        DBMS=EXCEL REPLACE;
   RANGE="formatted$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;

* F-6: quantities of all tree nuts;
PROC IMPORT OUT= hnut.f6
        DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\Table-
F6 for SAS.xls"
        DBMS=EXCEL REPLACE;
```

```
   RANGE="SAS$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;



* Data from the HMB combined with Population Data from the US Census Bureau and
Disposable Income data;

PROC IMPORT OUT= WORK.hmb
        DATAFILE= "C:\Documents and
Settings\millejas\Dropbox\hazelnuts\Data\Compiled Data from HMB.xls"
        DBMS=EXCEL REPLACE;
   RANGE="SAS$";
   GETNAMES=YES;
   MIXED=NO;
   SCANTEXT=YES;
   USEDATE=YES;
   SCANTIME=YES;
RUN;

data hmb;
        set hmb;
        if year ='.' then delete;
        population = population*1000;
run;


* Inshell Price per Short Ton (2,000lbs) from the Oregon Field Office of USDA NASS;
* Note: 1981 1982 1983 and 1984 were taken from the 1987-1988 Oregon Agricultural &
Fisheries Statistics

report;
PROC IMPORT OUT= WORK.price
        DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\Price
Per Ton in Oregon from

Oregon Field Office of USDA NASS.xls"
        DBMS=EXCEL REPLACE;
   RANGE="Data$";
   GETNAMES=YES;
   MIXED=YES;
```

```
    SCANTEXT=YES;
    USEDATE=YES;
    SCANTIME=YES;
RUN;

* Other nut farm prices (CENTS per Pound and KERNEL BASIS) from Table F-4;
PROC IMPORT OUT= WORK.SUBSTITUTES
         DATAFILE= "C:\Documents and Settings\millejas\Dropbox\hazelnuts\Data\Table-
F4.xls"
         DBMS=EXCEL REPLACE;
    RANGE="SAS$";
    GETNAMES=YES;
    MIXED=NO;
    SCANTEXT=YES;
    USEDATE=YES;
    SCANTIME=YES;
RUN;

* Non-US GSP;
PROC IMPORT OUT= non_us_gdp
         DATAFILE= "C:\Documents and
Settings\millejas\Dropbox\hazelnuts\Data\HistoricalRealGDPValues.xls"
         DBMS=EXCEL REPLACE;
    RANGE="SAS$";
    GETNAMES=YES;
    MIXED=NO;
    SCANTEXT=YES;
    USEDATE=YES;
    SCANTIME=YES;
RUN;

* Sort Data Sets ;
PROC SORT data = gats_exports_q_mt;
         by year;
run;

PROC SORT data = gats_imports_q_mt;
         by year;
run;

PROC SORT data = gats_exports_v_dollars;
         by year;
run;

PROC SORT data = gats_imports_v_dollars;
         by year;
```

```
run;

PROC SORT data = cpi;
	by year;
run;

PROC SORT data = f11;
	by year;
run;

PROC SORT data = hmb;
	by year;
run;

PROC SORT data = price;
	by year;
run;

PROC SORT data = non_us_gdp;
	by year;
run;

PROC SORT data = hnut.f6;
	by year;
run;


* This part converts GATS year to Marketing Year ("marketing_year"), remove partial
year;
DATA gats_exports_q_mt;
	set gats_exports_q_mt;
	marketing_year = year-1;
	drop year;
run;
DATA gats_exports_v_dollars;
	set gats_exports_v_dollars;
	marketing_year = year-1;
	drop year;
run;
DATA gats_imports_q_mt;
	set gats_imports_q_mt;
	marketing_year = year-1;
	drop year;
run;
DATA gats_imports_v_dollars;
	set gats_imports_v_dollars;
```

```
        marketing_year = year-1;
        drop year;
run;


* This part makes "Farm Price per US Ton" into "Farm Price per MT";
DATA price;
        set price;
        farm_price_mt = Dollars_per_ton*0.907185;
run;

* Keeps only relevant DATA from GATSOnline by creating composite variables and
dropping the rest;
* This also creates the USDA FAS GATSOnline implied export and import prices;
        ** EXPORTS**;
DATA gats_exports_q_mt;
        set gats_exports_q_mt;
        kernel_export_q_mt = q802220000 + q1454500;
        inshell_export_q_mt = q802210000 + q1451600;
        keep  marketing_year  kernel_export_q_mt inshell_export_q_mt;
run;
DATA gats_exports_v_dollars;
        set gats_exports_v_dollars;
        kernel_export_v_dollars = v802220000 + v1454500 ;
        inshell_export_v_dollars = v802210000 + v1451600;
        keep  marketing_year inshell_export_v_dollars kernel_export_v_dollars;
run;
PROC SORT DATA = gats_exports_q_mt;
        by marketing_year;
run;
PROC SORT DATA = gats_exports_v_dollars;
        by marketing_year;
run;
DATA gats_exports;
        merge gats_exports_q_mt gats_exports_v_dollars;
run;
DATA gats_exports;
        set gats_exports;
        inshell_export_p_USD_MT = inshell_export_v_dollars/inshell_export_q_mt;
        kernel_export_p_USD_MT = kernel_export_v_dollars/kernel_export_q_mt;
run;
        **IMPORTS**;
DATA gats_imports_q_mt;
        set gats_imports_q_mt;
        kernel_import_q_mt = q802220000 + q1454600 + q2008192000;
        inshell_import_q_mt = q802210000 + q1451800;
```

```
	keep  marketing_year  kernel_import_q_mt inshell_import_q_mt;
run;
DATA gats_imports_v_dollars;
	set gats_imports_v_dollars;
	kernel_import_v_dollars = v802220000 + v1454600 + v2008192000;
	inshell_import_v_dollars = v802210000 + v1451800;
	keep  marketing_year inshell_import_v_dollars kernel_import_v_dollars;
run;
DATA gats_imports;
	merge gats_imports_q_mt gats_imports_v_dollars;
run;
DATA gats_imports;
	set gats_imports;
	inshell_import_v_dollars_nonzero =  inshell_import_v_dollars+ 0.0001;
	inshell_import_q_mt_nonzero = inshell_import_q_mt + 0.0001;
	inshell_import_p_USD_MT =
inshell_import_v_dollars_nonzero/inshell_import_q_mt_nonzero;
	kernel_import_p_USD_MT = kernel_import_v_dollars/kernel_import_q_mt;
run;
PROC SORT data = gats_imports;
	by marketing_year;
run;
PROC SORT data = gats_exports;
	by marketing_year;
run;
DATA gats;
	merge gats_imports gats_exports;
	by marketing_year;
	year = marketing_year;
	drop marketing_year;
run;

DATA hnut.substitutes;
	merge substitutes hnut.f6;
	palmonds = almonds;
	phazelnuts = hazelnuts;
	ppecans = pecans;
	pwalnuts = walnuts;
	pMacadamias = macadamias;
	pPistachios = pistachios;
	pall = all;
	pAll = (((pAll/2)/100)*2204.6); /* Converts to in-shell price per MT */
	pAlmonds = (((pAlmonds/1.66)/100)*2204.6);
	pHazelnuts =(((pHazelnuts/2.5)/100)*2204.6);
	pMacadamias =(((pMacadamias/4.5)/100)*2204.6);
	pPecans =(((pPecans/2)/100)*2204.6);
```

```
        pPistachios =(((pPistachios/2.5)/100)*2204.6);
        pWalnuts =(((pWalnuts/2.4)/100)*2204.6);
run;

* Create data set with all of the new data so that price can be made real, etc;
PROC SORT data = cpi;
        by year;
run;

PROC SORT data = f11;
        by year;
run;

PROC SORT data = hmb;
        by year;
run;

PROC SORT data = price;
        by year;
run;
PROC SORT data = gats;
        by year;
run;
PROC SORT data = substitutes;
        by year;
run;

DATA hnut.working1;
        merge cpi f11 gats hmb price hnut.substitutes Non_us_gdp;
        by year;
        where year GE 1986;
run;

* Make GATS prices real and create a weighted average;
* The weighted averages are in inshell basis, real dollars per MT;
DATA hnut.working2;
        set hnut.working1;
        kernel_import_rp_USD_MT = kernel_import_p_USD_MT/(mycpi10/100);
        inshell_import_rp_USD_MT = inshell_import_p_USD_MT/(mycpi10/100);
        kernel_export_rp_USD_MT = kernel_export_p_USD_MT/(mycpi10/100);
        inshell_export_rp_USD_MT = inshell_export_p_USD_MT/(mycpi10/100);
        weighted_import_price = (inshell_import_v_dollars + kernel_import_v_dollars)/

(((2.5*kernel_import_q_mt)+inshell_import_q_mt));
        weighted_export_price = (inshell_export_v_dollars + kernel_export_v_dollars)/
```

```
(((2.5*kernel_export_q_mt)+inshell_export_q_mt)) ;
        weighted_import_rp = weighted_import_price / (mycpi10/100);
        weighted_export_rp = weighted_export_price / (mycpi10/100);
run;


* Make "Farm Price per MT" into "Real Farm Price per MT";
DATA hnut.working3;
        set hnut.working2;
        rfarm_price_mt = farm_price_mt/(mycpi10/100);
        if year gt 1979;
run;

* Make real promotion and substitute variables;
DATA hnut.working4;
        set hnut.working3;
        if year = 2011 then ads = 212723;
        if year = 2011 then admin = 83862;
        if year = 2011 then oregonb = 101596;
        if year = 2011 then culinaryl =15612;
        if year = 2011 then research = 12653;
        promo = OregonB+CulinaryL+Admin+Research;
        promo_ads = OregonB+CulinaryL;
        promo_nores = OregonB + CulinaryL + Admin;
        rpromo_nores = promo_nores/(mycpi10/100);
        rpromo = promo/(mycpi10/100);
        rpromo_ads = promo_ads/(mycpi10/100);
        sqrtrpromo = sqrt(rpromo);
        sqrtrpromo_ads = sqrt(rpromo_ads);
        sqrtroregonb = sqrt(oregonb/(mycpi10/100));
        sqrtrculinaryl = sqrt(culinaryl/(mycpi10/100));
        sqrtrcul_or = sqrt((oregonb/(mycpi10/100))+(culinaryl/(mycpi10/100)));
        rpAll = pAll /(mycpi10/100);
        rpAlmonds = pAlmonds/(mycpi10/100);
        rpHazelnuts = pHazelnuts /(mycpi10/100);
        rpMacadamias = pMacadamias/(mycpi10/100);
        rpPecans =pPecans/(mycpi10/100);
        rpPistachios = pPistachios/(mycpi10/100);
        rpWalnuts = pWalnuts/(mycpi10/100);
        percap_util_all_mt = (percap_utilization_all*2.5)*0.0004535924;
        percap_util_mt = (percap_util*2.5)*.0004535924;
        percap_almonds_mt = percap_almonds*2.5*.0004535924;
        rpall_sub = ((percap_util_all_mt*rpall)-
(rpHazelnuts*percap_util_mt))/(percap_util_all_mt -

percap_util_mt);
```

```
        rp_others = ((percap_util_all_mt*rpall)-(rpHazelnuts*percap_util_mt)-
(rpAlmonds*percap_almonds_mt))/

(percap_util_all_mt - percap_util_mt-percap_almonds_mt);
        rpall_sub_k = ((percap_utilization_all*rpall)-
(rpHazelnuts*percap_util))/(percap_utilization_all -

percap_util);
        rp_others_k =((percap_utilization_all*rpall)-(rpHazelnuts*percap_util)-
(rpAlmonds*percap_almonds))/

(percap_utilization_all - percap_util-percap_almonds);
        time = year-1979;
        timesq = time*time;
        lag_rfarm_price_mt = lag(rfarm_price_mt );
        lag2_rfarm_price_mt = lag2(rfarm_price_mt );
        lag3_rfarm_price_mt = lag3(rfarm_price_mt );
        drop f1-f51;
run;


* Put F-11 variables into Inshell Basis;
DATA hnut.working5;
        set hnut.working4;
        utilized_production=utilized_production*2.5;
        loss_and_exempt =loss_and_exempt*2.5;
        Marketable_production=Marketable_production*2.5;
        beginning_stocks=beginning_stocks*2.5;
        total_supply=total_supply*2.5;
        ending_stocks=ending_stocks*2.5;
        percap_util=percap_util*2.5;
run;


* Create domestic demand/consumption and some RS variables;
DATA hnut.working6;
        set hnut.working5;
        marketable_production_mt = marketable_production*0.45359233;
        beginning_stocks_mt = beginning_stocks*0.45359233;
        ending_stocks_mt = ending_stocks*0.45359233;
        adj_dom_con = marketable_production_mt +  inshell_import_q_mt +
(2.5*kernel_import_q_mt) -

inshell_export_q_mt-(2.5*kernel_export_q_mt) + beginning_stocks_mt - ending_stocks_mt
;
        adj_dom_con_percap = adj_dom_con/population;
```

```
        lag_adj_dom_con_percap = lag(adj_dom_con_percap );
        dom_con_of_dom = marketable_production_mt - inshell_export_q_mt -
(2.5*kernel_export_q_mt) +

beginning_stocks_mt - ending_stocks_mt;
        us_exports = inshell_export_q_mt + (2.5*kernel_export_q_mt);
        export_ratio = us_exports/dom_con_of_dom;
        alt_export_ratio = us_exports/adj_dom_con;
        rpromo_ads_MT=rpromo_ads/ marketable_production_mt;
        return_per_mt = (1-(rpromo_ads_MT/rfarm_price_mt))*rfarm_price_mt;
run;

* The problem with "dom_con_of_dom"...(re-exports innacurately included in source);
proc print data = hnut.working7;
        var year dom_con_of_dom;
run;

* Add new (2011) data;
DATA hnut.working7;
        set hnut.working6;
        if year = 2011 then DI_per_cap_2005D = 37078; /* from Google Public Data */
run;


* Alternative promotion and new variables;
DATA hnut.working8;
        set hnut.working7;
        rOregonB = sqrtrOregonB*sqrtrOregonB;
        rCulinaryL = sqrtrCulinaryL*sqrtrCulinaryL;
        rpromo_ads_percap = rpromo_ads/population;
        rOregonB_percap = rOregonB/population;
        rCulinaryL_percap = rCulinaryL/population;
        sqrtrpromo_ads_percap = sqrtrpromo_ads/population;
        sqrtrCulinaryL_percap = sqrtrCulinaryL/population;
        sqrtrOregonB_percap = sqrtrOregoNB/population;
        marketable_production_percap = marketable_production_mt/population;
        lag_sqrtrpromo = lag(sqrtrpromo);
        lag2_sqrtrpromo = lag2(sqrtrpromo);
        lag3_sqrtrpromo = lag3(sqrtrpromo);
        rpromo_mt = rpromo/marketable_production_mt;
        if year ='2011' then population=311800000; /* update */
        where year GE 1986;
        if year = 2012 then delete;
run;
```

```
* Table: Industry Trends;
proc print data = hnut.working8;
        title 'Industry Trends';
        var year marketable_production_mt rfarm_price_mt rpromo;
run;
title;

* Table: Summary Statistics;
        title 'Descriptive Stats';
proc means data = hnut.working8;
        var rfarm_price_mt marketable_production_mt rpromo  DI_Per_Cap_2005D
Population DI_Per_Cap_2005D;
run;
title;

******************************************************************
**          Section II: Descriptive Statistics, OLS, Diagnostic Testing            **
******************************************************************;

* Table: OLS Demand Models;
title 'Table: OLS Demand Models';
PROC REG data = hnut.working8;
                model marketable_production_mt = rfarm_price_mt rpromo_ads ;
        model marketable_production_mt = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others_k sqrtrpromo_ads
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others sqrtrpromo
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others sqrtrpromo_ads
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others rpromo
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others rpromo_ads
DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others_k sqrtroregonb
sqrtrculinaryl

DI_Per_Cap_2005D time;
        model marketable_production_mt = rfarm_price_mt rp_others sqrtroregonb
sqrtrculinaryl DI_Per_Cap_2005D

time;
        model marketable_production_mt = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D ;
```

model marketable_production_mt = rfarm_price_mt rp_others_k sqrtrpromo_ads DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others sqrtrpromo DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others sqrtrpromo_ads DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others rpromo DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others_k sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rp_others sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D

;
model marketable_production_mt = rfarm_price_mt sqrtrpromo DI_Per_Cap_2005D ;

model marketable_production_percap = rfarm_price_mt rpromo_ads_percap ;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D time;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D ;

model marketable_production_percap = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D ;

model marketable_production_mt = rfarm_price_mt rpromo_ads ;
model marketable_production_mt = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D time;
model marketable_production_mt = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D

time;
model marketable_production_mt = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D

time;
model marketable_production_mt = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D ;
model marketable_production_mt = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D ;

```
	model marketable_production_mt = rfarm_price_mt rpalmonds rpromo
DI_Per_Cap_2005D ;
	model marketable_production_mt = rfarm_price_mt rpalmonds rpromo_ads
DI_Per_Cap_2005D ;
	model marketable_production_mt = rfarm_price_mt rpall_sub sqrtroregonb
sqrtrculinaryl DI_Per_Cap_2005D

;
	model marketable_production_mt = rfarm_price_mt rpalmonds sqrtroregonb
sqrtrculinaryl DI_Per_Cap_2005D

;
	model marketable_production_mt = rfarm_price_mt  sqrtrpromo
DI_Per_Cap_2005D ;

	model marketable_production_percap = rfarm_price_mt rpromo_ads_percap ;
	model marketable_production_percap = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others_k
sqrtrpromo_ads DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others sqrtrpromo
DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others sqrtrpromo_ads
DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others rpromo
DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others rpromo_ads
DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others_k sqrtroregonb
sqrtrculinaryl

DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others sqrtroregonb
sqrtrculinaryl

DI_Per_Cap_2005D time;
	model marketable_production_percap = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D ;
	model marketable_production_percap = rfarm_price_mt rp_others_k
sqrtrpromo_ads DI_Per_Cap_2005D ;
	model marketable_production_percap = rfarm_price_mt rp_others sqrtrpromo
DI_Per_Cap_2005D ;
	model marketable_production_percap = rfarm_price_mt rp_others sqrtrpromo_ads
DI_Per_Cap_2005D ;
	model marketable_production_percap = rfarm_price_mt rp_others rpromo
DI_Per_Cap_2005D ;
```

model marketable_production_percap = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rp_others_k sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D ;
model marketable_production_percap = rfarm_price_mt rp_others sqrtroregonb sqrtrculinaryl

DI_Per_Cap_2005D ;

model adj_dom_con_percap = rfarm_price_mt rpromo_ads_percap ; /* Decent - this is a very subjective

and temporary classification*/
model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtrpromo DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtrpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others sqrtrpromo DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others sqrtrpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others rpromo DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D

time;
model adj_dom_con_percap = rfarm_price_mt rp_others sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtrpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtrpromo_ads DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rp_others sqrtrpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rp_others sqrtrpromo_ads DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rp_others rpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D ;

```
        model adj_dom_con_percap = rfarm_price_mt rp_others_k sqrtroregonb
sqrtrculinaryl DI_Per_Cap_2005D ;
        model adj_dom_con_percap = rfarm_price_mt rp_others sqrtroregonb
sqrtrculinaryl DI_Per_Cap_2005D ;

        model adj_dom_con = rfarm_price_mt rpromo_ads ;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtrpromo_ads
DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others sqrtrpromo DI_Per_Cap_2005D
time;
        model adj_dom_con = rfarm_price_mt rp_others sqrtrpromo_ads
DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others rpromo DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D
time;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D time;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtrpromo
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtrpromo_ads
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others sqrtrpromo DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others sqrtrpromo_ads
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others rpromo DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others rpromo_ads DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others_k sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rp_others sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt  sqrtrpromo DI_Per_Cap_2005D ;

        model adj_dom_con_percap = rfarm_price_mt rpromo_ads_percap ;
        model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtrpromo
DI_Per_Cap_2005D time;
        model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtrpromo_ads
DI_Per_Cap_2005D time;
        model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtrpromo
DI_Per_Cap_2005D time;
        model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtrpromo_ads
DI_Per_Cap_2005D time;
```

model adj_dom_con_percap = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D time;
model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D ;
model adj_dom_con_percap = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D ;

model adj_dom_con = rfarm_price_mt rpromo_ads ;
model adj_dom_con = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpalmonds sqrtrpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl DI_Per_Cap_2005D time;
model adj_dom_con = rfarm_price_mt rpall_sub sqrtrpromo DI_Per_Cap_2005D ;
model adj_dom_con = rfarm_price_mt rpall_sub sqrtrpromo_ads DI_Per_Cap_2005D ;

```
        model adj_dom_con = rfarm_price_mt rpalmonds sqrtrpromo DI_Per_Cap_2005D
;
        model adj_dom_con = rfarm_price_mt rpalmonds sqrtrpromo_ads
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rpalmonds rpromo DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rpalmonds rpromo_ads DI_Per_Cap_2005D
;
        model adj_dom_con = rfarm_price_mt rpall_sub sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt rpalmonds sqrtroregonb sqrtrculinaryl
DI_Per_Cap_2005D ;
        model adj_dom_con = rfarm_price_mt  sqrtrpromo DI_Per_Cap_2005D ;

run;
quit;
title;

* Hausman Tests;
title 'Hausman Tests';
/* H0: Price is exogenous */
PROC REG data = hnut.working8;
                title 'Price - Hausman';
                model rfarm_price_mt =    lag2_rfarm_price_mt; /* the IV */
                output out =hnut.table5_out p=rfarm_predicted r=res;
run;
PROC REG data = hnut.table5_out; /* This table number has been depricated*/
        model marketable_production_mt = rfarm_price_mt rpromo_ads_percap res; /*
Tests for exogeneity */
        model marketable_production_mt = rfarm_predicted rpromo_ads_percap res;
run;
quit;
title;


/* H0: Advertising Per Cap is exogenous */
PROC REG data = hnut.working8;
                model rpromo_ads_percap = rpalmonds rpall_sub mycpi10
DI_Per_Cap_2005D lag_rfarm_price_mt

lag2_rfarm_price_mt lag3_rfarm_price_mt;
                output out =hnut.table5_out p=rpromo_predicted r=res;
run;
PROC REG data = hnut.table5_out;
        model marketable_production_mt = rfarm_price_mt rpromo_ads_percap res ;
        model marketable_production_mt = rfarm_price_mt rpromo_predicted res ;
run;
```

```
/* H0: Advertising is exogenous */
PROC REG data = hnut.working8;
                model rpromo_ads = rpalmonds rpall_sub mycpi10  DI_Per_Cap_2005D
lag_rfarm_price_mt

lag2_rfarm_price_mt lag3_rfarm_price_mt;
                output out =hnut.table5_out2 p=rpromo_predicted r=res;
PROC REG data = hnut.table5_out2;
        model marketable_production_mt = rfarm_price_mt rpromo_ads_percap res ;
        model marketable_production_mt = rfarm_price_mt rpromo_predicted res ;
/* H0: Promotion is exogenous */
PROC REG data = hnut.working8;
                model rpromo = rpalmonds rpall_sub mycpi10  DI_Per_Cap_2005D
lag_rfarm_price_mt

lag2_rfarm_price_mt lag3_rfarm_price_mt;
                output out =hnut.table5_out3 p=rpromo_predicted r=res;
PROC REG data = hnut.table5_out3;
        model marketable_production_mt = rfarm_price_mt rpromo res ;
        model marketable_production_mt = rfarm_price_mt rpromo_predicted res ;
run;
title;

* Making new instruments for Z2;
data working9;
        set hnut.working9;
        lag_inshell_export_p_USD_MT = lag(inshell_export_p_USD_MT);
        lag_rp_others  = lag(rp_others);
        lag_sqrtrpromo  = lag(sqrtrpromo);
        lag_timesq =lag(timesq);
        lag_DI_Per_Cap_2005D = lag(DI_Per_Cap_2005D);
run;


************************************************************
**      Section III: 2SLS, SEM, Monte Carlo, and B-C with Y1, Z1    **
************************************************************;


* Section III: 2SLS Demand Model;
title'Section III: 2SLS Demand Model';
PROC SYSLIN DATA = hnut.working8 2sls out=hnut.tsls_predicted outest=hnut.est first;
        endogenous  rfarm_price_mt;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
```

```
        demand: model marketable_production_mt = rfarm_price_mt  sqrtrpromo
DI_Per_Cap_2005D ;
        output predicted=qhat residual=r;

run;
title;

* DATA step to create variables from qhat;
DATA hnut.working9;
        set hnut.tsls_predicted;
        A_0=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**0);
        A_1=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**1);
        A_2=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**2);
        A_5=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**5);
        where time GE 7;
run;

DATA hnut.nopromo;
        set hnut.working9;
        promo=0;
        rpromo=0;
        sqrtrpromo=0;
        where time GE 7;
run;

DATA hnut.promo101;
        set hnut.working9;
        promo=promo*1.01;
        rpromo=rpromo*1.01;
        sqrtrpromo=sqrtrpromo*1.01;
        where time GE 7;
run;


*********************
* SEM and Monte Carlo*
*********************;

* Actual promotion, e = 0;
PROC MODEL DATA = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
```

```
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
	eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	  instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
	  solve marketable_production_mt rfarm_price_mt / DATA= hnut.working9
estdata=xch_est  outpredict
	rsndom = 1000 seed = 1 out = hnut.section3_mc_actual_e0;
run;
quit;

* Actual promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
	VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
	PARMS a1 b1 c1 d1 e1;
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
	eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
	  solve marketable_production_mt rfarm_price_mt / data= hnut.working9
estdata=xch_est  outpredict
	rsndom = 1000 seed = 1 out = hnut.section3_mc_actual_e1;
run;
quit;
* Actual promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
	VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
	PARMS a1 b1 c1 d1 e1;
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
	eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
	  solve marketable_production_mt rfarm_price_mt / data= hnut.working9
estdata=xch_est  outpredict

CONVERGE=1
	rsndom = 1000 seed = 1 out = hnut.section3_mc_actual_e2;
run;
```

```
quit;
* Actual promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
	VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
	PARMS a1 b1 c1 d1 e1;
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D - 
marketable_production_mt;
	eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) - 
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq 
DI_Per_Cap_2005D;
	  solve marketable_production_mt rfarm_price_mt / data= hnut.working9 
estdata=xch_est  outpredict
	rsndom = 1000 seed = 1 out = hnut.section3_mc_actual_e5;
run;
quit;

* No promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
	VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
	PARMS a1 b1 c1 d1 e1;
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D - 
marketable_production_mt;
	eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) - 
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq 
DI_Per_Cap_2005D;
	  solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo 
estdata=xch_est  outpredict
	rsndom = 1000 seed = 1 out = hnut.section3_mc_nopromo_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
	VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
	PARMS a1 b1 c1 d1 e1;
	eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D - 
marketable_production_mt;
	eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) - 
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
	instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq 
DI_Per_Cap_2005D;
```

```
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section3_mc_nopromo_e1;
run;
quit;

* No promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
           instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section3_mc_nopromo_e2;
run;
quit;

* No promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
           instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section3_mc_nopromo_e5;
run;
quit;

* 101% promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
```

```
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section3_mc_101_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=.1
        rsndom = 1000 seed = 1 out = hnut.section3_mc_101_e1;
run;
quit;

* 101% promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict
```

```
CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section3_mc_101_e2;
run;
quit;

* 101% promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section3_mc_101_e5;
run;
quit;


******************************
*    Marginal Cost-Benefit ratio    *
******************************;
data tmp0_101;
        set hnut.section3_mc_101_e0;
        q_prime_101_e0 = marketable_production_mt;
        p_prime_101_e0 = rfarm_price_mt;
run;

DATA tmp1_101;
        set hnut.section3_mc_101_e1;
        q_prime_101_e1 = marketable_production_mt;
        p_prime_101_e1 = rfarm_price_mt;
run;

DATA tmp2_101;
        set hnut.section3_mc_101_e2;
        q_prime_101_e2 = marketable_production_mt;
        p_prime_101_e2 = rfarm_price_mt;
run;
```

```
DATA tmp5_101;
        set hnut.section3_mc_101_e5;
        q_prime_101_e5 = marketable_production_mt;
        p_prime_101_e5 = rfarm_price_mt;
run;

DATA tmp0;
        set hnut.section3_mc_actual_e0;
        q_prime_actual_e0 = marketable_production_mt;
        p_prime_actual_e0 = rfarm_price_mt;
run;

DATA tmp1;
        set hnut.section3_mc_actual_e1;
        q_prime_actual_e1 = marketable_production_mt;
        p_prime_actual_e1 = rfarm_price_mt;
run;

DATA tmp2;
        set hnut.section3_mc_actual_e2;
        q_prime_actual_e2 = marketable_production_mt;
        p_prime_actual_e2 = rfarm_price_mt;
run;


DATA tmp5;
        set hnut.section3_mc_actual_e5;
        q_prime_actual_e5 = marketable_production_mt;
        p_prime_actual_e5 = rfarm_price_mt;
run;

DATA tmp0_nopromo;
        set hnut.section3_mc_nopromo_e0;
        q_prime_nopromo_e0 = marketable_production_mt;
        p_prime_nopromo_e0 = rfarm_price_mt;
run;

DATA tmp1_nopromo;
        set hnut.section3_mc_nopromo_e1;
        q_prime_nopromo_e1 = marketable_production_mt;
        p_prime_nopromo_e1 = rfarm_price_mt;
run;

DATA tmp2_nopromo;
        set hnut.section3_mc_nopromo_e2;
        q_prime_nopromo_e2 = marketable_production_mt;
```

```
        p_prime_nopromo_e2 = rfarm_price_mt;
run;

DATA tmp5_nopromo;
        set hnut.section3_mc_nopromo_e5;
        q_prime_nopromo_e5 = marketable_production_mt;
        p_prime_nopromo_e5 = rfarm_price_mt;
run;

PROC SORT data = tmp0;
        by _REP_ time;
PROC SORT data = tmp1;
        by _REP_ time;
PROC SORT data = tmp2;
        by _REP_ time;
PROC SORT data = tmp5;
        by _REP_ time;
PROC SORT data = tmp0_nopromo;
        by _REP_ time;
PROC SORT data = tmp1_nopromo;
        by _REP_ time;
PROC SORT data = tmp2_nopromo;
        by _REP_ time;
PROC SORT data = tmp5_nopromo;
        by _REP_ time;
PROC SORT data = tmp0_101;
        by _REP_ time;
PROC SORT data = tmp1_101;
        by _REP_ time;
PROC SORT data = tmp2_101;
        by _REP_ time;
PROC SORT data = tmp5_101;
        by _REP_ time;
run;
lock <hnut.BC_actual_nopromo> clear ;
DATA hnut.BC_actual_nopromo;
        merge tmp0 tmp1 tmp2 tmp5 tmp0_nopromo tmp1_nopromo tmp2_nopromo
tmp5_nopromo;
        by _REP_ time;
run;
lock <hnut.BC_actual_nopromo> clear ;
PROC SORT data= hnut.BC_actual_nopromo;
        by _REP_ time ;
run;
```

```
lock <hnut.BC_actual_101> clear ;
DATA hnut.BC_actual_101;
        merge tmp0_101 tmp1_101 tmp2_101 tmp5_101 tmp0 tmp1 tmp2 tmp5;
        by _REP_ time;
run;
PROC SORT data= hnut.BC_actual_101;
        by _REP_ time ;
run;
DATA price; /* I'm recovering the actual price variable */
        set hnut.working9;
        keep time rfarm_price_mt rpromo;
run;
lock <hnut.BC_actual_nopromo> clear ;
DATA hnut.BC_actual_nopromo;
        set hnut.BC_actual_nopromo;
        drop rfarm_price_mt;
run;
lock <hnut.BC_actual_nopromo> clear ;
PROC SORT data = hnut.BC_actual_nopromo;
        by time;
run;
PROC SORT data = price;
        by time;
run;
lock <hnut.BC_actual_nopromo> clear ;
DATA hnut.BC_actual_nopromo;
        merge hnut.BC_actual_nopromo price;
        by time;
run;

lock <hnut.BC_actual_101> clear ;
DATA hnut.BC_actual_101;
        set hnut.BC_actual_101;
        drop rfarm_price_mt;
run;
PROC SORT data = hnut.BC_actual_101;
        by time;
run;
PROC SORT data = price;
        by time;
run;
lock <hnut.BC_actual_101> clear ; DATA hnut.BC_actual_101;
        merge hnut.BC_actual_101 price;
        by time;
run;
proc print data = hnut.BC_actual_101;
```

```
	var rfarm_price_mt;
	where _REP_ LE 4;
run;

lock <hnut.BC_actual_nopromo> clear ;
DATA hnut.S3_benefitcost_actual_nopromo;
	set hnut.BC_actual_nopromo;
	rpromo = marketable_production_mt*rpromo_mt;
	tau = rpromo_mt/rfarm_price_mt;
	tau_nopromo = 0;
	prod_surplus_e0 = ((((1-tau)*p_prime_actual_e0)*q_prime_actual_e0) - (((1-
tau_nopromo)*

p_prime_nopromo_e0)*q_prime_nopromo_e0))/(1+0);
	prod_surplus_e1 = ((((1-tau)*p_prime_actual_e1)*q_prime_actual_e1) -(((1-
tau_nopromo)*

p_prime_nopromo_e1)*q_prime_nopromo_e1))/(1+1);
	prod_surplus_e2 = ((((1-tau)*p_prime_actual_e2)*q_prime_actual_e2) - (((1-
tau_nopromo)*

p_prime_nopromo_e2)*q_prime_nopromo_e2))/(1+2);
	prod_surplus_e5 = ((((1-tau)*p_prime_actual_e5)*q_prime_actual_e5) - (((1-
tau_nopromo)*

p_prime_nopromo_e5)*q_prime_nopromo_e5))/(1+5);
	BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt);
	BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt);
	BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt);
	BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt);
	where time GE 8;
run;
quit;

DATA hnut.S3_benefitcost_actual_101;
	set hnut.BC_actual_101;
	rpromo = marketable_production_mt*rpromo_mt;
	tau = rpromo_mt/rfarm_price_mt;
	tau_nopromo = 0;
	tau_101 = (rpromo_mt*1.01)/rfarm_price_mt;
	prod_surplus_e0 = ((((1-tau_101)* p_prime_101_e0)*q_prime_101_e0)- (((1-tau)*
p_prime_actual_e0)*

q_prime_actual_e0))/(1+0);
```

```
        prod_surplus_e1 = ((((1-tau_101)* p_prime_101_e1)*q_prime_101_e1)- (((1-tau)*
p_prime_actual_e1)*

q_prime_actual_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau_101)* p_prime_101_e2)*q_prime_101_e2)- (((1-tau)*
p_prime_actual_e2)*

q_prime_actual_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau_101)* p_prime_101_e5)*q_prime_101_e5)- (((1-tau)*
p_prime_actual_e5)*

q_prime_actual_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt*.01);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt*.01);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt*.01);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt*.01);
        where time GE 8;
run;
quit;

title 'Benefit-Cost Ratio: Actual v. No Promo';
PROC MEANS data = hnut.S3_benefitcost_actual_nopromo;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s3_bc_actual_nopromo;
run;
title;
ods output close;


title 'Benefit-Cost Ratio: Actual v. 1% Increase in Promotion';
PROC MEANS data = hnut.S3_benefitcost_actual_101;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
```

```
        output out = hnut.RESULTS_s3_bc_actual_101;
run;
title;
ods output close;




**********************************************************
**    Section IV: 2SLS, SEM, Monte Carlo, and B-C with Y1, Z2     **
**********************************************************;


        * Table: 2SLS Demand Model;
title'Section 6: 2SLS Demand Model';
PROC SYSLIN DATA = hnut.working8 2sls out=hnut.tsls_predicted outest=hnut.est first;
        endogenous sqrtrpromo rfarm_price_mt;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
        demand: model marketable_production_mt = rfarm_price_mt  sqrtrpromo
DI_Per_Cap_2005D ;
        output predicted=qhat residual=r;
run;
title;

* DATA step to create variables from qhat;
DATA hnut.working9;
        set hnut.tsls_predicted;
        A_0=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**0);
        A_1=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**1);
        A_2=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**2);
        A_5=qhat/(((1-
((rpromo/marketable_production_mt)/rfarm_price_mt))*rfarm_price_mt)**5);
        where time GE 7;
run;

DATA hnut.nopromo;
        set hnut.working9;
        promo=0;
        rpromo=0;
        sqrtrpromo=0;
        where time GE 7;
```

```
run;

DATA hnut.promo101;
        set hnut.working9;
        promo=promo*1.01;
        rpromo=rpromo*1.01;
        sqrtrpromo=sqrtrpromo*1.01;
        where time GE 7;
run;


* SEM and Monte Carlo;

* Actual promotion, e = 0;
PROC MODEL DATA = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt
lag_inshell_export_p_USD_MT lag_rp_others

lag_sqrtrpromo timesq lag_DI_Per_Cap_2005D;
        PARMS a1 b1 c1 d1;
        eq.demand = a1 + b1*rfarm_price_mt + c1*sqrtrpromo + d1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve marketable_production_mt rfarm_price_mt / DATA= hnut.working9
estdata=xch_est  outpredict
        rsndom = 1000 seed = 1 out = hnut.section4_mc_actual_e0;
run;
quit;

* Actual promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 ;
        eq.demand = a1 + b1*rfarm_price_mt + c1*sqrtrpromo + d1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve marketable_production_mt rfarm_price_mt / data= hnut.working9
estdata=xch_est  outpredict
```

```
        rsndom = 1000 seed = 1 out = hnut.section4_mc_actual_e1;
run;
quit;
* Actual promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve marketable_production_mt rfarm_price_mt / data= hnut.working9
estdata=xch_est  outpredict

CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section4_mc_actual_e2;
run;
quit;
* Actual promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
marketable_production_mt;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve marketable_production_mt rfarm_price_mt / data= hnut.working9
estdata=xch_est  outpredict
        rsndom = 1000 seed = 1 out = hnut.section4_mc_actual_e5;
run;
quit;

* No promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
marketable_production_mt;
```

```
     fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section4_mc_nopromo_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section4_mc_nopromo_e1;
run;
quit;

* No promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
           instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section4_mc_nopromo_e2;
run;
quit;

* No promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
```

```
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
           instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.nopromo
estdata=xch_est  outpredict
          rsndom = 1000 seed = 1 out = hnut.section4_mc_nopromo_e5;
run;
quit;

* 101% promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
           instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
           solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=0.1
          rsndom = 1000 seed = 1 out = hnut.section4_mc_101_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
```

```
            solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=.1
          rsndom = 1000 seed = 1 out = hnut.section4_mc_101_e1;
run;
quit;

* 101% promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
            solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=1
          rsndom = 1000 seed = 1 out = hnut.section4_mc_101_e2;
run;
quit;

* 101% promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
          VAR rfarm_price_mt sqrtrpromo time marketable_production_mt;
          PARMS a1 b1 c1 d1 e1;
          eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
marketable_production_mt;
          eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
marketable_production_mt;
     fit demand /  outest=xch_est outcov outs=s n2sls;
            instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
            solve marketable_production_mt rfarm_price_mt / data= hnut.promo101
estdata=xch_est  outpredict

CONVERGE=0.1
          rsndom = 1000 seed = 1 out = hnut.section4_mc_101_e5;
run;
quit;
```

```
******************************
*    Marginal Cost-Benefit ratio    *
******************************;
data tmp0_101;
	set hnut.section4_mc_101_e0;
	q_prime_101_e0 = marketable_production_mt;
	p_prime_101_e0 = rfarm_price_mt;
run;

DATA tmp1_101;
	set hnut.section4_mc_101_e1;
	q_prime_101_e1 = marketable_production_mt;
	p_prime_101_e1 = rfarm_price_mt;
run;

DATA tmp2_101;
	set hnut.section4_mc_101_e2;
	q_prime_101_e2 = marketable_production_mt;
	p_prime_101_e2 = rfarm_price_mt;
run;

DATA tmp5_101;
	set hnut.section4_mc_101_e5;
	q_prime_101_e5 = marketable_production_mt;
	p_prime_101_e5 = rfarm_price_mt;
run;

DATA tmp0;
	set hnut.section4_mc_actual_e0;
	q_prime_actual_e0 = marketable_production_mt;
	p_prime_actual_e0 = rfarm_price_mt;
run;

DATA tmp1;
	set hnut.section4_mc_actual_e1;
	q_prime_actual_e1 = marketable_production_mt;
	p_prime_actual_e1 = rfarm_price_mt;
run;

DATA tmp2;
	set hnut.section4_mc_actual_e2;
	q_prime_actual_e2 = marketable_production_mt;
	p_prime_actual_e2 = rfarm_price_mt;
run;
```

```
DATA tmp5;
        set hnut.section4_mc_actual_e5;
        q_prime_actual_e5 = marketable_production_mt;
        p_prime_actual_e5 = rfarm_price_mt;
run;

DATA tmp0_nopromo;
        set hnut.section4_mc_nopromo_e0;
        q_prime_nopromo_e0 = marketable_production_mt;
        p_prime_nopromo_e0 = rfarm_price_mt;
run;

DATA tmp1_nopromo;
        set hnut.section4_mc_nopromo_e1;
        q_prime_nopromo_e1 = marketable_production_mt;
        p_prime_nopromo_e1 = rfarm_price_mt;
run;

DATA tmp2_nopromo;
        set hnut.section4_mc_nopromo_e2;
        q_prime_nopromo_e2 = marketable_production_mt;
        p_prime_nopromo_e2 = rfarm_price_mt;
run;

DATA tmp5_nopromo;
        set hnut.section4_mc_nopromo_e5;
        q_prime_nopromo_e5 = marketable_production_mt;
        p_prime_nopromo_e5 = rfarm_price_mt;
run;

PROC SORT data = tmp0;
        by _REP_ time;
PROC SORT data = tmp1;
        by _REP_ time;
PROC SORT data = tmp2;
        by _REP_ time;
PROC SORT data = tmp5;
        by _REP_ time;
PROC SORT data = tmp0_nopromo;
        by _REP_ time;
PROC SORT data = tmp1_nopromo;
        by _REP_ time;
PROC SORT data = tmp2_nopromo;
        by _REP_ time;
PROC SORT data = tmp5_nopromo;
```

```
        by _REP_ time;
PROC SORT data = tmp0_101;
        by _REP_ time;
PROC SORT data = tmp1_101;
        by _REP_ time;
PROC SORT data = tmp2_101;
        by _REP_ time;
PROC SORT data = tmp5_101;
        by _REP_ time;
run;

DATA hnut.benefitcost_actual_nopromo;
        merge tmp0 tmp1 tmp2 tmp5 tmp0_nopromo tmp1_nopromo tmp2_nopromo
tmp5_nopromo;
        by _REP_ time;
run;

PROC SORT data= hnut.benefitcost_actual_nopromo;
        by _REP_ time ;
run;

DATA hnut.benefitcost_actual_101;
        merge tmp0_101 tmp1_101 tmp2_101 tmp5_101 tmp0 tmp1 tmp2 tmp5;
        by _REP_ time;
run;
PROC SORT data= hnut.benefitcost_actual_101;
        by _REP_ time ;
run;
DATA price; /* I'm recovering the actual price variable */
        set hnut.working9;
        keep time rfarm_price_mt rpromo;
run;
DATA hnut.benefitcost_actual_nopromo;
        set hnut.benefitcost_actual_nopromo;
        drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_nopromo;
        by time;
run;
PROC SORT data = price;
        by time;
run;
DATA hnut.benefitcost_actual_nopromo;
        merge hnut.benefitcost_actual_nopromo price;
        by time;
run;
```

```
DATA hnut.benefitcost_actual_101;
        set hnut.benefitcost_actual_101;
        drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_101;
        by time;
run;
PROC SORT data = price;
        by time;
run;
DATA hnut.benefitcost_actual_101;
        merge hnut.benefitcost_actual_101 price;
        by time;
run;
proc print data = hnut.benefitcost_actual_101;
        var rfarm_price_mt;
        where _REP_ LE 4;
run;


DATA hnut.S4_benefitcost_actual_nopromo;
        set hnut.benefitcost_actual_nopromo;
        rpromo = marketable_production_mt*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
        prod_surplus_e0 = ((((1-tau)*p_prime_actual_e0)*q_prime_actual_e0) - (((1-
tau_nopromo)*

p_prime_nopromo_e0)*q_prime_nopromo_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau)*p_prime_actual_e1)*q_prime_actual_e1) -(((1-
tau_nopromo)*

p_prime_nopromo_e1)*q_prime_nopromo_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau)*p_prime_actual_e2)*q_prime_actual_e2) - (((1-
tau_nopromo)*

p_prime_nopromo_e2)*q_prime_nopromo_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau)*p_prime_actual_e5)*q_prime_actual_e5) - (((1-
tau_nopromo)*

p_prime_nopromo_e5)*q_prime_nopromo_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt);
```

```
        where time GE 8;
run;
quit;

DATA hnut.S4_benefitcost_actual_101;
        set hnut.benefitcost_actual_101;
        rpromo = marketable_production_mt*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
        tau_101 = (rpromo_mt*1.01)/rfarm_price_mt;
        prod_surplus_e0 = ((((1-tau_101)* p_prime_101_e0)*q_prime_101_e0)- (((1-tau)*
p_prime_actual_e0)*

q_prime_actual_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau_101)* p_prime_101_e1)*q_prime_101_e1)- (((1-tau)*
p_prime_actual_e1)*

q_prime_actual_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau_101)* p_prime_101_e2)*q_prime_101_e2)- (((1-tau)*
p_prime_actual_e2)*

q_prime_actual_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau_101)* p_prime_101_e5)*q_prime_101_e5)- (((1-tau)*
p_prime_actual_e5)*

q_prime_actual_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt*.01);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt*.01);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt*.01);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt*.01);
        where time GE 8;
run;
quit;

title 'Benefit-Cost Ratio: Actual v. No Promo';
PROC MEANS data = hnut.S4_benefitcost_actual_nopromo;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s4_bc_actual_nopromo;
run;
```

```
title;
ods output close;


title 'Benefit-Cost Ratio: Actual v. 1% Increase in Promotion';
PROC MEANS data = hnut.S4_benefitcost_actual_101;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s4_bc_actual_101;
run;
title;
ods output close;


***********************************************************
** Section V: 2SLS, SEM, Monte Carlo, and B-C with Y2, Z1 **
***********************************************************;

* Table: 2SLS Demand Model;
title'Section V: 2SLS Demand Model';
PROC SYSLIN DATA = hnut.working8 2sls out=hnut.tsls_predicted outest=hnut.est first;
        endogenous sqrtrpromo rfarm_price_mt;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
        demand: model adj_dom_con = rfarm_price_mt  sqrtrpromo DI_Per_Cap_2005D ;
        output predicted=qhat residual=r;
        where time GE 7;
run;
title;

* DATA step to create variables from qhat;
DATA hnut.working9;
        set hnut.tsls_predicted;
        A_0=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**0);
        A_1=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**1);
        A_2=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**2);
        A_5=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**5);
        where time GE 7;
run;
```

```
DATA hnut.nopromo;
        set hnut.working9;
        promo=0;
        rpromo=0;
        sqrtrpromo=0;
        where time GE 7;
run;

DATA hnut.promo101;
        set hnut.working9;
        promo=promo*1.01;
        rpromo=rpromo*1.01;
        sqrtrpromo=sqrtrpromo*1.01;
        where time GE 7;
run;


* SEM and Monte Carlo;

* Actual promotion, e = 0;
PROC MODEL DATA = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / DATA= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_actual_e0;
run;
quit;

* Actual promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
```

```
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_actual_e1;
run;
quit;
* Actual promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section5_mc_actual_e2;
run;
quit;
* Actual promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_actual_e5;
run;
quit;

* No promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
```

```
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_nopromo_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_nopromo_e1;
run;
quit;

* No promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_nopromo_e2;
run;
quit;

* No promotion, e = 5;
```

```
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section5_mc_nopromo_e5;
run;
quit;

* 101% promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section5_mc_101_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=.1
```

```
        rsndom = 1000 seed = 1 out = hnut.section5_mc_101_e1;
run;
quit;

* 101% promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section5_mc_101_e2;
run;
quit;

* 101% promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments inshell_export_p_USD_MT rp_others sqrtrpromo timesq
DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section5_mc_101_e5;
run;
quit;


******************************
*    Marginal Cost-Benefit ratio     *
******************************;
data tmp0_101;
        set hnut.section5_mc_101_e0;
        q_prime_101_e0 = adj_dom_con;
        p_prime_101_e0 = rfarm_price_mt;
```

```
run;

DATA tmp1_101;
	set hnut.section5_mc_101_e1;
	q_prime_101_e1 = adj_dom_con;
	p_prime_101_e1 = rfarm_price_mt;
run;

DATA tmp2_101;
	set hnut.section5_mc_101_e2;
	q_prime_101_e2 = adj_dom_con;
	p_prime_101_e2 = rfarm_price_mt;
run;

DATA tmp5_101;
	set hnut.section5_mc_101_e5;
	q_prime_101_e5 = adj_dom_con;
	p_prime_101_e5 = rfarm_price_mt;
run;

DATA tmp0;
	set hnut.section5_mc_actual_e0;
	q_prime_actual_e0 = adj_dom_con;
	p_prime_actual_e0 = rfarm_price_mt;
run;

DATA tmp1;
	set hnut.section5_mc_actual_e1;
	q_prime_actual_e1 = adj_dom_con;
	p_prime_actual_e1 = rfarm_price_mt;
run;

DATA tmp2;
	set hnut.section5_mc_actual_e2;
	q_prime_actual_e2 = adj_dom_con;
	p_prime_actual_e2 = rfarm_price_mt;
run;


DATA tmp5;
	set hnut.section5_mc_actual_e5;
	q_prime_actual_e5 = adj_dom_con;
	p_prime_actual_e5 = rfarm_price_mt;
run;

DATA tmp0_nopromo;
```

```
        set hnut.section5_mc_nopromo_e0;
        q_prime_nopromo_e0 = adj_dom_con;
        p_prime_nopromo_e0 = rfarm_price_mt;
run;

DATA tmp1_nopromo;
        set hnut.section5_mc_nopromo_e1;
        q_prime_nopromo_e1 = adj_dom_con;
        p_prime_nopromo_e1 = rfarm_price_mt;
run;

DATA tmp2_nopromo;
        set hnut.section5_mc_nopromo_e2;
        q_prime_nopromo_e2 = adj_dom_con;
        p_prime_nopromo_e2 = rfarm_price_mt;
run;

DATA tmp5_nopromo;
        set hnut.section5_mc_nopromo_e5;
        q_prime_nopromo_e5 = adj_dom_con;
        p_prime_nopromo_e5 = rfarm_price_mt;
run;

PROC SORT data = tmp0;
        by _REP_ time;
PROC SORT data = tmp1;
        by _REP_ time;
PROC SORT data = tmp2;
        by _REP_ time;
PROC SORT data = tmp5;
        by _REP_ time;
PROC SORT data = tmp0_nopromo;
        by _REP_ time;
PROC SORT data = tmp1_nopromo;
        by _REP_ time;
PROC SORT data = tmp2_nopromo;
        by _REP_ time;
PROC SORT data = tmp5_nopromo;
        by _REP_ time;
PROC SORT data = tmp0_101;
        by _REP_ time;
PROC SORT data = tmp1_101;
        by _REP_ time;
PROC SORT data = tmp2_101;
        by _REP_ time;
PROC SORT data = tmp5_101;
```

```
        by _REP_ time;
run;

DATA hnut.benefitcost_actual_nopromo;
        merge tmp0 tmp1 tmp2 tmp5 tmp0_nopromo tmp1_nopromo tmp2_nopromo
tmp5_nopromo;
        by _REP_ time;
run;
PROC SORT data= hnut.benefitcost_actual_nopromo;
        by _REP_ time ;
run;

DATA hnut.benefitcost_actual_101;
        merge tmp0_101 tmp1_101 tmp2_101 tmp5_101 tmp0 tmp1 tmp2 tmp5;
        by _REP_ time;
run;
PROC SORT data= hnut.benefitcost_actual_101;
        by _REP_ time ;
run;
DATA price; /* I'm recovering the actual price variable */
        set hnut.working9;
        keep time rfarm_price_mt rpromo;
run;
DATA hnut.benefitcost_actual_nopromo;
        set hnut.benefitcost_actual_nopromo;
        drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_nopromo;
        by time;
run;
PROC SORT data = price;
        by time;
run;
DATA hnut.benefitcost_actual_nopromo;
        merge hnut.benefitcost_actual_nopromo price;
        by time;
run;

DATA hnut.benefitcost_actual_101;
        set hnut.benefitcost_actual_101;
        drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_101;
        by time;
run;
PROC SORT data = price;
```

```
        by time;
run;
DATA hnut.benefitcost_actual_101;
        merge hnut.benefitcost_actual_101 price;
        by time;
run;
proc print data = hnut.benefitcost_actual_101;
        var rfarm_price_mt;
        where _REP_ LE 4;
run;


DATA hnut.S5_benefitcost_actual_nopromo;
        set hnut.benefitcost_actual_nopromo;
        rpromo = adj_dom_con*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
        prod_surplus_e0 = ((((1-tau)*p_prime_actual_e0)*q_prime_actual_e0) - (((1-
tau_nopromo)*

p_prime_nopromo_e0)*q_prime_nopromo_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau)*p_prime_actual_e1)*q_prime_actual_e1) -(((1-
tau_nopromo)*

p_prime_nopromo_e1)*q_prime_nopromo_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau)*p_prime_actual_e2)*q_prime_actual_e2) - (((1-
tau_nopromo)*

p_prime_nopromo_e2)*q_prime_nopromo_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau)*p_prime_actual_e5)*q_prime_actual_e5) - (((1-
tau_nopromo)*

p_prime_nopromo_e5)*q_prime_nopromo_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt);
        where time GE 8;
run;
quit;

DATA hnut.S5_benefitcost_actual_101;
        set hnut.benefitcost_actual_101;
        rpromo = adj_dom_con*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
```

```
        tau_101 = (rpromo_mt*1.01)/rfarm_price_mt;
        prod_surplus_e0 = ((((1-tau_101)* p_prime_101_e0)*q_prime_101_e0)- (((1-tau)*
p_prime_actual_e0)*

q_prime_actual_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau_101)* p_prime_101_e1)*q_prime_101_e1)- (((1-tau)*
p_prime_actual_e1)*

q_prime_actual_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau_101)* p_prime_101_e2)*q_prime_101_e2)- (((1-tau)*
p_prime_actual_e2)*

q_prime_actual_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau_101)* p_prime_101_e5)*q_prime_101_e5)- (((1-tau)*
p_prime_actual_e5)*

q_prime_actual_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt);
        where time GE 8;
run;
quit;

title 'Benefit-Cost Ratio: Actual v. No Promo';
PROC MEANS data = hnut.S5_benefitcost_actual_nopromo;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s5_bc_actual_nopromo;
run;
title;
ods output close;


title 'Benefit-Cost Ratio: Actual v. 1% Increase in Promotion';
PROC MEANS data = hnut.S5_benefitcost_actual_101;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
```

```
            BC_ratio_e5
            prod_surplus_e0
            prod_surplus_e1
            prod_surplus_e2
            prod_surplus_e5;
        output out = hnut.RESULTS_s5_bc_actual_101;
run;
title;
ods output close;

*************************************************************
** Section VI: 2SLS, SEM, Monte Carlo, and B-C with Y2, Z2 **
*************************************************************;


        * Table: 2SLS Demand Model;
title'Section 6: 2SLS Demand Model';
PROC SYSLIN DATA = hnut.working8 2sls out=hnut.tsls_predicted outest=hnut.est first;
        endogenous sqrtrpromo rfarm_price_mt;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
        demand: model adj_dom_con = rfarm_price_mt  sqrtrpromo DI_Per_Cap_2005D ;
        output predicted=qhat residual=r;
run;
title;

* DATA step to create variables from qhat;
DATA hnut.working9;
        set hnut.tsls_predicted;
        A_0=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**0);
        A_1=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**1);
        A_2=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**2);
        A_5=qhat/(((1-((rpromo/adj_dom_con)/rfarm_price_mt))*rfarm_price_mt)**5);
        where time GE 7;
run;

DATA hnut.nopromo;
        set hnut.working9;
        promo=0;
        rpromo=0;
        sqrtrpromo=0;
        where time GE 7;
run;

DATA hnut.promo101;
        set hnut.working9;
```

```
        promo=promo*1.01;
        rpromo=rpromo*1.01;
        sqrtrpromo=sqrtrpromo*1.01;
        where time GE 7;
run;


* SEM and Monte Carlo;

* Actual promotion, e = 0;
PROC MODEL DATA = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / DATA= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_actual_e0;
run;
quit;

* Actual promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_actual_e1;
run;
quit;
* Actual promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
```

```
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section6_mc_actual_e2;
run;
quit;
* Actual promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.working9 estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_actual_e5;
run;
quit;

* No promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_nopromo_e0;
run;
quit;
```

```
* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_nopromo_e1;
run;
quit;

* No promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
         solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_nopromo_e2;
run;
quit;

* No promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
         instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
```

```
          solve adj_dom_con rfarm_price_mt / data= hnut.nopromo estdata=xch_est
outpredict
        rsndom = 1000 seed = 1 out = hnut.section6_mc_nopromo_e5;
run;
quit;

* 101% promotion, e = 0;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_0*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**0) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section6_mc_101_e0;
run;
quit;

* No promotion, e = 1;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_1*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**1) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=.1
        rsndom = 1000 seed = 1 out = hnut.section6_mc_101_e1;
run;
quit;

* 101% promotion, e = 2;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
```

```
        eq.supply = A_2*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**2) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
        instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=1
        rsndom = 1000 seed = 1 out = hnut.section6_mc_101_e2;
run;
quit;

* 101% promotion, e = 5;
PROC MODEL data = hnut.working9 maxiter = 32000;
        VAR rfarm_price_mt sqrtrpromo time adj_dom_con;
        PARMS a1 b1 c1 d1 e1;
        eq.demand = a1 + b1*rfarm_price_mt + d1*sqrtrpromo + e1*DI_Per_Cap_2005D -
adj_dom_con;
        eq.supply = A_5*(((1-(rpromo_mt/rfarm_price_mt))*rfarm_price_mt)**5) -
adj_dom_con;
    fit demand /  outest=xch_est outcov outs=s n2sls;
          instruments lag_inshell_export_p_USD_MT lag_rp_others lag_sqrtrpromo timesq
lag_DI_Per_Cap_2005D;
          solve adj_dom_con rfarm_price_mt / data= hnut.promo101 estdata=xch_est
outpredict CONVERGE=0.1
        rsndom = 1000 seed = 1 out = hnut.section6_mc_101_e5;
run;
quit;


******************************
* Marginal Cost-Benefit ratio *
******************************;
data tmp0_101;
        set hnut.section6_mc_101_e0;
        q_prime_101_e0 = adj_dom_con;
        p_prime_101_e0 = rfarm_price_mt;
run;

DATA tmp1_101;
        set hnut.section6_mc_101_e1;
        q_prime_101_e1 = adj_dom_con;
        p_prime_101_e1 = rfarm_price_mt;
run;

DATA tmp2_101;
        set hnut.section6_mc_101_e2;
```

```
        q_prime_101_e2 = adj_dom_con;
        p_prime_101_e2 = rfarm_price_mt;
run;

DATA tmp5_101;
        set hnut.section6_mc_101_e5;
        q_prime_101_e5 = adj_dom_con;
        p_prime_101_e5 = rfarm_price_mt;
run;

DATA tmp0;
        set hnut.section6_mc_actual_e0;
        q_prime_actual_e0 = adj_dom_con;
        p_prime_actual_e0 = rfarm_price_mt;
run;

DATA tmp1;
        set hnut.section6_mc_actual_e1;
        q_prime_actual_e1 = adj_dom_con;
        p_prime_actual_e1 = rfarm_price_mt;
run;

DATA tmp2;
        set hnut.section6_mc_actual_e2;
        q_prime_actual_e2 = adj_dom_con;
        p_prime_actual_e2 = rfarm_price_mt;
run;


DATA tmp5;
        set hnut.section6_mc_actual_e5;
        q_prime_actual_e5 = adj_dom_con;
        p_prime_actual_e5 = rfarm_price_mt;
run;

DATA tmp0_nopromo;
        set hnut.section6_mc_nopromo_e0;
        q_prime_nopromo_e0 = adj_dom_con;
        p_prime_nopromo_e0 = rfarm_price_mt;
run;

DATA tmp1_nopromo;
        set hnut.section6_mc_nopromo_e1;
        q_prime_nopromo_e1 = adj_dom_con;
        p_prime_nopromo_e1 = rfarm_price_mt;
run;
```

```
DATA tmp2_nopromo;
        set hnut.section6_mc_nopromo_e2;
        q_prime_nopromo_e2 = adj_dom_con;
        p_prime_nopromo_e2 = rfarm_price_mt;
run;

DATA tmp5_nopromo;
        set hnut.section6_mc_nopromo_e5;
        q_prime_nopromo_e5 = adj_dom_con;
        p_prime_nopromo_e5 = rfarm_price_mt;
run;

PROC SORT data = tmp0;
        by _REP_ time;
PROC SORT data = tmp1;
        by _REP_ time;
PROC SORT data = tmp2;
        by _REP_ time;
PROC SORT data = tmp5;
        by _REP_ time;
PROC SORT data = tmp0_nopromo;
        by _REP_ time;
PROC SORT data = tmp1_nopromo;
        by _REP_ time;
PROC SORT data = tmp2_nopromo;
        by _REP_ time;
PROC SORT data = tmp5_nopromo;
        by _REP_ time;
PROC SORT data = tmp0_101;
        by _REP_ time;
PROC SORT data = tmp1_101;
        by _REP_ time;
PROC SORT data = tmp2_101;
        by _REP_ time;
PROC SORT data = tmp5_101;
        by _REP_ time;
run;

DATA hnut.benefitcost_actual_nopromo;
        merge tmp0 tmp1 tmp2 tmp5 tmp0_nopromo tmp1_nopromo tmp2_nopromo
tmp5_nopromo;
        by _REP_ time;
run;
PROC SORT data= hnut.benefitcost_actual_nopromo;
        by _REP_ time ;
```

```
run;

DATA hnut.benefitcost_actual_101;
	merge tmp0_101 tmp1_101 tmp2_101 tmp5_101 tmp0 tmp1 tmp2 tmp5;
	by _REP_ time;
run;
PROC SORT data= hnut.benefitcost_actual_101;
	by _REP_ time ;
run;
DATA price; /* I'm recovering the actual price variable */
	set hnut.working9;
	keep time rfarm_price_mt rpromo;
run;
DATA hnut.benefitcost_actual_nopromo;
	set hnut.benefitcost_actual_nopromo;
	drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_nopromo;
	by time;
run;
PROC SORT data = price;
	by time;
run;
DATA hnut.benefitcost_actual_nopromo;
	merge hnut.benefitcost_actual_nopromo price;
	by time;
run;

DATA hnut.benefitcost_actual_101;
	set hnut.benefitcost_actual_101;
	drop rfarm_price_mt;
run;
PROC SORT data = hnut.benefitcost_actual_101;
	by time;
run;
PROC SORT data = price;
	by time;
run;
DATA hnut.benefitcost_actual_101;
	merge hnut.benefitcost_actual_101 price;
	by time;
run;
proc print data = hnut.benefitcost_actual_101;
	var rfarm_price_mt;
	where _REP_ LE 4;
run;
```

```
DATA hnut.S6_benefitcost_actual_nopromo;
        set hnut.benefitcost_actual_nopromo;
        rpromo = adj_dom_con*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
        prod_surplus_e0 = ((((1-tau)*p_prime_actual_e0)*q_prime_actual_e0) - (((1-
tau_nopromo)*

p_prime_nopromo_e0)*q_prime_nopromo_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau)*p_prime_actual_e1)*q_prime_actual_e1) -(((1-
tau_nopromo)*

p_prime_nopromo_e1)*q_prime_nopromo_e1))/(1+1);
        prod_surplus_e2 = ((((1-tau)*p_prime_actual_e2)*q_prime_actual_e2) - (((1-
tau_nopromo)*

p_prime_nopromo_e2)*q_prime_nopromo_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau)*p_prime_actual_e5)*q_prime_actual_e5) - (((1-
tau_nopromo)*

p_prime_nopromo_e5)*q_prime_nopromo_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt);
        where time GE 8;
run;
quit;


DATA hnut.S6_benefitcost_actual_101;
        set hnut.benefitcost_actual_101;
        rpromo = adj_dom_con*rpromo_mt;
        tau = rpromo_mt/rfarm_price_mt;
        tau_nopromo = 0;
        tau_101 = (rpromo_mt*1.01)/rfarm_price_mt;
        prod_surplus_e0 = ((((1-tau_101)* p_prime_101_e0)*q_prime_101_e0)- (((1-tau)*
p_prime_actual_e0)*

q_prime_actual_e0))/(1+0);
        prod_surplus_e1 = ((((1-tau_101)* p_prime_101_e1)*q_prime_101_e1)- (((1-tau)*
p_prime_actual_e1)*

q_prime_actual_e1))/(1+1);
```

```
        prod_surplus_e2 = ((((1-tau_101)* p_prime_101_e2)*q_prime_101_e2)- (((1-tau)*
p_prime_actual_e2)*

q_prime_actual_e2))/(1+2);
        prod_surplus_e5 = ((((1-tau_101)* p_prime_101_e5)*q_prime_101_e5)- (((1-tau)*
p_prime_actual_e5)*

q_prime_actual_e5))/(1+5);
        BC_ratio_e0 = prod_surplus_e0/(q_prime_actual_e0*rpromo_mt*.01);
        BC_ratio_e1 = prod_surplus_e1/(q_prime_actual_e1*rpromo_mt*.01);
        BC_ratio_e2 = prod_surplus_e2/(q_prime_actual_e2*rpromo_mt*.01);
        BC_ratio_e5 = prod_surplus_e5/(q_prime_actual_e5*rpromo_mt*.01);
        where time GE 8;
run;
quit;




title 'Benefit-Cost Ratio: Actual v. No Promo';
PROC MEANS data = hnut.S6_benefitcost_actual_nopromo;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s6_bc_actual_nopromo;
run;
title;
ods output close;


title 'Benefit-Cost Ratio: Actual v. 1% Increase in Promotion';
PROC MEANS data = hnut.S6_benefitcost_actual_101;
        var BC_ratio_e0
                BC_ratio_e1
                BC_ratio_e2
                BC_ratio_e5
                prod_surplus_e0
                prod_surplus_e1
                prod_surplus_e2
                prod_surplus_e5;
        output out = hnut.RESULTS_s6_bc_actual_101;
```

```
run;
title;
ods output close;

************************
* Table of Key Results *
************************;

DATA hnut.Results_s3_bc_actual_101;
        length ds $ 25;
        set hnut.Results_s3_bc_actual_101;
        input ds;
        datalines;
Results_s3_bc_actual_101
Results_s3_bc_actual_101
Results_s3_bc_actual_101
Results_s3_bc_actual_101
Results_s3_bc_actual_101
;
run;

DATA hnut.Results_s3_bc_actual_nopromo;
        length ds $ 25;
        set hnut.Results_s3_bc_actual_nopromo;
        input ds;
        datalines;
   s3_bc_actual_nopromo
        s3_bc_actual_nopromo
   s3_bc_actual_nopromo
   s3_bc_actual_nopromo
   s3_bc_actual_nopromo
;
run;

DATA hnut.Results_s4_bc_actual_101;
        length ds $ 25;
        set hnut.Results_s4_bc_actual_101;
        input ds;
        datalines;
   s4_bc_actual_101
        s4_bc_actual_101
   s4_bc_actual_101
   s4_bc_actual_101
   s4_bc_actual_101
;
run;
```

```
DATA hnut.Results_s4_bc_actual_nopromo;
        length ds $ 25;
        set hnut.Results_s4_bc_actual_nopromo;
        input ds;
        datalines;
   s4_bc_actual_nopromo
        s4_bc_actual_nopromo
   s4_bc_actual_nopromo
   s4_bc_actual_nopromo
   s4_bc_actual_nopromo
;
run;

DATA hnut.Results_s5_bc_actual_101;
        length ds $ 25;
        set hnut.Results_s5_bc_actual_101;
        input ds;
        datalines;
   s5_bc_actual_101
        s5_bc_actual_101
   s5_bc_actual_101
   s5_bc_actual_101
   s5_bc_actual_101
;
run;
DATA hnut.Results_s5_bc_actual_nopromo;
        length ds $ 25;
        set hnut.Results_s5_bc_actual_nopromo;
        input ds;
        datalines;
   s5_bc_actual_nopromo
        s5_bc_actual_nopromo
   s5_bc_actual_nopromo
   s5_bc_actual_nopromo
   s5_bc_actual_nopromo
;
run;

DATA hnut.Results_s6_bc_actual_101;
        length ds $ 25;
        set hnut.Results_s6_bc_actual_101;
        input ds;
        datalines;
   s6_bc_actual_101
        s6_bc_actual_101
```

```
   s6_bc_actual_101
   s6_bc_actual_101
   s6_bc_actual_101
;
run;

DATA hnut.Results_s6_bc_actual_nopromo;
         length ds $ 25;
         set hnut.Results_s6_bc_actual_nopromo;
         input ds;
         datalines;
   s6_bc_actual_nopromo
         s6_bc_actual_nopromo
   s6_bc_actual_nopromo
   s6_bc_actual_nopromo
   s6_bc_actual_nopromo
;
run;

DATA hnut.final_results;
         merge
hnut.Results_s3_bc_actual_101
hnut.Results_s4_bc_actual_101
hnut.Results_s5_bc_actual_101
hnut.Results_s6_bc_actual_101
hnut.Results_s3_bc_actual_nopromo
hnut.Results_s4_bc_actual_nopromo
hnut.Results_s5_bc_actual_nopromo
hnut.Results_s6_bc_actual_nopromo;
         by ds;
run;
*******
* EOF *
*******;
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APPENDIX B: ALTERNATIVE MODEL

Below are the results of a 2SLS model that used adjusted domestic consumption as the dependent variable. It also made use of a smaller set of instrumental variables: export price of hazelnuts, real price of other tree nuts, promotion, disposable income and a squared time trend.

Variable	Parameter Estimate	t-value	p-value
B_0	4731.281	0.54	0.5919
RPH	-8.06281	-2.08	0.0490
$\sqrt{Real\ Promotion\ (RPROMO)}$	11.26224	1.24	0.2285
RDI	0.744287	2.44	0.0234
Adjusted R^2	**0.18245**		

Marketable production was chosen for the main analysis, because it was the most relevant to US farmers. Marketable Production is the quantity sold by US farmers. The research objective is to determine the effect of promotion on domestic farmers. The alternative dependent variable is calculated as marketable production - exports + imports + beginning stocks - ending stocks.

We have seen in the data that there are errors in the primary source's recording related to re-importation that allow this number to become negative in some years. Using marketable production allows us to analyze the effect of assessments on the US farmer on their own revenue. On the other hand, even if the data in adjusted domestic consumption were correct, it would change the interpretation to the effect of assessments on US farmers on the domestic hazelnut market (most of which is Turkey) and ignore the effect on US farmers from exportations, while also obscuring the effect of their payments to the

HMB on their domestic sales by aggregating them with imports. The effect of US promotion on other nations' sales and on the domestic market is an interesting, but separate research question.