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World Soybean Demand:

An Elasticity Analysis and Long-Term Projections

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Abstract

Soybeans are one of the most valuable crops in the world and are characterized by their multi-purpose uses: food, feed, fuel and other industrial usages such as paint, inks, and plastics. Out of 183.9 million tons of world supply/demand of soybeans in 2001-03 year, about 10% of them were directly consumed as food (5.9%) or feed (3.8%) but 84.2% of them were crushed into soyoil and soymeal. Soyoil is mainly processed to vegetable oil for human consumption and recently used as a biodiesel feedstock. Soymeal is used not only as feed for livestock (especially for pork and poultry due to its low fiber level) and aquaculture, but also as a good source of protein for the human diet in a variety of forms in different cultures. This paper analyzes the relationship of the demand for soybeans with economy at country and international levels. We use the county level domestic demand quantities with GDP data and apply an error correction mechanism (ECM) to estimate the long-term elasticities of demand for soybeans in the market/economy. Using the estimated long-term elasticities, the demands for soybeans are projected through 2030.

Keyword: soybean demand, elasticity, projection

JEL classifications: C22, C53, Q11

Introduction

Soybeans are one of the most valuable crops in the world and are characterized by their multi-purpose uses: food, feed, fuel and other industrial usages such as paint, inks, and plastics. Out of 183.9 million tons of world supply/demand of soybeans in 2001-03 year, about 10% of them were directly consumed as food (5.9%) or feed (3.8%) but 84.2% of them were crushed into soyoil and soymeal. Soyoil is mainly processed to vegetable oil for human consumption and recently used as a biodiesel feedstock. Soymeal is used not only as feed for livestock (especially for pork and poultry due to its low fiber level) and aquaculture, but also as a good source of protein for the human diet in a variety of forms in different cultures.

This paper analyzes the relationship of the demand for soybeans with economy at country and international levels. Soybeans are used primarily as an industrial product in the form of feed, fiber, fuel, and food ingredients, but also can be found in the form of final consumer goods in Asian and specialty markets. We use the county level time series with GDP data and apply an error correction mechanism (ECM) to estimate the long-term elasticities of demand for soybeans in the market/economy. Using the estimated long-term elasticities, the demands for soybeans are projected through 2030.

World Soybean Industry

On 2001-03 year average, totally 183.9 million tons of soybeans were consumed in the world. The quantity has increased 7.4 times during four decades (Figure 1). The top five soybean consuming countries are the USA (48.3 million tons, 26.3% of world total demand), China (33.1 million tons, 18.0%), Brazil (27.0 million tons, 14.7%), Argentina (22.3 million tons, 12.2%) and India (6.1 million tons, 3.3%). These top five countries share about three forth (74.4%) of the

world soybean demand market (Figure 2). Most of soybeans are provided to processing industry and crushed into soymeal and soyoil.

After processed, totally 121.7 million tons of soymeal was consumed in the world on 2001-03 year average (Figure 3). The top three soymeal consuming countries are the USA (29.0 million tons, 23.9% of world total demand), China (18.7 million tons, 15.4%), and Brazil (7.7 million tons, 6.4%). With France (5.0 million tons, 4.1%) and Spain (4.7 million tons, 3.9%), the top five countries share more than half (53.6%) of the world soymeal demand market. Almost all soymeal supplied to these countries is used as feed.

Regarding soyoil, total 26.5 million tons were consumed in the world on 2001-03 year average (Figure 4). The top three soyoil consuming countries are the USA (7.2 million tons, 27.1% of world total demand), China (5.0 million tons, 18.7%), and Brazil (3.0 million tons, 11.4%). With India (2.2 million tons, 8.1%) and Japan (0.8 million tons, 2.9%), the top five countries share more than two third (68.2%) of the world soyoil demand market. Most of soyoil is processed and consumed as vegetable oil but some are used for other utility including industrial raw materials and biodiesel.

Soy Supply-Demand Balances in the World and the US, China, Brazil

Though part of soybeans can be found in the form of final consumer goods in Asia and specialty markets, most of them are used primarily as an industrial product in the form of feed, fuel, and food ingredients. On 2001-03 year average, the world produced 182.2 million tons of soybeans and 183.9 million tons[1] were supplied to the domestic markets. 6.1 million tons (3.3%) out of the domestic supply were secured as seeds and 7.0 million tons (3.8%) and 10.8 million tons (5.9%) were used directly as feed and food respectively. 154.8 million tons (84.2%) of soybeans

[1] Due to stock variation and statistical error in import & export.

went to food manufacture[2] then 122.9 million tons of soymeal and 28.7 million tons of soyoil were produced. Regarding soymeal, 99.4% (120.5 million tons) out of the supply was used as feed and 0.6% (787 thousand tons) was used as other utility. Regarding soyoil, 84.6% (22.6 million tons) was consumed as food and 15.0% (4.0 million tons) was consumed as other utility including industrial raw materials and biofuel. Using the same format, the soy supply-demand balances are described for the top three soy consuming counties[3]: the US, China, Brazil as follows:

The US

The US produced 73.4 million tons of soybeans on 2001-03 year average and 48.3 million tons were supplied to its domestic market. 2.4 million tons (5.0%) out of the domestic supply were secured as seeds and 77 thousand tons (0.2%) and 11 thousand tons (0.0%) were used directly as feed and food respectively. 44.0 million tons (90.9%) of soybeans went to food manufacture and 34.8 million tons of soymeal and 8.2 million tons of soyoil were produced domestically. Regarding soymeal, 5.7 million tons (about 20% of domestic production) were net-exported and 29.0 million tons were supplied to its domestic market. All domestic supply was used as feed. Regarding soyoil, 904 thousand tons (12.5% of domestic production) were net exported and 7.2 million tons were supplied to its domestic market. 6.4 million tons (88.8% of domestic supply) were consumed as food and 788 thousand tons (10.9%) were consumed as other utility including industrial raw materials and biofuel.

China

[2] Includes crushing and processing.

[3] Argentina is a major soybean (and soymeal & soyoil) producing country. However, they don't consume the products domestically but export most of them (Table 1).

China produced 15.8 million tons of soybeans on 2001-03 year average and with 17.5 million tons of net import (greater than its domestic production) 33.1 million tons were supplied to its domestic market. 1.3 million tons (4.0%) out of the domestic supply were secured as seeds and 2.4 million tons (7.2%) and 5.1 million tons (15.5%) were used directly as feed and food respectively. 23.6 million tons (71.4%) of soybeans went to food manufacture and 19.3 million tons of soymeal and 4.3 million tons of soyoil were produced domestically. Regarding soymeal, 625 thousand tons (about 3% of domestic production) were net-exported and 18.7 million tons were supplied to its domestic market. All domestic soymeal was used as feed. Regarding soyoil, additional 1.1 million tons (about 27% of domestic production) were net-imported and totally 5.0 million tons were supplied to its domestic market. 4.8 million tons (96.5%) were consumed as food and 173 thousand tons were consumed as other utility.

Brazil

Brazil produced 43.8 million tons of soybeans on 2001-03 year average. Out of the production quantity, 16.2 million tons (more than one third of domestic production) were net-exported and 27.0 million tons (two third of it) were supplied to its domestic market. 751 thousand tons (2.8%) out of the domestic supply were secured as seeds and 608 thousand tons (2.3%) and 512 thousand tons (1.9%) were directly consumed as feed and food respectively. 25.1 million tons (93.1%) of soybeans went to food manufacture and 19.9 million tons of soymeal and 4.9 million tons of soyoil were produced domestically. Regarding soymeal, 12.2 million tons (61% of domestic production) were net-exported and 7.7 million tons (39% of it) were supplied to its domestic market. All domestic soymeal was used as feed. Regarding soyoil, 1.9 million tons (40% of domestic production) were net-exported and 3.0 million tons (approximately 60%) were supplied to its domestic market. 1.8 million tons (61.0%) were consumed as food and

remarkably 1.2 million tons (39%) were consumed as other utility including industrial raw materials and biofuel.

Objectives

This paper has three objectives: 1) to estimate the long-term elasticity of demand for soybeans with respect to the economy by major consuming counties and by continent, then discuss the differences and backgrounds; 2) to estimate the long-term elasticities of demand for soymeal and soyoil in the USA, China and Brazil markets and examine the soybean industry complex; 3) to project the long range demand of soybeans at the country and international levels.

Methodology

In order to estimate elasticities, we deal with time series of domestic soybean supply (i.e. demand) quantities in metric tons from top 10 consuming countries (USA, China, Brazil, Argentina, India, Japan, Mexico, Germany, Netherlands, and Spain) and 4 continents (Rest of Eurasia, Rest of America, Africa, and Oceania) from 1961 to 2003. We also use series of domestic supply/demand quantities for soymeal and soyoil from the top 3 consuming countries: USA, China, and Brazil. Data are provided from FAOSTAT.

We employ the concept of income elasticity of demand[4] using the domestic supply quantity data as demand term and real GDP data as income term. Soybeans are both intermediate goods and final consumption goods. Some portion of soybeans are directly consumed as food or feed in their domestic markets. However, the major part is provided to the processing industry and crushed into soymeal and soyoil, then consumed as feed (further meat), food, or other utility.

[4] For income effect, refer to Deaton and Muellbauer (1983).

Additionally more than one third of produced soybeans, meal and oil (34.6, 38.8, and 36.1% respectively in 2003) are traded between countries. All these activities are counted within the gross domestic product (GDP) or gross domestic income (GDI) and the real GDP is considered as income term corresponding to the soybean demand term in the economy.[5]

Following the Granger Representation Theorem (Engle and Granger (1987)), error correction mechanism (ECM) is employed to estimate the cointegrating equations and the long-term elasticities as their coefficients.

The basic concept of error correction mechanism (ECM) is shown in Mills (1990) or Hendry et al (1984) as follows:

$$\Delta\ln(soydm_{\mathrm{t}}) = \phi\Delta\ln(soydm_{t-1}) - \gamma(\ln(soydm_{t-1}) - \alpha - \beta\ln(gdp_{t-1})) + \varepsilon_t, \qquad (1)$$

where $\ln(soydm_t)$ = natural logarithm of soybean (or soymeal, soyoil) domestic demand quantity by country in year t

$\ln(gdp_{t-1})$ = natural logarithm of GDP of the country in year t-1

α, β, γ, and ϕ are parameters. ε_t = error term.

$(\ln(soydm_{t-1}) - \alpha - \beta\ln(gdp_{t-1}))$ is the cointegrating equation and β is the long-term elasticity of the demand with respect to the GDP. In practice, vector error-correction model (VECM) is employ and parameters are restricted as necessary for model specification. In some cases, autoregressive and/or trend terms are incorporated.

Using the estimated long-term elasticity $\hat{\beta}$, the next year's soybean (or soymeal, soyoil) demand is projected using recursive form as follows:

$$ln(soydm_{t+1}) = \hat{\beta}\ln(gdp_{t+1}) + \hat{\alpha} \qquad (2)$$

$$ln(soydm_t) = \hat{\beta}\ln(gdp_t) + \hat{\alpha} \qquad (3)$$

[5] GDP equals to GDI by definition though measurement errors make the two figures slightly different in practice.

Subtract equation (3) from (2) to obtain

$$ln(soydm_{t+1}) = ln(soydm_t) + \hat{\beta}\Delta \ln(gdp_{t+1}). \quad (4)$$

Take exponential for the both sides:

$$soydm_{t+1} = soydm_t * e^{\hat{\beta}\Delta \ln(gdp_{t+1})}. \text{ (Note } e^{a+b} = e^a * e^b \text{ and } e^{\ln(x)} = x.) \quad (5)$$

GDP data are provided by the World Bank and gdp_{t+1} is calculated by multiplying population, pop_{t+1}, and per capita GDP, $pcgdp_{t+1}$. Per capita GDP is estimated as univariate time series (equation 6). Out of Box-Jenkins or ARIMA type univariate time series model employs exponential smoothing with a damped trend (See Gardner and McKenzie, 1985; Hamilton, 1994; Mills, 1990). Introducing a damped trend into exponential smoothing makes sense as growth rates in per capita GDP begins to plateau. Following Gardner and McKenzie (1985) and Gardner (1985), the general damped-trend linear exponential smoothing model is as follows:

$$pcgdp_t = \mu_t + \beta_t t + \epsilon_t \quad (6)$$

where $pcgdp_t$ is per capita GDP by country at time t, μ_t is the mean or level of per capita GDP at time t, β_t is parameter at t, *t* is the time trend or year, and ϵ_t is error term at t.

The smoothing equations are:

Level: $L_t = \alpha(pcgdp_t) + (1-\alpha)(L_{t-1} + \phi T_{t-1})$, and (7)

Trend: $T_t = \gamma(L_t - L_{t-1}) + (1-\gamma)\phi T_{t-1}$ (8)

where L_t = smoothed level at *t* of the series, computed after $pcgdp_t$ is observed,

α = smoothing parameter for the level of the series,

ϕ = trend modification or damping parameter,

T_t = smoothed trend at the end of period *t*, and

γ = smoothing parameter for trend.

The error-correction form of the smoothing equations is:

$L_t = L_{t-1} + \phi T_{t-1} + \alpha e_t$, and (9)

$T_t = \phi T_{t-1} + \alpha\gamma e_t$ (10)

where $e_t = pcgdp_t - \widehat{pcgdp}_t(1)$ is a one-period-ahead forecast error.

The forecast for *k* period(s) ahead from origin *t* is:

$\widehat{pcgdp}_t(k) = L_t + \sum_{i=1}^{k} \phi^i T_t$. (11)

If $0 < \phi < 1$, the trend is damped and the forecasts approach an asymptote given by the horizontal linear line or plateau: $L_t + T_t\phi(1-\phi)$. The equivalent process is ARIMA (1, 1, 2)[6] which can be written as:

$(1-\phi B)(1-B)pcgdp_t = (1-\theta_1 B - \theta_2 B^2)\epsilon_t$, (12)

where $\theta_1 = 1 + \phi - \alpha - \alpha\gamma\phi$, and $\theta_2 = (\alpha - 1)\phi$.

If $\phi = 1$, the model is equivalent to the standard version of Holt (1960) model and the trend is linear. The equivalent process is ARIMA (0, 2, 2):

$(1-B)^2 pcgdp_t = (1-\theta_3 B - \theta_4 B^2)\epsilon_t$ (13)

where $\theta_3 = 2 - \alpha - \alpha\gamma$, and $\theta_4 = \alpha - 1$.

For damped trend estimation, set $\phi = 0.98$ and the level and trend parameters were chosen to minimize the mean square error (MSE). The 2008 Revision Population Projections provided by the UN Population Division are adopted to compute $GDP_{t+1} = pcgdp_{t+1} * pop_{t+1}$.

Data arrangement and analysis are conducted using Microsoft (MS) Excel 2007 and STATA 10.

Estimation Results and Projections

The estimation results indicate strong support for a cointegrating equation such that

$ln(soybdm_{USA}) - 0.611 * ln(GDP_{USA})$ (14)[7]

[6] In the general ARIMA (1, 1, 2), $-1 < \phi < 1$.

should be a stationary series (Table 2). The coefficient 0.611 plays the role of long-term elasticity of soybean domestic demand in the US with respect to the GDP and it suggests that the US soybean domestic demand quantity increases by 0.611% as the GDP increases by 1.000%. China shows the highest elasticity (0.778) and the elasticity of Brazil is 0.632, slightly greater than that of US. India shows a negative coefficient and we use the coefficient of Rest of Eurasia, 0.600, for estimating India's soybean domestic demand quantity projections.

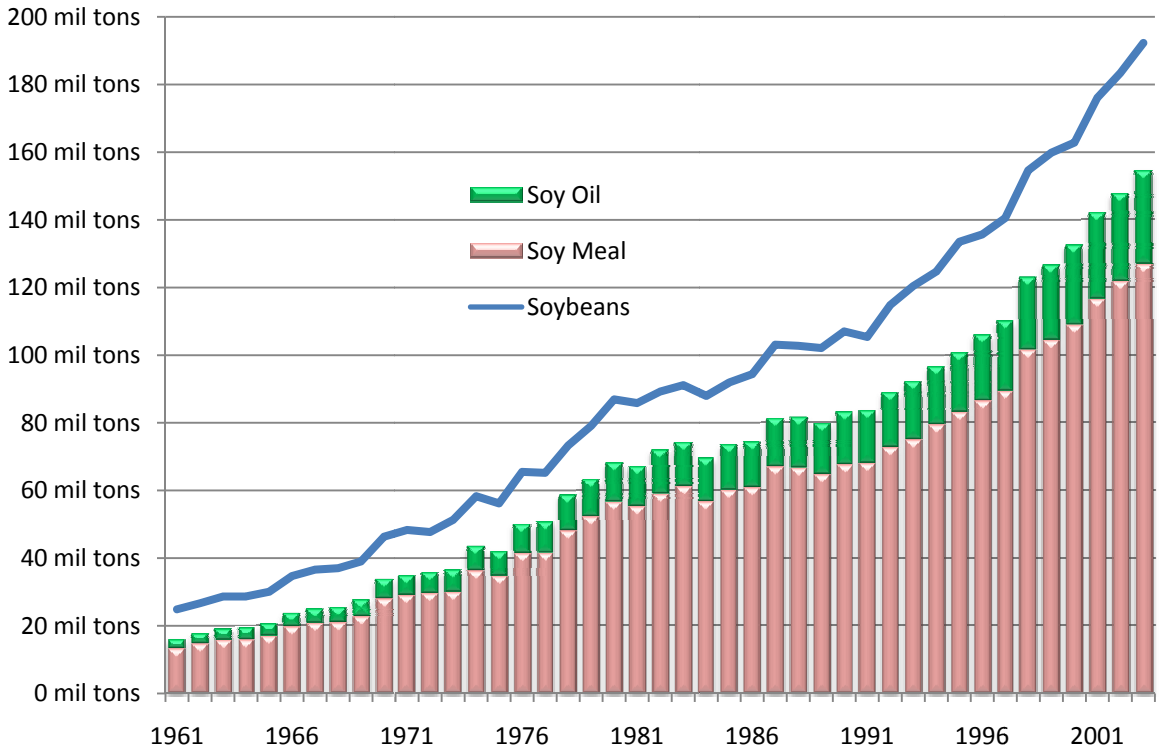
Using the estimated elasticities with GDP projections, each country's (continent's) soybean domestic demand quantities (additionally soymeal & soyoil for the US, China, Brazil) are projected through 2030. In 2030, the World total soybean demand quantity reaches 307.5 million tons, which are 1.35 times greater than that in 2010. The US share of soybean demand gradually declines to 18.1% while China's share increases to 35.3% through 2030.

Summary and Discussion

Keyzer et al (2005) argues that world cereal feed demand will be significantly higher in the coming 30 years than is currently projected by international organizations. Linked with the expansion of meat consumption and biofuel usage, it is expected that the world demand for soybean and soy products will increase steadily.

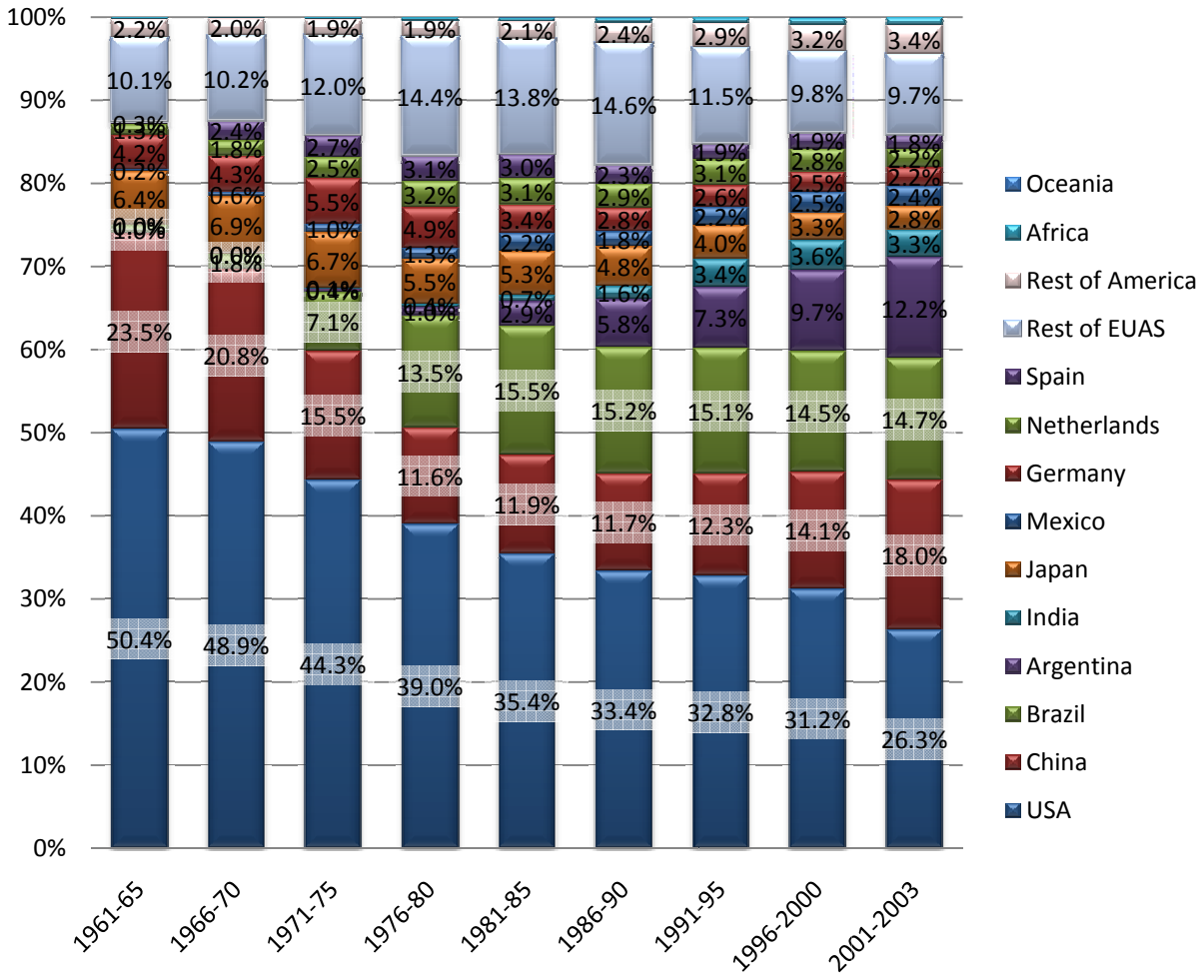
[7] soybdm = soybean domestic demand, soymdm = soymeal domestic demand, soyodm = soyoil domestic demand.

Figure 1. World Soybean Demand: 1961-2003



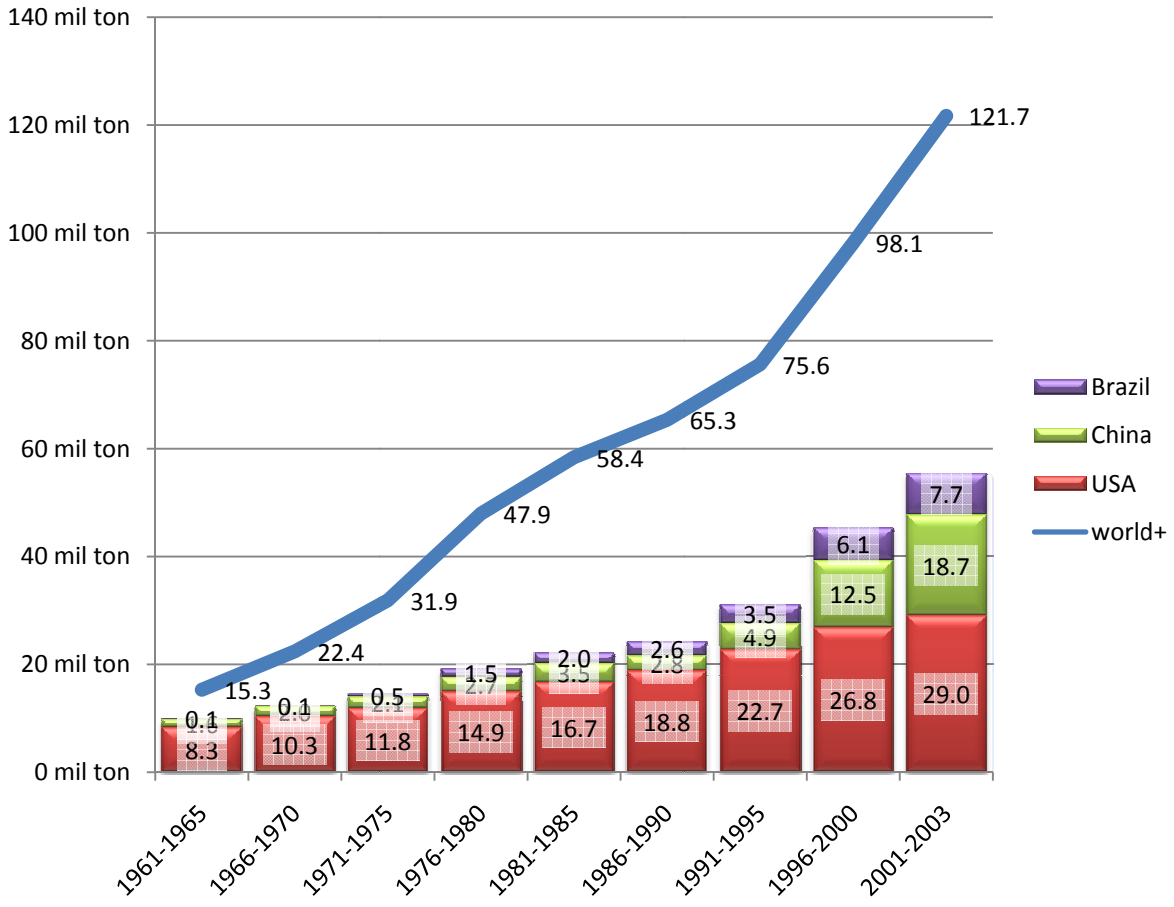
Source: FAOSTAT.

Figure 2. Shifts of Domestic Soybean Supply/Demand Share by Top 10 Countries: 1961-2003



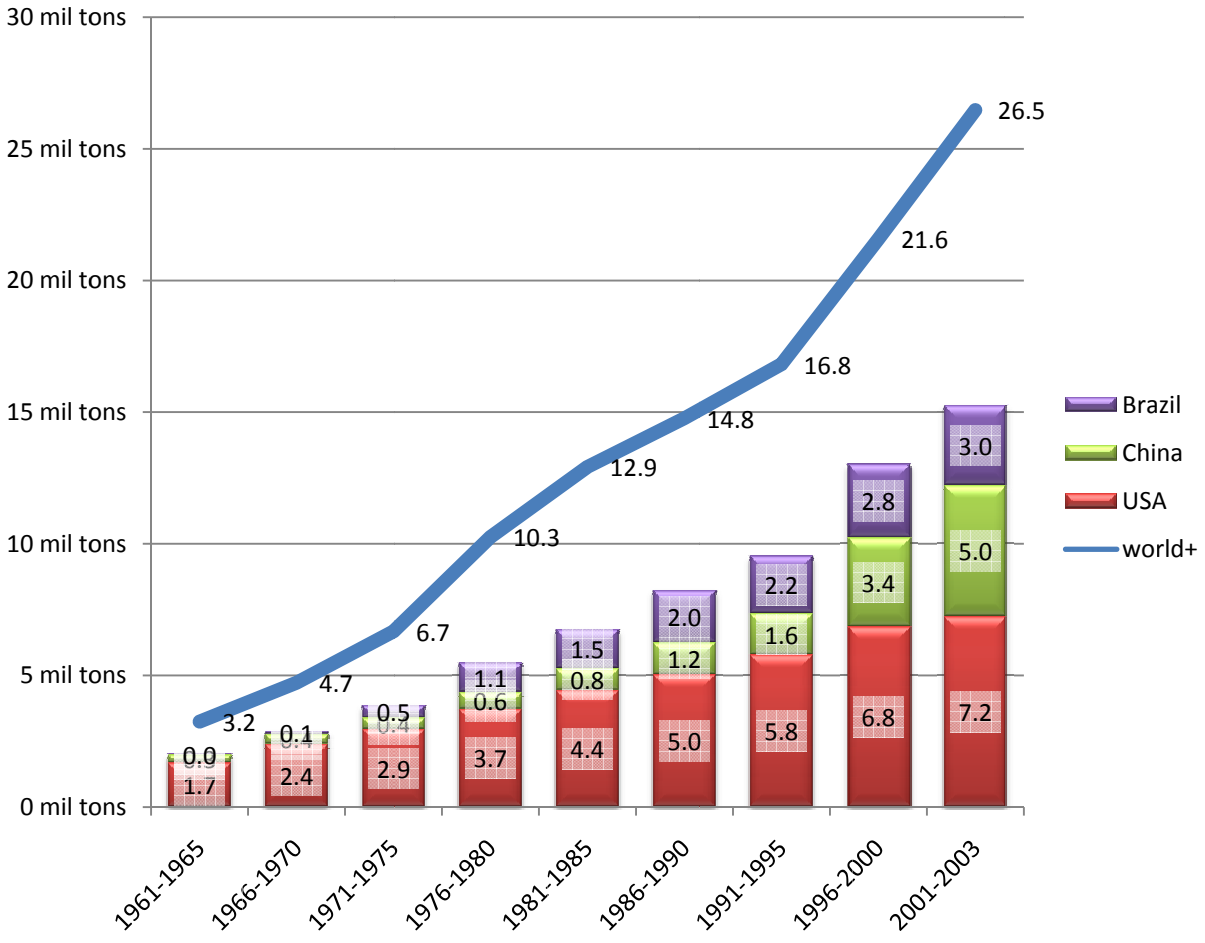
Source: FAOSTAT and author's calculation.

Figure 3. Domestic Soymeal Demand in US, China & Brazil: 1961-2003



Source: FAOSTAT.

Figure 4. Domestic Soyoil Demand in US, China & Brazil: 1961-2003



Source: FAOSTAT.

Table 1. Soy Supply-Demand Balances: 2001-03 year average

item	element (000 tons, ratio*)	World		USA		China		Brazil		Argentina	
Soybeans	Domestic Production	182,200	99.1%	73,425	151.9%	15,769	47.6%	43,830	162.5%	30,615	137.0%
	Import Quantity	60,102	32.7%	150	0.3%	17,859	54.0%	1,028	3.8%	309	1.4%
	Stock Variation	802	0.4%	3,900	8.1%	-185	-0.6%	-700	-2.6%	-1,163	-5.2%
	Export Quantity	59,174	32.2%	29,133	60.3%	345	1.0%	17,179	63.7%	7,413	33.2%
	Net Import (Im-Ex)	928	0.5%	-28,983	-60.0%	17,514	52.9%	-16,151	-59.9%	-7,103	-31.8%
	Domestic Supply Qu.	183,930	100.0%	48,341	100.0%	33,098	100.0%	26,979	100.0%	22,348	100.0%
	Feed	6,996	3.8%	77	0.2%	2,391	7.2%	608	2.3%	0	0.0%
	Seed	6,089	3.3%	2,395	5.0%	1,311	4.0%	751	2.8%	710	3.2%
	Food Manuf. Qu.	154,798	84.2%	43,955	90.9%	23,625	71.4%	25,108	93.1%	21,328	95.4%
	Waste	4,127	2.2%	1,904	3.9%	628	1.9%	-	-	309	1.4%
	Food	10,824	5.9%	11	0.0%	5,142	15.5%	512	1.9%	0	0.0%
	Other Util.	1,100	0.6%	-	-	1	0.0%	-	-	-	-
Soymeal	Domestic Production	122,945	101.4%	34,763	119.8%	19,316	103.3%	19,907	257.2%	16,911	3974.5%
	Import Quantity	45,271	37.3%	100	0.3%	77	0.4%	297	3.8%	0	0.0%
	Stock Variation	-548	-0.5%	0	0.0%	0	0.0%	0	0.0%	-33	-7.8%
	Export Quantity	46,419	38.3%	5,843	20.1%	701	3.8%	12,463	161.0%	16,452	3866.7%
	Net Import (Im-Ex)	-1,148	-0.9%	-5,742	-19.8%	-625	-3.3%	-12,166	-157.2%	-16,452	-3866.7%
	Domestic Supply Qu.	121,250	100.0%	29,021	100.0%	18,692	100.0%	7,741	100.0%	425	100.0%
	Feed	120,463	99.4%	29,021	100.0%	18,692	100.0%	7,741	100.0%	425	100.0%
	Food	1	0.0%	-	-	-	-	-	-	-	-
	Other Util.	787	0.6%	-	-	-	-	-	-	-	-
Soyoil	Domestic Production	28,721	107.7%	8,230	113.8%	4,250	85.2%	4,918	161.9%	3,973	6274.8%
	Import Quantity	8,949	33.5%	130	1.8%	1,232	24.7%	81	2.7%	0	0.3%
	Stock Variation	-1,133	-4.2%	-93	-1.3%	-413	-8.3%	67	2.2%	-267	-421.1%
	Export Quantity	9,862	37.0%	1,035	14.3%	83	1.7%	2,029	66.8%	3,643	5754.0%
	Net Import (Im-Ex)	-913	-3.4%	-904	-12.5%	1,149	23.0%	-1,948	-64.1%	-3,643	-5753.7%
	Domestic Supply Qu.	26,675	100.0%	7,233	100.0%	4,986	100.0%	3,037	100.0%	63	100.0%
	Feed	93	0.3%	-	-	2	0.0%	-	-	-	-
	Food Manuf. Qu.	-17	-0.1%	-	-	0	0.0%	-	-	-	-
	Waste	27	0.1%	20	0.3%	-	-	-	-	-	-
	Food	22,565	84.6%	6,425	88.8%	4,811	96.5%	1,846	60.8%	63	100.0%
	Other Util.	4,007	15.0%	788	10.9%	173	3.5%	1,191	39.2%	-	-

Note. * Domestic Supply Quantity as 100%.

Source: FAOSTAT and author's calculation.

Table 2. Cointegrating Equation Estimation Results

a. Soybeans domestic demand and GDP

Country/Continent	Beta		Std. Err.	const.	Std. Err.	log likelihood	# of lags	period	# of Obs.
USA	0.61145	***	0.00218	-	-	160.472	1	1962-2003	42
China	0.77826	***	0.02734	-	-	129.268	3	1964-2003	40
Brazil	0.63222	***	0.01709	-	-	121.707	2	1965-2003	39
Argentina	0.69359	***	0.03240	-	-	44.699	1	1962-2003	42
India	-0.33528	***	0.07472	-	-	81.732	1	1962-2003	42
Japan	0.53879	***	0.00106	-	-	157.324	1	1962-2003	42
Mexico	0.56902	***	0.01331	-	-	106.080	4	1965-2003	39
Germany	0.55349	***	0.00224	-	-	110.357	1	1972-2003	32
Netherlands	0.60104	***	0.01216	-	-	144.226	3	1964-2003	40
Spain	0.57175	***	0.00959	-	-	108.191	2	1963-2003	41
Rest of EUAS	0.59995	***	0.00397	-	-	152.946	1	1962-2003	42
Rest of America	0.66443	***	0.02020	-	-	78.711	1	1962-2003	42
Africa	0.65569	***	0.01250	-	-	131.766	1	1962-2003	42
Oceania	0.59524	***	0.01309	-	-	76.268	1	1962-2003	42

b. Soymeal domestic demand and GDP

country	Beta		Std. Err.	const.	Std. Err.	log likelihood	# of lags	sample period	# of Obs.
USA	0.60114	***	0.00307	-	-	152.211	1	1962-2003	42
China	1.01421	***	0.07122	-	-	100.626	3	1964-2003	40
Brazil	0.62017	***	0.01294	-	-	73.902	1	1962-2003	42

c. Soyoil domestic demand and GDP

country	Beta		Std. Err.	const.		Std.Err.	log likelihood	# of lags	sample period	# of Obs.
USA	0.76344	***	0.12354	-6.81239		-	179.664	2	1963-2003	41
China	0.99780	***	0.19356	-9.97688	**	5.07030	104.127	3	1964-2003	40
Brazil	0.81974	*	0.43946	-7.47376		-	118.174	3	1964-2003	40

Notes. ***Denotes significant at 1%, ** significant at 5%, and * significant at 10%.

Due to the choice of model specification, many constant terms and their some standard errors do not appear.

Table 3. Soybean demand projection summary

a. soybean domestic demand quantity (thousand tons) and share (%)

country	2001-03		2010		2015		2020		2025		2030	
World Total	183,931	100.0%	228,520	100.0%	252,380	100.0%	273,291	100.0%	291,523	100.0%	307,543	100.0%
USA	48,341	26.3%	49,139	21.5%	51,124	20.3%	52,879	19.3%	54,435	18.7%	55,817	18.1%
China	33,098	18.0%	58,757	25.7%	74,008	29.3%	87,193	31.9%	98,637	33.8%	108,663	35.3%
Brazil	26,979	14.7%	31,997	14.0%	34,168	13.5%	36,106	13.2%	37,806	13.0%	39,306	12.8%
Argentina	22,348	12.2%	29,148	12.8%	30,195	12.0%	31,250	11.4%	32,190	11.0%	33,029	10.7%
India	6,075	3.3%	9,040	4.0%	10,432	4.1%	11,601	4.2%	12,594	4.3%	13,449	4.4%
Japan	5,231	2.8%	5,608	2.5%	5,850	2.3%	6,063	2.2%	6,250	2.1%	6,415	2.1%
Mexico	4,441	2.4%	4,489	2.0%	4,612	1.8%	4,724	1.7%	4,824	1.7%	4,913	1.6%
Germany	4,107	2.2%	4,056	1.8%	4,182	1.7%	4,298	1.6%	4,400	1.5%	4,491	1.5%
Netherlands	4,051	2.2%	4,085	1.8%	4,307	1.7%	4,506	1.6%	4,681	1.6%	4,835	1.6%
Spain	3,219	1.8%	3,545	1.6%	3,714	1.5%	3,863	1.4%	3,994	1.4%	4,109	1.3%
Rest of EUAS	17,832	9.7%	19,450	8.5%	20,224	8.0%	20,919	7.7%	21,535	7.4%	22,081	7.2%
Rest of America	6,321	3.4%	7,040	3.1%	7,238	2.9%	7,425	2.7%	7,592	2.6%	7,742	2.5%
Africa	1,801	1.0%	2,048	0.9%	2,200	0.9%	2,335	0.9%	2,454	0.8%	2,558	0.8%
Oceania	88	0.0%	119	0.1%	123	0.0%	128	0.0%	132	0.0%	135	0.0%

b. annual average growth rate (%)

country	2001/03-2010	2010-2015	2015-2020	2020-2025	2025-2030
World Total	2.8%	2.0%	1.6%	1.3%	1.1%
USA	0.2%	0.8%	0.7%	0.6%	0.5%
China	7.4%	4.7%	3.3%	2.5%	2.0%
Brazil	2.2%	1.3%	1.1%	0.9%	0.8%
Argentina	3.4%	0.7%	0.7%	0.6%	0.5%
India	5.1%	2.9%	2.1%	1.7%	1.3%
Japan	0.9%	0.8%	0.7%	0.6%	0.5%
Mexico	0.1%	0.5%	0.5%	0.4%	0.4%
Germany	-0.2%	0.6%	0.5%	0.5%	0.4%
Netherlands	0.1%	1.1%	0.9%	0.8%	0.7%
Spain	1.2%	0.9%	0.8%	0.7%	0.6%
Rest of Eurasia	1.1%	0.8%	0.7%	0.6%	0.5%
Rest of America	1.4%	0.6%	0.5%	0.4%	0.4%
Africa	1.6%	1.4%	1.2%	1.0%	0.8%
Oceania	3.8%	0.8%	0.7%	0.6%	0.5%

Table 4. Soymeal domestic demand projection summary: US, China, and Brazil

a. domestic demand quantity (thousand tons)

country	2001-03 ave.	2010	2015	2020	2025	2030
USA	29,021	29,662	30,840	31,881	32,803	33,621
China	18,692	39,412	53,240	65,922	77,415	87,825
Brazil	7,741	9,105	9,711	10,251	10,724	11,141

b. annual average growth rate (%)

country	2001/03-2010	2010-15	2015-20	2020-25	2025-30
USA	0.3%	0.8%	0.7%	0.6%	0.5%
China	9.8%	6.2%	4.4%	3.3%	2.6%
Brazil	2.0%	1.3%	1.1%	0.9%	0.8%

Table 5. Soyoil domestic demand projection summary: US, China, and Brazil

a. domestic demand quantity (thousand tons)

country	2001-03 ave.	2010	2015	2020	2025	2030
USA	7,233	7,785	8,180	8,532	8,847	9,128
China	4,986	12,474	16,768	20,691	24,235	27,438
Brazil	3,037	3,259	3,548	3,811	4,046	4,255

b. annual average growth rate (%)

country	2001/03-2010	2010-15	2015-20	2020-25	2025-30
USA	0.9%	1.0%	0.8%	0.7%	0.6%
China	12.1%	6.1%	4.3%	3.2%	2.5%
Brazil	0.9%	1.7%	1.4%	1.2%	1.0%

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References

Deaton, A. and Muellbauer, J. 1983. Economics and Consumer Behavior. Cambridge Univ. Press.

FAO. FAOSTAT. http://faostat.fao.org/

Gardner, E.S.Jr, 1985. Exponential Smoothing: The State of the Art. Journal of Forecasting. 4: 1-28.

Gardner, E.S.Jr. and Mckenzie E, 1985. Forecasting Trends in Time Series. Management Science. 31 (10): 1237-1246.

Hamilton, J.D. 1994. Time Series Analysis. Princeton Univ. Press.

Hendry et al. 1984. Dynamic Specification. Ch. 18. Grilishes, Z. and Intrigator, M.D. Eds. Handbook of Econometrics, Vol. II. Elsevier.

Holt C. et al. 1960. Planning, Production, Innovation, and Work Force. Prentice-Hall.

Kennedy, P.A. 2003. Guide to Econometrics. 5th ed. MIT Press.

Keyzer et al. 2005. Diet shift towards meat and the effects on cereal use: can we feed the animals in 2030? Ecological Economics. 55: 187-202.

Mills, T.C. 1990. Time series techniques for economists. Cambridge Univ. Press.

UN Population Division. World Population Prospects: The 2008 Revision. http://esa.un.org/unpp/index.asp

The World Bank. WDI Online. http://publications.worldbank.org/WDI/