The Demand for Imported Apple Juice in the United States

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This study estimates U.S. demand for imported apple juice by exporting country. Given that China has emerged as the top supplier to the U.S., we focus on the impact of China on competing exporting countries. Results show that U.S. imports from Argentina, Chile, and the rest of the world (ROW) were significantly responsive to apple juice prices in China. U.S. imports from China were significantly responsive to prices in Argentina, Chile and the ROW as well; however, the responsiveness of imports from China to apple juice prices in these countries was relatively smaller than the responsiveness of imports from these countries to China's price.

U.S. apple juice and cider production increased from 86 million gallons in 1970 to around 200 million gallons in late 1990. Since 1999, apple juice production has decreased from 206 to 149 million gallons. Although U.S. production has increased overall since 1970, apple juice imports increased at an even greater rate. From 1970 to 2005, U.S. apple juice imports increased from 27 million gallons to 418 million gallons. As a result, imports currently account for a much larger share of the total U.S. supply. In 1970, imports accounted for 24 percent of total U.S. supply; in 2005 imports accounted for 74 percent (Table 1) (United States Department of Agriculture 2007).

Given the increase in U.S. imports, the purpose of this study was to estimate U.S. demand for imported apple juice by country. Because China has emerged as the top supplier to the U.S. market, we focus on the impact of China on competing exporting countries. The absolute price version of the Rotterdam model is used to estimate U.S. import demand. Following Armington (1969), we assume that imported apple juice is differentiated by country of origin, where apple juice imports from Brazil and China (for example) are considered imperfect substitutes due to origin-specific factors. Specific objectives of this study are to estimate U.S. demand for imported apple juice by country of origin and to use these empirical estimates to derive sensitivity measures of import demand with respect to changes in import prices and total import expenditures. Of particular importance is the impact of China on U.S. imports from competing exporting countries.

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Overview of World Apple Production

The United States is ranked 2nd in the world in apple production (Table 2); however, the gap between production in China (the top producing country) and the United States is quite large. In 2001, China produced 22 million short tons of apples compared to 4.7 million short tons produced by the United States. Since 2001, production in China has continued to increase while production in the United State has remained relatively unchanged. Currently, China accounts for 40 percent of world apple production while the U.S. accounts for only seven percent. Other major apple-producing countries include Turkey, Iran, Italy, France, Poland, and Russia. Production in these countries is significantly less than production in China as well (Pollack and Perez 2006).

U.S. Apple Juice Imports

Top exporters of apple juice to the United States include China, Argentina, Brazil, Chile, and Germany. In 1995, Argentina and Germany were the top exporters to the United States, exporting 78 and 49 million gallons, respectively. After 1995, Argentina continued to have significant sales of apple juice to the United States. Imports from Argentina peaked in 1999 at 104 million gallons. While total imports from Argentina and Germany have been decreasing steadily in recent years, U.S. imports from China have significantly increased, from 2.2 million gallons in 1995 to 253 million gallons in 2005 (Table 3).

Import Demand Model

Here we present the absolute price version of the Rotterdam model which is used in estimating the

Table 1. U.S. Apple Juice Supply and Demand: 1970–2005 (Million gallons, single strength).

Year	Production	Imports	Total supply	Exports
1970	86.0	26.6	112.5	3.1
1975	99.3	29.9	129.2	4.9
1980	178.1	77.0	255.1	6.9
1985	153.5	220.2	373.7	5.9
1990	173.1	277.1	450.1	16.5
1995	211.3	226.6	438.0	16.1
2000	194.5	318.1	512.6	7.0
2001	162.0	353.7	515.7	7.0
2002	123.3	399.9	523.2	5.6
2003	119.5	449.5	569.0	5.7
2004	156.3	471.3	627.7	5.8
2005	148.5	417.6	566.2	7.2

Source: USDA/Economic Research Service.

Table 2. Apple Production by Country: 2001–2005 (1,000 short tons).

Country	2001	2002	2003	2004	2005
China	22,071	21,220	23,264	26,104	27,565
U.S.	4,714	4,262	4,397	5,210	4,690
Turkey	2,701	2,425	2,866	2,315	2,811
Iran	2,594	2,573	2,646	2,646	2,646
Italy	2,580	2,045	1,775	2,355	2,419
France	2,642	2,681	2,356	2,444	2,340
Poland	2,683	2,389	2,676	2,779	2,260
Russia	1,808	2,150	1,863	2,238	2,260
Others	21,798	21,518	23,174	23,582	22,994
World	63,591	61,263	65,016	69,672	69,985

Source: Pollack and Perez, 2006.

demand for imported apple juice in the United States (Theil 1980; Theil and Clements 1987; Seal, Sparks, and Buxton 1992). Assume that the United States imports apple juice from n supplying countries. Letting q_i denote the quantity imported from the ith country and p_i the import price for the ith country, the Rotterdam model is specified as

$$(1)\quad \bar{w}_{it} Dq_{it} = \theta_i DQ_t + \sum_{j=1}^{n} \pi_{ij} Dp_{jt} + \varepsilon_{it}.$$

Here, $\bar{w}_{it} = (w_{it} + w_{it-1})$, where $w_i = p_i q_i / \sum_i p_i q_i$, which is the share of the ith import in total import expenditures. D is the log change operator where for any q and p, $Dq_i = \log q_i - \log q_{i-1}$ and $Dp_i = \log p_i - \log p_{i-1}$. θ_i is the marginal share of the ith import in

Table 3. U.S. Apple Juice Imports By Exporting Country: 1995–2005 (Million single-strength equivalent gallons).

Year	Total	China	Argentina	Brazil	Chile	Germany	Others
1995	230.9	2.2	78.2	4.4	18.4	49.4	78.3
1996	258.0	4.5	79.4	7	29.9	55.9	81.3
1997	277.1	20.7	93.2	8.1	29.8	37.9	87.4
1998	266.2	49.3	73.1	3.8	32.1	30.1	77.8
1999	308.3	38.9	104.2	5.7	64.0	21.4	74.1
2000	305.3	50.3	57.1	15.5	40.1	34.2	108.1
2001	344.4	56.7	97.5	3.1	57.9	31.1	98.1
2002	351.6	95.7	67.9	8.9	49	41.9	87.9
2003	419.1	174.2	84.9	3.4	68	26.2	62.3
2004	420.8	236.6	50.7	4.2	60.1	23.1	46.2
2005	502.9	253.0	83.6	69.1	57.6	10.4	29.1

Source: Foreign Agricultural Service.

total import expenditures where $\theta_i = \partial p_i q_i / \partial \sum_i p_i q_i$. DQ_t is the finite version of the Divisia index where $DQ_t = \sum_i \bar{w}_{it} Dq_{it}$. DQ_t is a measure of real import expenditures. π_{ij} is the Slutsky price coefficient which measures the impact of the price of the *j*th import on the demand for the *i*th import. θ_i and π_{ij} are assumed constant for estimation, and ε_{it} is a random disturbance term. The Rotterdam model requires that the following parameter restrictions be met in order to conform to theoretical considerations: $\sum_i \theta_i = 1$ and $\sum_i \pi_{ij} = 0$ (adding up); $\sum_j \pi_{ij} = 0$ (homogeneity); $\pi_{ij} = \pi_{ji}$ (symmetry).

Empirical Results

The USDA Foreign Agricultural Service provided the data used in this study. Monthly import data was used to estimate Equation 1 over the period January 2001 through December 2006. The exporting countries were Argentina, Brazil, Chile, China, Germany, and the rest of the world (ROW). ROW was an aggregation of the remaining exporters of apple juice to the United States. Imports were on a cost, insurance, and freight basis (CIF) and per-unit import values were used as proxies for import prices ($ per kiloliter).

U.S. demand for imported apple juice was estimated using the LSQ procedure in TSP version 5.0. Preliminary tests indicated that homogeneity and symmetry could not be rejected. Therefore all results that follow have these two properties imposed. Results are presented in Table 4.

From 2000 through 2006, apple juice from Argentina accounted for 16 percent of total U.S. imports. Brazil, Chile, China, and Germany accounted for 2.9, 14.5, 36.9, and 7.8 percent, respectively. The ROW accounted for 22.0 percent. Marginal import-share estimates indicated that a one dollar increase in total import expenditures was allocated as follows: Argentina 0.63, Brazil 0.20, Chile −0.05, and China 0.18. The impact of expenditures on imports from Germany and the ROW was insignificant. The own-price effects (the impact of own price on U.S. imports from a given country) were significant for Argentina (−0.090), Chile (−0.048), China (−0.340), and the ROW (−0.249). The cross-price effects indicated that apple juice from Argentina and from China were substitutes (0.037). Other substitute relationships included Argentina and the ROW (0.033), Brazil and Chile (0.012), Chile and China (0.086), and China and the ROW (0.214). Complementary relationships were found for Brazil and Germany (−0.014) and for Chile and the ROW (−0.042).

The conditional own-price and cross-price elasticities are presented in Table 5. The own-price

Table 4. Estimation Results.

Exporting country	Import shares	Marginal import shares, θ_i	Price coefficients, π_{ij}					
			Argentina	Brazil	Chile	China	Germany	ROW
Argentina	0.159	0.635**	−0.090**	0.015	0.000	0.037*	0.003	0.033**
		(0.066)	(0.020)	(0.010)	(0.008)	(0.019)	(0.005)	(0.011)
Brazil	0.029	0.205**		−0.005	0.012**	0.007	−0.014**	−0.002
		(0.050)		(0.008)	(0.004)	(0.008)	(0.003)	(0.004)
Chile	0.145	−0.055*			−0.048*	0.086**	−0.009	−0.042*
		(0.035)			(0.022)	(0.031)	(0.013)	(0.021)
China	0.369	0.178**				−0.340**	0.009	0.214**
		(0.054)				(0.074)	(0.027)	(0.050)
Germany	0.078	0.023			Symmetry		−0.036	0.0194
		(0.015)					(0.024)	(0.027)
ROW	0.220	0.014						−0.249**
		(0.027)						(0.045)

Table 5. Conditional Demand Elasticities.

Country	Own-price elasticity	Cross-price elasticity	
		Imports from China	Impact of China's price
Argentina	−0.563*	0.101*	0.235*
Brazil	−0.160	−0.019	−0.245
Chile	−0.334*	0.234*	0.597*
China	−0.921*		
Germany	−0.459	0.024	0.114
ROW	−1.133*	0.581*	0.975*

* indicates significance level of 0.05.

elasticities were significant at the 0.05 level for Argentina, Chile, China, and the ROW. Import demand for ROW apple juice was the most elastic (−1.133) and import demand for Chinese apple juice was relatively more elastic (−0.921) than for apple juice from Argentina (−0.563) and Chile (−0.334).

Given a one-percent increase in the price of apple juice from China, the price of imports from Argentina, Chile, and ROW increased by 0.235, 0.597, and 0.975 percent, respectively. Of the countries that exported apple juice to the United States, apple juice prices in Argentina, Chile, and the ROW significantly affected U.S. imports from China. However, the responsiveness of imports from China to changes in each exporting country's apple juice prices was relatively small. For Argentina, a one-percent increase in price caused imports from China to decrease by 0.101 percent on average. For Chile, imports from China decreased by 0.234 percent on average, and for the ROW, 0.581 percent on average.

Conclusion

This study estimates U.S. demand for imported apple juice by country. Given that China has emerged as the top supplier to the U.S., we focused on the impact of China on competing exporting countries. Results showed that U.S. imports from Argentina, Chile, and the rest of the world (ROW) were significantly responsive to apple juice prices in China. U.S. imports from China were significantly responsive to prices in Argentina, Chile, and the ROW as well; however, the responsiveness of imports from China to apple juice prices in these countries was relatively small when compared to the responsiveness of imports from these countries to China's price.

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