

# Trade Liberalization and the Exchange Rate: A Game Theoretic Examination

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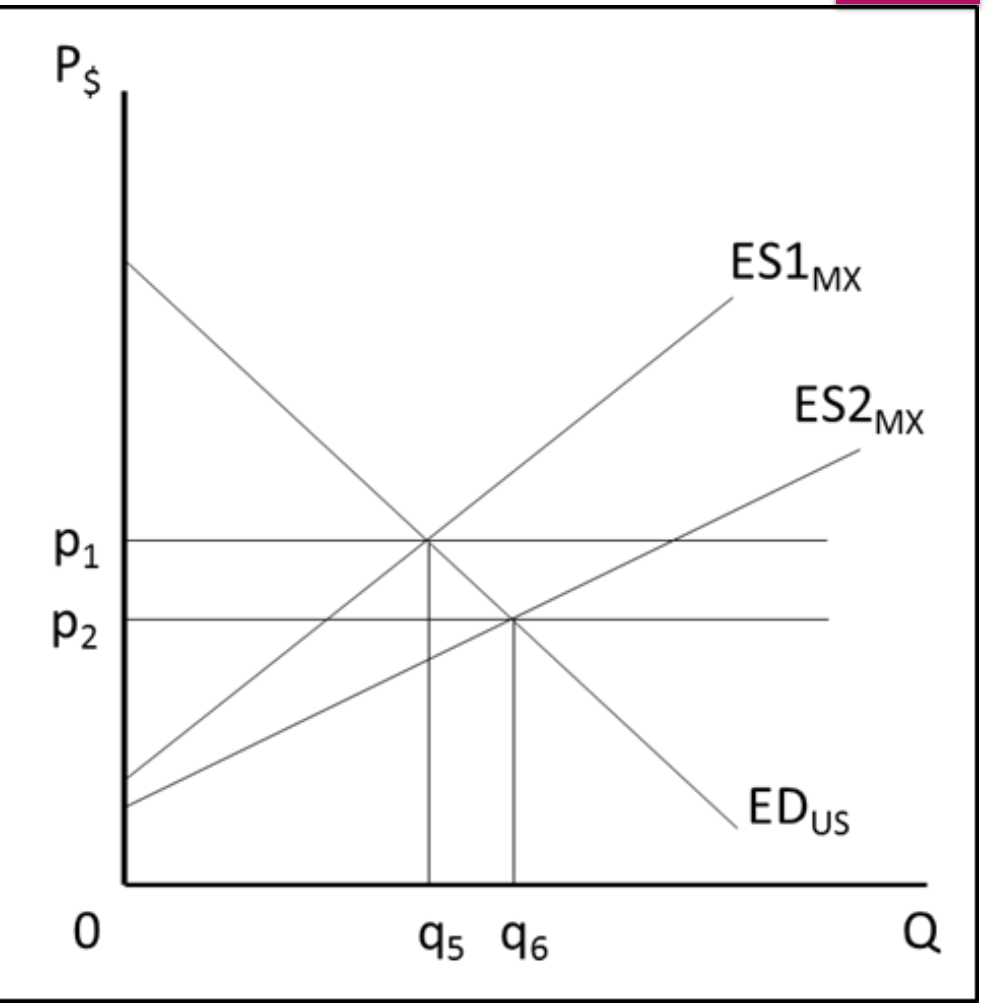
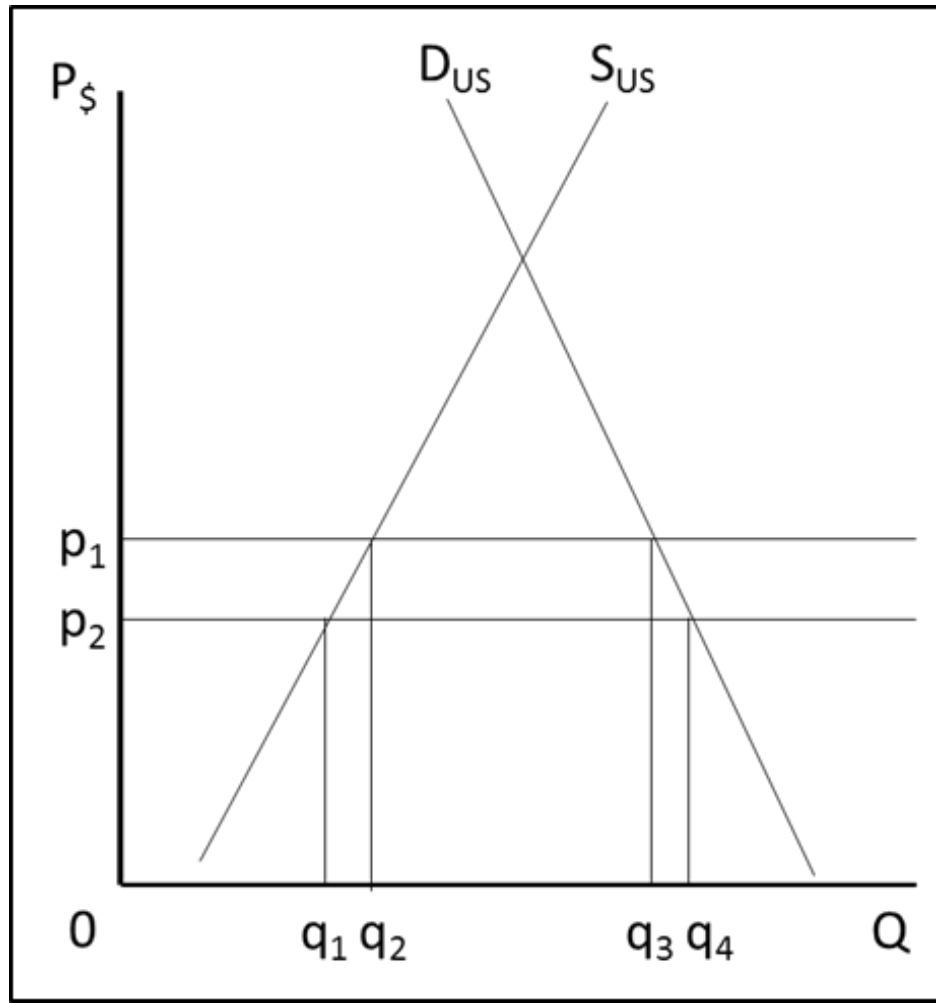
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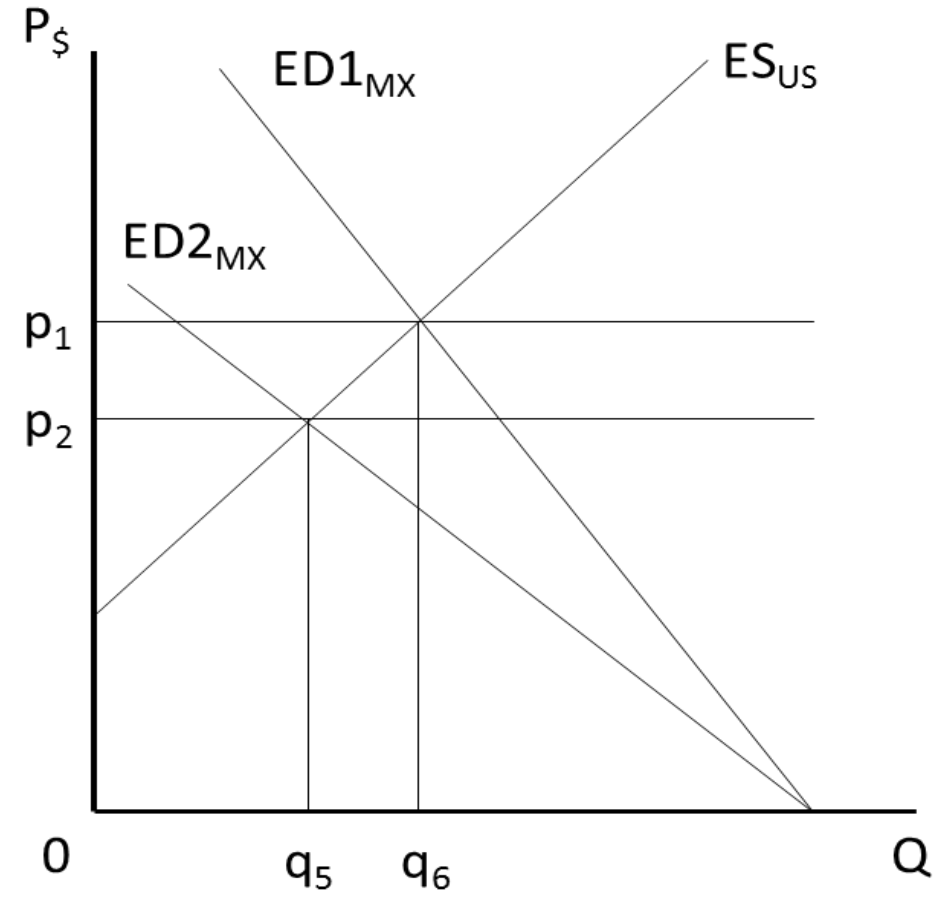
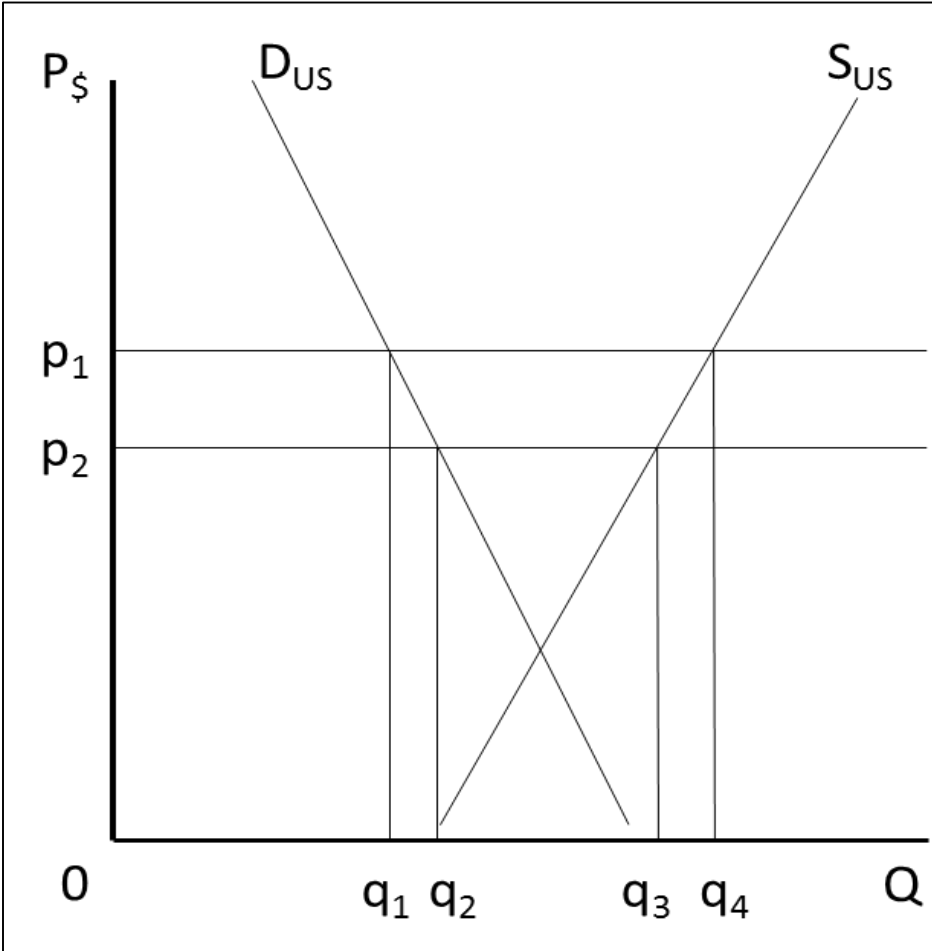
# Introduction

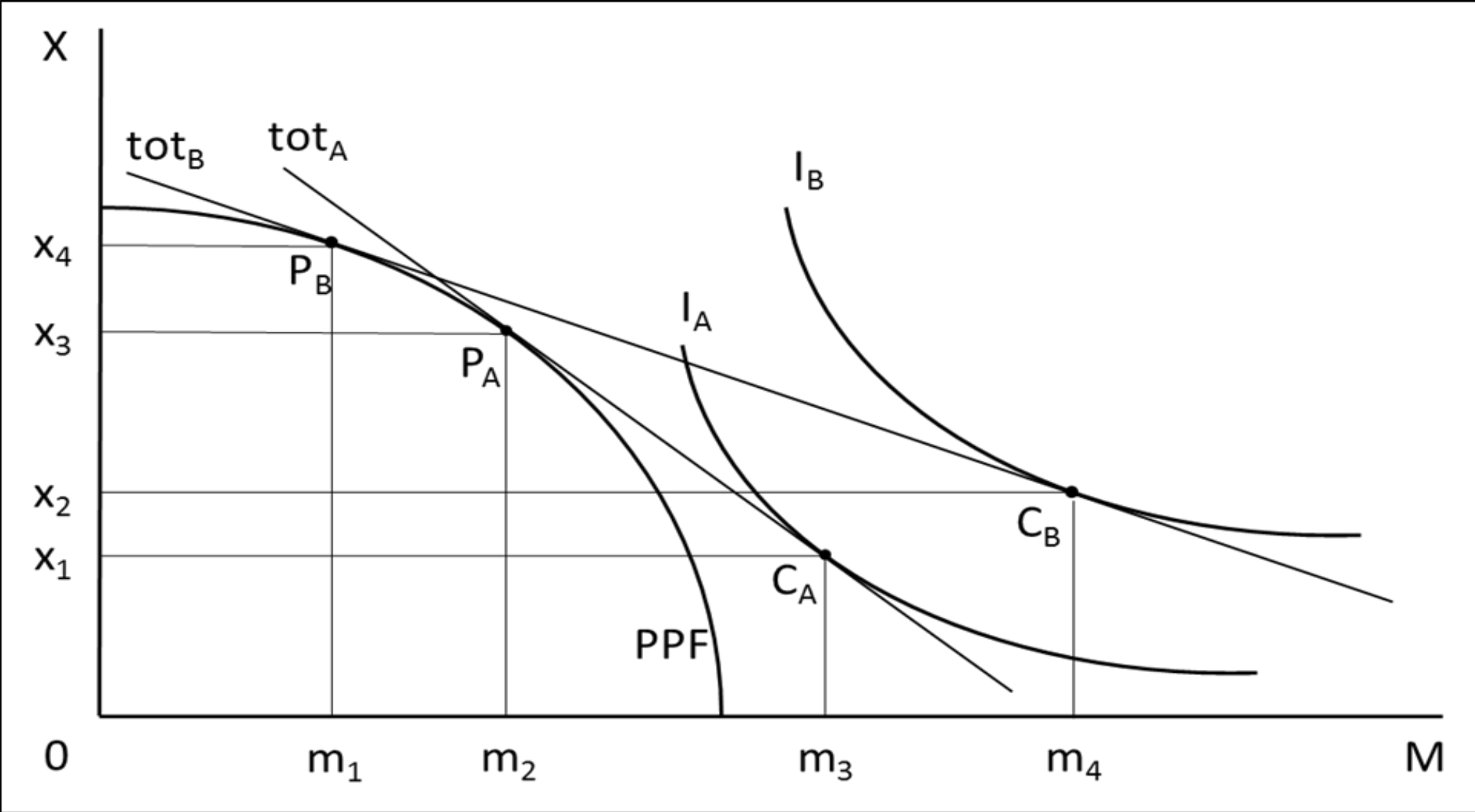
- ▶ From the time of the initial NAFTA negotiations in 1992 to the 2016 U.S. Presidential Election, the value of the Mexican Peso declined from 3.095 to 18.664 Pesos per U.S. Dollar and from 2.560 to 14.082 Pesos per Canadian Dollar, a devaluation of approximately 500% and 450%, respectively (IMF, 2018).
- ▶ This paper seeks to determine the effect of the exchange rate on the willingness of the United States to participate in a trade agreement with Mexico and Canada.

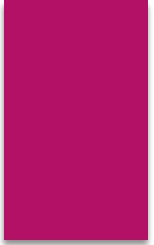
# Literature

- ▶ Schuh (1974) noted in the early 1970s that previous analyses of U.S. agricultural trade and development had neglected the role of exchange rate policy.
- ▶ Impact of exchange rate fluctuations on agricultural balance of trade (Chambers and Just, 1981).
- ▶ Long term effects, hysteresis: Baldwin (1988), Dixit (1989), Baldwin (1988), and Baldwin and Krugman (1989).
- ▶ Fernández-Arias et al. (2002) reference the January 1999 devaluation of the Brazilian Real as a catalyst for the adoption of protectionist measures by Argentina and the movement of Argentinian firms to Brazil.









Given that a devaluation of the peso relative to the dollar will result in a decrease in the dollar denominated prices  $P_X$  and  $P_M$ , we propose the following:

- ▶ If  $E_{ES} < E_{ED}$ , then  $\Delta P_X > \Delta P_M$  and the terms of trade ( $P_X/P_M$ ) will decrease;
- ▶ If  $E_{ES} > E_{ED}$ , then  $\Delta P_X < \Delta P_M$  and the terms of trade ( $P_X/P_M$ ) will increase; and
- ▶ If  $E_{ES} = E_{ED}$ , then  $\Delta P_X = \Delta P_M$  and the terms of trade ( $P_X/P_M$ ) do not change.

## A three-player, normal-form, non-cooperative game

►  $G = \{\mathbf{A}_{US}, \mathbf{A}_{MX}, \mathbf{A}_{CA}; \mathbf{P}_{US}, \mathbf{P}_{MX}, \mathbf{P}_{CA}\}.$

Each country  $k$  chooses some action  $A_k \in \mathbf{A}_k$  to maximize its payoff function,  $P_k$ , given the action choices of the other two countries.



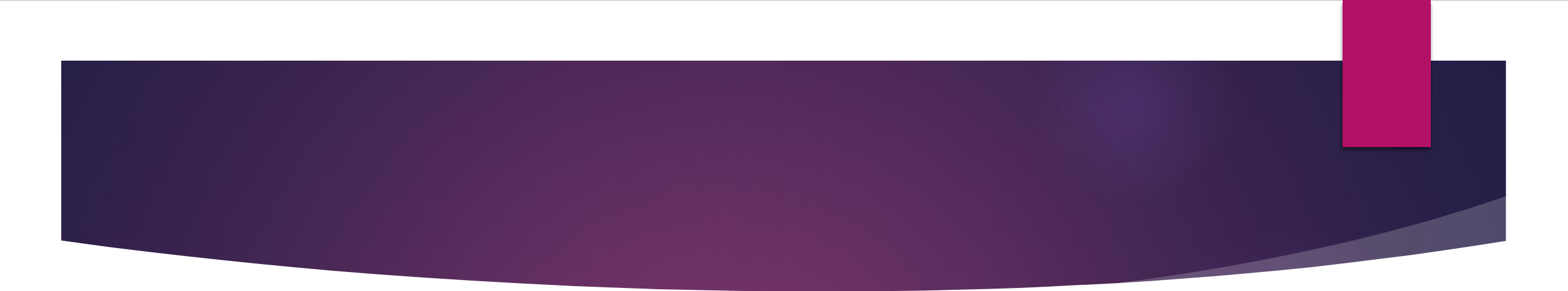
# Action Space

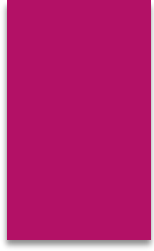
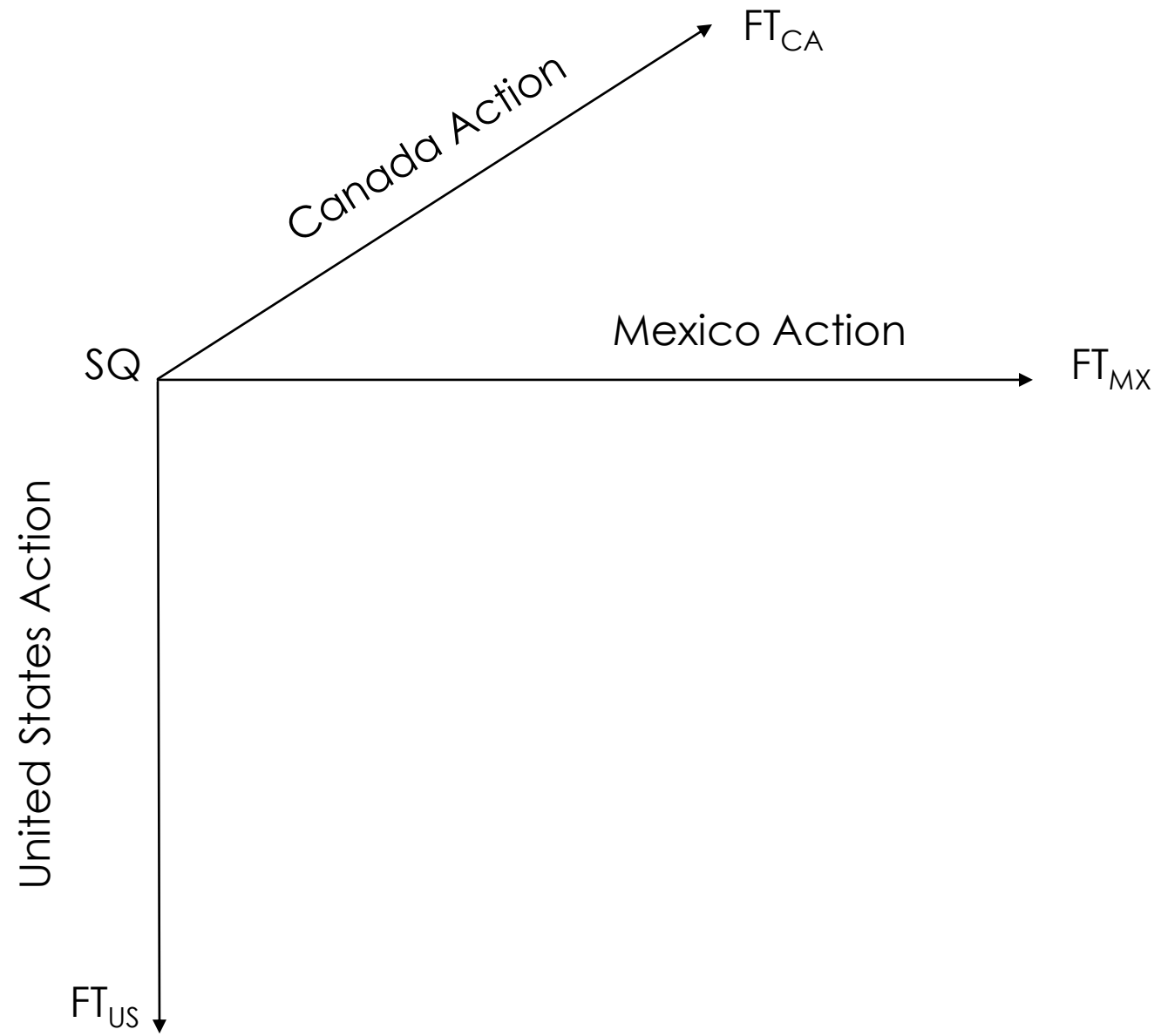
- ▶  $\mathbf{A}_k = \{SQ_k, 75_k, 50_k, 25_k, FT_k\}$  for  $k = \text{US, MX, and CA}$ , where
  - ▶  $SQ_k$  represents status quo policies;
  - ▶  $75_k$  represents protection at 75% of the status quo level;
  - ▶  $50_k$  represents protection at 50% of the status quo level;
  - ▶  $25_k$  represents protection at 25% of the status quo level; and
  - ▶  $FT_k$  represents free trade (FT).

# Payoff Function

The payoff function for each country  $k$  is the summation of changes in its producer and consumer surplus and changes to its government budget resulting from the strategy choices of all three countries.

$$\blacktriangleright P(A_{US}, A_{MX}, A_{CA}) = \begin{matrix} P_{US} \\ P_{MX} \\ P_{CA}. \end{matrix}$$

- 
- ▶ Four regions: the United States (US), Mexico (MX), Canada (CA), and the rest of the world (RW).
  - ▶ Twelve agricultural commodity groups: beef, pork, poultry, dairy, wheat, corn, rice, soybeans, cotton, sugar, vegetables, and fruit.
  - ▶ Production and consumption data for each commodity in each zone is based on a 2015-2017 average. Quantity data is obtained from the USDA (United States Department of Agriculture, 2018-b), except for fruits and vegetables, which is obtained from FAOSTAT (Foreign Agricultural Organization, 2018).
  - ▶ Protection levels for each commodity are based on the 2016 most-favored-nation tariff and non-tariff data (WTO, 2018).



*Game 1, Tri-Matrices of U.S., Mexican, and Canadian Payoffs for alternative U.S. and Mexican Strategies, 2016 Exchange Rate.*

		MEXICO				
	SQ <sub>CA</sub>	SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	0.00	13.52	113.22	356.82	827.73
		0.00	887.13	1,550.15	1,958.42	1,987.81
		0.00	-200.13	-423.94	-693.74	-1,007.91
	75 <sub>US</sub>	280.61	248.11	298.32	479.49	842.89
		-242.56	675.93	1,368.50	1,801.79	1,851.96
		-273.17	-494.49	-738.66	-1,030.24	-1,376.27
	50 <sub>US</sub>	466.33	457.51	523.71	716.91	1,101.59
		-593.76	368.70	1,095.89	1,555.86	1,624.56
		-626.45	-848.64	-1,099.81	-1,396.76	-1,746.38
	25 <sub>US</sub>	428.10	408.28	458.09	635.50	1,000.94
		-860.60	148.89	919.83	1,417.96	1,513.42
		-975.77	-1,197.59	-1,446.06	-1,744.29	-2,090.88
FT <sub>US</sub>	170.26	175.39	252.98	457.57	830.78	
	-1,146.37	-70.80	758.71	1,304.56	1,443.74	
	-1,342.69	-1,567.20	-1,818.47	-2,121.43	-2,482.56	

		MEXICO				
	75 <sub>CA</sub>	SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-121.52	-99.74	11.88	269.19	754.38
		-100.14	795.96	1,464.78	1,877.25	1,909.12
		1,740.73	1,567.16	1,374.86	1,144.70	879.63
	75 <sub>US</sub>	229.63	207.53	271.59	466.26	847.10
		-346.08	581.91	1,279.75	1,718.29	1,770.56
		1,505.81	1,311.84	1,100.00	848.97	555.93
	50 <sub>US</sub>	442.93	443.46	524.05	722.23	1,100.46
		-694.60	276.64	1,010.60	1,478.83	1,553.42
		1,203.75	1,008.90	792.25	541.41	252.73
	25 <sub>US</sub>	414.73	405.32	470.26	648.43	1,047.90
-955.64		63.03	841.23	1,380.82	1,444.27	
909.39		719.84	505.62	-572.55	-36.65	
FT <sub>US</sub>	195.20	208.39	300.09	523.21	922.80	
	-1,236.81	-152.64	686.15	1,238.05	1,377.81	
	611.95	417.40	201.90	-52.45	-350.67	

	50 <sub>CA</sub>	MEXICO				
		SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-249.60	-216.72	-88.91	197.38	706.44
		-227.64	678.87	1,357.14	1,776.59	1,811.40
		3,281.80	3,125.59	2,953.75	2,754.49	2,524.17
	75 <sub>US</sub>	184.27	175.70	255.05	469.41	869.10
		-475.80	462.33	1,169.83	1,612.97	1,669.55
		3,074.07	2,899.55	2,709.63	2,486.75	2,231.02
	50 <sub>US</sub>	432.44	445.67	536.37	745.08	1,146.28
		-822.17	160.92	906.28	1,382.94	1,461.61
		2,808.08	2,632.99	2,442.66	2,225.99	1,976.28
	25 <sub>US</sub>	416.49	423.63	505.92	720.51	1,127.32
-1,077.69		-46.76	743.32	1,254.47	1,357.68	
2,559.27		2,389.78	2,200.72	1,981.46	1,731.50	
FT <sub>US</sub>	241.13	270.05	379.37	624.07	1,048.75	
	-1,353.03	-254.68	593.96	1,154.95	1,299.50	
	2,308.71	2,137.25	1,949.43	1,728.96	1,473.38	



	25 <sub>CA</sub>	MEXICO				
		SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-374.56	-322.11	-179.12	131.76	669.63
		-399.67	523.02	1,212.81	1,642.02	1,682.48
		4,598.65	4,446.72	4,281.70	4,091.38	3,873.34
	75 <sub>US</sub>	154.56	164.76	262.56	502.12	933.29
		-651.86	302.70	1,022.19	1,475.88	1,537.88
		4,403.72	4,233.49	4,051.11	3,839.32	3,598.36
	50 <sub>US</sub>	446.72	479.19	573.43	808.61	1,239.87
		-992.65	7.42	768.84	1,255.25	1,340.47
		4,151.89	3,984.74	3,807.11	3,602.22	3,369.38
	25 <sub>US</sub>	456.39	482.45	587.43	830.08	1,268.59
-1,242.21		-192.41	610.86	1,133.47	1,243.94	
3,925.48		3,764.44	3,586.03	3,379.87	3,147.41	
FT <sub>US</sub>	331.14	383.64	516.79	787.72	1,246.58	
	-1,511.13	-395.04	469.80	1,042.75	1,195.03	
	3,698.86	3,535.07	3,359.24	3,154.15	2,919.66	

	FT <sub>CA</sub>	MEXICO				
		SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-476.39	-397.27	-217.58	131.10	708.02
		-680.14	269.10	981.34	1,427.31	1,478.71
		5,786.04	5,613.85	5,427.95	5,212.84	4,969.29
	75 <sub>US</sub>	172.71	212.96	343.40	622.78	1,098.08
		-937.53	45.29	788.64	1,259.34	1,331.82
		5,578.36	5,389.52	5,185.90	4,951.35	4,685.29
	50 <sub>US</sub>	533.54	575.99	705.95	985.28	1,462.79
		-1,270.09	-237.61	547.90	1,052.87	1,149.54
		5,303.99	5,123.05	4,926.78	4,699.54	4,442.36
	25 <sub>US</sub>	584.60	642.60	783.71	1,068.32	1,555.14
-1,511.25		-429.90	399.04	941.28	1,064.49	
5,063.96		4,884.76	4,688.15	4,461.95	4,207.57	
FT <sub>US</sub>	537.51	622.74	794.32	1,109.13	1,618.89	
	-1,771.18	-621.77	270.47	864.18	1,030.51	
	4,815.41	4,636.08	4,442.99	4,219.28	3,963.80	

*Game 2, Tri-Matrices of U.S., Mexican, and Canadian Payoffs for alternative U.S. and Mexican Strategies, 25% Peso Depreciation.*

	FT <sub>CA</sub>	MEXICO				
		SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-395.16	-238.79	-45.60	267.69	756.62
		-3,095.57	-2,085.59	-1,292.53	-733.09	-502.80
		6,123.57	5,989.87	5,845.06	5,673.02	5,463.71
	75 <sub>US</sub>	23.20	150.74	354.28	674.87	1,160.78
		-3,218.81	-2,194.24	-1,391.86	-833.60	-612.06
		5,901.95	5,768.48	5,624.45	5,440.69	5,213.47
	50 <sub>US</sub>	330.22	475.74	691.94	1,023.02	1,516.77
		-3,341.05	-2,298.28	-1,485.99	-917.99	-690.53
		5,676.36	5,544.55	5,379.91	5,184.04	4,959.43
	25 <sub>US</sub>	435.21	584.61	797.57	1,122.64	1,601.70
-3,424.29		-2,362.35	-1,525.66	-939.31	-696.55	
5,450.46		5,300.17	5,133.43	4,937.40	4,718.39	
FT <sub>US</sub>	371.28	518.83	732.14	1,055.08	1,392.48	
	-3,460.35	-2,347.36	-1,465.45	-841.88	-550.10	
	5,190.13	5,046.96	4,888.67	4,701.70	4,472.30	

*Game 3, Tri-Matrices of U.S., Mexican, and Canadian Payoffs for alternative U.S. and Mexican Strategies, 75% Peso Depreciation.*

	FT <sub>CA</sub>	MEXICO				
		SQ <sub>MX</sub>	75 <sub>MX</sub>	50 <sub>MX</sub>	25 <sub>MX</sub>	FT <sub>MX</sub>
UNITED STATES	SQ <sub>US</sub>	-721.35	-594.53	-417.61	-140.38	296.05
		-925.46	18.08	769.24	1,300.93	1,586.85
		6,353.70	6,318.61	6,261.57	6,087.24	5,892.54
	75 <sub>US</sub>	-129.61	-63.00	61.03	284.41	647.45
		-878.76	64.50	794.49	1,335.18	1,624.83
		6,247.75	6,188.85	6,047.97	5,872.73	5,677.23
	50 <sub>US</sub>	21.04	97.68	231.51	461.25	829.85
		-747.20	168.41	899.01	1,437.78	1,717.20
		6,108.14	5,965.92	5,817.12	5,643.91	5,451.10
	25 <sub>US</sub>	21.63	97.96	226.22	446.84	808.51
-658.38		266.44	1,001.26	1,539.44	1,813.15	
5,894.27		5,756.01	5,608.77	5,436.48	5,247.03	
FT <sub>US</sub>	-121.04	-32.12	108.45	341.11	615.56	
	-489.03	448.85	1,190.96	1,735.12	2,025.30	
	5,656.02	5,520.11	5,373.82	5,199.08	4,977.90	

Table 4. United States Net Exports by Commodity for Alternative Scenarios, Million Metric Tonnes.

	<i>2016 Status Quo</i>	<i>Game One Solution</i>	<i>Game Two Solution</i>	<i>Game Three Solution</i>
Beef	-0.25	-0.25	-0.40	-0.74
Pork	1.90	1.79	1.76	1.75
Poultry	2.95	5.82	5.17	4.06
Dairy Milk	0.08	5.22	4.26	2.54
Wheat	24.40	23.60	23.79	24.06
Corn	56.64	57.49	48.20	38.85
Rice	2.32	2.30	2.26	2.18
Soybeans	57.97	59.23	58.73	58.28
Cotton	13.54	11.84	12.24	12.57
Sugar	-2.80	-2.91	-2.41	-1.99
Vegetables	-2.24	-7.63	-8.92	-7.72
Fruit	-7.16	-4.50	-9.04	-8.93
Source: Author Calculations				

Table 5. Mexican Net Exports by Commodity for Alternative Scenarios, Million Metric Tonnes.

	<i>2016 Status Quo</i>	<i>Game One Solution</i>	<i>Game Two Solution</i>	<i>Game Three Solution</i>
Beef	0.06	0.17	0.40	0.81
Pork	-0.89	-1.37	-0.93	-0.35
Poultry	-0.79	-2.45	-1.68	-0.43
Dairy Milk	-0.03	0.10	1.30	3.29
Wheat	-3.84	-4.23	-3.30	-1.80
Corn	-13.22	-13.76	-7.07	3.28
Rice	-0.74	-0.74	-0.69	-0.60
Soybeans	-4.27	-4.46	-3.95	-3.23
Cotton	-0.77	-0.73	-0.38	0.14
Sugar	1.68	1.62	1.22	1.44
Vegetables	3.67	2.91	5.09	9.73
Fruit	3.00	0.12	5.06	19.30
Source: Author Calculations				



Table 6. Canadian Net Exports by Commodity for Alternative Scenarios, Million Metric Tonnes.

	<i>2016 Status Quo</i>	<i>Game One Solution</i>	<i>Game Two Solution</i>	<i>Game Three Solution</i>
Beef	0.19	0.08	0.00	-0.07
Pork	1.08	1.34	1.34	1.34
Poultry	0.00	-1.50	-1.62	-1.77
Dairy Milk	-0.05	-5.32	-5.55	-5.84
Wheat	20.59	12.34	12.31	12.26
Corn	0.89	1.17	1.20	1.19
Rice	-0.35	-0.34	-0.34	-0.35
Soybeans	4.42	4.75	4.75	4.75
Cotton	0.00	0.00	0.00	0.00
Sugar	-1.14	-0.98	-1.07	-1.16
Vegetables	4.90	4.57	3.69	3.56
Fruit	-2.21	-1.99	-2.33	-2.36
Source: Author Calculations				

Table 7. Rest of World Net Exports by Commodity for Alternative Scenarios, Million Metric Tonnes.

	<i>2016 Status Quo</i>	<i>Game One Solution</i>	<i>Game Two Solution</i>	<i>Game Three Solution</i>
Beef	1.85	1.85	1.85	1.85
Pork	-1.68	-1.35	-1.77	-2.34
Poultry	-0.29	0.00	0.00	0.00
Dairy Milk	0.54	0.54	0.54	0.54
Wheat	-20.55	-11.06	-12.26	-13.87
Corn	-46.95	-47.27	-44.64	-45.67
Rice	6.75	6.75	6.75	6.75
Soybeans	-51.41	-52.82	-52.82	-53.10
Cotton	-21.52	-19.86	-20.60	-21.46
Sugar	4.95	4.95	4.95	4.42
Vegetables	-6.29	0.00	0.00	-5.81
Fruit	7.60	7.60	7.60	-6.77
Source: Author Calculations				

Table 8. U.S. Actual Net Exports by Commodity by Country - 1986, Million U.S. Dollars.

	<i>World</i>	<i>Mexico</i>	<i>Canada</i>	<i>Rest of World</i>
Beef	389	-300	-569	1,258
Pork	2,894	978	-527	2,443
Poultry	3,014	797	211	2,006
Dairy Milk	1,449	1,152	177	120
Wheat	4,888	607	-394	4,675
Corn	9,744	2,596	104	7,044
Rice	1,135	264	143	728
Soybeans	22,512	1,466	15	21,031
Cotton	4,700	621	26	4,053
Sugar	-2,378	-703	-273	-1,402
Vegetables	-5,750	-5,814	423	-359
Fruit	-2,512	-5,179	1,786	881

Source: USDA-FAS, Global Agricultural Trade System, Harmonized System 2 and 4 digit data

# Conclusions

- ▶ Neoclassical economic theory suggests that countries will improve their welfare through the elimination of trade barriers.
- ▶ The approach utilized here highlights the sensitivity of U.S. agricultural trade liberalization to the value of the currency of its trading partners.
- ▶ One example of the fragility of these agreements involves ongoing disputes concerning vegetable trade between Mexico and the United States.
- ▶ Future research can seek to identify policy mechanisms that will minimize the movement of Nash equilibria away from free trade.