2011

Exchange Rate Volatility And U.S. Pork Exports To China

Daniel J. Boisson
North Carolina Agricultural and Technical State University

EXCHANGE RATE VOLATILITY AND U.S. PORK EXPORTS TO CHINA

by

Daniel J. Boisson

A thesis submitted to the graduate facility
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

Department: Agribusiness, Applied Economics and Agriscience Education
Major: Agricultural Economics
Major Professor: Dr. Osei-Agyeman Yeboah

North Carolina A&T State University
Greensboro, North Carolina
2011

School of Graduate Studies
North Carolina Agricultural and Technical State University

This is to certify that the Master's Thesis of

Daniel J. Boisson

has met the thesis requirements of
North Carolina Agricultural and Technical State University

Greensboro, North Carolina
2011

Approved by:

Dr. Osei-Agyeman Yeboah Major Professor	Dr. Benjamin Gray Committee Member
Dr. Godfrey Ejimakor Committee Member	Dr. Anthony Yeboah Department Chairperson

Dr. Sanjiv Sarin
Dean of Graduate Studies

BIOGRAPHICAL SKETCH

Daniel J. Boisson was born on October 12, 1983 in San Diego, California and grew up in the scenic Hudson Valley in upstate New York. He received the Bachelor of Arts degree in Psychology from the State University of New York at Buffalo in 2007. He is a candidate for the Master of Science in Agricultural Economics.

ACKNOWLEDGMENTS

Of the many people who have been enormously helpful in the preparation of this thesis, I am especially thankful to the Department of Agribusiness, Applied Economics and Agriscience Education at A&T, my advisor Dr. Osei-Agyeman Yeboah, committee members Dr. Godfrey Ejimakor, Dr. Benjammin Gray, and my family for their support.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURES **PAGE**

LIST OF TABLES

TABLES **PAGE**

LIST OF ABBREVIATIONS

ERS	Economic Research Service
WTO	World Trade Organization
USDA	United States Department of Agriculture
GDP	Gross Domestic Product
FOB	Free on Board
FAS	Foreign Agricultural Service
GATT	General Agreement on Tariffs and Trade
NAFTA	North American Free Trade Agreement
GATS	Global Agricultural Trade System
PPP	Purchasing Power Parity
Fr/Ch/Fz	Fresh, Chilled, Frozen
PBoC	People's Bank of China

ABSTRACT

Boisson, Daniel J. EXCHANGE RATE VOLATILITY AND U.S. PORK EXPORTS TO CHINA**. (Advisor: Dr. Osei-Agyeman Yeboah),** North Carolina Agricultural and Technical State University**.**

The share of U.S. pork exports in the world market has grown considerably in recent years. China has become a major importer of U.S. pork products as its per capita income growth has led to a population demanding higher quality meats. One major barrier U.S. producers/exporters face is a yuan that is subject to significant intervention. At present, the yuan is officially under a managed floating exchange rate based on market supply and demand with reference to a basket of foreign currencies, the main one being the U.S. Dollar. It is currently allowed to float in a narrow range of 0.5% around the central parity published by the People's Bank of China (PBC) daily. Demands to let the yuan float within a greater range have grown in the past few years as major economies have struggled with large trade imbalances. As the yuan appreciates in value against the dollar, U.S. pork exporters should enjoy increased demand due to increased purchasing power of the Chinese consumer. However, as the yuan is allowed to float within a greater range, exchange rate volatility also increases.

Various research efforts have demonstrated both negative and positive effects on trade due to increased exchange rate volatility. Using quarterly data, this study attempts to measure the level of exchange rate volatility that exists between U.S. and Chinese pork markets, and its effect on U.S. pork exports during the period of 1995 through 2009. Multiple measures of volatility were investigated with one exhibiting a negative and

statistically significant impact on export values while the other yielding a positive impact, but not at a statistically significant level. The results suggest exchange rate volatility may have a negative impact on U.S. pork exports to China, especially as the yuan moves toward market valuation.

CHAPTER 1

INTRODUCTION

China has been under increasing scrutiny to allow its currency to float on the open market. Currently, the yuan is maintained within a very narrow range of 0.5% around the central parity published by the People's Bank of China (PBC) on a daily basis. This narrow range prevents the yuan from trading at actual market rates. Because the yuan is artificially maintained at a lower valuation to the dollar, U.S. exporters face great difficulty in getting their products to China. An artificially devalued yuan means U.S. products will cost more than similar domestically produced Chinese products. The resulting trade imbalance continues to be a source of friction for lawmakers who want to protect U.S. workers from unfair trade practices.

Some progress has been made, however, in influencing China to relax its hold on the yuan. Overtime, China has gone from a yuan pegged to the U.S. Dollar, to a floating system which allows for a small amount of variability, using a basket of currencies as benchmark. The dollar however is a main component. Presently, lawmakers are calling for much more sweeping changes, with some even calling for a one time major reevaluation. In either case, as the yuan is allowed to float further within a greater range with respect to market conditions, exchange rate volatility will undoubtedly increase.

There has been controversy among economists on whether a high level of exchange rate volatility which characterizes the current world economic climate can affect U.S. exports.

The purpose of this study is two-fold. The first objective is to identify a valid metric of exchange rate volatility of the yuan against the U.S. Dollar. Medium to long-term changes in exchange rate will be studied as risk from short-term volatility can readily be mitigated using a variety of existing hedging instruments. Second, a model will be constructed, which illustrates China import demand of pork products as well as capturing the impact of exchange rate volatility. Finally, policy implications of the findings of this study and others will be discussed.

CHAPTER 2

BACKGROUND

2.1 The yuan

2.1.1 History of yuan regimes

The Renminbi, or Chinese yuan, is the official currency of China, having been first introduced in 1948 by the newly founded People's Bank of China. It is currently in its fifth series, having undergone periodic redesigns as well as reissuing in different denominations. Prior to 1972, the yuan was officially fixed to the U.S. dollar at 2.46 yuan per dollar. This was the height of Soviet-style central planning of the economy and the yuan was tightly controlled. It was gradually appreciated until it reached 1.50 yuan per USD in 1980. However, during the 1980s and 1990s the yuan was devalued in order to improve export competitiveness in international markets. As a result of devaluation, the yuan reached a record low in 1994 when the official exchange rate hit 8.62 yuan per USD. From 1997 to 2005, the yuan was officially pegged to the dollar at 8.27 yuan per USD. During this period, China experienced a great deal of economic expansion, including strong growth in exports. Under intense pressure, the peg was finally lifted in early 2005, and replaced with a managed floating exchange rate. This saw an immediate one-time reevaluation of 2.1%, which left the yuan at 8.11 yuan per USD. The yuan in

the inter-bank foreign exchange market would be allowed to float within a narrow range of 0.3% around the central parity published daily by the People's Bank of China. The range was later increased to 0.5% around the central parity. By April, 2008, the yuan had appreciated against the dollar, trading at a record 6.9920 yuan per USD.

Upon the onset of the financial crisis that rocked the global economy in 2008, the People's Bank of China reinstituted the peg in order to protect Chinese exports as well as the domestic economy. Though unofficial, the yuan shadowed the movements of the dollar. In June 2010, the People's Bank of China released a statement both in English and Chinese pledging to proceed with further currency regime reforms and increase exchange rate flexibility to a more market oriented approach. The People's Bank of China also pledged to prevent 'large swings' in the exchange rate, suggesting the yuan will continue to be tightly controlled for the near future.

2.1.2 Account convertibility of the yuan

Historically, the yuan has been considered a domestic currency due to the lack of account convertibility, as well as tight restrictions on cross-border flow of money. With the opening of mainland China to foreign markets in the late 1970s, the People's Bank of China instituted a two-tier system. The yuan was official currency only domestically, and could not be converted into foreign currency. Further, foreign visitors had to purchase official foreign exchange certificates to use while in China. This two tier system led to a high level of misalignment between official exchange rates and real exchange rates, encouraging the growth of black market exchanges. In an effort to move toward convertibility, the PBoC ended the two-tier system and setup the first foreign

exchange in Shanghai. On December 1, 1996, the PBoC began allowing current account convertibility, further opening China's market to global trade. It still, however, maintained tight controls over the convertibility of capital accounts, in an attempt to guard from sudden financial swings, and prevent a deluge of 'hot money' from entering the country. 'Hot money' is commonly described as foreign funds used to invest in short-term securities, as opposed to long-term capital investments. Limiting the flow of 'hot money' is one way to deter wild short-term swings in market prices, and can also deter foreign investment.

The Peoples Bank of China has taken a number of steps recently, however, to advance the convertibility of the yuan and allow it to better reflect supply and demand of economic conditions. For example, it has been working to allow full convertibility on the islands of Taiwan and Hong Kong, by setting up mechanisms of exchange currency between banks. Also, the PBoC implemented a pilot program in July 2009 to allow certain companies to settle import and export accounts in yuan. While only allowed in selected regions, this is a major move toward opening up the yuan internationally. As part of its five year plan to gradually allow full account convertibility, the PBoC plans to relax restrictions on cross-border securities investments and foreign direct investment starting in 2011.

2.1.3 The Devaluation of the yuan

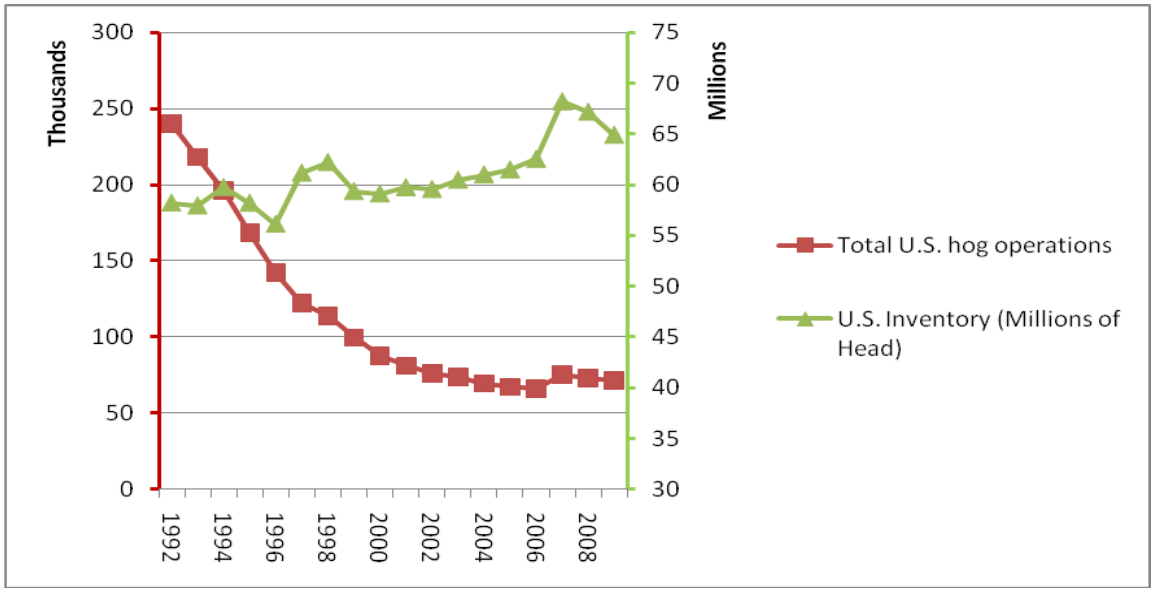
The value of the yuan is an issue that has grown in significance in recent years as a result of a number of economic pressures. By maintaining tight control over monetary outflows, China is able to restrict the flow of currency out of mainland China. Further, as

a result of the large current account and capital account surpluses, China is able to accumulate large amounts of international reserves. China's large international reserves further enable it to maintain greater control over its currency, whether through adding to its dollar reserves, or through purchasing currencies of neighboring countries. For example, China has recently begun diversifying its foreign currency reserves. It currently holds more than 1.5 trillion USD in reserves; however, it has also begun purchasing yen, among other currencies. Therefore, Japan is forced to purchase dollars in order to prevent the yen from appreciating as a result of the Chinese buying. Estimates of the amount the yuan is undervalued vary. For example, Goldstein (2004) estimates real yuan is undervaluation in 2003 is between 15-30 percent, using a trade model for China's overall balance of payments. Similarly, Coudert and Couharde (2007) estimate an undervaluation of 23 percent. However, Dunaway, Leigh, and Li (2009) caution subtleties in variable definition, time periods, and model design can lead to very dramatic differences in equilibrium exchange rate estimates. Estimates utilizing purchasing power parity (PPP) have shown similar undervaluation. The World Bank estimated in 2004 that one international dollar was equivalent to approximately 1.9 yuan. Further, the International Monetary Fund estimated that in 2008, one US dollar was equivalent to 3.798 yuan. In 2006, it estimated a US dollar to be equivalent to 3.462 yuan, and 3.621 yuan in 2007, suggesting currency reforms already in place have had little effect.

2.2 Trends in the U.S. Pork industry

2.1.1 U.S. Pork production

The pork industry in the U.S. has grown to be a major worldwide exporter in recent years. In 1994 the U.S. went from a net importer to a net exporter. Although the traditional pork producers in the U.S. were often smaller, multi-enterprise operations, much consolidation has taken place. The prevailing trend in U.S. agriculture in the past few decades has been to move toward fewer, larger farms. The pork industry has followed this trend as well. Between 1992 and 2004, for example, the number of farming operations with hogs decreased by 70 percent. During the same period however, the size of hogs farming operations have grown larger as figure 2.1 demonstrates. In 1992, the average hog operation had 945 head; however, by 2004 that number had grown to 4,646 head.

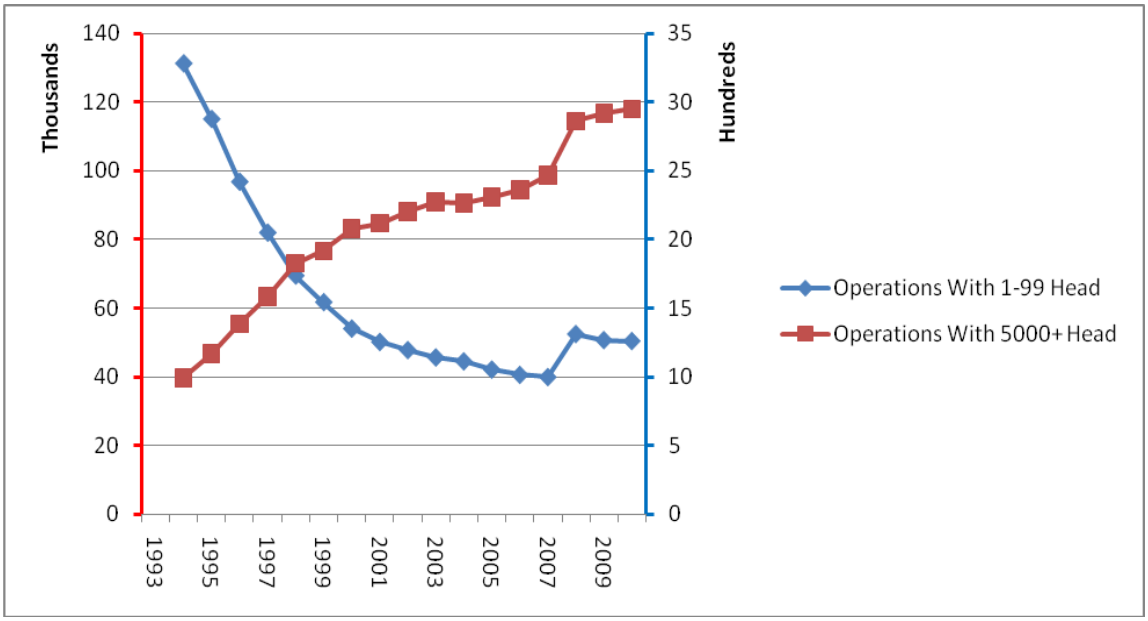


Source: USDA, ERS using data from NASS

Figure 2.1 Number of U.S. hog operations and total hog inventory

The largest pork producers are located in the Southeast and Midwest. Eastern North Carolina alone accounted for on average about 92 percent of the pork produced in the Southeast region. Hog operations have also become more specialized. A traditional operation would typically breed and raise their hogs to slaughter weight, around 225-300 pounds, in one location. These types of operations are called farrow-to-finish. In contrast, hog operations that specialize in one particular phase of production have become widespread due to their increased efficiency and lower cost. Many large scale processors have also begun to use more specialized farms to contract production. The proportion of hogs produced under contract has grown from 5 percent in 1992 to 67 percent in 2004. These operations receive young hogs and raise them until slaughter weight. Such operations are called feeder-to-finish. Feeder-to-finish operations have

accounted for a reduction in the amount of feed per unit of output by 4.7 percent annually, and have reduced the quantity of labor required per unit of output by over 13 percent annually between 1992 and 2004 (Economic Research Report No. ERR-52). Such increases in scale and efficiency have led to substantial increases in production on these large scale farms. Figure 2.2 illustrates this trend toward larger farm production. Locating these farms in regions where access to low cost feed further reduces production costs and increases efficiency.



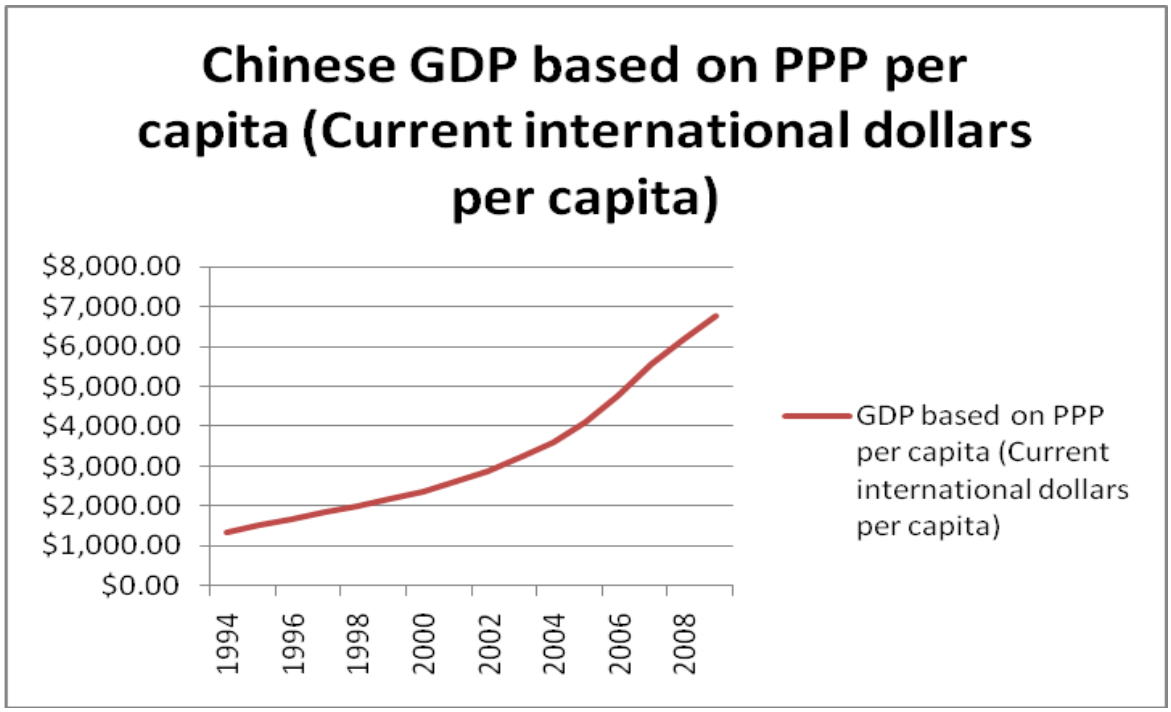
Source: USDA, ERS using data from NASS

Figure 2.2 Increases in Pork Operation Scale

In recent years, the growth of hog operations in the Southeast has slowed, primarily as a result of the State of North Carolina enacting a moratorium on hog farm expansion due to environmental concerns. Exceptions to the moratorium include however bio-waste reactors, and other systems that reduce local water pollution. On the other hand, hog farming operations in the Midwest have continued to grow. Feed is a major constituent in the cost of producing pork and with the majority corn and soy crops grown in the Midwest; many large scale pork producers have setup operations to take advantage of the abundant and cheap inputs. While Chinese pork producers may eventually modernize their operations in an attempt to compete with imported pork, such comparative advantage is not likely to go away since China has a relatively small amount of land available to produce animal feed.

2.1.2 Pork Consumption in China

While data on Chinese pork consumption is readily available, its accuracy is often suspect. For example, the USDA estimated annual meat and poultry consumption at 42kg per capita, while Huang (1996) estimated about half that amount. Regardless, as incomes in China continue to improve, consumers will demand higher quality meats (Hayes and Clemens, 2003). Figure 2.3 illustrates this steady growth in income level. Consumers in urban areas especially, have shifted from consuming primarily grains to higher quality food products (Wang, Jensen, and Johnson, 1993). Between 1984 and 1996, for example, annual per capita grain consumption declined from 142kg to 94kg in urban areas (State Statistical Bureau of China). In contrast, consumption of meat, eggs, milk, and fruit increased dramatically.



Source: IMF, World Economic Outlook 2010

Figure 2.3 Chinese GDP based on PPP per Capita

Demand for U.S. pork products in China is strong enough that, despite official import restrictions prior to WTO ascension, large quantities have been smuggled into the mainland. Hong Kong is the principle port that smugglers use and represents a sizeable quantity of pork imports. For example official pork exports to China in 1999 were valued at $5 million. However, this illegal trade through Hong Kong accounted for an additional $32 million worth of U.S. pork exports (U.S. Dept of Agriculture, 2000). Clearly, there is a strong demand for U.S. pork as smuggling requires great expense and effort.

Chinese consumers tend to prefer variety cuts of pork; non-muscle meat cuts such as internal organs with a strong taste. In contrast, U.S. consumers tend to prefer muscle

meats and usually shy away from variety cuts. Since consumers in one country will pay a premium for cuts that consumers in the other country dislike, U.S. and Chinese consumers are perfect compliments (Hayes and Clemens, 1997). U.S. pork products are particularly desired by Chinese consumers for their high-quality. Since most domestically produced pork is traditionally fed a diet low in proteins and essential amino acids, it tends to be very fatty and less preferred than leaner meat.

2.1.3 Problem Statement

As trade between the U.S. and China has grown in recent years, so has the overall trade deficit. The U.S. has imported far more goods from China than it exported for many years. While the current accounts deficit is much smaller, relatively, there is still a strong outcry among many in the U.S. that a fairer exchange rate will balance trade, and improve both economies. While not officially considered a 'currency manipulator' by the U.S., there is strong evidence that China does manipulate its currency to give certain domestic industries an unfair advantage. For example, as the world financial crisis was occurring in 2008 and many nations were coping with slumping economies and negative GDP growth, China unofficially re-pegged the yuan to the dollar. This move essentially reversed any reform efforts that had occurred prior as well as prevent the market from better valuing the yuan with respect to world market conditions. Although the unofficial peg has since been lifted, the move showed that the Chinese Government was willing to manipulate its currency in order to 'insulate' the domestic economy from international market turmoil.

While the yuan is currently allowed to float within a narrow range of the central parity price, published daily by the People's Bank of China, many U.S. lawmakers have continued to call for further 'flexibility' and large-scale appreciation. Further, the 2010 G20 Summit held in Toronto included many G20 nations, led by the U.S., calling for China to make more dramatic and immediate changes to its currency regime. Goldstein (2007), for example calls for an immediate 10-15 percent adjustment. Sudden, drastic changes to the yuan could, however, be counter-productive in growing international trade. Due to tight controls on the flow of capital, for example, a freely floating currency regime applied to the yaun could mean a sudden change in value, depending on the value that currency markets place on it. As many economist feel the yuan is currently undervalued compared to the dollar, a sudden correction to markets rates could hamper economic growth significantly (Woo and Xiao, 2007). Therefore, Woo and Xiao suggest the steady process of yuan reform should be accelerated and happen alongside with import liberalization reforms. As China moves toward a more flexible exchange rate regime, exchange rate volatility will undoubtedly increase given the nature of the currency markets.

Presently, U.S. pork is competitive among Chinese consumers in terms of price and quality. Although U.S. pork exporters face an unfavorable exchange rate, their lower cost of production allows U.S. pork to remain competitive with domestically produced pork. This is primarily a result of structural improvements in the U.S. pork industry, as well as lower feed cost. However, Chinese producers are slowly modernizing and may eventually be competitive with U.S producers. The effects of exchange rate volatility

will be an important determinant to the success of U.S. pork exporters as they continue to increase trade. This study therefore attempts to estimate the degree to which exchange rate volatility affects the value of pork exports to China.

2.1.4 Justification

As the international community, including the U.S., continues to call for China to revalue the yuan and let it float in a more market oriented regime, any changes made will undoubtedly have an effect of trading patterns. Since the yuan has been maintained at a lower value than the dollar for such an extended period of time, long-term trading patterns have developed. While immediate, short-term disruptions and risk to exchange rates can generally be mitigated against through hedging in the futures markets, no simple solution exists to insure those long-term trade patterns. Policy changes affecting the value of the yuan will therefore have long-term effects. These medium to long-term effects can be just as disruptive to trade patterns as an artificially low currency. Medium to long-term changes to the yuan need to be studied in order to minimize the long-term effects on U.S. farmers who export to China, and who are often unable to hedge against long-term volatility in currency valuation.

An artificially weakened yuan serves to make products imported from the U.S more expensive than domestically produced products. While a devalued yuan serves to increase the price of U.S. sourced pork in China, the U.S. still retains a comparative advantage producing pork at a lower cost, higher quality, and greater efficiency. This comparative advantage enables U.S. producers to capture some of the Chinese market successfully. However, if the yuan were floated and allowed to appreciate as dictated by

market conditions, U.S. pork producers would stand to capture a greater proportion of the Chinese market.

Finally, a more market oriented value of the yuan would naturally carry with it an increased level of exchange rate volatility as markets tend to fluctuate. Prominent Chinese officials have stated on numerous occasions that China fully intends to eventually open up the yuan to foreign exchange markets, albeit slowly and on their terms. As the yuan does become more market oriented, much study will be required on how U.S. exporters will be affected by the resulting exchange rate volatility. Knowledge of the real impact of such volatility will enable U.S. pork producers, as well as policy-makers, to plan accordingly and remain competitive internationally.

2.1.5 Objectives

The overall goal of this study is to determine the impact of medium to long-term exchange rate volatility on the total value of U.S. pork exports to China. The objectives are as follows:

1. To construct a standard and widely used measure of exchange rate volatility.
2. Apply the exchange rate volatility data in objective (1) in addition to traditional trade factors to a static gravity model to econometrically determine the impact of exchange rate volatility on U.S. pork exports to China.
3. Provide policy recommendations based on the results of 1, and 2.

CHAPTER 3

LITERATURE REVIEW

3.1 Exchange rate volatility

Despite numerous comprehensive studies conducted over the past few decades, there is little consensus on the impact of exchange rate volatility on U.S. agricultural exports, Further, there have been used a variety of ways to measure exchange rate volatility. McKenzie (1999), for example, offers a thorough review of the available literature on measures of exchange rate volatility. Hooper and Kohlhagen (1977) constructed a theoretical model of market equilibrium for traded goods that include both import demand and export supply. They analyzed trade prices and volumes of U.S. and German trade flow cases for 1965-1975 and found a statistically significant negative impact on import demand and market prices. As exchange rate volatility increases, import demand is depressed and market price is reduced, ceteris paribus. To measure exchange rate volatility, Hooper and Kohlhagen used the average absolute difference between a period's spot exchange rate and the preceding period's forward rate. They found this measure to yield the most significant coefficients as well as yield a better overall 'goodness of fit.'

Perée and Steinherr (1989) offer a measure of exchange rate volatility that has become widely used. They reject the use of the variance of the exchange rates, or some form of, as a means of measuring volatility, opting for a measure utilizing historical experience. Perée and Steinherr argue a measure utilizing variance of the exchange rate cannot be used to forecast several years into the future, and is therefore of very little relevance. Because decisions are influenced by expected variability and not past variability, a measure with no predictive attributes would make it of little use. Perée and Steinherr offer instead a measure of volatility taking into account accumulated experience by the trader and exchange rate misalignment.

Sun, Kim, Koo, Cho, and Jin (2002) studied the effect of exchange rate volatility on worldwide wheat exports. They utilized a gravity-type model within a panel framework to look at both short-term and long-term measures of volatility. For the short-term measure, with a window of only one to two years, a moving sample standard deviation of the percentage real exchange rates is used. This has been widely used in other studies as well (Koray and Lastrapes 1989, Chowdhury, 1993). As a means of measuring long-term volatility, Sun *et al.* applied a second measure, originally used by Perée and Steinher (1989). As expected, Sun *et al.* found both measures of volatility, short and long-term, to have a negative effect on worldwide wheat trade. Further, the long-term measure showed a larger effect. This suggests exchange rate volatility is indeed a significant factor in worldwide wheat export patterns.

Koray and Lastrapes (1989) used VAR models to investigate the impact of exchange rate volatility on trade between several developed economies. They applied a

moving standard deviation of the growth rate of the real exchange rate. This measure is similar to previous studies such as Ahktar and Hilton (1984), Cushman (1983), and Kenen and Rodrik (1986). Their results suggest exchange rate volatility does indeed have a weak effect on trade. Further, permanent shocks to volatility do have a negative impact on trade. These effects are relatively more important over the flexible exchange rate period.

Yuan and Awokuse (2003) examined U.S. poultry exports using unbalanced panel data of 49 U.S. trading partners. They employed a standard gravity model and used several measures of exchange rate volatility; the absolute percentage of the exchange rate, the variances of the spot exchange rate around its trend, and the moving average of the standard deviation of the exchange rate. Yuan and Awokuse find that in all three cases, exchange rate volatility has an adverse effect of U.S. poultry exports. However, only the variance of the spot rate measure showed a statistically significant effect, albeit a small effect. By using multiple measures of exchange rate volatility, Yuan and Awokuse demonstrate that measuring techniques make a difference in capturing exchange rate volatility.

Sheldon (2003) applied a gravity model to the bilateral trade flows of 10 developed countries from 1975-1995, and examined the effect of medium to long-range exchange rate volatility on U.S. agricultural exports. Utilizing a measure similar to Perée and Steinherr (1989), Sheldon compares the effects of exchange rate volatility on the agricultural sector, as well as three other sectors; machinery, chemicals, and other

manufacturing. He concludes that compared to the other sectors, there is a clear adverse effect on agricultural trade from exchange rate volatility.

Sheldon, Mishra, Pick, Thompson (2010) further investigate the effect of exchange rate volatility on U.S. bilateral fresh fruit and vegetable trade with Latin America. They employ two datasets, one for fresh fruit over the period 1976-1999 for a panel of 26 countries, and a second dataset for fresh vegetables during the period 1976-2006 with a panel of 9 countries. The Perée and Steinherr (1989) measure of exchange rate volatility is also used in this study. Sheldon *et al.* conclude that exchange rate volatility has an adverse impact on fresh fruit bilateral trade. Further, they find the greatest source of volatility stems from the exchange rates of Latin American currencies and the U.S. Dollar.

CHAPTER 4

METHODOLOGY AND DATA

4.1 Operationalizing Exchange Rate Volatility

To measure exchange rate volatility, a variety of measures have been used in the past. Typically, measures utilizing the standard deviation of the real exchange rate, or some form of, have been used. Since real exchange rates tend to revert to equilibrium values over the long run, it can be regarded as a suitable measure of volatility; stationarity of a variable implies the existence of a finite long-run variance of the series. A moving standard deviation of the real exchange rates, in the order of *m* periods, can be expressed as:

$$V_t^{KL} = \left[m^{-1} \sum_{i=1}^{m} (X_{t+i-1} - X_{t+i-2})^2 \right]^{1/2} \quad (1)$$

Where X_t is the real exchange rate in period *t*. Either annual or quarterly data is often used, depending on availability and target time frame to be studied. In this study, the prior 8 quarters are used as reference, giving *m* a value of 8. This measure is often used to capture short-term volatility and is consistent with the literature (Koray and Lastrapes 1989, Chowdhury 1993). Koray and Lastrapes, for example, used monthly real exchange

rates and found that the effect of volatility on imports is weak. However, permanent shocks to volatility did have a significant negative impact on trade and that impact was relatively more important over the flexible rate period.

Perée and Steinherr have noted that as long as exchange rates closely follow purchasing power parity, exchange rate volatility is not significant. Essentially, short-term exchange rate volatility can be hedged in a variety of ways, reducing the overall volatility to an insignificant amount. Utilizing the futures market is one cost effective way of hedging against short-term volatility, among other tools. On the other hand, most international agricultural trading involves long-term contracts. While exchange rate misalignment in the short-term is insignificant, long-term misalignment and the associated exchange rate volatility are more likely to have an impact on trade, as long-term hedging is often unavailable and/or costly. As a result, medium to long-term exchange rate volatility is the focus of this paper.

Measures utilizing variances over past periods have very little relevance in projecting into the future. Considering the unfeasibility of long-run exchange rate misalignment forecasts, as well as lack of knowing the distribution function which governs real exchange rates, volatility is the prevailing factor, as opposed to risk. LeRoy and Singell (1987) aptly argue the important distinction between risk and volatility. Furthermore, this condition is not specific to a completely flexible exchange rate regime, but also to regimes which allow some amount of adjustment. Long-term forecasts of valuation, changes in real exchange rate, and historical measure of variability are

therefore are of little use. This leads Perée and Steinherr to seek a measure of volatility based on historical experience of the agent.

Volatility that is based on the agents' previous experience where they remember highs and lows of the previous period, adjusted for the experience of the last year relative to the agents' perception of the proper 'equilibrium exchange rate' is the second measure investigate. Specifically, Perée and Steinherr propose:

$$V_t^{PS} = \frac{MaxX_{t-m}^t - MinX_{t-m}^t}{MinX_{t-m}^t} + \left[1 + \frac{\left|X_t - X_t^p\right|}{X_t^p}\right]^2 \quad (2)$$

where the first term attempts to capture the agents' 'accumulated experience' rather than just variation. 'Accumulated experience' is preferred over variation since the agent may still remember past negative experience, which affects current behavior, regardless of current variation. $Max\ (Min)X_{t-m}^t$ is the maximum (minimum) value of real exchange rate over the previous *m* periods. This paper uses *m*= 8, conditioning the agent over the previous 8 quarters, or two years. The second term attempts to capture more recent information pertaining to the level of exchange rate misalignment. This term measures the deviations of the real exchange rate, X_t , from the 'equilibrium exchange rate', X_t^p. 'Equilibrium exchange rate' is a somewhat ambiguous term as there is no single measure, nor any preferred calculation. However, keeping in line with previous studies, the mean of the real exchange rate over the entire study period is used for this paper. Both V_t^{KL} and V_t^{PS} will be compared to find the better measure of volatility.

4.2 The Chinese Import Demand Model for U.S. Pork

The application of the gravity model to spatial flows, based on Newton's gravity equation in physics, has been used increasingly in the past few years in measuring regional and international trade flows. Further, it has been relatively successful in accounting for most of the variation in international trade. Anderson (1979) developed a theoretical framework for the gravity model that utilizes the properties of the Cobb-Douglas expenditure systems which assumes identical homothetic preferences across regions as well as the Armington assumption that goods produced by different countries are inherently imperfect substitutes by virtue of their origin. This model assumes a zero balance of trade at the start of each period. A similar approach based on the gravity model is used in this study, utilizing general demand-side factors.

$$M_{ijt} = f(Vol_{ijt}, AgGDP_{it}, GDP_{jt}, Pop_{jt}, WTOmem_{jt}, H1N1Flu_{jt}) \quad (3)$$

Where M_{ijt}^{k} is the total value exports from countries *i* to *j*, of product *k* during period *t*, and is a function of *Vol*, measuring exchange rate volatility between the dollar and the yuan, $AgGDP_i$ is the U.S. agricultural gross domestic product, GDP_j is the Chinese GDP, Pop_j is the population of China. *WTOmem* is a dummy variable representative of membership to the WTO by China, and *H1S1Flu* is a dummy variable representative of the trade ban on U.S. pork that China instituted as a result of reported cases of the H1N1 virus found in some U.S. hogs. Accordingly, the value of U.S. pork exports can be explained by positive factors as income, represented in per capita data, and negative factors such as exchange rate volatility. Membership into the World Trade Organization

should be a positive factor as well, while existence of trade restrictions due to the H1N1 virus would be negative. Information pertaining to the 2009 pandemic H1N1 influenza outbreak and the resulting trade restrictions is obtained from the USDA and the Congressional Research Service.

Transportation cost is captured in FOB values of the export value. In measuring U.S. pork export value, two pork export categories using the FAS product category system were chosen, which represent the two largest pork export categories. Variety pork cuts offer U.S. pork producers a channel to export cuts that are in relatively low demand domestically, but high demand in China. For example, pork stomach sells at a 50 percent premium to loins in China, as opposed to the U.S market where stomach sells for 40 percent of the loin price. As U.S. pork producers are optimized for muscle meat production, fresh, chilled, and frozen cuts constitute the second category of pork studied. The total value of both categories is then added to each other to construct the dependent variable.

Consistent with the underlying micro-foundations, GDP per capita is used to capture market size and is expected to have a positive effect on trade. The total GDP per capita of the importing country, China, is represented as *China_GDP*. Correspondingly, the agricultural GDP of the exporting country, United States, is utilized to capture the size of the agricultural sector. Agricultural GDP is expected to have a positive effect on trade as well, since a larger agriculture sector would imply greater production, and therefore exporting. This is represented as *AgGDP*. All values of GDP used are in real terms, and 2005 dollars. Ascension into the World trade Organization is represented as a

dummy variable, *WTOmem.* Membership in a free trade organization whose aim is to liberalize trade would be a positive stimulant to trade. Rose (2003) examines whether admission to a free trade agreement does, in fact, increase trade within its members and offers interesting findings. The measure of exchange rate volatility corresponds to *Vol*. As the level of exchange rate volatility increases in the market, the value of exports is expected to be negatively impacted. Finally, natural logs are applied to all real numerical variables which include *ExpVal* , *China_GDP,* and *AgGDP.* Applying the above variables to an econometric model yields the following:

$$\ln ExpVal_{ijt}^{k} = \beta_0 + \beta_1 Vol_{ijt} + \beta_2 \ln AgGDP_{it} + \beta_3 \ln China\_GDP_{jt} + \beta_4 WTOmem_{jt} + \beta_5 H1N1\_Flu_{jt} + \varepsilon_{ijt} \quad (4)$$

Where *k* is the product category, *t* is the current time period, *i* is the exporting country, *j* is the importing country, and the error term is lognormally distributed with a mean of zero and can be written as:

$$\varepsilon_{ijt} = u_{ijt} + v_{ijt} + w_{ijt} \quad (5)$$

Where,u_{ijt} as the unobserved bilateral effect, v_{ijt} as the unobserved time effect and w_{ijt} as the remaining residual error.

4.3 Data

Data for the period 1995 to 2009 is gathered from a variety of databases. This period covers both floating and fixed rate regimes. Quarterly data is used in order to have a medium to long-term exchange rate variable. Therefore the study period is from

second quarter 1995 to fourth quarter 2009. Expanding the study period to earlier dates proved difficult due to the increasing number of zero trade values for the dependent variable. U.S. export data for the regressand comes from the Foreign Agricultural Service's GATS database which supplies FOB export value data in 2005 U.S. dollars to trading partners on a quarterly basis. Annual population data was data was obtained from the Penn World Table and converted into quarterly format using cubic spline interpolation. Quarterly GDP data for China was obtained from the Nation Bureau of Statistics representing official Chinese Government statistics. Data for the U.S. agricultural GDP was obtained from the USDA's ERS website. Spot exchange rate data was obtained from the Board of Governors of the Federal Reserve System Data Download Program in monthly format and averaged into quarterly figures. This exchange rate data was then utilized to construct the exchange rate volatility measures. The website of the WTO provides accession dates for trading partners in this study while information pertaining to the spread of the H1N1 outbreak is found on the USDA's website.

The reliability of data reported from official Chinese sources has been a topic of some interest. Variations arise in many different types of data when official Chinese sourced data is compared to non- official Chinese data. Movshuk (2002) identifies two sources of inaccurate growth figures; political pressure on local officials to report high growth rates and the use of obsolete statistical methodology. Observers have repeatedly questioned the official growth numbers supplied by the National Bureau of Statistics, suggesting the actual growth rate could be far less. For example, Rawski (2001) asserts

that energy usage during the period of 1997-2000 does not match reported GDP growth rates. Nevertheless, official government GDP data is used in the absence of a better metric for income.

4.4 Estimation Procedure

Issues with a zero-value variable were present in some of the export trade value data. Toward the end of the study period, for example, U.S. uncooked pork was banned for phytosanitary concerns. Taking the natural logs of these values would prove futile. Consequently, there are several ways of dealing with zero values. Biessen (1991) used the Tobit model, while Ratnayake and Townsend (1999) removed the zero value observations from the dataset. Because the countries in this study have traded in pork for years prior, it is assumed the zero value observations inherently contain important information and cannot be neglected. By combing both pork categories, issues with zero-values were eliminated.

Natural log forms of the total export value, agricultural GDP, and Chinese GDP per capita were used so that estimated coefficients are interpreted as elasticities. The U.S. pork export data was then regressed using OLS (ordinary least squares) on a set of the explanatory variables: exchange rate volatility, Chinese GDP per capita, U.S. agricultural GDP and dummy variables accounting for WTO membership and trade restrictions due to phytosanitary concerns regarding the spread of the H1N1 influenza outbreak occurring toward the end of the study period.

CHAPTER 5

RESULTS

5.1 Results

Coefficients for the estimates of volatility varied, with V_t^{KL} utilizing a moving standard deviation significant and negative (-2.74) at the 5% level indicating a percent increase in exchange rate volatility will decrease exports by 2.74%, while V_t^{PS} incorporating the magnitude of past movements as well as current deviation of real exchange rate was not statistically significant in the results. Consequently it was discarded. Empirical results of the entire import demand model and both measures of volatility can be found in Table 5.1. Descriptive statistics for the estimates can be found in Table 5.2. These results are in line with previous studies such as Sun *et al.* (2002), Yuan and Awokuse (2003) and Sheldon (2003), among others, which found exchange rate volatility had a negative effect on trade.

Variables measuring income were positive and significant, as expected. The estimate for per capita GDP for China was 0.44 which implies a percent increase in per capita income will be accompanied by a 0.44 percent increase in demand for U.S. pork. The elasticity is in line with previous studies such as Yuan and Awokuse where foreign income was found to be an important determinant in trade value. U.S. agricultural GDP

was positive, as expected, and significant to the 1% level. As the U.S. agricultural sector continues to grow, it will export greater amounts of products, including pork. Elasticity for U.S. agricultural GDP was 3.54, indicating a percent increase in the U.S. agricultural GDP would increase pork exports to China by 3.54%.

Table 5.1. Empirical Results

Parameter Estimates	V_t^{KL}	V_t^{PS}
Constant	-11.08** (-2.20)	-16.44*** (-3.16)
Vol	-2.74** (-2.33)	0.23 (0.26)
China_GDP	0.44*** (2.14)	0.42* (1.82)
US_AgGDP	3.54*** (2.92)	4.74*** (3.92)
WTOmem	1.27*** (3.09)	1.11** (2.60)
H1N1_Flu	-3.60*** (-4.92)	-3.82*** (-4.81)
R^2	**0.75**	**0.73**

Notes:
1. *t* statistics are in parentheses
2. Statistically significant at the 10%*, 5%**, or 1%*** level.

Dummy variables representing China's ascension into the WTO and phytosanitary trade restrictions resulting from the 2009 H1N1 influenza pandemic were also significant with expected signs. The WTO membership coefficient estimate was positive with a level of significance of 1%. The coefficient estimate for trade restrictions

resulting from concerns over 2009 H1N1 influenza pandemic was negative, as expected, and at the 1% level of significance. Naturally, imposed barriers to trade clearly have a negative effect on demand for U.S. pork products.

Table 5.2. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Median	Minimum	Maximum
ExpVal	59	11,207	22,475	3,001	28	140,110
V_t^{KL}	59	0.028801	0.11753	6.4187e-005	2.9722e-008	0.53249
V_t^{PS}	59	1.1487	0.16233	1.0657	1.0260	1.6046
$China\_GDP$	59	933.51	772.17	689.89	155.24	3,659.7
$AgGDP_{it}$	59	85.164	15.507	85.500	53.700	111.50
$H1N1\_Flu_{jt}$	59	0.033898	0.18252	0	0	1
$WTOmem_{jt}$	59	0.57627	0.49839	1	0	1

CHAPTER 6

CONCLUSION AND DISCUSSION

6.1 Conclusion

A standard model of trade was employed to evaluate the effect of exchange rate volatility on U.S. pork exports to China. There is currently a great deal of pressure on China to give the yuan greater market flexibility which would likely see an increase in value against the dollar, as opposed to the central bank determining the value. Many estimates suggest the yuan is undervalued and subject to significant intervention by the government. Further, an undervalued yuan serves to undermine trade by giving Chinese exporters an advantage over their American counterparts. As a result a significant trade deficit has developed over the past few years.

This study examined U.S. pork exports to mainland China using a standard trade model. Pork is an appropriate example for studying exchange rate volatility because there is strong, growing demand among Chinese consumers as well as an established and growing pork industry in the U.S. After constructing a suitable measure of exchange rate volatility, it was included in the standard trade model. This study found exchange rate volatility to have a negative effect on U.S. exports. An increase in exchange rate volatility will serve to decrease U.S. exports, a finding that concurs with existing

literature on the subject. In this study, the measure of volatility based on Koray and Lastrapes' moving standard deviation of the growth rate of the real exchange rate was found to be a suitable metric.

Other trade factors included in the study were also found to be important determinants affecting trade. Chinese per capita income was found to be an important factor encouraging exports. As individual income continues rise in China, demand for U.S. exports will also continue to rise. U.S. agricultural GDP was also found to be an important factor encouraging U.S. exports. As the agricultural sector in the U.S. continues to grow, exports will continue to rise in concert. Lastly, membership to the WTO is shown to encourage exports while border restrictions arising from phytosanitary concerns are shown to decrease exports.

6.2 Policy Recommendations

Economic wisdom suggests a more open marketplace will always benefit trade. Even with a devalued yuan, which stands to increase the price of U.S. pork for Chinese consumers, U.S. pork remains competitive in price and quality versus pork produced domestically in China, a result of a highly efficient industry. U.S. pork exporters would undoubtedly benefit from a more appreciated yuan, making U.S. pork further competitive from a price stand point to Chinese consumers. As U.S. policymakers call for greater market valuation of the yuan, they must also be mindful of the resulting exchange rate volatility and its impacts on U.S. exports. The official position of the Bank of China is to slowly move toward greater market control over time, but not at the expense of current

economic growth. Floating the yuan in a market oriented regime would likely see an appreciation in value as it transitions from a fixed rate system, which would benefit U.S. pork exporters as well as Chinese consumers alike. However a careful implementation where medium to long-term exchange rate volatility is minimized will be paramount to the success of any future yuan regime.

In the case of pork, U.S. exporters are able to produce at lower costs and greater efficiency than their Chinese counterparts. The Chinese pork industry has undergone some development in recent years to modernize large scale enterprises near population centers and continues this trend; however there is little that can be done ultimately to lower feed input prices, which account for the largest input factor cost of raising hogs. Thus, U.S. pork producers benefit from a larger U.S. agricultural sector which stands to lower production costs.

6.3 Limitations

Official data published by the Chinese Government has been subject to a great deal of study. Many papers have cast doubt on the accuracy of economic statistics and official numbers may deviate from real world numbers. Studies utilizing questionnaires to survey Chinese household income may be one possible alternative to official government statistics.

While this paper examines exports to mainland China, trade statistics may not fully capture the value of exports. Hong Kong, for example, is often used as an intermediary port between the U.S. and mainland China. Official trade statistics do not

differentiate between U.S. goods destined for Hong Kong and goods that will be forwarded on to mainland China. Further, although Hong Kong is one of the largest East Asian ports, other ports such as Taiwan serve similar intermediary purposes.

6.4 Suggestions for Future Research

Increasing the time horizon of the measures of volatility may yield interesting results. *Sun et* al. found the long-term effect to be more significant. As long-term volatility may be more difficult to hedge against, it should have a more significant effect on trade and therefore studied further.

Expanding the focus to include intermediary ports associated with Chinese trade to better capture the total value of U.S. pork exports that are ultimately destined for mainland Chinese consumers would likely improve the model. Further, including neighboring Asian trading partners may improve the models since many other countries in the region are experiencing similar growth in income levels, albeit have more open currency regimes than in China. Studying other individual U.S. sourced agricultural products with similar consumer preferences may also reveal further effects on trade from exchange rate volatility. While exchange rate volatility has been well studied in other regions, the level of growth and market potential represented in China is immense and should be further studied as trade will undoubtedly only increase with time and become more important to U.S. pork producers and exporters.

Lastly, the speed of yuan reform is a topic of question. While a slow and methodical implementation of a market oriented yuan regime is the position of some,

others argue a more immediate one-time correction is more preferable. Future research should address this issue as exchange rate volatility should be minimized to reduce the negative effects on export values.

REFERENCES

2010 World Economic Outlook. (2010). Retrieved November 15, 2010, from International Monetary Fund: http://www.imf.org/external/data.htm

Amponsah, W. A., Qin, X. D., & Peng, X. (20003). China as a Potential Market for U.S. Pork Exports. *Review of Agricultural Economics* , pp. 259-269.

Anderson, J. E. (1979, March). A Theoretical Foundation for the Gravity Equation. *The American Economic Review , 69* (1), pp. 106-116.

Cushman, D. O. (1986). Has Exchange Risk Depressed International Trade? The Impact of Third-Country Exchange Risk. *Journal of International Economics* , pp. 361-379.

Cushman, D. O. (1982). The Effects of Real Exchange Rate Risk on International Trade. *Journal of International Economics* , pp. 45-63.

Cushman, D. O. (1988). U.S. Bilateral Trade Flows and Exchange Risk During The Floating Period. *Journal of International Economics* , pp. 317-330.

Exchange Rates and International Data. (n.d.). Retrieved December 12, 2010, from Board of Governors of the Federal Reserve System: http://www.federalreserve.gov/datadownload/

Gale, F. (2000). China's Statistics: Are They Reliable? *China's Food and Agriculture: Issues for the 21st Century/AIB-775* .

Global Agricultural Trade System (GATS) . (n.d.). Retrieved December 12, 2010, from USDA Foreign Agriculture Service: http://www.fas.usda.gov/gats/default.aspx

Goldstein, M. (Composer). (2003). China's Exchange Rate Regime. On *Testimoney before Subcommittee on Domestic and International Monetary Policy, Trade, and Technology*. U.S. House of Representatives.

Hayes, D. J., & Clemens, R. (1997). *The Chinese Market for U.S. Pork Exports.* Center for Agricultural and Rural Developement, Iowa State University.

Hayes, D. (1997). The Chinese Market for U.S. Pork Exports. *Trade Policy Center, Iowa State University* .

Hooper, P., & Kohlhagen, S. W. (1978). The Effect of Exchange Rate Volatility on The Prices and Volume of International Trade. *Journal of International Economics* , pp. 483-511.

Johnson, R. (2009). *Potential Farm Sector Effects of 2009 H1N1*. Congressional Research Service.

Movshuk, O. (2002). *The reliability of China's Growth Figure: A Survey of Recent Statistical Controveries.* The International Center for the Study of East Asian Developement.

National Accounts. (n.d.). Retrieved November 15, 2010, from National Bureau of Statistics (China): http://219.235.129.58/welcome.do

National Economic Accounts. (n.d.). Retrieved December 12, 2010, from Bureau of Economic Analysis: http://www.bea.gov/national/index.htm

News Release No. 0533.09. (2009, October 29). Retrieved November 15, 2010, from United States Department of Agriculture: http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2009/10/0533.xml

Ortega, D. L., Wang, H. H., & Wu, L. (2009). Consumer Preferences for U.S. Pork in Urban China. *Agricultural & Applied Economics Association* .

Perée, E., & Steinherr, A. (1989). Exchange Rate Volatility and Foreign Trade. *European Economic Review* (33), pp. 1241-1264.

Rose, A. K. (2004, March). Do We Really know that the WTO Increases Trade? *American Economic Review , 94* (1), pp. 98-114.

Sheldon, I. (2003). Exchange Rate Volatility and Agricultural Trade. *Agricultural Competativeness and World Trade Liberalization: Implications of the WTO and NAFTA.* Fargo, ND.

Sheldon, I., Mishhra, S. K., Pick, D., & Thompson, S. (2010, February). Exchange Rate Volatility and US Bilateral Fresh Fruit and Vegetable Trade: An Application of the Gravity Model.

Somwaru, A., Xiaohui, Z., & Tuan, F. (2003). China's Hog Production Structure and Efficiency. *American Agriculltural Economics Association.* Montreal, Canada.

Steven Dunaway, L. L. (2009). How Robust are Estimates of Equilibrium Real Exchange Rates:The Case of China. *Pacific Economic Review* , pp. 361-375.

Sun, C., Kim, M., Koo, W., Cho, G., & Jin, H. (2002). *The Effect of Exchange Rate Volatility on Wheat Trade Worldwide.* Deptartment of Agribusiness and Appled Economics, Center for Agricultural Policy and Trade Studies. Fargo: North Dakota State University.

Takahashi, K. (2006). On the Credibility of GDP Statistics in China: Official Historical Data Reexamined. *Kobe University Economic Review* , 79-91.

Wang, Q., Fuller, F., Hayes, D., & Halbrendt, C. (1998). Chinese Consumer Demand for Animal Products and Implications for U.S. Pork and Poultry Exports. *Journal of Agricultural and Applied Economics* , pp. 127-140.

Woo, W. T., & Xiao, G. (2007). Facing Protectionsim Generated by Trade Disputes: China's Post-WTO Blues. *Integrating Markets in China: Domestic and International.* Canberra, Australia.

World Trade Organization. (n.d.). Retrieved November 15, 2010, from Members and Observers: http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm

Yuan, Y., & Awokuse, T. O. (2003). *Exchange rate Volatility and U.S. Poultry Exports: Evidence From Panel Data.* University of Delaware, Deptartment of Food and Resource Economics. Montreal: American Agricultural Economics Association.