Essays on Production Efficiency, Tariffs and Trade, and Oil Price and US Macroeconomic

by

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Abstract

The dissertation explores three different subjects. The first chapter investigates the source and trend of agricultural productivity growth in African countries with a translog production function. The second chapter examines whether the anti-dumping policy implemented by the United States and China have the expected impacts on the auto parts, poultry, and tires industries in the US and Alabama. The third chapter examines the impact of oil prices on the US economy in a model of the product market, money market, and trade balance.

The first topic examines technical efficiency, technical change, and total factor productivity for the agricultural sector of 23 African countries with a stochastic production frontier function. Data are from Food and Agriculture Organization and World Bank, 1971-2006. Results show a low level of efficiency (13 %). Technical efficiency varies from 1% to 94%. Irrigation increases productivity growth while the amount of rain has a negative effect. The results show an efficiency regression with slow technical progress over the sample period. These opposing effects lead to 1.4% annual productivity growth which is marginal for ensuring food security in Africa.

The second chapter examines whether the anti-dumping policy implemented by the United States and China have the expected impacts on the auto parts, poultry, and tires industries in the US and Alabama. The estimation of the chicken parts, auto parts, and tires is carried out with a partial equilibrium model and two stage least square methods. The welfare impacts are calculated for the US and China. The results reveal that trade policy had adverse effects on consumers and producers. In the three products, China loses from trade retaliation more than US. The total cost of trade restriction for China and US economy is about $1.3 billion and $1 billion respectively. In poultry products, chicken feet and wings are significantly hurt from the tariff policy. Chinese consumers bore more tariff than US producers in legs, wings, and offal, while US producers endure almost two third of the chicken feet tariff. In auto parts, Chinese consumers experienced the highest welfare losses. Furthermore, the economic impact of trade retaliation was carried out in Alabama using market share. Alabama consumer loss was great due to Alabama's largest market share in those industries.

The third chapter examines the impact of oil price fluctuations on the US economy in a model of the product market, money market, and balance of trade with annual time series data from 1974 to 2012. The study includes GDP per capita, trade balance, the exchange rate, and consumer price index as endogenous variables, and the oil price, money supply, fiscal budget, and foreign income as exogenous. The analysis uses a vector error correction model regression. The results find an inverse relationship between crude oil prices and the trade balance but a positive relationship with inflation. However, the magnitude of the effect on trade balance was greater than on inflation.

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1. INTRODUCTION

Agriculture is a crucial economic activity in Africa. It employs about 65 percent of the population, contributes to about 32 percent of the continent's Gross Domestic Product (GDP), comprises of 50 percent of the export value, and generates 34 percent of income (Jemaneh, 2011). Subsequently, a major portion of Africa's economy and population are dependent on agriculture. From 1973, the African continent has relied heavily on food imports and food aid. However, even though Africa possesses large portions of arable land, food insecurity and malnutrition affect one third of the population according to the Consultancy Africa Intelligence (2012). One of the most critical challenges facing Africa today is how to scale up agricultural production to meet increasing domestic demand arising from population pressure (Hunt, 2011). This gloomy outlook will worsen in the future if Africa fails to achieve sustainable productivity gains. Growth in agriculture, or more precisely productivity performance, will continue to be the cornerstone of hunger and misery reduction. It is perplexing why African agriculture is in crisis today and why the replication of Asia's Green Revolution model in Africa between 1996 and 2006 has failed (Hunt, 2011).

Researchers blame global climate change for variation in agricultural production (Gregory et al, 2005). Soil fertility is a major issue that exacerbates per capita food production in the region (Sanchez, 1997). Droughts are common and more frequent (1969-1972) and (1985) than any other regions of the world. Low levels of inputs other than in South Africa and political conflicts and wars also explain the poor agricultural performance (Fulginiti et al, 2004). Another constraint to agricultural development is limitation of research and development (R&D), and it has been falling for two decades (Oxford Policy Management, 2007).

Lusigi and Thirtle (1997) showed a positive and significant impact of R&D on total factor productivity growth, while Alene (2010) found that institutional factors had a positive outcome on African agriculture.

While many previous studies have listed the reasons for the poor performance of African agriculture, those who attempt to measure agricultural productivity have received mixed results regarding the source and trend of productivity growth. Some studies show improvement in agricultural performance of 1.5 percent annually (Block, 1994 and Fulginiti et al., 2004) while others find poor productivity growth of 0.3 percent per year (Nkamelu, 2004). The large variation in results is due to the methods employed (traditional data envelopment analysis (DEA) versus Tornqvist index). Nkamelu (2004) studied total factor productivity of sixteen African countries from 1970 to 2000 using DEA. The analysis demonstrated that the main source of growth was due to technical efficiency rather than technical change. The DEA method has been criticized for methodological issues and its sensitivity to the number of inputs and outputs (Talluri, 2000). Alene (2010) also examined agricultural productivity over the period 1970-2004 by applying an improved version of the DEA method. A major finding was that the improved performance of African productivity was due to technical change rather than technical efficiency which contradicted Nkamelu’s finding. Interestingly, both authors based their studies on the DEA technique to derive the Malmquist total factor productivity index. Therefore, the objectives of the current study are to determine the source of agricultural productivity using a stochastic frontier translog production function, to investigate thoroughly the changes in efficiency and technology, and to identify contributing factors that influence productivity.

The remainder of the paper is organized as follows: The next section sets up the methodology used to calculate total factor productivity (TFP) from the stochastic frontier. Section three describes the data sources employed in this study. Section four provides methods of estimation and hypothesis testing. Discussion of results is presented in section five. Finally, section six draws conclusions and highlights some policy implications.

2. METHODOLOGY

The stochastic production frontier was developed by Aigner, et al., (1977) in an effort to reduce the difference between theory and empirical work. It can be used to estimate not only output-oriented technical efficiency but also input-oriented technical efficiency for production, cost, and profit functions (Kumbhakar and Tsionas, 2006). The stochastic frontier function differs from other approaches (data envelopment analysis and Tornquist index) that have been used to estimate agricultural productivity in Africa in that it requires no information on prices, is less vulnerable to bias, and is robust to measurement errors and noise. Thus, it is a convenient approach for studying African agriculture since their data are not very reliable (Headey, 2010).

Stochastic production frontier for panel data is as follows:

(1) $$Y_{it} = f(X_{nit}\beta_s) + v_{it} - u_{it} \,; \qquad i=1,2\ldots23,\ t=1,2\ldots36,$$

Y_{it} is the output of the i-th country in the t-year; X_{nit} denotes n-th input variable. These inputs include labor (L), capital (K), fertilizer (F), area harvested (A), and seed (S). t is a time trend capturing technical change; β_s are unknown parameters to be estimated; $v_{it}s$ are random errors assumed to be independently and identically distributed and have N (0,σ_v^2) distribution and independent of $u_{it}s$; and $u_{it}s$ are non negative random variables, measuring production technical efficiency of the countries and ranging from zero to one. A value of one indicates the maximum technical efficiency achievable by *i*-th country.

The prediction of technical efficiency (TE) is based on exponential specification following Coelli *et al*., (2005). TE measures the output of the *i*-th country relative to the output that is produced by a fully efficient country using the same inputs. Technical change (TC) refers to a shift in the production function or measures the output changes over time between two adjacent periods *s* and *t* for the *i*-th country and can be calculated from the estimated parameters.

From equation (1), we can obtain:

(2) $TE_{it} = E[\exp(-u_{it}) / (v_{it} - u_{it})]$. E is the expected value

(3) $TEC = TE_{it}/TE_{is}$. TEC is technical efficiency change

(4)$TC = exp\left\{\frac{1}{2}\left[\frac{\partial \ln y_{is}}{\partial s} + \frac{\partial \ln y_{it}}{\partial t}\right]\right\}$.

All equations come from Coelli et al (2005. Ch.11).

Equation (1) can be estimated by maximum likelihood (ML) which possesses favorable asymptotic properties (Coelli, 2005) in that the estimation of equation (1) will lead to consistent and efficient estimators for β, γ, and σ^2.

γ $\left(\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)\right)$ is the ratio of the error variance of technical efficiency and it is between zero and one. Where $\sigma^2 = \sigma_u^2 + \sigma_v^2$ is the variance of technical efficiency and random errors. If $\gamma = 0$, there is no technical inefficiency, and where $\gamma = 1$, all deviation from the production frontier is due to technical inefficiency.

Agricultural productivity and efficiency are important indicators of economic growth and poverty reduction. They become the focus of agricultural analysts and policy makers. Many governments have recently included them as targets for country's growth plans (Belloumi and Matoussi, 2009). The productivity can be measured using Malmquist index. This index is the most popular method to analyze and measure changes in the productivity. It is also a convenient method for African agriculture because it does not require input and output prices. Malmquist index allows the division of productivity into two components: improvement in efficiency (catching up) and shift in technology (technical progress). The index also shows the level and the source of productivity of a country.

The total factor productivity (TFP) is measured in this study by the Malmquist index methods following Coelli et al (2005. Ch.11). The TFP index can be obtained by multiplying equations (3) and (4) which is equivalent to Malmquisit TFP index.

(5) $$TFP_{it} = TEC_{it} * TC_{it}.$$

Since TFP lacks explicit theoretical form, Evenson and Pray (1991) suggested a two stage method. The First step is to calculate the TFP. Second, this must be extended to include explanatory variables that explain the productivity growth. Therefore, the TFP is given as:

(6) $$TFP_{it} = f(X_{it}\beta_s) + \varepsilon_{it}.$$

Where TFP_{it} and β_s are as defined before, X_{it} is the explanatory variables associated with the TFP in t-year for the i-th country. These variables include irrigation (irg), precipitation (p), and food aid (fa). ε_{it} is random error term. Irrigation and precipitation are expected to increase productivity while food aid can have positive or negative influence.

3. DATA AND VARIABLES

The present study uses balanced annual panel data from 1970-2006 in the estimation for the 23 African countries listed in Table 4. Due to scarcity of disaggregated input data on crops, aggregate data was used instead. Table 1 presents detailed description of the data. Data limitation in Africa restricts the analysis of TFP to three variables: irrigation, precipitation, and food aid while production frontier function includes output and five inputs (Labor, capital, fertilizer, seeds, and area harvested). The output includes aggregate crops for all seasons with quantity in millions of tons. Labor (in thousands) is the total economically active population consisting of farmers and employees engaged in the agriculture sector. Capital includes harvesters, threshers and tractors and it is measured in thousands of units. Fertilizer is measured as consumption of nitrogen, phosphate, and potash (in metric tons). Seeds are the total seed used (in metric tons). Area harvested is the total agricultural area which includes the arable land, area under permanent crops, and land under permanent pasture; it is measured in thousand hectares. All variables are in the natural logarithmic form. Output, capital, fertilizer, seeds, and area harvested were obtained from FAOSTAT database under FAO statistics division (FAO, 2010). Labor data were obtained from the World Bank (2010).

The total factor productivity variables include irrigation, precipitation, and food aid. Irrigation is the percentage of irrigated land and it is used as proxy for land quality. Precipitation is the annual amount of rainfall received in millimeters. Food aid is the total of food aid received in dollars by each country in thousands. Irrigation and Food aid are drawn from World Bank (2010). Precipitation data were taken from Jefferson and O'Connell (2004).

4. ESTIMATION AND HYPOTHESIS TESTS

Cobb-Douglas production function (7) is first order flexible and special case of translog function (8). Since translog encompasses the Cobb-Douglas, zero restriction can be used to determine whether the two models are statistically equivalent. The Cobb-Douglas (7) and translog (8) are as follow:

$$(7) \qquad lnQ_{it} = \beta_0 + \sum_{n=1}^{N} \beta_n \, lnX_{nit} + \beta_t t + v_{it} - u_{it}.$$

$$(8) \qquad lnQ_{it} = \beta_0 + \sum_{n=1}^{N} \beta_n lnX_{nit} + \frac{1}{2}\sum_{n=1}^{N}\sum_{j=1}^{N} \beta_{nj} \, lnX_{nit} lnX_{nit} + \sum_{n=1}^{N} \beta_{tn} \, tlnX_{nit} + \beta_t t + \frac{1}{2}\beta_{tt} t^2 + v_{it} - u_{it}.$$

Where Q is the total agricultural output and X denotes the input variables (labor, capital, area harvested, fertilizer, and seed). Time trend is t.

The estimation of the Cobb Douglas and translog function was conducted by maximum likelihood estimator using STATA statistical software. All tables are presented in Appendix. A hypothesis test was performed to choose the best functional form and results are presented in Table 2. The first test is that the null hypothesis is a Cobb Douglas production function which is strongly rejected implying that the translog function is adequate for this analysis. The second test is that there is no technical change in African agriculture over time, this test is also rejected (Table 2).

5. EMPRICAL RESULTS

Estimation of the empirical model is based on random effects estimator for two reasons. First, it disentangles technological change and the effects of inefficiency (Coelli et al, 2005). Second, STATA software has automated maximum log likelihood procedure. Results are presented in Table 3. For comparison, Cobb Douglas production function was estimated as well. The Wald Test determines goodness of fit. It is significant at the 1% level confirming that the translog model is a good fit. The high gamma estimate of 0.97 indicates that the variation in the random error term is due to inefficiency.

Output elasticities are calculated for each input at the mean level. The first order parameters are well behaved since estimates fall between zero and one. The output elasticities with respect to area harvested, labor, seed, fertilizer, and capital are (0.40), (0.19), (0.17), (0.03), and (0.01), respectively. Area harvested, labor, and seed are significantly different from zero and appear to be the most important factors in African agricultural growth while fertilizer and capital are not. The average intensity of fertilizer use has been stagnant since the 1980s declining sharply (about 50%) in the 1990s. According to International Fertilizer Development Center (2009), Africa ranks low among developing regions in terms of fertilizer use (20 kg/hectare (h)) compared to 116kg/h in South America, and 134kg/h in South Asia. The statistically insignificant coefficient of capital implies that labor and animals are most used in agricultural work.

The Wald test confirms that African agricultural production is experiencing decreasing returns to scale at the sample mean. The coefficient of time squared means that the rate of technical progress increases by 0.1%. This estimate is statistically significant at the 5% level.

TE and its average are computed and presented in Table 4 for each country. The average of TE is 0.13 which means that only 13.3% of outputs are produced efficiently while 86.7% are lost to inefficiency. Mauritius has the maximum mean TE of 93.68%. This good performance is due to government interventions. Its number of agencies involved in agricultural R&D increased to sixteen in 2000 with an annual average of 23 million dollars which is the highest among African countries (Beintema et al, 2003). On the other hand, the rest of the countries performed poorly. This suggests that the poorest performers need to adapt the techniques used by the best performer.

Furthermore, total factor productivity, technical efficiency, and technical change are estimated for the countries over the period 1971-2006. The Malmquisit TFP index is reported in Table 5. It summarizes the mean values of the measures of EC, TC, and TFP change for each country as well as the whole sample over a 35 year period. Growth in agricultural TFP of the 23 African countries has been positive; it has increased by 1.4% annually. TEC and TC contributed to growth by 1% and 0.4%, respectively. Overall, all countries achieved a productivity gain over the reference period. However, countries did not perform uniformly; some of them had increases in TEC but decreases in TC. This is the case for Cape Verde and Comoros. Their TEC were 1.8% and 1.3% while their TC was -0.2 and -0.8, respectively. Negative technical change in Comoros was due to lack of investment, limited agricultural credit and low level of mechanization. Poverty Reduction Strategy Paper (PRSP) in 2006 noted that "most farm work is manual and production techniques are for the most part still not capital intensive".

The declining of technical change in Cape Verde is related to archaic cultivation techniques. This is because human and animal power still cultivates the majority of the total area. Mali and Morocco have the highest annual average TFP (2%). Both TEC and TC are responsible for this success.

Since 1973, Morocco undertook a structural adjustment policy which represents a major reform in its history; a reform that led to engagement in General Agreement on Tariff and Trade

(GATT), which resulted in a reduction of government's role in agriculture and the liberalization of domestic markets and trade (Arndt and Tyner, 2003). Mali adapted some agricultural reforms in 1981 through improvement of irrigation system, reduction in the conversion of arable lands to real estates, and development of research. However, its TFP (2) is still low considering that agriculture employs 70% of its population and contributes 37% to GDP.

Alene (2010) found a 1.8% productivity growth in 52 African countries over the time period 1970-2004. On the other hand, Nkamleu et al (2004) showed a 0.1% of TFP for 16 African countries over the period 1970-2001. Alene's TFP estimates for Cameroon, Ghana, Kenya, Malawi, Mali, Morocco, Mozambique, Senegal, and Uganda were 2, 0.9, 1.8, 2, 0.1, 2.1, -0.6, 0.8, 4.2, respectively while Nkamleu et al estimates for the same countries were -0.8, -0.2, 1.3, 2.4, -1.1, 0.6, 0.9, 0, 0.1, respectively.

Figure 1 shows the annual trends of agriculture growth over the years. The technical change was increasing while efficiency change was decreasing over the whole period.

Technical progress was due to efforts made by Agriculture Research Organization (ARO) nationally and internationally in introducing several technologies in the regions in the last decades (FAO, 2008). The decline of efficiency is mainly related to political instability and civil wars (Fulginiti et al, 2004). Beginning in 1970, some regions have experienced major armed conflicts. Low investment in R&D is another factor in falling efficiency because the governments' spending share in agriculture has been reduced by 37% between 1971 and 1991 in favor of other sectors (Oehmke et al, 1997). Soil depletion affects most areas in Africa with nutrient losses estimated from 30kg to 60 kg per hectare each year (Henao and Baanante, 2006).

TFP model was regressed on irrigation, amount of rain, and food aid in an attempt to evaluate agricultural productivity growth. Since Hausman test rejected random effects regression, the estimation was based on fixed effects. Results are presented in Table 6. Irrigation has a positive and significant influence on productivity. A 10% increase in irrigated land raises productivity by 0.06%. This small effect is due to the dominance of rain-fed agriculture in the region. Irrigated areas are less than 5% of the total cultivated land. The amount of rain is significant and negatively correlated with agricultural productivity. This opposite relation is probably due to the fact that precipitation starts late or finish early in most countries. Another reason is unreliable amount of rain. The food aid coefficient has no effect on productivity level.

6. CONCLUSION

This study uses stochastic frontier production function to determine the source and trend of agricultural productivity growth in African countries over 35 years. The results agree with Alene's work (2010) but differ from Nkamelu's finding (2004). Nkamelu demonstrated that the main source of growth was due to technical efficiency rather than technical change. These divergent findings are due to differences in methods used (traditional DEA or sequential DEA). Empirical results reveal that technical efficiency, rather than technical change, is the main constraint for agricultural productivity growth over the whole period. Declining efficiency and slow technical progress resulted in low annual average growth rate of 1.4%. The study shows Mauritius as close to the frontier while the remaining countries are largely inefficient. The average mean of technical efficiency was low (13%) implying a large room for productivity improvement. This rate indicates to policy makers the urgent need to increase efficiency. This could be accomplished by improving labor quality, modernizing agricultural mechanization, investing in R&D, and improving agricultural infrastructure. Such actions will lead to higher total factor productivity and thus help ensure food security and sustainability in the region.

Table1. Variables Description of Production Frontier and TFP

Variable	Description	Source
Production frontier variables:		
Output	includes aggregate detailed crops and it is measured as quantity in millions tons	Food and Agriculture Organization
Labor	agricultural labor force in thousands; this include farmers and employers	World Bank
Capital	combines harvesters, threshers and agriculture tractors used measured in thousands of units	Food and Agriculture Organization
Fertilizer	measured as consumption of nitrogen, phosphate, and potash in metric tons of nutrient in thousands	Food and Agriculture Organization
Seeds	total seed used in metric tons	Food and Agriculture Organization
Area Harvested	includes the arable land, area under permanent crops, and land under permanent pasture; it is measured in thousand hectares	Food and Agriculture Organization
TFP variables:		
Irrigation	it is the percentage of irrigated land and it is used as proxy for land quality	World Bank
Precipitation	it is the annual amount of rainfall received in millimeters	Jefferson and O'Connell (2004)
Food aid	it is the total of food aid received by each country in thousands	World Bank

Table2. Hypothesis Tests of Cobb Douglas Production Function versus Translog Production Function and Technical Change

Null Hypothesis	x^2 statistic	Critical $x^2_{v,0.95}$	Decision at 5%
Test 1:			
H_0 = Cobb Douglas production function			
$H_0:\ \beta_{ij} = 0, i, j = 1, \dots 6$	371.18	$x^2_{22,0.95} = 33.92$	Reject H_0
Test 2:			
H_0 = No technical change			
$H_0: \beta_6 = \beta_{6i} = \cdots = 0$	54.48	$x^2_{7,0.95} = 14.07$	Reject H_0

Note: The critical values come from table G.4 (Wooldridge, 2006).

Table3. Estimated Coefficients of the Stochastic Frontier Model

	Translog Model		Cobb-Douglas Model	
Parameters	Coefficients	T-Ratio	Coefficients	T-Ratio
β_0	2.139***	6.69	1.733***	6.41
β_L	0.187**	2.00	0.140***	3.08
β_K	0.044	0.15	-0.004	-0.26
β_A	0.400**	5.39	0.343***	8.92
β_F	0.029	1.39	0.042***	4.96
β_S	0.170***	3.22	0.089***	2.97
β_t	0.003	0.79	0.014***	6.65
β_{LL}	-0.543***	-6.65		
β_{KK}	-0.040***	-4.85		
β_{AA}	-0.169	-1.39		
β_{FF}	0.011*	1.67		
β_{SS}	0.016	0.35		
β_{KL}	0.061*	1.92		
β_{KA}	0.002	0.06		
β_{KF}	0.008	1.52		
β_{KS}	0.010	0.57		
β_{AL}	0.374***	4.52		
β_{AF}	-0.099***	-0.72		
β_{AS}	-0.041	0.57		
β_{FL}	0.073***	3.91		
β_{FS}	0.015	1.21		
β_{SL}	0.021	0.51		
β_{Lt}	-0.004**	-2.10		
β_{Kt}	0.001	1.31		
β_{At}	0.005**	2.32		
β_{Ft}	0.002***	3.73		
β_{St}	-0.001	-0.97		
β_{tt}	0.001**	2.19		
P-value	0.000		0.000	
γ	0.974		0.970	
σ^2	0.700		0.864	
σ_u^2	0.682		0.838	
σ_v^2	0.018		0.026	
Log-likelihood	401.635		253.083	

Number of observation is 828.
*** is significant at 1%; ** is significant at 5 %; *is significant at 10%.
Note: L is labor, K is capital, A is area harvested, F is fertilizer, S is seeds, and t is time.

Table4. Average TE over 1971-2006

Country	Technical Efficiency
Angola	12.33
Benin	10.98
Cameron	15.66
Cape Verde	01.14
Chad	06.27
Comoros	04.16
Gabon	09.55
Gambia	02.67
Ghana	18.18
Guinea	12.23
Kenya	13.80
Liberia	08.27
Malawi	10.24
Mali	06.41
Mauritania	01.58
Mauritius	93.68
Morocco	10.90
Mozambique	12.84
Senegal	06.14
Sierra Leone	07.74
Togo	08.15
Uganda	22.36
Zambia	10.81
Means	13.34

Table5. **Mean of Total Factor Productivity Change**

Country	TEC [1]	TC [2]	TFPC [3]
		Percent	
Angola	0.9	0.6	1.5
Benin	0.9	0.3	1.2
Cameron	0.9	0.6	1.5
Cape Verde	1.8	-0.2	1.6
Chad	1.2	0.2	1.4
Comoros	1.3	-0.8	0.5
Gabon	1.1	0.1	1.2
Gambia	1.4	0.1	1.5
Ghana	0.8	0.7	1.5
Guinea	0.9	0.4	1.3
Kenya	0.9	0.7	1.6
Liberia	1.0	0.3	1.3
Malawi	1.0	0.6	1.6
Mali	1.4	0.6	2.0
Mauritania	1.0	0.4	1.4
Mauritius	0.5	1.1	1.6
Morocco	0.9	1.1	2.0
Mozambique	1.0	0.6	1.6
Senegal	1.1	0.3	1.4
Sierra Leone	1.1	0.0	1.1
Togo	0.8	0.3	1.2
Uganda	0.8	0.7	1.5
Zambia	0.9	1.0	1.9
Means	1.0	0.4	1.4

TEC [1] is technical efficiency change.

TC [2] is technical change.

TFPC [3] is total factor productivity change.

Table6. Estimated Coefficients of the Total Factor productivity

ln TFP	Estimates	T-Ratio
Constant	0.031***	7.32
ln irrigation	0.006***	9.19
ln precipitation	-0.002**	-2.45
ln food aid	-0.0001	-1.74
Adjusted R^2	0.32	

Number of observation # 828
***is significant at 1%
**is significant at 5%

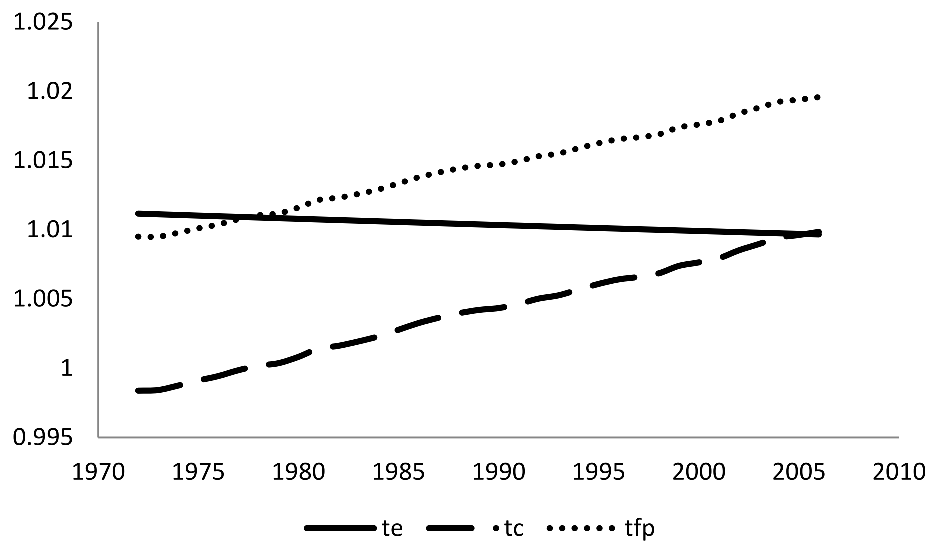

Figure1. Annual mean of productivity and its components, 1971-2006

Trade Actions on the Rubber Tires, Poultry, and Auto Parts:

Economic Impacts on Alabama

1. INTRODUCTION

In September 2009, the US government levied three year safeguard import duties up to 35% on certain Chinese passenger vehicle and light truck tires after a petition was initiated by the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union**,** Pittsburgh, Pennsylvania. The petitioners accused Chinese firms of increasing their exports in absolute as well as relative terms. Asserting that during 2004-2008 period, the subject imports accrued by 215% and 300% in volume and value, respectively, 22% with respect to domestic production, over 12% compared to domestic consumption, and higher than 70% since 2006 (USITC, 2009). The US International Trade Commission (USITC) launched an investigation in April, 2009 and determined "that certain passenger vehicle and light truck tires from China are being imported into the United States in such increased quantities or under such conditions as to cause or threaten to cause market disruption to the domestic producers of like or directly competitive products". (Section 421(b)(1) of the Trade Act of1974) (74 FR 30321, June 25, 2009) (USITC, 2013). The World Trade Organization ascertained the US safeguard provision to implement duties on $1.8 billion Chinese tires with intention to protect the US producers as well as workers from the import upsurge.

This action bristled the Chinese government and soon after the Chinese government decided to retaliate, the US faced steep ad valorem tariffs as well. China commenced its investigation in September 2009, and concluded that the prices of the imported US broilers were illicitly low; then the Ministry of Commerce of the People‘s Republic of China announced that importers of US poultry were ordered to pay duties linked to dumping margins (Ministry of Commerce, 2010).

In February 2010, after thorough investigation, China imposed punitive tariffs on imported US poultry products ranging from 50.3% to 105.4% for five years and on auto parts ranging from 2% to 21.8% for two years. The US automakers face different tariff rates. General Motor was hit with 21.8%, Chrysler faced 15%, Mercedes-Benz with 2.7%, and BMW 2%.

The US is the largest producer and second largest exporter of chicken meat in the world. Approximately 18% of its production is exported to China. Between 2005–2009, poultry constituted three-quarters of imported meat into China; its imports increasing at an annual rate higher than 50%; and US market share of China's broiler imports increasing from 53% to 80 %. However, the market share plunged markedly in 2010, with imports falling by 80% from 2009, and China's chicken product imports decreasing by 20% in 2011(USDA, FAS, China, Poultry and Products Annual Report, 2010 and 2011). According to USDA, the total exports of US broiler meat in 2012 reached $4.1 billion, with $679.2 million directed to China and Hong Kong.

The US is considered the third supplier of automobiles and the fourth major supplier of auto parts to China. From 2009 to 2012, passenger vehicle exports grew from $0.7 billion to $4.6 billion. However, US auto parts exports grew only 1.2% in 2012, but 19.8% in 2011 compared to 36.2% in 2010 (US Department of Commerce, 2013). The quantity of low quality tire imports from China increased from 14.6 million in 2004 to 46 million in 2008 while its value rose from $453.3 million in 2004 to $1.8 billion in 2008 (USITC, 2011).

Alabama exports poultry products and auto parts to China and imports low grade rubber tires from China. As of 2012, Alabama ranks the fourth largest exporter of poultry products ($519 million) (USDA, 2013). China is one of the leading US destination markets with exports increasing by 35% annually since 2002 (Thomas, 2013). Transportation equipment, Alabama's top merchandise export, amounted to $7.7 billion. Alabama's total exports to China were $ 2.4 billion of which half belongs to transportation equipment, with motor vehicles value amounting to $0.9 billion in 2012 (International Trade Division, 2013).

Since Alabama is a substantial producer and consumer of auto parts, chicken parts, and tires compared to other states, the antidumping actions may affect Alabama's economy disproportionally.

As the trade contention intensified, its impact on prices, demand, and supply surfaced in both US and Chinese markets. There have been incongruous debates whether the protectionism avails or hampers the US poultry and auto industry in terms of jobs, consumer and producer losses, and deadweight loss. For some, the increase of import tariffs will benefit the subject industry but for others, the anti-dumping will hurt. The USITC states that the antidumping policy will preserve jobs. Chung, Lee, and Osang (2012) found that the protective policy of US tire industry did not benefit employment or wages in that sector.

The objective of this study is to investigate the impact of trade disputes of tires, chicken parts, and auto parts on the US and Alabama economies, to predict the potential economic effects of trade actions, and to measure the cost of trade controversy and retaliations to US and Chinese economy using partial equilibrium model. These latter will be carried out via the estimation of excess supply and demand models and welfare analysis.

The remainder of the paper is organized as follows: The next section sets up the methodology to calculate the elasticities of excess supply and demand. Section two describes data sources. Section three provides estimation and hypothesis testing. The discussion of the results is presented in section four. Finally, section five draws conclusions, and highlights some policy implications.

2. METHODOLOGY

This study estimates excess demand and excess supply for rubber tires, chicken products, and auto parts for US and China. Excess supply is the sum of the quantity domestically supplied minus the quantity domestically demanded, while the excess demand is equal to domestic demand minus domestic supply.

This study is based on a model developed by Mahé, Travera, and Trochet (1988); Johnson, Mahé, Roe (1993); Kennedy, Witzke, and Roe (1996). The model suggests that there are N commodities consumed and traded by K countries at time t. Aggregate production, consumption, and trade levels for each country are portrayed by supply, demand, excess supply, and excess demand vectors.

The vector of supply sector produces some N commodities that maximize profit based on exogenous prices, technology, and endowments.

The vector of supply (S) functions depicts the aggregate production of the N commodities:

(1) $S_K(P_K^S;\ Z_K^S)$

where $P_K^S = (P_{1K}^S,\ P_{2K}^S, P_{3K}^S, \ldots , P_{NK}^S)$ is the vector of the prices perceived by the supply for country K and Z_K^S is the vector of exogenous variables for country K.

Aggregate consumption of those commodities is represented by the vector of the demand (D) functions:

(2) $D_K(P_K^D;\ Z_K^D)$

where $P_K^D = (P_{1K}^D,\ P_{2K}^D, P_{3K}^D, \ldots , P_{NK}^D)$ is the vectors of the prices perceived by the final demand sector for country K and Z_K^D is the vector of exogenous variables for country K.

Aggregate trade can be described by excess supply and excess demand functions:

(3) $XS_K(P_K^S, P_K^D; Z_K^S, Z_K^D)$

$$= S_K(P_K^S;\ Z_K^S) - D_K(P_K^D;\ Z_K^D)$$

$$XD_K(P_K^S, P_K^D; Z_K^S, Z_K^D)$$

$$= D_K(P_K^D;\ Z_K^D) - S_K(P_K^S;\ Z_K^S)$$

where $XD_K > 0$ and $XS_K < 0$ imply net imports while $XD_K < 0$ and $XS_K > 0$ indicate net exports.

The intervention of the government in domestic market can be via the use of the price (π) or the supply/demand shift (θ) instruments impact supply and demand prices as follows:

(4) $P_{iK}^S = P_{iK}^S\left(A_{iK}^{\pi S}, P_i^W\right)$

$$P_{iK}^D = P_{iK}^D(A_{iK}^{\pi D}, P_i^W), \qquad i = 1,2,3, \ldots , N$$

(5) $Z_K^S = Z_K^S\left(A_K^{\theta S}, \bar{Z}_K^S\right)$

$$Z_K^D = Z_K^D\left(A_K^{\theta D}, \bar{Z}_K^D\right)$$

where $A_{iK}^{\pi S}$ and $A_{iK}^{\pi D}$ are price instruments for producers and consumers respectively and P_i^W is the world price in country K of good i.

where $A_{iK}^{\theta S}$ and $A_{iK}^{\theta D}$ are supply and demand shifters for producers and consumers respectively in country K. $\overline{Z}_K^S$ and $\bar{Z}_K^D$ are given shifters for producers and consumers respectively in country K. Substituting (4) and (5) in(1),(2), and (3)leads to:

(6)$S_K\left[P_K^S(A_K^{\pi S}, P^W), A_K^{\theta S}; \bar{Z}_K^S\right]$

(7) $D_K\left[P_K^D(A_K^{\pi D}, P^W), A_K^{\theta D}; \bar{Z}_K^D\right]$

(8) $XS_K\left[P_K^S(A_K^{\pi S}, P^W), P_K^D(A_K^{\pi D}, P^W), A_K^{\theta S}, A_K^{\theta D}; \bar{Z}_K^S, \bar{Z}_K^D\right]$

(9) $XD_K\left[P_K^S(A_K^{\pi S}, P^W), P_K^D(A_K^{\pi D}, P^W), A_K^{\theta S}, A_K^{\theta D}; \bar{Z}_K^S, \bar{Z}_K^D\right]$

For more details, please see Mahé, Travera, and Trochet (1988); Johnson, Mahé, Roe (1993); Kennedy, Witzke, and Roe (1996).

Modeling the excess supply and demand of the three products is specified as

For chicken parts:

The chicken parts that US exports to China are predominantly dark meat (feet, legs, offal, wings) due to the preferences of Chinese consumers. The choice of some variables is based on the work of Li, Gunter, and Epperson (2011).

US excess supply of poultry products to China will be:

(10) $XS_{US-CH,t}^i(P_{US-CH,t}^i, P_{US,t}^i, P_{US,t}^{pork}, P_{US,t}^{feed}, P_{ROW,t}^i)$

Where

$XS_{US-CH,t}^i$ is the quantity of US broiler part i (frozen) exports in kilos to mainland China and Hong Kong at time t.

$P_{US-CH,t}^i$ is the price of US broiler part i exported to mainland China and Hong Kong at time t.

$P_{US,t}^i$ is wholesale chicken part i domestic price at time t.

$P_{US,t}^{pork}$ is wholesale domestic price of pork at time t.

$P_{US,t}^{feed}$ is wholesale domestic price of corn at time t.

$P_{ROW,t}^{i}$ is the price of US broiler part i exported to the rest of the world at time t .

The excess supply of each US chicken parts is negatively linked to US domestic price, rest of the world price, pork price, and feed price and positively related to export price. As import price goes up, the US producers will supply more. An increase in domestic price is associated with less supply to China. A rise in the price of the rest of the world reduces the supply to China. An increase in feed price causes an increase in the cost which shifts the supply inward. A rise in pork price will increase the domestic demand for chicken, and the excess supply for China falls.

Chinese excess demand of chicken parts is modeled as follow:

$$(11) \quad XD_{US-CH,t}^{i}(P_{US-CH,t}^{i},\ P_{CH,t}^{Chicken}, P_{CH,t}^{pork}, e_{\frac{¥}{\$},t})$$

$XD_{US-CH,t}^{i}$ is the quantity of US broiler part i (frozen) imports in kilos by mainland China and Hong Kong at time t.

$P_{US-CH,t}^{i}$ is the import price of US broiler part i by mainland China and Hong Kong at time t.

$P_{CH,t}^{Chicken}$ is Chinese domestic price of chicken at time t.

$P_{CH,t}^{pork}$ is Chinese domestic price of pork at time t.

e_t is Chinese Yuan to one US dollar.

The relationship between the excess demand for US poultry parts and the Chinese price of chicken and pork is expected to be positive. A rise in these commodity prices will lead to more imports from the US. The excess demand and import price should have an inverse relationship since an increase in import price will diminish the demand for US poultry parts. Yuan appreciation will increase the Chinese demand for chicken parts.

For tires model:

Chinese excess supply of tires is modeled as follows:

(12) $XS_{US-CH,t}^{Tires}(P_{US-CH,t}^{Tires},\ W_{CH,t}^{Tires}, P_{o,t}, t)$

$XS_{US-CH,t}$ is the quantity of Chinese tire exports to US at time t.

$P_{US-CH,t}^{Tires}$ is the price of Chinese tire exports to US at time t.

$W_{CH,t}^{Tires}$ is the Chinese wages of technical workers in motor vehicles in period t.

$P_{o,t}$ is the crude oil prices in dollars per barrel.

t is a time trend capturing technical change.

The excess supply of Chinese tires is expected to have a positive relationship with the export price and technological progress, and a negative one with the Chinese wages and oil price. As the export price goes up, China will supply more. An advance in technology increases production while higher production costs shift the supply curve downward.

US excess demand of tires is specified as

(13) $XD_{US-CH,t}^{Tires}(P_{US-CH,t}^{Tires}, P_{US-CJK,t}^{Tires}, e_t, pce)$

$XD_{US-CH,t}^{Tires}$ is the quantity of Chinese tires imported by US in time t.

$P_{US-CH,t}^{Tires}$ is the price of the imported tires by US from China in period t in US $.

$P_{US-CJK,t}^{Tires}$ is price of the imported tires by US from Canada, Japan, and Korea at time t in US $.

e_t is Chinese Yuan to one US dollar at time.

pce is the real personal consumption expenditure of US in billions of dollars.

The excess demand of Chinese tires is expected to be negatively linked to the import price and positively linked to the import price of the three alternative major trade partners

(Canada, Japan, and Korea), the exchange rate, and the US real personal consumption expenditure.

An increase in import price will decrease the demand for Chinese tires while raising their demand from Chinese competitors. An expansion of US consumption expenditure generates more demand. The Yuan depreciation encourages import.

For auto parts:

US excess supply of auto parts to China is modeled as follows:

(14) $XS_{US-CH,t}^{Auto\ parts}(P_{US-CH,t}^{Auto\ parts},\ W_{US,t}^{Auto\ parts}, GDP_t)$

$XS_{US-CH,t}^{Auto\ parts}$ is the quantity of US auto parts exported to China in period t.

$P_{US-CH,t}^{Auto\ parts}$ is the price of the US auto parts exported to China in period t.

$W_{US,t}^{Auto\ parts}$ is the wages of production and nonsupervisory employees in US motor vehicles

GDP_t is real US gross domestic product per capita.

The export price and GDP are expected to increase US excess supply of auto parts since a higher export price and GDP lead to greater exports to China. Wages are expected to decrease US excess supply of those products because the supply falls with higher costs.

Chinese excess demand of auto parts is

(15) $XD_{US-CH,t}^{Auto\ parts}(P_{US-CH,t}^{Auto\ parts},\ P_{CH-ROW,t}^{Auto\ parts}, P_{o,t}, e_t)$

$XD_{US-CH,t}^{Auto\ parts}$ is the quantity of US auto parts imported by China in time t.

$P_{US-CH,t}^{Auto\ parts}$ is the price of US auto parts imported by China in time t.

$P_{CH-ROW,t}^{Auto\ parts}$ is the price of the imported auto parts by China from the rest of the world at time t in US $.

$P_{o,t}$ is the crude oil prices in dollars per barrel.

e_t is the exchange rate expressed as Yuan per US $ in period t.

The excess demand of US auto parts is expected to be linked negatively to the import price and exchange rate, and positively to rest of the world price. The quantity demanded of US auto parts falls as the import price increases. Demand increases with the price in the rest of the world. An appreciation of Chinese Yuan raises imports.

3. DATA AND VARIABLES

I extracted data from wide variety of statistical resources. The empirical investigation deals with three products: chicken, tires, and auto parts. For chicken, Mainland China and Hong Kong are combined since more than half of Chinese imported poultry products are transshipped via Hong Kong port, and a large portion of the imported poultry meat is dark because of strong Chinese domestic demand for this product (USDA, 2008). The US exports frozen chicken parts to China which include feet, legs, offal, and wings. Table 1 describes the included variables in the model.

The poultry data are monthly and extends from January 1998 to November 2012. Data on chicken parts quantity and prices, beef price, pork price, and feed price come from the USDA[1]. The wholesale price for chicken parts is the domestic price. Due to unavailability of domestic chicken feet price, it was excluded from the excess supply model. The price of live chicken and pork chops are collected from Hong Kong Census Statistics Department. The ban variable is

[1] Data are gathered with the assistance of Dr. Harvey and Dr. Capehart, Agricultural Economists at USDA.

added due to Chinese import bans on US regions with low pathogenic avian influenza contamination. According to USDA, the ban began on September 2003 and ended July 1, 2008.

The data of the monthly imported tires are obtained from United States International Trade Commission (USITC) database using a Harmonized Tariff Schedule. Overall, 57 tires and related products are imported by US but only 9 tires[2] were placed under tariff modifications in the fourth quarter of 2009. Those subject tires contain new pneumatic tires, of rubber, from China, of a kind used on motor cars (except racing cars) and on-the-highway light trucks, vans, and sport utility vehicles with rim diameters ranging in size from 14 to 20 inches (USITC, 2009).

The monthly tire data are from January 2000 to December 2012. The import quantities and prices were obtained from USITC database. US personal consumption expenditure, exchange rate, and oil price were collected from Federal Reserve Bank of St. Louis (FRED). The real US gross domestic product is from Macroeconomic Advisers. The US wage data are from US Bureau of Labor Statistics, while Chinese wage data are from Hong Kong wage and payroll statistics. China imposed antidumping and anti-subsidy regulations on nineteen imported US auto parts in the middle of December of 2011, with two years duration. Those subject parts of automobiles were large cars and sports utility vehicles (SUVs) of engine displacement over 2.5 liters (China Customs Information Integration System, 2013). The data were disaggregated to the HS 8 level and were only available from January 2010 to October 2013. The trade data, which were under tariff policy, were purchased from Customs General Administration of the People's Republic of China. Table 2 provides detailed description of tires and auto parts variables employed in the model.

[2] The tires number is different from that of Chung, Lee, and Osang (2012) because I exclude radial tire that is 18 inches or more.

The estimation was carried out using real price data and all variables are in the natural logarithmic form. Data from the US is deflated by US consumer price index and by China consumer price index when they are from China.

4. EMPRICAL RESULTS

The study uses monthly time series data to estimate the parameters of the models. Stationarity tests were carried out using Augmented Dickey-Fuller (ADF) test. If the time series data have a unit root, the first difference must be used. The ADF test confirms that most of the variables are not stationary at levels while first differences are. Endogeneity tests were also conducted (Table 3). Since export (import) price has endogeneity problem, it was handled through Two-Stage Least Squares (2SLS) method with heteroskedasticity-autocoralation robust standard errors.

Estimation results of excess demand and excess supply for poultry parts are in Table 4. The results of each chicken part show a positive relationship between excess supply and export price and a negative relationship between the excess demand and import price which is consistent with trade theory. All variables of the excess supply of chicken feet have the expected signs and are significant except for feed price. All coefficients except for the domestic price of excess supply of chicken legs have the expected signs and are significant. All estimates of excess supply of chicken offal have the expected signs except the price of pork, and are significant except feed price. The parameters of the excess supply of poultry wings are significant but the domestic price, and have the expected signs, except the price of feed. The ban variable has the expected sign but only statistically significant in the wing model.

For excess demand of chicken parts, the signs of the coefficients of the exchange rates are as expected and statistically significant, but for the excess demand of legs. The estimates of live chicken price are either positive and insignificant, or negative and significant or insignificant. The price of pork has the expected sign and significant only for offal. Li, Gunter, and Epperson (2011) argue that Hong Kong pork and live chicken prices may not reflect the price of substitutes for China. Overall, the excess supply and demand are price elastic with respect to own price ranging from 1.3 for feet to 6.7 for legs in the excess supply model, and from 1.1 for offal to 2.5 for feet in the excess demand model. The supply of US chicken is more responsive to pork price while the demand for US poultry parts is strongly responsive to the exchange rate.

Estimation results for auto parts and tires are depicted in Table 5. The results show a positive relationship between excess supply and export price and a negative relationship between the excess demand and import price as expected. In excess supply estimates of auto parts and tires, GDP has the expected sign and highly significant. Wages have the opposite expected sign and significant only in tire model. All the variables of excess demand of auto parts and tires have the appropriate signs and are significant.

The excess supply and demand of auto parts and tires are price elastic with respect to own price. Their supplies are more responsive to wages while their demands are strongly responsive to the exchange rate.

Welfare Analysis:

The welfare effects of the tariff is assessed by the calculation of tariff incidence, deadweight loss, and consumer and producer surplus changes using price elasticities from Table 4 and 5. The tariff incidence is calculated using the following formula (Koo and Kennedy, 2005):

$$(16) \quad I_d = \frac{E_s}{E_s - E_d}$$

where I_d is tariff incidence borne by the importing countries. E_s is export elasticity and E_d is import elasticity.

Since most of the export elasticities are more elastic than its import counterparts, the consumers bear most of the tariff incidence (Table 6).The Chinese consumers endure most of the tariff imposed on most chicken parts. The absorption of the tariff for legs and wings are 76% and 68% respectively. US endures nearly two third of chicken feet tariff (66%). This is due to the lack of domestic market for such a product.

For the Auto parts, the Chinese consumers bear 60% while US producers endure 40% of the total tariff. Both consumers and producers of the subject tires share the tariff burden.

The deadweight loss (DWL) formula is developed by Hyman (1990):

$$(17) \quad \text{DWL} \ = \frac{1}{2}T^2\left[\frac{Q^*}{P^*}\frac{E_sE_d}{(E_s - E_d)}\right]$$

where

T is tariff, P^* is pre-tariff market price, Q^* is pre-tariff quantity, E_s is export elasticity, E_d is import elasticity. The calculation was carried out on average levels. Table 7 shows that with trade distortions, the total deadweight loss is larger for feet and wings registering nearly $3 and $1.3 million monthly, respectively. Chicken feet deadweight loss is $2 million in US and $1 million in China. Using the DWL formula and tariffs, consumers and producers surpluses were calculated as well. Chinese consumers' loss is $1.9 million, $1.6 million, $0.9 million, and $0.5 million for feet, wings, legs, and offal respectively while US producers' loss is $3.7 million, $0.8 million, $0.2 million, and $0.4 million respectively (Table 8). Chicken offal has the smallest impact on the welfare of China and US because they account for a small share (11 %) of the total poultry export (USDA, 2012). On the other hand, chicken feet and wings bear the highest loss due to the largest share (48% and 37 % respectively) in total poultry export (USDA, 2012). This is because of the absence of domestic market for chicken feet and the low value of chicken wings in US market, coupled with China lucrative market for both products. Chicken feet are considered as a delicacy for Chinese consumers. Nearly half of US broiler parts exports to China comprise of feet and wings while imports of these products to China represent more than 75% of China's total import of chicken feet and wings.

For the auto parts industry, the monthly total deadweight loss is $4.3 million, with a loss of $2.6 million attributed to China and $1.2 million to US. The consumers (China) suffer the most from trade retaliation while the producers (US) borne the rest resulting in a monthly consumer loss of $23 million and producer loss of $15 million totaling to a monthly net loss of $38 million. The heavy impact on China is due to the shift of Chinese consumers toward large and luxurious vehicles recently (EU SME Centre, 2012). The majority of the imported auto vehicles are sport utility transports, constituting of 58% of the total car imports in 2011 and the modest effect on US producers can be explained by the small US market share of Chinese vehicle imports (12%) (Drauz, 2012). The subject exported vehicles make up a tiny portion compared to other trading partners and to the inside vehicle production and sale. The largest US exporters of vehicles to China, General Motor (GM), sold less than 1% of its total sale in 2010, while GM auto plants in China sold more in China than it exported from US. All auto manufactured are affected by the tariff, except Chrysler have plants in China. As a result, they may shift their production when the tariffs take place. Another reason is that these luxury vehicles are purchased by buyers who are insensitive to the price changes.

In tires, the monthly total deadweight loss is $6.8 million with a loss of $3.7 million to China and $3 million to the US. The implementation of the tariffs leads to a decrease in imports of Chinese subject tires that decrease the monthly net welfare by $9.7 million. The monthly welfare losses from trade barriers are $4.3 million for the American economy and $5.4 million for the Chinese economy. This limited effect probably reflects the sharp increase of the low grade tires that are routed to US through other countries. Prusa (2011) suggests that high concentration in the tire industry leads suppliers to move their production to other free trade countries. Moreover, the low price Chinese tires attract mostly low income consumers.

The regional implication of trade distortion on Alabama was also investigated using market share. Alabamian tire producers complained that tire imports force them to reduce their production and lay off employers. As a result, two tire plants have been closed. United Steel workers (USW) speaks on behalf of fifteen thousand employers that worked in thirteen tire manufactures in nine states which they generate in 2008 about half of the total industry production (USW, 2009). Since Alabama is one of those states and encompasses five plants, then its market share is 19.2%. Alabama is the fourth largest chicken exporter in 2012. According to USDA, US chicken export amounted to $4149.8 million with Alabama's share valued at $519.3 million.

The US export of automobiles to China totaled $4.6 billion in 2012 (US Department of Commerce, 2013) and Alabama's share was $0.9 billion in 2012 (International Trade Division, 2013). Therefore, Alabama's market share in poultry, auto parts, and tires is 12.5%, 19.6%, and 19.2%, respectively. Table 9 shows the economic impact on Alabama. Its total consumer loss in chicken parts amounted to $0.6 million and $0.8 million in tires. Its total producer loss is $3 million in auto parts. The resulting monthly deadweight loss is $0.3 million, $0.3 million, and $0.6 million for chicken parts, auto parts, and tires respectively. This large loss is because chicken, motor vehicle, and tires are Alabama's top industries.

5. CONCLUSION

The study investigates the impact of trade barriers duties on three products on both Chinese, and US and Alabama economy using a partial equilibrium model. The estimation of the chicken parts, auto parts, and tires was carried out using a two stage least square method. The welfare impacts are calculated for US and China. Results reveal that a tariff had adverse impacts on consumers and producers. For the three products, China loses from trade retaliation more than US. The total cost of trade restriction for China and US economy amounts to $1.3 billion and $1 billion, respectively.

For poultry products, chicken feet and wings are significantly affected by tariff policy. Chinese consumers bore more of the tariff effects than US producers in legs, wings, and offal, while US producers endured almost two thirds of chicken feet tariff effects. Chinese consumers bore welfare losses nearly as much as US suppliers. The three year and half duration of tariff created a total welfare loss of $420 million, with $215 million loss to US suppliers and $205 million loss to Chinese consumers.

In auto parts, Chinese consumers experienced the highest welfare losses. The two year tariff leads to total welfare losses of $912 million, with $360 million losses to US economy and $552 million losses to Chinese economy. The total welfare losses arising from the tires tariff over three years period is about $349 million, with $194 million going to China and $154 million to the US.

Furthermore, the economic impact of trade retaliation was carried out on Alabama using market share. Alabama consumers' loss in chicken parts, auto parts, and tires over the entire tariff period is $26 million, $72.4 million, $29.5 million respectively. Thus, Alabama total welfare change is $128 million and its total deadweight loss is $43.1 million. The impact is considerable because Alabama market share is large.

Even though the spillover of the antidumping duties transcends these industries influencing other markets, further research is needed. For the US, it will be interesting to see if the gain of tire producers surpasses the loss of chicken parts and auto parts. For China, is the benefits of the discriminatory policy outweigh the costs in such a way to induce larger surplus to Chinese producers of chicken and auto parts than its tire loss.

Table1. **Description of Chicken Variables**

Variable	Description
$XS_{US-CH,t}^{Feet}$	Quantity of U.S. broiler feet exported in kilos to mainland China and Hong Kong at time t.
$XS_{US-CH,t}^{Legs}$	Quantity of U.S. broiler legs exported in kilos to mainland China and Hong Kong at time t.
$XS_{US-CH,t}^{Offal}$	Quantity of U.S. broiler offal exported in kilos to mainland China and Hong Kong at time t.
$XS_{US-CH,t}^{Wing}$	Quantity of U.S. broiler wings exported in kilos to mainland China and Hong Kong at time t.
$P_{US-CH,t}^{Feet}$	Price of U.S. broiler feet exported to mainland China and Hong Kong at time at t in U.S dollar per kilogram.
$P_{US-CH,t}^{Legs}$	Price of U.S. broiler legs exported to mainland China and Hong Kong at time t in U.S dollar per kilogram.
$P_{US-CH,t}^{offal}$	Price of U.S. broiler offal exported to mainland China and Hong Kong at time t in U.S dollar per kilogram.
$P_{US-CH,t}^{Wing}$	Price of U.S. broiler wings exported to mainland China and Hong Kong at time t in U.S dollar per kilogram.
$P_{US,t}^{Legs}$	Wholesale chicken legs domestic price at time t in U.S dollar per pound.
$P_{US,t}^{Offal}$	Wholesale chicken offal domestic price at time t in U.S dollar per pound.
$P_{US,t}^{Wings}$	Wholesale chicken wings domestic price at time t in U.S dollar per pound.
$P_{ROW,t}^{Feet}$	Value per unit of U.S. broiler feet exported to the rest of the world at time t in U.S dollar per kilogram.
$P_{ROW,t}^{Legs}$	Value per unit of U.S. broiler legs exported to the rest of the world at time in U.S dollar per kilogram.
$P_{ROW,t}^{Offal}$	Value per unit of U.S. broiler offal exported to the rest of the world at time t in U.S dollar per kilogram.
$P_{ROW,t}^{Wings}$	Value per unit of U.S. broiler wings exported to the rest of the world at time t in U.S dollar per kilogram.
$P_{US,t}^{pork}$	Wholesale domestic price of pork at time t in U.S dollar per pound.
$P_{US,t}^{feed}$	Wholesale domestic price of corn at time t in U.S dollar per bushel.
$P_{CH,t}^{Chicken}$	Hong Kong (HK)domestic price of live chicken (top grade) at time t in HK dollars.
$P_{CH,t}^{pork}$	Hong Kongdomestic price of pork chop at time t in HK dollars.
$e_{\frac{¥}{\$},t}$	Exchange rate expressed as Chinese Yuan per U.S dollar in period t.
Ban	Dummy variable (September 2003 to July 2008 =1, otherwise =0)
ed	Dummy variable for the exchange rate (July 2005 to November 2012 =1, otherwise =0)

Table2. Variable Description of Tires and Auto Parts Models

Variable	Description
Tire model:	
$XS_{US-CH,t}^{Tires}$	Quantity of Chinese tires imported by USA in time t.
$P_{US-CH,t}^{Tires}$	Price of the imported tires by U.S from China in period t in U.S $.
$P_{US-CJK,t}^{Tires}$	Price of the imported tires by U.S from Canada, Japan, and Korea in period t in U.S $.
$e_{¥/\$}$	Exchange rate expressed as Yuan per U.S dollars.
pce	Real personal consumption expenditure of USA in billions of dollars.
W	Average hourly earnings of technical workers in motor vehicles calculated using monthly salary data from Hong Kong Statistics in HK dollars.
P_O	Crude oil prices of West Texas Intermediate expressed in US dollar per barrel.
t	Time trend capturing technical progress.
Auto part model:	
$XS_{US-CH,t}^{Auto\ parts}$	Quantity of U.S auto parts exported to China in period t.
$P_{US-CH,t}^{Auto\ parts}$	Price of the U.S auto parts exported to China in period t.
$P_{CH-ROW,t}^{Auto\ parts}$	Price of the auto parts imported by China from the rest of the world in period t.
GDP	Real US gross domestic product per capita in billions of chained 2005 US dollars.
W	Average hourly earnings of production and nonsupervisory employees in USA motor vehicles and parts.
P_O	Crude oil prices of West Texas Intermediate expressed in US dollar per barrel.
$e_{¥/\$}$	Exchange rate expressed as Chinese Yuan per U.S dollar in period t.

Table3. Endogeinty Tests for Chicken, Auto Parts, and Tires

Null Hypothesis	F statistic	Critical F	Decision at 5%
$H_0 = variables\ are\ exogenous$			
Poultry Products:			
XS:			
Feet	3041.30	3.84	Reject
Legs	10.92	3.84	Reject
Offal	84.49	3.84	Reject
Wings	19.91	3.84	Reject
XD:			
Feet	7.86	3.84	Reject
Legs	225.26	3.84	Reject
Offal	5.28	3.84	Reject
Wings	37.67	3.84	Reject
Auto Parts:			
XS:	6.96	4.00	Reject
XD:	5.24	4.00	Reject
Tires:			
XS	14.45	3.84	Reject
XD	14.66	3.84	Reject

Note: The critical values come from table 4 (Griffiths, Hill, and Judge, 1993).

Table4. Estimation of Excess Demand and Excess Supply for Chicken Parts

Variable	Feet	Legs	Offal	Wings
Excess Supply				
Constant	17.193***	0.025	-0.038	0.023*
	(0.448)	(0.022)	(0.028)	(0.013)
$P^{i}_{US-CH,t}$	1.262**	6.699***	1.491***	3.424***
	(0.502)	(1.945)	(0.523)	(0.866)
$P^{i}_{ROW,t}$	-0.234***	-0.490**	-1.249***	-0.254**
	(0.038)	(0.280)	(0.029)	(0.100)
$P^{i}_{US,t}$	-	0.072	-0.327***	-0.161
		(0.145)	(0.044)	(0.157)
$P^{pork}_{US,t}$	-1.825***	-5.046***	1.138*	-1.823*
	(0.551)	(1.606)	(0.609)	(1.094)
$P^{feed}_{US,t}$	0.307	-1.173**	-0.112	0.380***
	(0.303)	(0.504)	(0.166)	(0.127)
Ban	-0.133	-0.065	-0.055	-0.058***
	(0.124)	(0.047)	(0.039)	(0.012)
Excess Demand				
Constant	0.018***	0.002	-0.005	0.010***
	(0.004)	(0.005)	(0.018)	(0.002)
$P^{i}_{US-CH,t}$	-2.494***	-1.822***	-1.132***	-1.615***
	(0.480)	(0.695)	(0.243)	(0.431)
e	-4.904***	2.050	-20. 337***	-11.296***
	(0.757)	(4.095)	(3.058)	(2.966)
$P^{Chicken}_{CH,t}$	0.064	-0.787***	0.101	-0.179
	(0.113)	(0.037)	(0.119)	(0.140)
$P^{pork}_{CH,t}$	-0.671	0.261	1.980***	-0.569
	(0.659)	(1.828)	(0.135)	(0.496)
ed	-0.022**	0.019	-0.061***	-0.046***
	(0.010)	(0.027)	(0.018)	(0.012)
F	0.000	0.000	0.000	0.000
Sample size	178	178	178	178

Note: *** 1% significance level, ** 5% significance level, 10% significance level. HAC standard errors are in parentheses.
Note: US is the exporter and China is the importer.

Table5. Estimation of Excess Demand and Excess Supply for Auto parts and Tires

Variable	Auto parts	Tires
Excess Supply		
Constant	0.013	0.030
	(0.020)	(0.022)
P^{i}_{US-CH}	3.869***	4.895***
	(0.916)	(1.349)
W	4.126	2.189***
	(2. 958)	(0.663)
GDP	3.176***	–
	(0.570)	
P_O	–	0.176
		(0.111)
t	–	-0.035
		(0.140)
Excess Demand		
Constant	-0.091***	0.038***
	(0.014)	(0.005)
P^{i}_{US-CH}	-2.549**	-6.158***
	(0.995)	(0.449)
P^{i}_{CH-ROW}	1.525**	–
	(0.727)	
P^{i}_{US-CJK}	–	2.100**
		(1.028)
pce	–	9.323***
		(1.733)
e	-34.097***	-9.743***
	(1.556)	(2.586)
ed	–	-0.072***
		(0.006)
P_O	1.078***	
	(0.167)	-
F	0.000	0.000
Sample size	57	155

Note: *** 1% significance level, ** 5% significance level. HAC standard error in parentheses i is auto parts or tires.

Note: In auto parts: US is the exporter and China is the importer.

In tires: US is the importer and China is the exporter.

Table6. Tariff Incidence of the Three Products

	Tariff born by consumers	Tariff born by Producers
Poultry Products:		
Feet	0.336	0.664
Legs	0.759	0.241
Offal	0.568	0.432
Wings	0.679	0.321
Auto Parts:	0.603	0.397
Tires:	0.443	0.557

Table7. Monthly Deadweight Loss of the Three Products

Variable					Deadweight Loss		
	P*	**Q***	E_s	E_d	**China**	**U.S**	**Total**
Poultry Products:							
Feet	0.649	0.623	1.262	-2.494	1.005	1.987	2.992
Legs	0.640	5.128	6.699	-1.822	0. 769	0.209	0.978
Offal	0.749	2.219	1.491	-1.132	0.127	0.096	0.223
Wings	0.834	6.829	3.424	-1.615	0.884	0.417	1.301
Auto Parts:	49021	6752	3.869	-2.549	2.591	1.707	4.298
Tires:	32.348	1.682	4.895	-6.158	3.719	2.957	6.676

Note: The deadweights loss is in million dollars. All quantities are in millions except auto parts.

Table8. Monthly Consumer and Producer Surplus and Total Welfare

Variable	Consumer Surplus Change ($)	Producer Surplus Change ($)	Welfare Change ($)
Poultry Products:			
	China	**US**	
Feet	1,895,409.89	3,745,762.49	5,641,172.37
Legs	895,556.13	243,574.16	1,139,130.29
Offal	483,079.28	366,764.41	849, 843.69
Wings	1,613,613.10	761,093.79	2,374,706.89
Auto Parts:			
	China	**US**	
	23,348,378.32	15,382,532.00	38,730, 910.32
Tires:			
	US	**China**	
	4,270,954.41	5,372,939.18	9,643,893.59

Note**:** Consumer and producer surplus and total welfare reflect the losses.

Table9. Monthly Economic Impact on Alabama based on the Market Share

Product	**Welfare Change ($)**	**Deadweight Loss ($)**
Chicken parts	0.640	0.339
Auto parts	3.015	0.335
Tires	0.820	0.580

Note: The numbers are in million.

Oil Price and US Macroeconomic

1. INTRODUCTION

Crude oil is an important energy resource in the economy due to its application in many areas. Today, the US consumes nearly 20 million barrels of crude oil per day which is over one fifth of the world's total consumption. To meet demand, the US imports 40% from the rest of the world making it the top world net importer and consumer. It imports the largest portion from Canada, Saudi Arabia, and Mexico. Oil imports represent a consequential fraction of US trade balance. In 2012, the US spent $433 billion on petroleum related products. However, its total net import share was more than 60% in 2005 and declined to 40% in 2012. (See Figure 1) (Energy Information Administration, 2013).

Historically, fluctuation in the oil market triggers economic disturbances worldwide and catches attention of consumers, producers, and policymakers. The spikes in oil prices in the1970s and 1990s prompted economic downturns in the US. Since World War II, the substantial swings in the oil price contributed to ten recessions (Hamilton, 2011). Today, the hikes in oil price have become a regular phenomenon. From 1990 to 2012, the oil price, import, and value increased by 5%, 4%, and 7% respectively (Jackson, 2013). Recently, the world has experienced a sharp oil price rise, registering the highest historical price in July 2008 of $147 dollars per barrel.

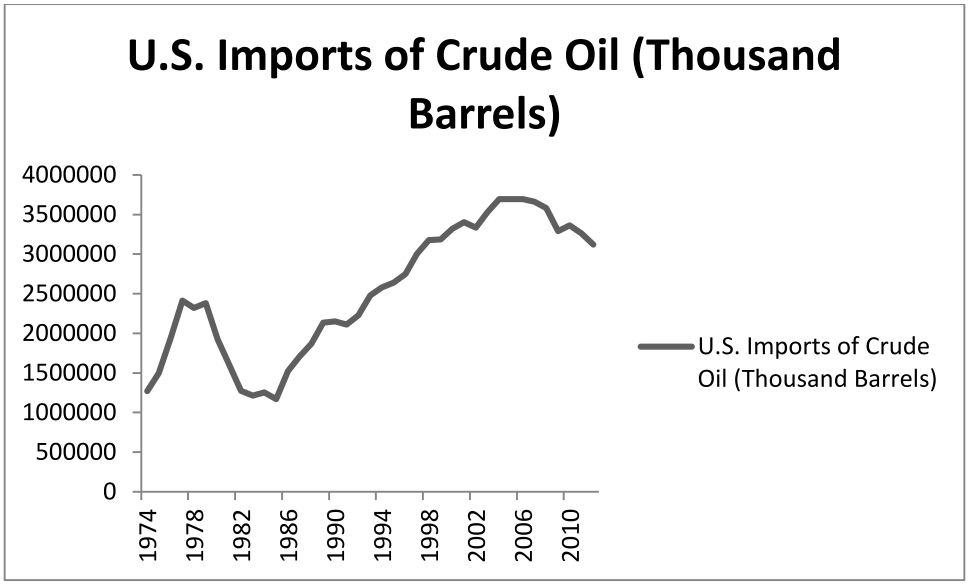

Figure1. US Imports of Crude Oil during 1974-2012

Although the cause of substantial swings in oil price is disruption in demand and supply, and political instability, its consequences on the economy deserve research. The majority of studies have documented the relationship between the oil price and GDP growth (Hamilton 1983, 1996, 2003; Mork, 1989; Hooker, 1996) while few investigate the correlation between the oil price and exchange rate (Amano and Nordan 1998a, b; Chaudhuri and Daniel, 1998), other researchers studied the interdependence of oil price and inflation (Chen and Wen, 2011; Evans and Fisher, 2011). Very limited studies explore the linkage between oil and trade balance (Maravalle, 2013). In contrast to the existing literature examining those markets separately, the present study combines them into one model.

This study is different from previous researches because it uses system of equations with some macroeconomic variables that have been overlooked in the literature, it enters price of energy as exogenous variable in the standard macro model, it replaces interest rate with exchange rate in the money model, and it compares long term and short term correlations.

The study objectives are to employ the theory of product, money, and trade balance systematically; to evaluate the impact of oil price fluctuation on macro-economic variables; and to determine whether oil price volatility is sensitive to macroeconomic variables such as exchange rate and interest rate.

The remainder of the paper is organized as follows: The next section provides an overview of the literature. The third section discusses the intensity of oil-macroeconomic relationship. Section four sets up the methodology. Section five describes the data set employed in this study. The discussion of the results is presented in section six. Finally, the seventh section draws conclusions, and highlights some remarks for policy makers.

2. LITERATURE REVIEW

The frequent oil price volatility has attracted many researchers which led to its study. The analyses proved to be problematical, leading to mixed results.

Hamilton (1983) examines the impact of the oil price on US economic activities for the time period 1948-1980 with a vector auto regression (VAR) method. He showed that oil price increases were statistically significant and partially responsible for US recessions. Hamilton (1996) confirms a negative correlation between oil price changes and macroeconomic activity. The same results are confirmed by Leduc (2002), Barsky (2004), and Anzuini (2007). However, in a study of the oil price macroeconomic relationship, Hooker (1996) utilizes Granger causality and Chow stability tests and concludes that negative US oil-macroeconomic correlation was smaller after 1973. Hess (2000) shows also that oil price spikes influenced real GDP only in the

1970s. He found a short term effect that may not retard US economic growth. Raymond and Rich (1997) analyzed the impact of the oil price on US business cycle using Markov switching model. They concluded that the swing in oil price were not responsible for growth phases. Hooker (2002) uses oil prices as an explanatory variable in a traditional Phillips Curve method for the US economy. His conclusion was that oil-macroeconomic relationships have been insignificant since the 1980s. Edelstein and Kilian (2009) use monthly data from 1970 to 2007 with VAR approach and documented that the impact of energy prices for the US economy is declining.

3. RECENT OIL-MACROECONOMIC INTENSITY

The relationships between oil price and US macroeconomic activities are depicted in Figure 2. Since 2002, the volatility in the oil price and exchange rate has emerged. The relationship has escalated. From 2000 to 2002, the decrease in oil price was accompanied by dollar appreciation. After 2002, the oil price has increased sharply and the dollar depreciated simultaneously relative to other major currencies (Novotny, 2012).

Energy imports constitute the largest share of US trade deficit. In December, 2012, the share was 33%. In 2006-2008 and 2010-2011, oil price volatility was accompanied by big trade deficit. In 2011, the import of crude oil plunged by 1.6% and its costs increased by 31.5% compared to 2010. On the other hand, the drop of the value of petroleum products in 2009 reduces US trade deficit by almost half compared to 2008. In 2012, the US quantity and cost of the imported crude oil plummeted by 6.9% and $19 billion respectively compared to 2011.

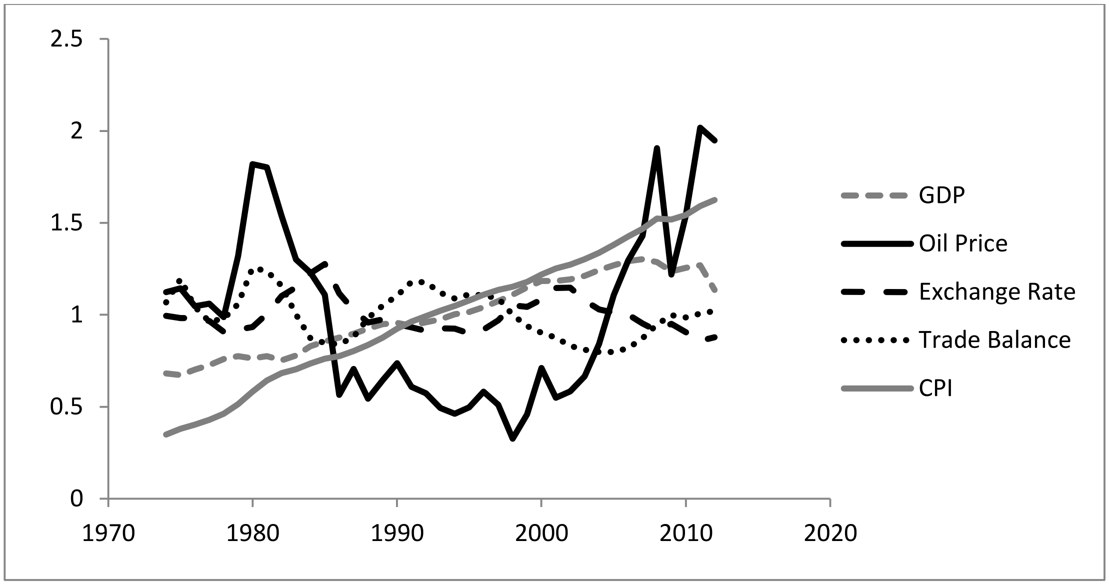

Figure2. Annual Evolution of Crude Oil and US Macroeconomic Variables

The steady oil price coupled with reduction of oil import led to a small decline in US trade deficit (Jackson, 2013).

The recession of 2009 was accompanied by a drop in the oil price. From 2010 to the middle of 2011, as economic growth improved, the oil price increased. The crude oil price has been decreased following the slow economic growth in 2013 (Jackson, 2013).

The inflation rate for USA in 2012 was 2.07% in which 0.95% goes to energy. So energy comprises nearly half the total inflation rate. The pass through effect of inflation was strong in 1970s. Evans and Fisher (2011) showed that the shocks of oil price did not cause core inflation between 1982 and 2008 but did before the 1980s. Chen and Wen (2011) found that between 1985 and 2011, oil price shocks are less damaging to core consumer price index (CPI) but significantly affected CPI inflation.

4. METHODOLOGY

4.1. The product market, money market, and balance of trade

This analysis is built on the theory as developed by Thompson (2012). The theory is based on monetary policy and fiscal policy. Expansionary monetary policy causes an increase in output, a depreciation in currency, and an increase in balance of trade. Expansionary fiscal policy causes an increase in output, an appreciation in currency, and a decrease in balance of trade. Assuming interest rate parity, the exchange rate is used instead of interest rate. The equilibrium in money market is M=L(Y, e, B) where M, L, Y, e, and B are the money supply, demand for cash, income, exchange rate, and balance of trade.

The model incorporates oil price into product market, money market, and balance of trade. These markets may be affected by oil price fluctuations. A higher price will increase production cost causing the supply to shift inward and thus slow output. Since the US is a large importer of oil, a rise in the price will lead to trade deficit and cause inflation. Furthermore, a sharp rise in the oil price will cause a fall in the purchasing power for both households and firms and transfer wealth from oil importing countries to their exporting counterparts. Since oil price is globally quoted in US dollars, the oil price and US exchange rate may be correlated. The higher oil price, the greater the costs which deepen trade deficit. As a result, the currency depreciates. Following Thompson (2012), the equilibrium conditions are as follows:

Product market equilibrium is characterized by

(1) $Y = A(Y_d, e, F, P_o) + B(P_o)$

Money market equilibrium is specified as

(2) $M = L(Y, e, B)$

Balance of trade is

(3) $B = B(Y, Y*, e, P_o)$

Inflation is as follows

(4) $\Pi = \Pi(M, F, Y*, P_o)$

where A, Y_d, F, P_o, and $Y*$ are absorption, disposable income, fiscal budget, oil price, and foreign income respectively.

Assuming the functions (1) to (4) are linear and differentiating the product, money, and trade of balance market equilibrium from (1) to (4) reduce to:

(5) $$\begin{pmatrix} a_1 & a_2 & a_3 & a_4 \\ b_1 & b_2 & b_3 & b_4 \\ c_1 & c_2 & c_3 & c_4 \\ d_1 & d_2 & d_3 & d_4 \end{pmatrix} \begin{pmatrix} \partial m \\ \partial f \\ \partial y^* \\ \partial P \end{pmatrix} = \begin{pmatrix} \partial y \\ \partial e \\ \partial b \\ \partial \Pi \end{pmatrix}$$

The price of oil, fiscal variable, money supply, and the rest of the world output are treated as exogenous.

4.2. Theoretical Framework

This study implements the vector error correction model (VECM). The VECM is the restricted vector autoregression model (VAR) developed by Sims (1980) in an effort to forecast a system of equations and to investigate the effect of the error term on the variables.

The VAR is as follow:

(6) $Y_t = a + \beta_1 Y_{t-1} + \dots + \beta_p Y_{t-p} + \mu_t$

where Y_t is $(K \times 1)$ vector of endogenous variables in the t-year; β_1, …, β_p and α are matrix of coefficients; p is the number of lags; a is $(K \times 1)$ vector of constant terms; and μ_t are the error terms which are assumed to be independently and identically distributed.

Using (11) with some manipulations, VECM is

(7) $$\Delta Y_t = a + \Pi\, Y_{t-1} + \ldots + \sum_{i=1}^{p-1} \Gamma_i\, \Delta Y_{t-i} + \mu_t$$

where

$\Pi = \sum_{j=1}^{j=p} \beta_j - I_k$ and $\Gamma_i = -\sum_{j=i+1}^{j=p} \beta_j$

Engle and Granger (1987) show that if the variables Y_t are first difference, the matrix Π has rank $r < k$. Thus, $\Pi = \gamma A'$. The parameters (γ, A) are $K \times r$ matrices of rank r. r is the number of cointegrating vectors.

The model considers output, balance of trade, exchange rate, and inflation as dependent variables, and real oil price, monetary policy, fiscal policy, and foreign income as independent variables.

4.2.1. Unit Root Test

Time series analysis often encounters problems such as nonstationary variables. If the time series data has a unit root, the first difference must be used. The augmented Dickey-Fuller test is implemented in this analysis to check if the variables are levels stationary I (0) or difference stationary I (1). Table 2 reports test on levels and first differences. The ADF test confirms that all the variables are not stationary at levels while first differences are.

4.2.2. Cointegration Test

Cointegration is another test that must be taken in consideration which is known as the relationship and correlation among the variables in the system. Johansen (1988) and Juselius developed a method to test if the variables have long relationship or not. If the variables are not cointegrated, the VAR is the appropriate model otherwise vector error correction model (VECM) must be used.

VECM is given as follows:

(8) $\Delta Y_t = a + \sum_{k=1}^{p-1} \Gamma_k \Delta Y_{t-k} + \Pi Y_{t-1} + \mu_t$

Where Δ denotes the difference operator; Γ_k is matrix of coefficients and indicates the short run relationships between the variables; Π is $(K \times r)$ matrix of coefficients with rank r$< K$ that contains information about long run relationship among the variables. The rank r of Γ is equal to the number of cointegrating equations. Anderson (1951) and Johansen (1995) developed a maximum likelihood estimator, trace statistics, and maximum-eigenvalue statistic for r.

The Trace test is as follow:

(9) $\lambda_{trace}(r) = -T \sum_{i=r+1}^{K} ln(1 - \lambda_i)$

where T is the number of observations; λ_i is the estimated eignvalue of the matrix Γ; r is the number of cointegration relations; K is the number of variables. The null hypothesis for this test is that max of cointegration equations is equal to r. If r = 0, there is no cointegration.

If the value of trace test is bigger than the critical value, the null hypothesis will be rejected. Applying Johansen technique, the results as indicated in Table 3 implies that they are cointegration relations between the dependent and independents variables. At 5 percent level, the Trace and Maximum-Eigenvalue tests prove that there are four long run cointegration in the inflation model; three long run cointegration relations in the output and trade balance models; and one long run cointegration relations in the exchange rate model. Harri, Nalley, and Hudson (2009) argue that one cointegration relations is likely due to small sample data. Since all the variables are first differences and cointegrated, the ECM is used for the analysis.

5. DATA AND VARIABLES

This study used annual time series data from 1974-2012 to estimate the parameters of the vector error correction model and to evaluate their shifts for the US. Table 1 provides details description of the data.

The data includes output per capita (Y) is real GDP per capita; the real effective exchange rate (e) is expressed in real trade weighted US dollar against Broad currencies of major trading partners of US (Index 1973=100).The oil price (P) is the US real acquisition cost of imported crude oil per barrel in dollars. The inflation rate (Π) is the consumer price index for all items (Index 2005=100), the foreign income (y*) is the real world income minus US income; M is real money (M2) per capita; fiscal budget F is the government total receipts divided by government total expenditures in billions of dollars; balance of trade B is real exports of goods and services divided by real import of goods and services in billions of chained 2009 US dollars.

The data used for this study comes from different sources. Variables P, F, and B are drawn from International Energy Agency (IEA), Π, e, M, and Y are from Federal Reserve Bank of St. Louis (FRED), and Y, and y* are from U.S. Department of Agriculture (USDA). All variables are expressed in natural logs.

6. EMPRICAL RESULTS

The estimation of the empirical models is based on error correction model (ECM). For comparison, the VAR estimation was carried out as well. The ECM is based on long term relationships while VAR is based on short term correlations. Table 4 presents the four estimated models. In the VAR, the test results for the four equations reject heteroskedasticity, autocorrelation, no normality, and no stability. In the ECM, the residual diagnostic tests show no evidence of heteroskedasticity, autocorrelation, and no normality in the GDP, trade balance, and exchange rate models while inflation model suffers from serial autocorrelation.

In the ECM model, the coefficient of oil price has the correct sign and highly significant for balance of trade and inflation models but insignificant for the exchange rate model and GDP model. The money supply has the correct sign in all models expect for the inflation model. The coefficients of the fiscal budget have the expected sign and highly significant in GDP and trade balance models but have wrong signs and insignificant for the exchange rate and inflation models. The world output has the anticipated sign in all models, expect for inflation model and only significant in the exchange rate model.

A 10 % increase in oil price will reduce the trade balance by 1.9% and add 0.2% to the consumer price index. The decrease in trade balance is attributed to the rise in oil import costs, while the small effect on the inflation is due to the decline in oil share in the production costs. Another reason is attributed to the monetary policy. Chen and Wen (2011) argue that oil impacts principally energy commodities but not the rest of CPI components. A 10% increase in money supply will lower balance of trade by 24.2%. This result is similar to the estimate (19%) of Thompson (2012). A 10% rise in fiscal budget will cause the output to increase by 6.4%. This is in line with the work of Thompson (2012), who found a 10% increase in fiscal budget will raise the output by 6.1%. This is consistent with the theory since an expansionary fiscal policy stimulates the economy by expanding the real output. On the other hand, 10% rise in fiscal budget is accompanied by a decrease in trade balance of 11.7%. A 10% increase in world output will appreciate the US dollar by 38.1%.

In the VAR model, all estimates of oil price in the four models have the expected sign but only insignificant in the output and inflation model. A 10% rise in oil price decreases trade balance by 0.6% and raises inflation by 0.2%. In the estimates of the output model only the money supply and the fiscal budget are significant. A 10% increase in the money supply and in expansionary fiscal policy raises the output by 1.5% and 2.5%, respectively. The coefficients of balance of trade have the expected sign and statistically significant, expect for foreign income variable. The expansionary monetary and fiscal policy decreases the trade deficit. A 10% increase in the money supply and in expansionary fiscal policy reduces the trade deficit by 5.2% and 3.3% respectively. The estimates of exchange rate model have the expected sign except fiscal budget variable and significant but the money supply. A 10% increase in the foreign income will appreciate the currency by 25%. The result shows that oil price is related to dollar depreciation. The inflation model has only the oil price and world income with the expected sign. A 10% increase in world income will raise the inflation by 4.6%.

Overall, the ECM and VAR estimates are generally comparable and specifically similar for the oil price. The ECM shows an insignificant weak positive relationship between the oil price and output per capita while the VAR shows an insignificant weak negative relationship. This tenuous correlation between the oil price and output may be due to decreased energy dependence, the decline of the oil share in the aggregate production, energy conservation, other energy sources, and progress in technology. The strong linkage between oil price and balance of trade may be attributed to the largest share of US trade deficit in petroleum products which comprises 41% of the total trade deficit in 2010 (Jackson, 2013). The mild correlation between oil price and inflation is because oil is considered as an input in various production processes. As a result, rising oil price leads to downward shifts of the aggregate supply curve in the short run, and, therefore, pushing up the price. The impact of oil price on exchange rate is insignificant with a lower coefficient. This detachment can be explained by the reduction of oil import share in total US imports. Oil imports accounts for 16% of total US imports compared to 25% in 1970s Maravalle (2013). In contrast to Amano and Nordan (1998a, b) and Chaudhuri and Daniel (1998) who found that rise in oil price causes dollar appreciation.

In sum, the paper highlights that fiscal policy is the primal factor in US output; monetary policy is the top driver of US trade balance, foreign income is the major cause of exchange rate variation, and oil price is the significant component in US inflation.

7. CONCLUSION

The study examines the impact of oil price on macroeconomic variables in United States with annual time series data from 1974 through 2012. This analysis is built on the theory of product market, money market, and balance of trade. Furthermore, it incorporates oil price into the market equilibrium. This permits the study of monetary policy, fiscal policy, and trade balance. The estimation of the models was based on ECM and VAR methods. The results are comparable. Both techniques show that oil price has significant impact only on trade balance and inflation.

The model reveals weak effective monetary expansion in US from1974 to 2012. In the present model, monetary expansion lowers the trade balance. This result is consistent with the finding of Thompson (2012). Another interesting result is that the estimates find that the oil price has no significant impact on the exchange rate or output.

The results find some evidence on the balance of trade and inflation. Oil prices have a detrimental impact on trade balance; however; inflation is less responsive to the oil price. Higher oil price lowers balance of trade, indicating inelastic oil import demand. Higher oil price increases inflation, suggesting cost push inflation.

The effect of crude oil price on trade balance suggests levying a tariff on oil imports in order to reduce the trade deficit. However, the spillover of the duties may affect other macroeconomic variables. Imposing a tariff on oil may reduce output, appreciate the currency, and raise inflation. The extent of tariff impacts requires further research to see whether the benefits outweigh the losses.

Table1.Variable Description

Variable	Description	Source
Y	real US GDP per capita in thousands of US dollars	Federal Reserve Bank of St. Louis (FRED
e	real trade weighted US dollar against Broad currencies of major trading partners of US (Index 1973=100)	Federal Reserve Bank of St. Louis (FRED
P_o	US real acquisition cost of imported crude oil per barrel in US dollars	International Energy Agency (IEA)
Π	consumer price index for all items (Index2005=100)	Federal Reserve Bank of St. Louis (FRED
Y^*	real world income minus US income in thousands of dollars	Department of Agriculture (USDA)
M	real money (M2) per capita in thousands of dollars	Federal Reserve Bank of St. Louis (FRED
F	government total receipts divided by government total expenditures in billions of dollars	International Energy Agency (IEA),
B	real exports of goods and services divided by real import of goods and services in billions of chained 2009dollars	International Energy Agency (IEA),

Table2. Stationary Tests of the Variables Used

	ADF test		
Variable	**Level**	**I (1)**	**I (2)**
P_o	-1.13	-6.28***	-4.14***
M	-1.77	-2.99**	-6.71***
Y^*	-0.50	-5.18***	-3.85***
F	-2.17	-4.42***	-4.59***
Y	-2.02	-3.68***	-3.88***
B	-2.05	-3.92***	-8.16***
e	-2.62	-3.53***	-7.04***
Π	-0.69	-1.83**	-4.83***

Note: The null hypothesis is unit root in the ADF test. ** is rejection at 5%, *** is rejection at 1% of the null hypothesis.
Note: Y is real output, B is trade balance, e is exchange rate, Π is inflation, P_o is oil price, M is money supply, F is fiscal budget, Y^* is rest of world's output.

Table3. Johansen Cointegration Test for GDP, Trade Balance, Exchange rate, and Inflation

	Maximum-Eigen value Statistic	**Trace Statistic**
Y **Equation:**		
$H_0 : r = 0$	98.42***	226.05***
$H_1 : r \leq 3$	12.77	13.37
B **Equation:**		
$H_0 : r = 0$	39.11***	103.93***
$H_1 : r \leq 3$	10.52	10.90
e**Equation:**		
$H_0 : r = 0$	30.30***	71.16***
$H_1 : r \leq 1$	20.95	40.86
Π**Equation:**		
$H_0 : r = 0$	126.61***	255.45***
$H_1 : r \leq 4$	1.91	1.91

Note: *** is rejection at 1% of the null hypothesis.
Note: Y is real output, B is trade balance, e is exchange rate, Π is inflation.

Table4. Parameter Estimates of ECM and VAR for GDP, Trade Balance, Exchange rate, and Inflation

Variable	ECM				VAR			
	Y	B	e	Π	Y	B	e	Π
P_o	0.01	-0.19***	0.02	0.02***	-0.01	-0.06*	0.05	0.02***
	(0.01)	(0.05)	(0.05)	(0.01)	(0.01)	(0.04)	(0.03)	(0.01)
M	0.29	-2.42***	0.05	-0.78***	0.15**	-0.52*	0.04	-0.22***
	(0.17)	(0.56)	(0.54)	(0.11)	(0.07)	(0.28)	(0.26)	(0.05)
F	0.64***	-1.17***	0.51	-0.01	0.25***	-0.33*	0.33*	-0.03
	(0.11)	(0.31)	(0.31)	(0.06)	(0.05)	(0.20)	(0.18)	(0.04)
Y^*	0.51	-0.19	-3.81***	-0.43**	0.34	1.10	-2.48***	0.46***
	(0.41)	(1.23)	(1.32)	(0.20)	(0.22)	(0.93)	(0.78)	(0.15)
Constant	-	-	-	-	0.01	-0.03	0.07***	-0.01
					(0.01)	(0.03)	(0.02)	(0.01)
R^2	-	-	-	-	0.66	0.44	0.37	0.91
$P\ value$					0.00	0.00	0.00	0.00
N	35	35	35	35	37	36	36	37

Note: *** 1% significance level, ** 5% significance level, 10% significance level. HAC standard errors are in parentheses.

Note: Y is real output, B is trade balance, e is exchange rate, Π is inflation, P_o is oil price, M is money supply, F is fiscal budget, Y^* is rest of world's output.

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