Energizing Livelihoods: The Impact of the Biofuel Act in the Philippines

Jessica Georges
University of Florida
jgeorges@ufl.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual Meeting, Seattle, Washington, August 12-14, 2012

Energizing Livelihoods: The Impact of the Biofuel Act in the Philippines

Jessica Georges
University of Florida
jgeorges@ufl.edu

Abstract

As petroleum supplies remain in constant limbo, alternative sources are needed to meet energy demands. Considering that biofuels are expected to gain a larger share of the automotive fuel market, biofuels are pertinent to both developed and developing countries. It is necessary to conduct an economic analysis on a biofuel mandate since most countries are moving towards a biofuel economy or at least contemplating mandates. The paper investigates the Philippine Biofuel Act effect on coconut farmers since they are the feedstock suppliers for biodiesel. The results show that the coconut farmers enjoyed higher prices but experienced more price volatility. While coconut workers overall real wage decreased.

Introduction

Climate change has emerged as one of the biggest environmental challenges of the twenty first century (FAO 2011). Atmospheric concentrations of carbon dioxide (CO_2) worldwide has risen by thirty nine percent since the Industrial Revolution and continues to increase by about 1.5 parts per million per year (Kirschbaum 2003; WMO 2011). The primary source of this large increase is the burning of fossil fuels. An increase in concentrations of CO_2 and other greenhouse gases causes global temperatures to rise, which in turn lead to climate change including shifts in rainfall patterns. Due to the evidence of disastrous environmental effects triggered by global warming along with high fuel prices, there is a desire to move towards finding greener solutions like substituting bioenergy for fossil fuels.

The environmental benefit of replacing fossil fuels with biofuels is the reduction of carbon dioxide in the atmosphere. Compared to conventional gasoline and depending on the biofuel feedstock, bioethanol can provide a reduction as high as 90 percent in CO_2 emissions. Likewise, biodiesel can reduce emissions by 60 percent versus regular diesel (IEA 2007). In addition to the environmental benefits, biofuels have garnered attention due to the promise of increased rural employment and higher prices for farmers. The demand for biofuels is expected to spur the agricultural sector to increase production, resulting in higher employment rates and wages particularly where agriculture is labor intensive (Koh and Ghazoul 2008).

However, despite the fact that a variety of positive environmental and economic benefits are associated with biofuels, there is still a debate about the effect of biofuel production on subsistence farmers. Dauvergne and Neville (2010) claim that biofuel production tends to exclude the interest of subsistence farmers and further marginalizes them. Moreover, the United Nations has warned countries that the perils of biofuels could outweigh the benefits because biofuels are linked with the increase in food prices and the loss of biodiversity. Net buyers of food, including subsistence farmers are vulnerable to price increases because poor consumers typically spend a majority of their income on food (IFAD 2008). With the Food and Agricultural Organization (FAO) recording its highest Food Price Index in over 30 years in 2011, combined with the global economic downturn, rising prices are sure to create more food security issues while deepening the severity of poverty worldwide. In addition, biofuels compete with other crops for land and water. Thus, biofuels causes limited resources to be diverted to its production (UNEP 2009). Areas allocated for biofuel cultivation are quickly expanding creating habitat loss and threatening the lives of many native species (Koh 2007). For example, the increase in demand for palm oil has already caused Southeast Asia to experience increased deforestation rates (MSNBC 2007).

Recent empirical studies typically find that biofuel production can increase both income and employment. Based on De la Torre Ugarte et al. (2007) study, their projections show that increasing ethanol production is estimated to have positive economic impacts on employment. Under the 60 gallon ethanol production scenario, the anticipated cumulative increase in net farm income for the period 2007-30 is over $210 billion. By 2030, a predicted total of $110 billion annually should be directly generated in the economy via purchasing inputs. In addition, about 236,000 and 58,000 jobs would directly be added to the agricultural and biofuels sector respectively. The estimated economic impacts are $368 billion per year creating an estimated 2.4 million jobs if indirect impacts are included. Unfortunately, these calculations depend on changing land use patterns since the energy crops would need about 34.4 million acres.

Blanco and Isenhouer (2010) studied the impact of ethanol production on wages and employment in the Corn Belt states[1] using country level data from 2005 to 2006. While the results show that ethanol production had a positive significant effect on employment and wages, the magnitude was insignificant. A one percent increase in actual ethanol production was associated with an increase in employment of 0.011 percent. Whereas, a one percent increase in ethanol production led to an increase in average real wage by 0.004 percent.

The existing work on the effects of biofuels on employment and wages signal that biofuels may indeed be influential. However, there are important shortcomings and gaps in the literature. In general, most biofuel studies focus on the economies of the United States and European Union. Other than Brazil, biofuel policies implications in the developing country context have not been thoroughly investigated. Considering that biofuels are expected to gain a larger share of the energy market, biofuels are pertinent to both developed and developing countries. An assumption cannot be made that since biofuel policies seem to work in developed countries that the same will apply for developing countries. Especially since the supply of biofuels and agricultural commodities are likely to be different in developing countries compared to developed countries (Rajagopal and Zilberman 2007). Moreover, the population in developing countries tends to be more susceptible and less resilient to any type of shock. Therefore, it is essential to examine the impacts of a biofuel mandate on vulnerable populations since other developing countries are moving towards biofuels to reduce their dependency on foreign oil. For instance, low and medium income countries that have limited

[1] The Corn Belts states in the Blanco and Isenhouer (2010) study were Iowa, Indiana, Illinois, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota and Wisconsin

resources and a large vulnerable population such as Nigeria and Fiji are considering biofuel mandates in the near future.

In addition, most of the literature is centered on simulation or conceptual based models. While these models help quantify anticipated effects, the empirical evidence has not supported these projections (see Blanco and Isenhouer 2010). At first glance, these projections and estimates seem to satisfy the justification of biofuel policies, but empirically the results have not provided compelling evidence for the continued persistence towards creating and implementing biofuel policies. More econometric analysis needs to be conducted to assess the effects of biofuel policies since the economic and livelihood implications of biofuels remain poorly understood.

This paper simultaneously addresses these issues by studying the Philippines. It allows for a developing country perspective as well as provides robust econometric estimations. The coconut farm gate prices and coconut workers' wages are examined by using a large sample, controlling for unobserved heterogeneity thru estimations of fixed effects and dynamic regression models. Specifically, this study has the following goals:

(i) Estimate the effect of the Biofuel Act on coconut farm gate prices

(ii) Estimate the effect of the Biofuel Act on coconut workers' wages

(iii) Analyze whether coconut farmers have experienced reduced volatility in coconut farm gate prices.

The analysis of the Biofuel Act is important because there are discussions in the Philippines of possibly promoting a higher biodiesel blend of 5 percent despite opposition and warnings to rethink the current biofuel policies (BAR 2011).

Case Description

This paper builds on the literature concerning biofuel impacts, in addition to being the first study to analyze the influence of the Biofuel Act mandate on the livelihood of coconut farmers in the Philippines. About one-third of the population depends on the coconut industry and coconut farmers are small subsistence farmers. On average they receive the lowest farm gate price (USDA 2010; BAS 2011). Thus, any policy changes should significantly impact their welfare.

India attempted to issue a biofuel mandate in the early 2000s, but the Philippines is the first country in Asia to legislate and implement its mandate nationwide for the use of locally sources biofuels. On November 29, 2006 the Philippines' Senate and House of Representatives passed the Biofuel Act of 2006 and it was approved by the President on January 12, 2007. The Biofuel Act mandates that all liquid fuels sold in the Philippines must contain locally sourced biofuel. The aim of this Act is to attain energy security, boost farmers' income and create rural employment. Biofuels for all motor and engines in the Philippines are required to have the following blended components: bioethanol – 5 percent ethanol blend for gasoline in 2009, increasing to 10 percent in 2011; biodiesel – 1 percent blend for diesel in 2007, increasing to 2 percent in 2009 (Republic Act 9367).

The primary feedstock for the biodiesel production in the Philippines is coconut. Coconuts along with bananas are among the Philippines' significant agricultural commodities in terms of value and quantity. Since the late 1980s, they have ranked as the top two agricultural export commodities. In 2011, the export of coconuts and bananas were worth $ 1,387 and $352 million respectively. The farm gate price for coconut and banana saba basically followed the same trend until 2007 (see Figure 1). Coconut farm gate prices starts rising in 2007 and by the end of the year it surpassed banana farm gate prices. The timeframe in which this occurs coincides with the Biofuel Act implementation of the one percent blend requirement. However, coconut farm gate prices decreased, finally recovering in 2010. Despite, all the changes in the coconut farm gate prices, banana saba prices remained on a positive and stable trend.

Hypotheses

The Biofuel Act encourages the production and use of locally sourced biodiesel with coconuts being its primary feedstock. The majority of all Philippine motor vehicles run on diesel fuel, thus this mandate should increase in the demand for coconuts. The increase in demand should in turn affect farm gate prices and wages. As the demand for coconuts increases, the quantity demanded is greater at every price. Since technology and conditions under which capital and labor are supplied have remained constant, a shift in coconut demand should lead to an increase in the labor demanded at any wage level that might prevail. The shift in the demand for labor is expected to result in an increase in wages in the short run. However, coconut farmers may experience an increased in price volatility since coconuts are now essential to the diesel production process. This could mean that feedstock demand would become perfect inelastic. The feedstock price volatility would be caused by changes in the feedstock market since buyers would now have to buy the coconuts from the farmers at whatever prevailing price (Meyer and Thompson 2010). This paper will focus on the biodiesel sector since this sector is in compliance with the mandated biodiesel blend.

Empirical Approach

The enactment of the Biofuel Act can be treated as a natural experiment due to the exogenous change in policy though legislation. This paper employs the difference-in-difference methodology to determine the effect of the Biofuel Act on farmers and workers. The time period selected for the analysis is 2002-2010 since it covers the duration before and after the mandate. The effect of the mandate on coconut farm gate prices is determined by estimating a farm gate price equation that compares farm gate prices received by coconut farmers (treatment) to the price received by banana saba farmers (control). Since, coconuts are the primary feedstock for biodiesel and banana saba is not a feedstock, farm gate prices for banana saba should not be affected by the biofuel mandate.

A similar methodology to determine the effect of the Biofuel Act on the wages of coconut farm workers is also utilized. The control group for the wage estimation equation is palay farm workers. Palay workers share similar characteristics to coconut workers due to the low skill nature of both the occupations. Again, a parallel assumption is made concerning the palay workers: since palay is not a feedstock, palay workers' wages should not have been affected by the mandate. These respective distinctions help compare the experiences of the treatment and control groups before and after the enactment of the Biofuel Act under the assumption that other temporal coincident changes are the same for the two sets of groups.

To analyze the impact of the Biofuel Act on farm gate prices, time invariant sources of unobserved heterogeneity was controlled for and a fixed effects estimation method was implemented. A host of variables that are likely to impact farm gate prices were included.

The following fixed effects specification was estimated:

$$FG_{itj} = \alpha_j + \delta_1 OnePerc + \delta_2 TwoPerc + \Sigma \beta_{1\text{-}5} + \Theta_t + \lambda_t + v_i + \varepsilon_{ijt} \qquad (1)$$

where FG_{itj} denotes the price received by farmers for the sale of their produce at the first point of sale, OnePerc is a interaction term that measures the change in coconut farmers' farm gate prices due to the biofuel mandate of a one percent coconut diesel blend, TwoPerc is a interaction term that measures the change in coconut farmers' farm gate prices due to the biofuel mandate of a two percent coconut diesel blend, β_1 is the actual area from which harvests are realized, β_2 is trees/hills where harvesting has been made (hills applies to banana saba), β_3 is average production per hectare (or yield) production expressed in metric ton, β_4 is a dummy variable equal to 1 if the province has a large amount of area devoted to the commodity, β_5 is a dummy variable equal to 1 if the province produces a high volume of the commodity, Θ_t is the year dummy, λ_t is the month dummy, v_i is the unobservable component and ε_{ijt} is the error term. The main parameters of interest are the interaction terms, δ_1 and $\delta_{2.}$ These coefficients can be interpreted to represent the impact of the Biofuel Act on coconut farmers' farm gate price due to the mandate requirements of a one percent and two percent blend respectively. All appropriate variables are monetary deflated and in logarithmic form.

Due to the persistence nature of wages, a dynamic approach was taken to estimate the wage equation. There are basic econometric problems of introducing a lagged variable among individual specific effect in an equation. Since the lagged dependent variable is a function of $\varepsilon_{i,\ t-1}$,, its correlated with the error term. The Fixed Effect estimator will be biased of $O(1/T)$ and its consistency will depend on T being large. Thus, only if $T \rightarrow \infty$ will the Fixed Effect Estimator be consistent for δ and β for the dynamic model (Balgati 2005; Nickell 1981). Anderson and Hsaio (1981) proposed a solution which involves taking the first difference since the first difference removes the fixed effect. While, there is still a correlation between the difference lagged variable and the disturbance, the fixed effect is gone so now an instrumental approach can be used. Instruments may be constructed for the lagged dependent variable from the second and third lags of the dependent variable. The lags will be correlated with the lagged dependent variable but uncorrelated with the error. The consistency of the estimator depends on the validity of the assumption of no serial correlation of the error term and on the validity of the instruments. If we believe that error might be serial correlated, the method of backing off one period and using the third and fourth lags of the dependent variable is suggested (Baum 2006). The Sargen test of over-identifying restrictions can test the overall validity of the instruments. Failure to reject the null hypotheses provides evidence that the instruments are valid. While the Anderson-Hsaio is consistent, it fails to utilize the orthogonality conditions that exist between the dependent lagged values and its disturbances (Balgati 2005). An extension of the Anderson-Hsiao estimator is the Arellano-Bond estimator.

The following wage equation was estimated using the twostep robust Arellano-Bond estimator:

$$Wage_{itj} = \alpha_j + \beta_1 Wages_{i,\,t\text{-}2} + \delta_1 OnePerc + \delta_2 TwoPerc + \Sigma\, \beta_{2\text{-}9} + \Theta_t + \varepsilon_{ijt} \quad (2)$$

where $Wage_{itj}$ denotes the real wage received by farmers and $Wages_{i,\,t\text{-}2}$ is its lagged value, OnePerc is a interaction term that measures the change in coconut workers' wage due to the biofuel mandate of a one percent coconut diesel blend, TwoPerc is a interaction term that measures the change in coconut workers' wage due to the biofuel mandate of a two percent coconut diesel blend, β_2 is the actual area from which harvests are realized, β_3 is where harvesting has been made, β_4 is average production per hectare (or yield) production expressed in metric ton, β_5 is the unemployment rate in the region, β_6 is the total agriculture employment in the region, β_7 is the primary dropout rate in the region, β_8 and β_9 is the farm gate price of each commodity and its lag, Θ_t is the year dummy and ε_{ijt} is the error term. Again, the main parameters of interest are the interaction terms, δ_1 and $\delta_{2.}$ These coefficients can be interpreted to represent the impact of the Biofuel Act on coconut workers' wage due to the mandate requirements of a one percent and two percent blend respectively. These variables were also appropriately put into logarithmic transformations and monetary deflated.

In order to investigate whether the passage of the Biofuel Act increased the volatility of coconut farm gate prices an autoregressive conditional heteroskedascity in mean model was developed and estimated. This model was chosen because current price volatility can carry over into future periods. The following ARCH model that was estimated with the typical control variables:

$$FG_{itj} = \alpha_j + \beta_1 FG_{i,\,t-1} + \delta_1 OnePerc + \delta_2 TwoPerc + \Sigma\,\beta_{2\text{-}4} + \Theta_t + \lambda_t + \alpha_i + \varepsilon_{ijt} \quad (3)$$

$$h_{itj} = \beta_0 + \beta_1 \varepsilon^2_{itj-1} + \gamma_1 FG_{i,\,t-1} + \gamma\,\Sigma\,\beta_{2\text{-}5} + \delta_1 OnePerc + \delta_2 TwoPerc + \Theta_t + \lambda_t + \alpha_i \quad (4)$$

β_2 is the area harvested, β_3 is trees where harvesting has been made, β_4 is average productions, Θ_t is the year dummy, λ_t is the month dummy, α_i is the province dummy and ε_{ijt} is the error term. The error term is assumed to be independent, identical and normally distributed with mean zero, variance *h* with ε^2_{itj-1} is its lagged disturbance. All data was collected from the Philippines Bureau of Agriculture Statistical Database and the Philippines Department of Labor.

Results

Fixed effects estimates on the effect of the Biofuel Act on farm gate prices are reported in Table 1. The coefficient on δ_1 indicates that the one percent mandate increased coconut farm gate prices by about 21 percent. While the coefficient on δ_2 representing the two percent mandate increased coconut farm gate by 20 percent. Both mandates have a statistically significant effect on coconut farm gate prices. A dynamic farm gate price model was also estimated to include lagged values on the dependent variable. The Anderson and Hsiao approach was used since the bias introduced by the lag variable decreases with respect to the time dimension. The results provide a clear but similar distinction of the effects between the two mandates. For the one percent requirement, coconut farm gate prices increased by 24 percent. This result is statistically significant and close to the previously estimated farm gate price model. However, for the two percent mandate, there is a slightly lower effect compared to the previously estimated model. The effect of the biofuel act on coconut farm gate prices only increased by about 19 percent (compared to 20 percent) but it is still statistically significant.

Table 2 reports the twostep robust Arellano-Bond estimates for the Biofuel Act effect on wages. In a twostep robust estimation, the standard covariance matrix is robust to panel-specific autocorrelation and heteroskedasticity. The coefficient δ_1 is negative, however it is not significant. Whereas, the coefficient δ_2 that specifies the two percent mandate is statistically significant and negative. The two percent required blend decreased coconut workers' wages by 14 percent. It is noteworthy to mention that when the wage equation is re-estimated using the third lag of the dependent variable, both the one and two percent mandate variables show a statistically significant decrease in wages of 16 and 20 percent respectively. This result is indeed very important because farm workers already earn less than the average worker. Any significant decrease in their wages is bound to have severe and perhaps lasting consequences. In all the cases, the Sargen and Hansen test are satisfactory and based on the Arellano–Bond test for autocorrelation there is no serial correlation.

The volatility results are reported in Table 3. Results from the mean equation indicate that farm gate prices increased during the one and two percent required blend. Both of these mandate indicator variables are statistically significant at the 1% level. Estimates from the variance equation show that the price volatility increased for coconut farm gate prices after the Biofuel Act was passed. The increase in volatility is statistically significant at the 1% level. Both variables OnePerc and TwoPerc variable are negative with TwoPerc being more negative than the OnePerc variable. This implies that the two percent mandate actually showed more price volatility that the one percent mandate.

Conclusion

In conclusion, the main contribution of this paper is to test whether the government led biofuel mandate was associated with an increase in coconut farm gate prices and an increase in coconut workers' wages. Due to the widespread contemplation of biofuel mandates around the world, along with the conflicting views of its impacts the biofuel issue is of considerable interest. Biofuels have the potential to mitigate environmental impacts, improve balance of payments through foreign exchange savings while providing countries with greater energy security. Understanding who the true winners and losers is important because policymakers need to be conscious of what group is bearing the brunt of the cost since it can result in a burden too heavy for one group to carry. The paper provides robust evidence that the coconut farm gate prices were higher after the mandate was implemented but unfortunately coconut farm workers real wage decreased and coconut farmers experienced increased price volatility.

References

APEC. 2008. "The Philippines Biofuels Activities." Retrieved on September 19, 2011. Available at: http://www.biofuels.apec.org/me_philippines.html

ASEAN. 2010. *Biofuels from Plant Oils*. Indonesia

Balgati, B. 2005. Economertic Analysic of Panel Data, Third Edition. England: Wiley.

BAS. 2011. "Farm gate Prices." Retrieved on November 9, 2011. Available at: http://countrystat.bas.gov.ph/index.asp?cont=tables&pageid=main/DETAILS/4_PR/1_FARMGATE/1_FARMGATE.xml

BAR. 2011. "Gov't urged to review biofuel incentives." Available at http://www.bar.gov.ph/biofuelsinfo/news&events/local/2011/27june2011_malaya.asp

Baum, C. 2006. An Introduction to Modern Econometrics Using Stata. Stata Press.

Blanco, L. and M. Isenhouer. 2010. "Powering America: the impact of ethanol production in the Corn Belt states." Energy Economics 32: 1228-1234.

Dauvergne,P., and K. Neville. 2010. "Forests, food, and fuel in the tropics: the uneven social and ecological consequences of the emerging political economy of biofuels. *The Journal of Peasant Studies 4.*

De la Torre Ugarte, D., Burton, E. and K. Jensen. Sixty billion gallons by 2030. American Journal of Agricultural Economics 89: 1290-1295.

Kirshbaum, M. 2003. "To sink or burn? A discussion of the potential contributions of forest to greenhouse gas balances through storing carbon or providing biofuels." *Biomass and Bioenergy* 24: 297-310.

Koh, L.P. 2007. Potential habitat and biodiversity losses from intensified biodiesel feedstock production. *Conservation Biology* 21:1373-1375.

Koh, L.P. & J. Ghazoul. 2008. Biofuels, biodiversity, and people: understanding the conflicts and finding opportunities. *Biological Conservation* 141: 2450-2460.

ESCAP. 2006. *State of the Environment in Asia and the Pacific*. Thailand: United Nations.

FAO. 2011. *State of the World's Forest 2011*. Rome: United Nations.

Global Facility for Disaster Reduction. 2011. *Disaster Risk Management Programs for Priority Countries: 2nd Edition*. World Bank.

Intergovernmental Panel on Climate Change. 2007b. *Mitigation of Climate Change.* New York: Cambridge University Press.

IFAD. 2008. Growing demand on agriculture and rising prices of commodities: An opportunity for smallholders in low-income, agriculture-based countries? New York. United Nations.

IEA. 2007. IEA Energy Technology Essentials: *Biofuel Production*. January 2007. OECD.

McCarthy J., and Z. Zen. 2010. " Regulating the oil palm boom: assessing the effectiveness of environmental governance approaches to agro-industrial pollution in Indonesia." *Law and policy 3*(1): 153-179

Meyer, S. and W. Thompson. 2010. *Handbook of Bioenergy Economics and Policy*: Natural Resource Management and Policy 33. Springer.

MSNBC. 2007. U.N.: Not so fast with ethanol, other biofuels. Available at http://www.msnbc.msn.com/id/18551000/ns/world_news-world_environment/t/un-not-so-fast-ethanol-other-biofuels/#

Nickell, S. 1981. Biases in dynamic models with fixed effects. *Econometrica* 49, 1417-1426.

Puhe, J. and B. Ulrich. 2001. *Global Climate Change and Human Impacts on Forest Ecosystems: Postglacial Development, Present Situations, and Future Trends in Central Europe.* Germany: Springer.

Rajagopal, D. and D. Zilberman. 2007. Review of environmental, economic and policy aspects of biofuels policy. *Research Working Paper Series 4341.* World Bank.

Republic of the Philippines, Congress of the Philippines. 2006. *Republic Act of 9367: The Biofuel Act of 2006.* Metro Manila.

Spray, S., and M. Moran. 2006. *Tropical Deforestation*. Lanhan: Rowman and Littlefield Publishers, Inc.

Tan, R., Culaba, A., and M. Purvis. 2004. Carbon balance implications of coconut biodiesel utilization in the Philippine automotive transport sector. Biomass and Bioenergy 26: 579-585.

UNEP. 2009. Biofuels and its Environmental Impacts. UNESCO Brief: June 2009, No. 9.

USDA. 2010. Gain Report: Philippines Biofuels Annual. Metro Manila.

World Metrological Organization. 2011. WMO Greenhouse Gas Bulletin. November 2011. No. 7

Figure 1: Philippines Farm Gate Prices

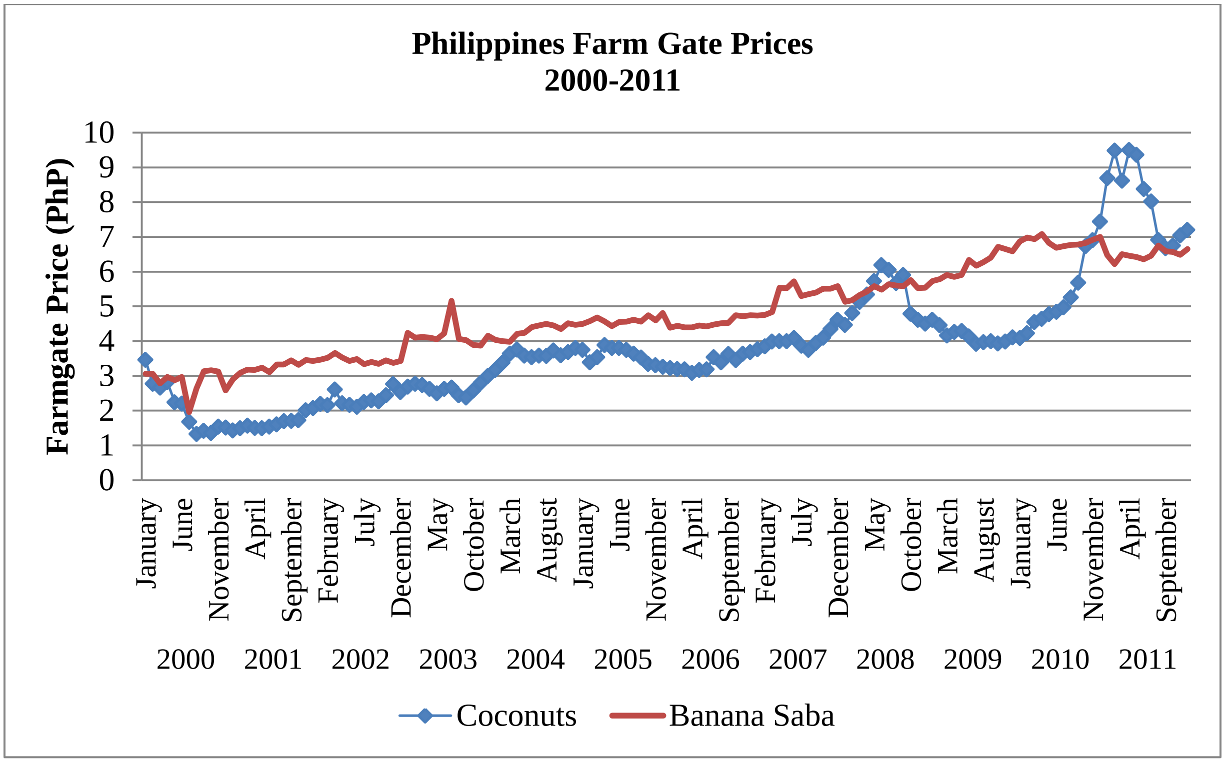

Figure 2: Philippines Coconut and Palay Worker Wages

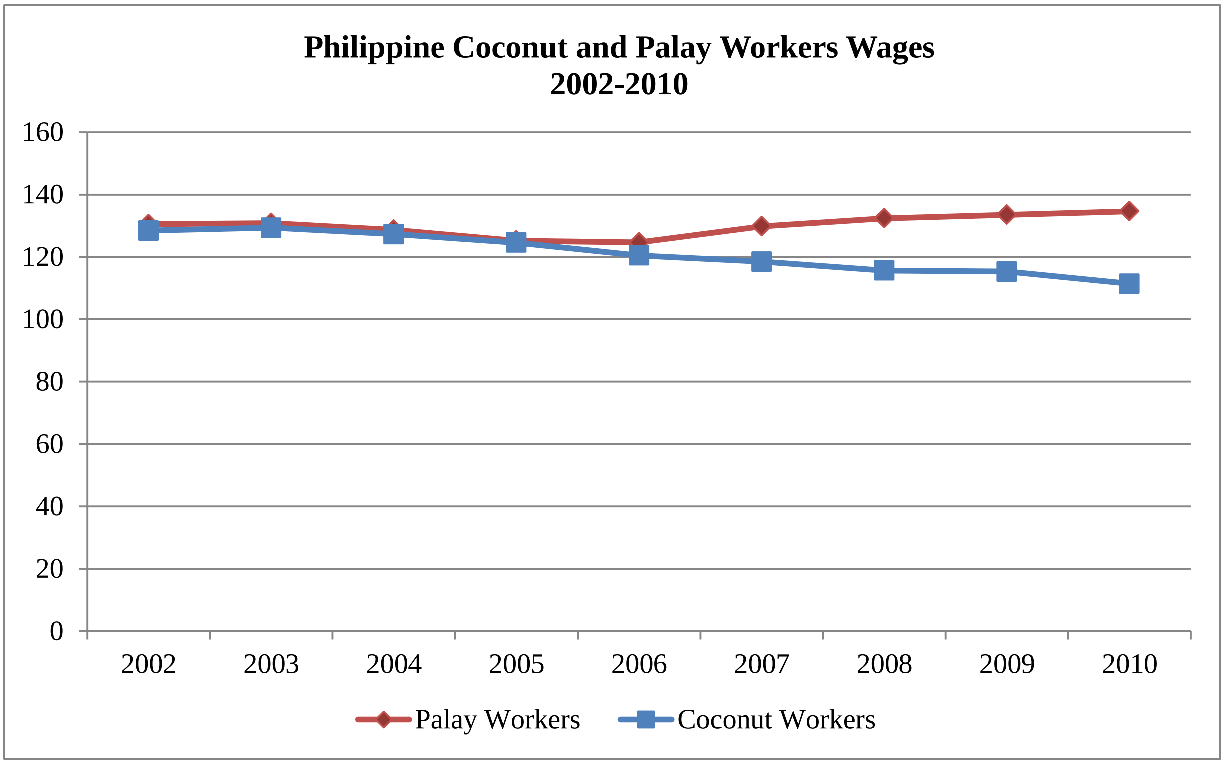

Figure 3: Coconut Farm Gate Price Differentials

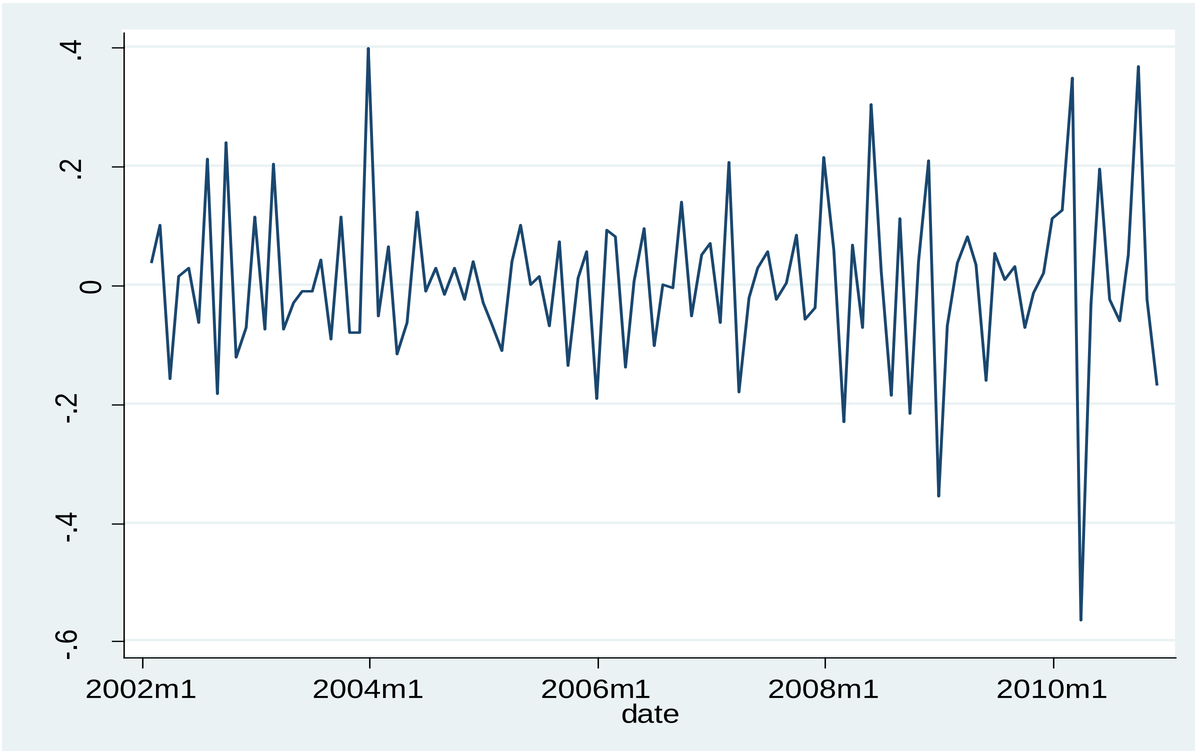

Figure 4: Coconut Farm Gate Price Conditional Variance

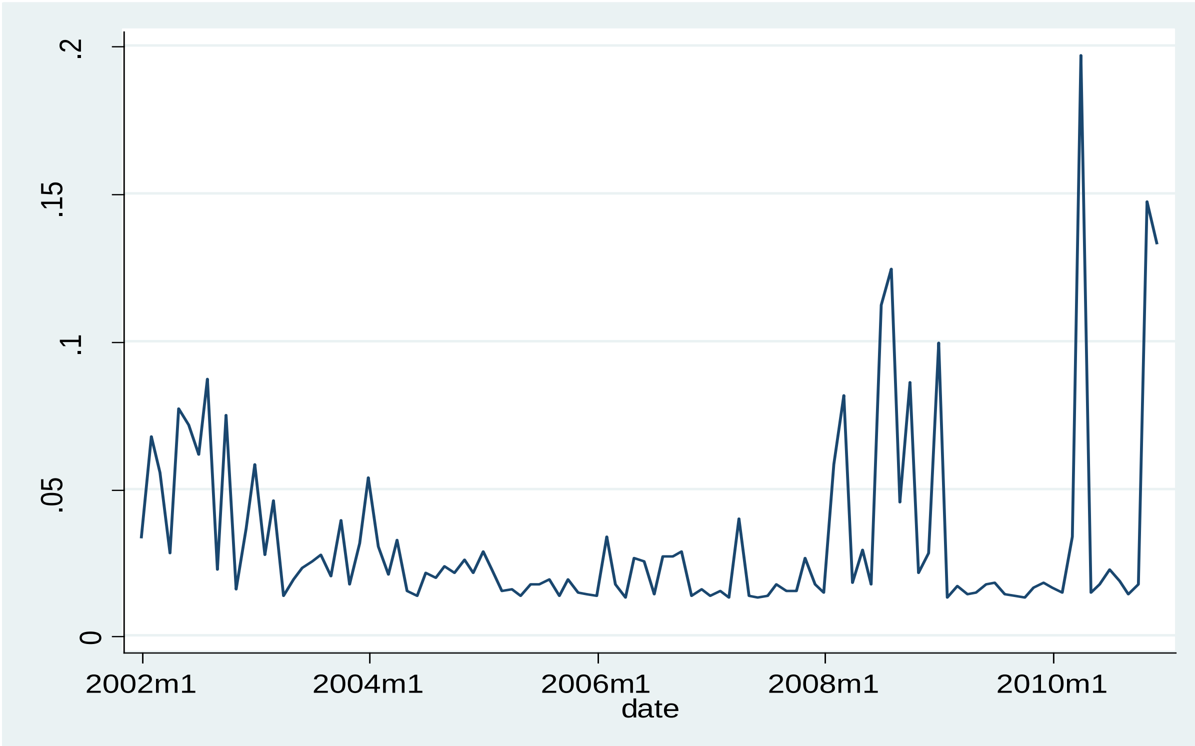

Table 1a: Effect of Biofuel Act on Farm Gate Prices (Fixed Effects)

LFG	Coefficient	Std. Err.	t	P>|t|
Oneperc	.2068542	.024148	8.57	0.000***
Twoperc	.2028457	.0248367	8.17	0.000***
LAreapharvest	-.0109192	.0516808	-0.21	0.833
Lntrees	.0637839	.0706563	0.90	0.370
Lvolume	-.1151963	.0593374	-1.94	0.056*
Areaint	.0701563	.0668009	1.05	0.297
Volint	.0771538	.0715135	1.08	0.284
Constant	1.307006	.3799892	3.44	0.001

Observations 14242
R-squared: within = 0.329

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Note: Time and Month dummies estimates not shown

Table 1b: Effect of Biofuel Act on Farm Gate Prices (Dynamic)

$LFG_{.D1}$	Coefficient	Std. Err.	z	P>|z|
$LFG_{i,\ t-2.D1}$	.573069	.02034	28.17	0.000***
$LFG_{i,\ t-3}$	-.049042	.0235366	-2.08	0.037**
$LFG_{i,\ t-4}$	.241986	.0218103	11.10	0.000***
$Oneperc_{.D1}$	.2441697	.099091	2.46	0.014**
$Twoperc_{.D1}$	.1855769	.0942487	1.97	0.049**
$Lareapharvest_{.D1}$	-.0014215	.0074418	-0.19	0.849
$Lntrees_{.D1}$	.0124574	.0126716	0.98	0.326
$Lvolume_{.D1}$	-.0128244	.0114233	-1.12	0.262
Constant	-.0007386	.0005291	-1.40	0.163

Observation 11422
R-squared .8091

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Note: Time and Month dummies estimates not shown

Table 2a: Effect of Biofuel Act on Wages

LWages	Corrected Coefficient	Std. Err.	z	P>|z|
$Wages_{i, t-2}$	2.084872	.9215826	2.26	0.024**
Oneperc	-.1184849	.0841299	-1.41	0.159
Twoperc	-.145384	.0760059	-1.91	0.056*
Lfarmgate	.3060913	.208675	1.47	0.142
$LFG_{i, t-1}$	.29743	.2287329	1.30	0.193
Lareapharv	-.504429	.5997739	-0.84	0.400
Lvolume	.5746325	.5080283	1.13	0.258
Lunemploy	.0950889	.1945822	0.49	0.625
lagemploy	-.9189954	.7707234	-1.19	0.233
Ldropout	-.9587244	.5023179	-1.91	0.056*
Observation 195				

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Arellano-Bond test for AR(1) in first differences: z = -0.78 Pr > z = 0.435
Arellano-Bond test for AR(2) in first differences: z = 0.68 Pr > z = 0.499

Sargan test of overid. restrictions: chi2(95) = 95.62 Prob > chi2 = 0.463

Hansen test of overid. restrictions: chi2(95) = 0.00 Prob > chi2 = 1.000

Note: Time and Month dummies estimates not shown

Table 2b: Effect of Biofuel on Wages (Third Lag)

LWages	Coefficient	Std. Err.	z	P>|z|
$LWages_{i,\ t-3}$	-1.749276	1.032511	-1.69	0.090*
Oneperc	-.1698123	.0656724	-2.59	0.010**
Twoperc	-.2049406	.0868176	-2.36	0.018**
LFG	.0964639	.059745	1.61	0.106
$LFG_{i,\ t-1}$	-.731696	.5275154	-1.39	0.165
$LFG_{i,\ t-2}$	-.8554986	.5793453	-1.48	0.140
Lvolume	-.1049003	.0917266	-1.14	0.253
Lagemploy	2.641679	1.127655	2.34	0.019**
Ldropout	-.3346055	.245174	-1.36	0.172
Observation 144				

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Arellano-Bond test for AR(1) in first differences: z = -1.20 Pr > z = 0.229
Arellano-Bond test for AR(2) in first differences: z = 1.00 Pr > z = 0.320

Sargan test of overid. restrictions: chi2(120) = 105.00 Prob > chi2 = 0.834

Hansen test of overid. restrictions: chi2(120) = 0.00 Prob > chi2 = 1.000

Note: Time and Month dummies estimates not shown

Table 3a: ARCH Mean Equation (dependent variable : Coconut Farm Gate Price)

Variable	Mean Equation	Standard Errors	P-value
Constant	.3587	.126	0.005***
$LFG_{i, t-1}$	.6672	.008	0.000***
lAreapharvest	.1529	.025	0.0000***
lntrees	.0485	.021	0.022**
lvolume	-.0362	.017	0.041**
Oneperc	.0835	.008	0.000***
Twoperc	.0613	.015	0.000***

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Notes: Year, month and province estimates not shown

Table 3b: ARCH Variance Equation (dependent variable – variance h_{ijt})

Variable	Variance Equation	Standard Errors	P-value
Constant	-6.01	.292	0.000
$LFG_{i, t-1}$	-.7435	.071	0.000
LAreapharvest	.0736	.040	0.072
lntrees	.6455	.061	0.000
lvolume	-.6105	.044	0.000
Oneperc	-.8121	.091	0.000
Twoperc	-1.438	.169	0.000

*** significant at 1 % level, ** significant at 5 % level, * significant at 10 % level

Notes: Year, month and province estimates not shown