Sustainable Agriculture Research; Vol. 5, No. 4; 2016
ISSN 1927-050X E-ISSN 1927-0518
Published by Canadian Center of Science and Education

Impact of the Farm Income Stabilization Insurance Program on Production Decisions in the Quebec Pork Industry: An Empirical and Theoretical Analysis

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Received: August 9, 2016 Accepted: September 18, 2016 Online Published: October 18, 2016

doi:10.5539/sar.v5n4p94 URL: http://dx.doi.org/10.5539/sar.v5n4p94

Abstract

The Farm Income Stabilization Insurance Program (ASRA) is an agricultural program implemented in several agricultural sectors in Quebec, including the pork sector. This article aims to empirically assess the effects of this program on production decisions in the pork industry in Quebec using a Vector Error Correction Model (VEC). As variables we used the pig supply, the price of pork, and stabilized income. The dataset contains information about the pork sector which cover the period 1981-2014. The annual average growth rate of the quantity offered in this period is 5.24%. The results suggest that the supply of pork is strongly correlated with lagged values of stabilized income. The results also show that there is only one long-term relationship between the three variables above-mentioned. By contrast, in the short term, an increase of one percentage point of the stabilized income leads to an increase of 0.80 percentage point of pork supply in the next period while an increase of one percentage point of pork price will result to a decrease of 0.47 percentage point of the production. Pork production decisions are dominated in short-term by the presence of ASRA program. This shows evidence that without the ASRA program, pork production would be less. These results confirm some of the criticisms of this program. Thus, through this article we suggest a compensation indicator which internalizes market signals in order to improve pork industry efficiency. Simulations of the compensation indicator were also performed. The adoption of this indicator as a measure of compensation for the ASRA program will generate an efficient production system, reduce the deficit of the program, and improve the competitiveness of pork industry. This indicator can be applied to other agricultural sectors covered by the ASRA program.

Keywords: ASRA, market signals, supply indicator, Vector Error Correction Model

1. Introduction

Farmer's annual income is marked by chronic instability due to several factors that influence agricultural outputs: climate change and biological crises such as animal diseases and the invasion of insects. This causes large fluctuations in the supply of agricultural products, and therefore induces food prices instability. According to Roux (2013), supply of agricultural products is price inelastic and is determined by the bioclimatic conditions and partly by the seasonality of production. All these conditions cause the imbalance between supply and demand in agricultural markets and thus create distortions in these markets. Agricultural products prices constantly undergo high volatility and therefore affect the producers' income. All these risks factors make farmers' welfare unstable.

These conditions have prompted government intervention in the agricultural sector by the implementation of various programs. These latter aimed to support farmers in order to guarantee a stable and reasonable income, and also allow them to pay out inputs cost. In industrialized countries, support programs for the agricultural sector were implemented, ranging from price support programs to income export subsidy programs.

Canada has adopted several agricultural support programs. The program of Agricultural Income Stabilization Insurance (ASRA) is one of these programs. ASRA is an income support program, in place since 1975 in Canada (Saint-Pierre, 1974). It covers a total of 16 specialized areas of agricultural production and livestock (FADQ, 2015) including hiring calves, lambs, oats, barley, feed wheat, wheat for human consumption, canola, calves grain, pigs, apples, veal calves, corn, steers, pigs, potatoes and soybeans. The aim of the Farm Income Stabilization Insurance program is to guarantee a positive net annual income to agricultural enterprises or categories of agricultural enterprises that operate on the structures of production and marketing in accordance

with methods recognized, as effective (Saint-pierre, 2009; FADQ, 2015). Its operation reflects two concepts namely: first, a cost of stabilized and uniform production for all regions and calculated for a company specializing in the production covered, and second, the principle of decent wages for producers set at 90% of that of a specialized worker in Quebec (Pronovost, 2008). Support to farmers is based on a comparison between the market price and the stabilized income per unit of production. The latter is determined by the production costs. If the market price exceeds the stabilized income, the producer receives no payment under ASRA, but if the market price is lower than the stabilized income, the program pays the producer differential per unit of production assured for offset the decline in income. ASRA is then an income support program perfectly linked to volume of production and helping farmers cope with various economic risks (Monsengo, 2009).

This program has been the case of many criticisms in previous studies including the basic principles of its functioning. Romain (1994) suggests that programs based solely on production costs and related production volumes have inertia influence on the level of production and implicitly the allocation of resources involved in the production process.

Indeed, in 2004, 30% of agricultural businesses in Quebec failed to cover their production costs (Gouin, Lamarche & Mercier, 2007). These also show that the debt ratio of these enterprises increased by 28.4% in 2004 to 32.2% in 2005, while this ratio stood at 20.4% in Ontario and 11.4 % in the US in 2005 (Pronovost, 2008). In addition, they argue that such support programs do not reflect long-term trends in demand or any changes likely in the production structures in the competitive and comparative advantages between products, between provinces and between countries. Therefore, they are bound to be expensive to the government and expose themselves to criticism of the World Trade Organization (WTO) where they will not be defensible (Roman, 1994). ASRA has paid 5.5 billion of compensation over the past decade in response to the low producer's incomes (Pronovost, 2008).

Moreover, ASRA achieved in 2010, a deficit of nearly 450 million and 239 million respectively in the sector of pork production and the production of piglets, from nearly 45 million in the sector production of feed wheat and over 45 million in the production of feeder calves (FADQ, 2011a; FADQ, 2011b; FADQ, 2011c; Pouliot, 2015). Furthermore, the results of the study on the development of a typology of Quebec farmers, led by AGECO group (2007) showed that in 2004, 23% of agricultural companies withdrew their entire net income payments of this program, 12% of agricultural businesses are more than 51% of their net income to these payments and the share of these payments is less than 50% in only 35% of companies. Through these descriptive analyzes, Romain (1994) suggests at first glance, that the production of certain agricultural sectors would be significantly reduced following the withdrawal of government support.

All these previous results gave a need to review the functioning of the political system of Insurance Stabilization of Agricultural Income in order to promote efficiency and effectiveness of the Quebec food industry. Saint-Pierre (2009) summarizes all the criticism laid against ASRA which include these two fundamental points that cause perverse distortions in agricultural markets:

- ASRA mask market signals
- ASRA forget risk management resulting in excessive debt

Despite all the criticisms made to the ASRA program, no studies have been conducted to test their empirical validity. According to microeconomic principles, the production level depends negatively on production costs and positively on the level of prices on the market. Especially in agriculture, it is the characteristics of supply and demand that determine the instability of agricultural markets. According to King's law, the revenue of farmers varies inversely with production (Butault, 2004). According the author, the principle of this law is that supply is rigid in the short term; it is demand that determines market prices. Demand is inelastic, an abundant amount offered will result in a strong market prices drop, while a small quantity offered induce a higher price increase. So there is a relationship between the market price and the quantities produced, which can be changed to medium and long term.

From this, farmers can manage their production to alter the market price to ensure a revenue that is higher. However, the behavior of farmers covered by ASRA such as producers of pigs and piglets seem to contradict these theoretical predictions that are based on the consideration of market risks in production decisions. We assume that the production decisions of pigs and piglets' producers are not rooted on the evolution of market prices but rather on stabilized income ASRA program.

The purpose of this article is to empirically examine the relationship between the level of production of pigs, the level of prices of pork in the market and stabilized ASRA income. The relevance of this study is part of a context of highlighting the empirical evidence of the criticisms made on ASRA and deepens the theoretical analysis by

proposing a theoretical solution taking into account market conditions induced by the program.

The rest of this article is organized as follows. Section 2 presents the data while Section 3 presents the econometric model and the empirical results. In Section 4, we develop a theoretical proposition program adjustment taking into account market conditions (construction of a stabilized income index called inclusion index of risk market in the stabilized income). In section 5, some concluding remarks are reported.

2. Methods

2.1 Data Presentation

This study aims to identify the factors that determine the pork production decisions in Quebec. We analyze the relationship between the production, the price of pork in the market and stabilized income stabilization insurance program of agricultural income. The annual data covering the period 1981-2014 are obtained from the website of the *Financière Agricole Du Québec* (FADQ). The production level (offre_porc) used is the number of pork units provided by the ASRA program. The current price of pork (prix_porc) and stabilized income (rs_porc) current are both indicators considered in this study. The evolution of the pork price reflects the market behavior while that of stabilized income shows the dynamics of government intervention. Figure 1 shows the dynamics of these variables. Data were log transformed to reduce the scale of the volatility: amount of pork (lnoff), pork prices (lnprice) and stabilized income (lnrs).

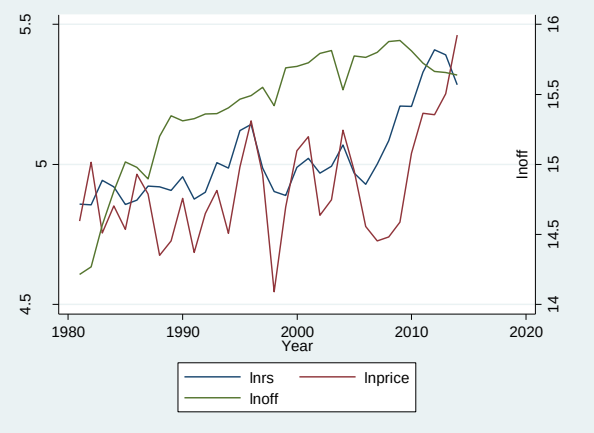


Figure 1. Evolution of the price of pork, stabilized income and the number of insured unit

Figure 1 exhibits the dynamics of the number of insured pork units (*lnoff*) by the insurance program of the Farm Income Stabilization (ASRA), the dynamics of income level stabilized per pork unit (*lnrs*) and the evolution of pork prices in the current market (*lnprice*).

Over the entire period covered by the study which is 1981-2014, the market price has almost always remained lower than the stabilized income. Only eight years that this industry was spared the intervention of the program. This shows a descriptive way that Quebec's pork industry is heavily dependent on Insurance Stabilization Agricultural Income program.

Table 1. Correlation between the pork market indicators

	Lnoffre	***lnrs***	***Lnprice***
lnoff	1		
lnrs	0.5149*** (0.0018)	1	
lnprice	0.2097 (0.2340)	0.6986*** (0.0000)	1
L.lnoff	0.9606*** (0.0000)	0.5468 *** (0.0010)	0.2634 (0.1386)
L.lnrs	0.4868*** (0.0041)	0.8846*** (0.0000)	0.6757*** (0.0000)
L.lnprice	0.1584 (0.3787)	0.4760*** (0.0051)	0.5024*** (0.0029)
L2.lnoff	0.9318*** (0.0000)	0.5609*** (0.0008)	0.3690** (0.0377)
L2.lnrs	0.4560*** (0.0087)	0.7273*** (0.0000)	0.6038*** (0.0003)
L2.lnprice	0.1744 (0.3398)	0.1703 (0.3514)	0.0871 (0.6356)

Note. (***) Significant at 1%, (**) significant at the 5% and (*) significant at 10%

However, the Quebec's pork producers seem to see this agricultural program as a principal condition of production. This is because during the periods of low market price, the annual amount available is growing at an annual average rate of 5.25%. Pork producers seem to ignore market signals, and their output decision depends mainly on the level of stabilized income.

Table 1 shows the correlation coefficients between economic indicators of the industry. The values in parentheses are the p-value. The manufacturing level was significantly correlated with the 1% threshold in its lagged values (L.lnoffre, L2.lnoffre) and income stabilized and its lagged values (L.lnrs, L2.lnrs). For cons, the correlations between contemporary quantity supplied and the market price (lnprice) and its lagged values (L.lnprice and L2.lnprice) are not significant at the 5% level.

On the theoretical basis, it is expected that the level of production is correlated to previous price levels, which is not the case in the pork industry in Quebec. So, anticipated prices in this market do not seem to be reflected in production decisions. This suggests that the existence of the insurance stabilization of farm income program is an incentive to increase production. Therefore, the producers ignore risk management and increases unconditionally investments in this industry. Grenon (2007) also says producers ignore market signals and continue to produce since they will be compensated based on their cost of production through insurance stabilization of agricultural income program.

2.2 Econometric Model

Huq and Arshad (2010) used the error correction model to estimate the response of the sweet potato supply in Bangladesh. The short-term price elasticity is 0.45 while that of long-term is 0.62. The rubber producers' response to price fluctuations and production input costs in Nigeria is analyzed by Mesike, Okoh and Inoni (2010) using the cointegration and vector error correction Model (VEC) Their results show that the response of the producers to rubber price is low with low short-term price elasticity of 0.373 and long term price elasticity of 0.204. They also showed that the adjustment of the production is based on the anticipated price. Mushtaq and Dawson (2003) have used the VEC model to evaluate the effect of the price level on the supply of wheat and cotton in Pakistan. The data used covered the period from 1960 to 1996. Results show that the supply of wheat is significantly influenced by the price of wheat, cotton and fertilizer while that of cotton was significantly impacted by the real price of cotton prices inputs such as fertilizers. By contrast, Ozkan, Ceylan and Kizilay (2011) found with the same model that the producers of wheat in Turkey do not react following the wheat product change and the supply of wheat is anchored on the level of the previous prices. Many other authors have used these models to examine the adjustments in production levels face of change in prices of agricultural products. We use the error correction model to investigate pork producers of the responses to changes in market prices.

2.3 Model Overview

The variables supply of pork (lnoff), stabilized income (lnrs) and market price (lnprice) are all considered as potentially endogenous. The stabilized income is calculated based on production costs. In the ASRA context, the costs of factors of production would rapidly raise with the level of the production. Therefore, the level of production may have effects on the stabilized income. According to microeconomic theory of production, the supply quantity depends positively on the level of prices on the market while the market price decreases with the increase of the production. By contrast, in agricultural sector, the level of the previous price is an indicator for adjusting production.

We use the Augmented Dickey-Fuller (ADF) and the Phillipe-Perron tests to investigate the presence of unit root in the series. We also apply the Johannsen's co-integration test to assess the presence of a long-term relationship between sets. The VEC model is used to analyze the dynamics of short and long term. The vector of endogenous variables is given by:

$$Y_t = (lnoff_t, lnrs_t, lnprice_t)' \quad (1)$$

Where t denotes the time index.

Vector Autoregressive Model (VAR) with the number of p optimal delay is specified as follows:

$$Y_t = \varphi + \sum_{i=1}^{P} \Pi_i Y_{t-i} + \varepsilon_t \quad (2)$$

With φ a vector of constants, Π_i a dimension of $n \times n$ matrix of parameters of short-term effects of lagged variables on contemporary values and ε_t is a vector of dimension n independent and identically distributed

residuals.

The specification of order p to vector error correction model is presented in matrix form as follows:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots + \Gamma_p \Delta Y_{t-p+1} + \Pi Y_{t-p} + u_t \quad (3)$$

Where $\Gamma_i = -\sum_{j=i+1}^{P} \Pi_j \ with\ i = 1, 2, \ldots, P-1$ and $\Pi = \sum_{j=1}^{P} \Pi_j - I = \alpha\beta'$

The Π matrix can be written as $\alpha\beta'$ where α represents the matrix of $n \times r$ adjustment speeds for each of the cointegrating vectors and a $r \times n$ matrix β' comprising the r cointegrating relationships ($r < n$).

While adapting the model to our vector Y_t endogenous variables we obtain the following system of equations:

$$\Delta lnoff_t = c_1 + \sum_{i=1}^{P} \delta_{11}^{i} \Delta lnoff_{t-i} + \sum_{i=1}^{P} \delta_{12}^{i} \Delta lnrs_{t-i} + \sum_{i=1}^{P} \delta_{13}^{i} \Delta lnprice_{t-i} + \gamma_1 \varepsilon_{t-1} + u_{1t} \quad (4)$$

$$\Delta lnrs_t = c_2 + \sum_{i=1}^{P} \delta_{21}^{i} \Delta lnoff_{t-i} + \sum_{i=1}^{P} \delta_{22}^{i} \Delta lnrs_{t-i} + \sum_{i=1}^{P} \delta_{23}^{i} \Delta lnprice_{t-i} + \gamma_2 \varepsilon_{t-1} + u_{2t} \quad (5)$$

$$\Delta lnprice_t = c_3 + \sum_{i=1}^{P} \delta_{31}^{i} \Delta lnoff_{t-i} + \sum_{i=1}^{P} \delta_{32}^{i} \Delta lnrs_{t-i} + \sum_{i=1}^{P} \delta_{33}^{i} \Delta lnprice_{t-i} + \gamma_3 \varepsilon_{t-1} + u_{3t} \quad (6)$$

Where ε_{t-1} is the term of error correction or long term relationship in the model, the coefficients of the variables have delayed the effects of short term. u_{1t}, u_{2t}, u_{3t} are white noise. The coefficients $\gamma_1, \gamma_2, \gamma_3$ are the speeds of adjustments to the long-term equilibrium disturbances. These coefficients are assumed to be negative, statistically significant and less than one an absolute value so that there is convergence to long-term balance. The MEC model is validated when this condition is met, if not there will be no adjustment and dynamics diverges from the long-term equilibrium.

3. Results and discussion

3.1 Empirical Results

Stationarity tests Augmented Dickey-Fuller (ADF) and Phillipe-Perron (PP) were used to examine the presence of unit root in the series. The statistics of these tests have been estimated and approximate probabilities Manckinon (1996) are reported. Table 2 summarizes the results. In fact, tests show that all series are not stationary in levels. However, they reveal that the three series in first differences do not contain unit root. All variables are integrated of the same order I (1). This suggests that there may be a co-integration relationship between the supply of pigs, the market price and the stabilized income ASRA program.

Table 2. The results of ADF stationarity test and Phillips Perron (PP)

Series	ADF test stat. estimated	Manckinon (1996) P-value estimated	PP test stat. estimated	Manckinon (1996) P-value estimated
$\boldsymbol{lnoff}$	-2,29	0,42	-2,26	0,44
$\boldsymbol{lnrs}$	-1,02	0,73	-1,08	0,70
$\boldsymbol{lnprice}$	-2,37	0,15	-2,31	0,17
$\boldsymbol{\Delta lnoff}$	-5,07**	0,00	-5,07**	0,00
$\boldsymbol{\Delta lnrs}$	-4,63**	0,00	-4,51**	0,00
$\boldsymbol{\Delta lnprice}$	-6,33**	0,00	-7,09**	0,00

Note. (**) Denotes rejection of the null hypothesis at 5%

Table 3. Johansen cointegration test (trace test)

Hypotheses	Eigen value	Trace Statistic	5% Critical value	Prob**
$\boldsymbol{H0: r = 0\ vs\ H1: r > 0}$	0,491692	40,91045**	35,19275	0,0108
$\boldsymbol{H0: r = 1\ vs\ H1: r > 1}$	0,308766	19,93373	20,26184	0,0554
$\boldsymbol{H0: r = 2\ vs\ H1: r > 2}$	0,239475	8,486154	9,164546	0,0671

Note. (**) Denotes rejection of the null hypothesis at 5%

The cointegration test of Johansen (1990) was used to test the existence of a long relationship between the three variables cointegrated of order one. This test is an incremental manner by testing the non-existence of a linear combination of long-term ($\boldsymbol{H0: r = 0\ vs\ H1: r > 0}$) between the variables to test the existence of N

relationship ($\boldsymbol{H0 : r = N - 1 \; vs \; H1 : r > N - 1}$) of long term. N is the number of endogenous variables and in our case it is equal to three. The test results in Table 3 show that there is only one statistically significant long-term relationship to the five percent threshold between the supply of pork, stabilized income and the price of pork. The error correction model was estimated and the cointegrating vector parameters were obtained. The estimated long-term relationship is given by the following equation:

$$lnoff_{t-1} = 6{,}802125^{**} lnprice_{t-1} - 6{,}334684^{**} lnrs_{t-1} + 13{,}88014$$

The coefficients of price and income are stabilized respectively positive and negative and statistically significant at the 5% level (t-stat -3.87821 and 3.54516 respectively). The pork supply in Quebec is determined in the long run simultaneously by the market price and the stabilized income. The elasticity term of the supply price of porks is 6.80% while the elasticity - long-term stable income in the supply of - 6.33%. That is, an increase of the price level of 1% leads to an increase in supply of 6.80% while a 1% increase in the stabilized income implies a reduction in supply of pigs to 6.33%. The effect of price on the long-term supply is more important than long-term stable income. Short-term relationships between the three variables are obtained through the estimation of the VEC model.

The validity of the VEC model is dependent on the significance and value of the return coefficient to the long-term equilibrium. This adjustment coefficient should be negative, a lower absolute value and must be statistically significant. One adjustment coefficients must verify the three conditions for the validity of VEC model. But also the vector of error terms must be white noise.

The results of the VEC model presented in Table 4 show that the long-term adjustment coefficient of the pig supply equation is negative, less than one in absolute value and statistically significant at the 5% threshold (Statistic of Student = -3.23199). Tables 6, 7 and 8 in the Annex present the Q-statistics of Ljung-Box test residue. The results show that residues of the three equations VEC model are white noise. All these criteria validate the results of our model VEC whose order of an optimal delay was obtained with the Akaike information criterion. The estimated equation of the pork supply is:

$$\Delta lnoff_t = \boldsymbol{-0,061216} \times \Delta lnoff_{t-1} - \boldsymbol{0,475387}^{**} \times \Delta lnprice_{t-1} + \boldsymbol{0,809527}^{**} \times \Delta lnrs_{t-1} - \boldsymbol{0,072060}^{**} \times (lnoff_{t-1} - 6{,}802125^{**} lnprice_{t-1} + 6{,}334684^{**} lnrs_{t-1} - 13{,}88014) + \boldsymbol{0,038768}^{***} \quad (7)$$

The equation of short term supply relates the growth rates of the price, the stabilized income and the supply. The estimated parameters of the price change and stabilized income are significant and of opposite sign. An increase of one percentage point of the variation of price levels on the market generally reduce the variation in supply of pigs from 0.47 percentage points in the next period while a one-point increase percentage of change in the stabilized income ASRA program causes a rise of 0.80 percentage point in short-term pork supply. These results contradict the results of the literature. Indeed, Mushtaq and Dawson (2003) ; Huh and Arshad (2010) and Mesike et al. (2010) found that the level of market prices had a positive effect on the level of production, and the supply was inelastic to the price change. Ozkan et al. (2011) found against by producers of wheat in Turkey do not take into account the market price in their production decision. According to these authors, the higher contemporary the price is, the higher more producers intend to increase production in the next period.

Our results show that the short term effect of stabilized income on pig farmer's production decisions is more important than the market price. This supports the theoretical criticisms made regarding this insurance program farm income stabilization. Indeed, in view of these results, we see that the level of prices on the market has consistently controversial effect as compared with the theoretical prediction of the relationship between the price level and market supply in the short term. The theory states that the level of production increases with the increase of a product own price on the market, and the product price drop leads to a reduction in its supply. In fact, as the effect of stabilized income on producer decisions outweighs the price, the effect of the latter is not really felt in the pork production system. We only observe the effect of stabilized income leading to a sustained increase in the offer even in times of low prices.

The anticipation mode of pork price in the market that guide production decision is different from that described by the King model, i.e. the naive anticipation. The principle of the Cobweb model is that (Butault, 2004):

«*Given a certain length of production cycles in agriculture, farmers make their decisions based on the anticipated price. A simplistic hypothesis, which is that the cobweb model is to consider that these expected prices are the prices observed in the previous period. Under such circumstances, the price of the current period will be the expected prices in early next production cycle and therefore determine the quantities available during the following period* ».

However, the results of our model suggest also that the basic assumption of the early formation of prices in the

pork industry in Quebec is more pronounced than the naive anticipation of the cobweb model. Indeed, the results show that to make production decisions, hog producers in Quebec assume that:

«If the level of the current price is higher than the price of the previous period then the price of the next period will drop compared to today's prices ».

According to this assumption, we must act on the supply in order to mitigate the decrease in prices on the market in the next period. And pork producers decide to produce less current period to the next period to keep the price level or lessen its decline. However, the ASRA program ensures a minimum income per unit of production, and there is no production limit its effect outweighs the impact of the anticipation of prices on production decisions, which means that overall, the producers increase their production level thus creating market distortions. Indeed, the market offer does not follow market signals (prices) as illustrated by Figure 1. This confirms the predictions of Grenon (2007); the ASRA program is a handicap for research productivity, the efficiency and competitiveness of the pork industry.

Thus, we observe that the empirical model showed a strong consideration of market signals in production decisions and that the ASRA program generates all market distortions and consequently the increase in government compensation. This explains the permanence of the intervention program in the pork industry.

Table 4. Empirical model results in Error Correction MEC

Error Correction	$\Delta lnoff_t$	$\Delta lnprice_t$	$\Delta lnrs_t$
	-0,072060**	0,121216	0,025619
$CointEq1$	(0,02230)	(0,02904)	(0,01460)
	[-3,23199]	[4,17409]	[1,75513]
	-0,061216	0,233149	0,074067
$\Delta lnoff_{t-1}$	(0,161215)	(0,21429)	(0,10771)
	[-0,37208]	[1,08802]	[0,68766]
	-0,475387**	-0,229859	0,111082
$\Delta lnprice_{t-1}$	(0,15274)	(0,19894)	(0,09999)
	[-3,11242]	[1,15542]	[1,11090]
	0,809527**	-0,122565	-0,037446
$\Delta lnrs_{t-1}$	(0,36282)	(0,47257)	(0,23753)
	[2,23120]	[-0,25936]	[-0,61837]
	0,038768***	0,002475	-0,009107
C	(0,02250)	(0,02930)	(0,01473)
	[1,72322]	[0,08445]	[0,61837]
R-spuared	0,330619	0,428529	0,122561
Adj.R-squared	0,231451	0,343867	0,00743
F-statistic	3,333937	5,061632	0,942841
Log likelihood	26,69915	18,24248	40,25519
Akaike AIC	1,356197	0,827655	2,20345
Schwarz SC	1,127176	0,598634	1,974428

Note. (***) Significant at 1%, (**) significant at the 5% and (*) significant at 10%; (...) is the standard deviation, and [...] is the Student statistic (t-student)

The existence of this guarantee of stable income is an incentive to increase supply in the pork market. Whatever the structure of the market and price volatility is, production still increase sustainably as ASRA remains implemented. Therefore, the increase in output involves additional investments. The average annual growth rate of production is higher than 5%, probably without this program, the rate would be lower. ASRA is offline production decisions on market signals.

ASRA is a program that benefits producers and a serious threat to the effectiveness of this industry. The ASRA operating system can be considered an export subsidy system since the pork market is open. And with the agreements of the Uruguay Round that recommend the removal of subsidy programs for agricultural exports, the industry faces real difficulties to recover after the suppression of the ASRA. The producers do not take into account the risks in their investment decisions because of ASRA program.

3.2 Index of Market's Risks Internalization in the ASRA Program

In order to lead farmers to reduce the effect of the ASRA in production decisions and allow the market price to partially fulfill its role, we propose an index taking into account market signals in the ASRA program. It is a weighted index of integrating market signals in the compensation of producers in order to lead indirectly to take partially or fully the market conditions in their production decisions. The index formula is given by:

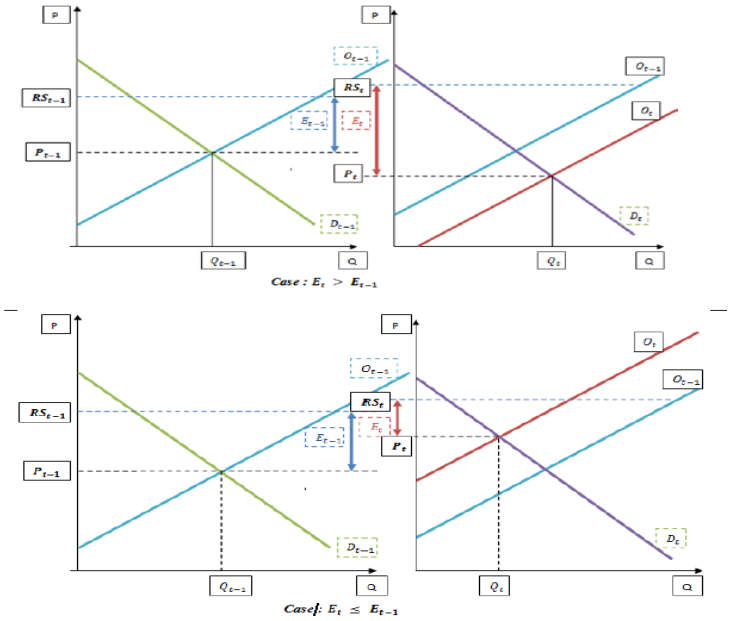
For a partial taking of the risk level of the market (Partial indicator)

$$I_{AB}^{t} = \begin{cases} E_t & if\ E_t \leq \bar{E} \\ \left[1 - Max\left\{\left(\frac{E_t - \bar{E}}{\bar{E}}\right), \quad \left(\frac{O_t - \bar{O}}{\bar{O}}\right)\right\}\right] E_t & if\ E_t > \bar{E}\ and\ O_t > \bar{O} \end{cases} \tag{8}$$

For total market signals outlet leading to the efficiency of the industry (Total Indicator)

$$I_{AB}^{t} = \begin{cases} E_t & if \quad E_t \leq \bar{E} \\ \left[\left(1 - \left(\frac{E_t - \bar{E}}{\bar{E}}\right)\right)\left(1 - \left(\frac{O_t - \bar{O}}{\bar{O}}\right)\right)\right] E_t & if \quad E_t > \bar{E}\ and\ O_t > \bar{O} \end{cases} \tag{9}$$

With $E_t = RS_t - P_t$ where RS_t stabilized income and P_t the pork prices in the current market, $\bar{E}$ and $\bar{O}$ are respectively the reference compensation and the reference offer set at priori. O_t and E_t represent respectively the offer on the market and the difference between the stabilized income of the current period and the current price of pork. This is the compensation per unit of pork provided by the ASRA program. To take into account market signals in production decisions, we propose the index I_{AB}^{t} which becomes the index of compensation per unit of product provided by ASRA. This index is a function of the current price and the quantity supplied of pork on the market. The lower the market price the lower the compensation received by producers per unit of output. Indeed, this indexing the compensation of producers that clearing down in periods of low prices - increased difference between the stabilized income and the market price - if this drop is induced by an increase in supply in the market. Producers must therefore manage their level of production so that they can maintain high market price. This index forces farmers to integrate market characteristics into their production decisions. Consequently, the impact of the program will be reduced and therefore the adoption of this indexing improves the efficiency of the Quebec pork industry. It will also lessen the investments generated by the ASRA program. Pork producers in Quebec have allocated on average 91% of the pork slaughter market in Quebec, and about 9% on average of the market is supplied by the rest of Canada over the period 2001-2007 (Asselin, Blouin, Dufour & Fournier, 2010).



An example of market conditions where $\boldsymbol{E_{t-1}}$ represents $\bar{\boldsymbol{E}}$

Figure 2. Illustration of the conditions of producer's compensations according to I_{AB}^{t} index

3.3 Simulation of the Index for Some Compensation Reference Values and Quantity Offered

Table 5. Statistics for the position of ASRA compensation and supply of pork

Variables	Minimum	Mean	Median	3rd quartile	Maximum
Pork supply (unit pork)	1489892	5309416	5455270	6815453	7921339
ASRA compensation (CA $)	0,00	17,55	15,40	28,33	61,95
After eliminating years of zero compensation					
Pork supply (unit pork)	1489892	5317101	5084853	7068720	7921339
ASRA compensation (CA $)	3,28	22,94	21,46	29,87	61,95

Figure 4 and Figure 5 show simulations of the internalization of market signals indicators in the Farm Income Stabilization Insurance program. The average compensation ASRA and third quartile ($\bar{E} = 22,94$ and $\bar{E} = 29{,}87$) were used to calculate our indicator to offer a level of pig supply equal to the median after eliminating good years (where compensation is zero) price ($\bar{O} = 5084853$ pig units). Figure 3 shows the simulation of the indicator of the partial integration of market signals to the fixed reference values (Indicateur1_sim1 for $\bar{E} = 22,94$, Indicateur_sim2 for $\bar{E} = 29{,}87$) and Figure 4 Simulation the indicator of the total catch to market signals by the ASRA program for the same values. We highlight that these indicators depend on reference values. If the level of actual compensation program is greater than the fixed reference level and the level of pig supply has also increased in the same period while compensation per unit of pork will be determined by applying one of these indicators at the discretion of policymaker. The effectiveness of these indicators to regulate this market is based on the benchmarks chosen by the public decision maker.

The adoption of these indicators in the program will stabilize the level of production and make it more efficient production system as the best strategy for producers in this situation is to integrate market conditions in their production decision. This taking into account of market risk will reduce the investment induced by the existence of the ASRA program and therefore gradually reduce the indebtedness of farmers. For periods of crisis, when the compensation level is greater than or equal to twice the reference level (as the period in 2009 in Figures 3 and 4, the proposed compensation is the baseline.

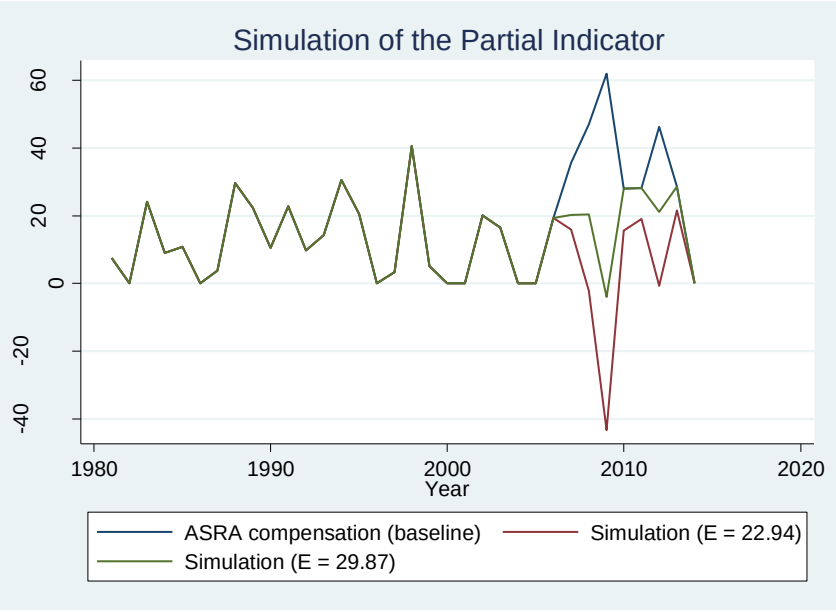


Figure 3. Simulation of the partial I_{AB}^{t} indicator for $\bar{E} = 22,94$ and $\bar{E} = 29{,}87$ and $\bar{O} = 5084853$

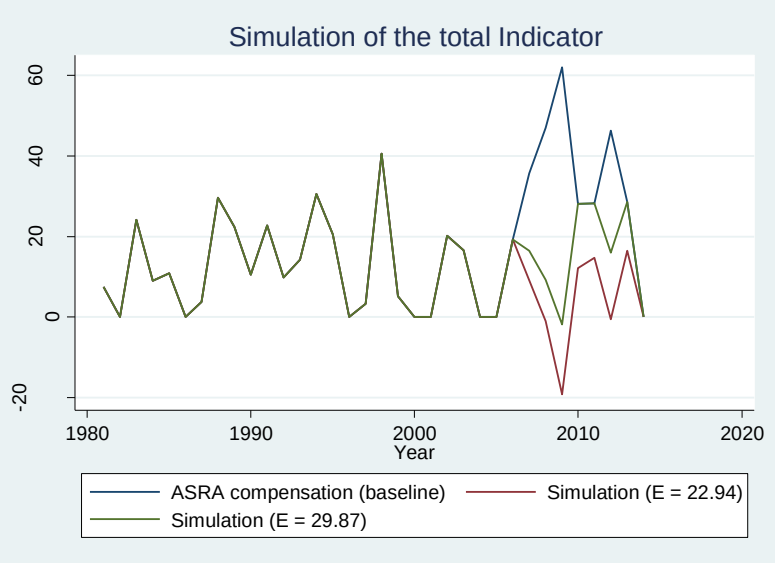


Figure 4. Simulation of the total I_{AB}^{t} indicator for $\bar{E} = 22,94$ and $\bar{E} = 29,87$ and $\bar{O} = 5084853$

4. Conclusion

The Farm Income Stabilization Insurance program covers several sectors of agricultural production in Quebec, especially the pork sector. This agricultural policy is subject to several criticisms in the literature, the most virulent are: ASRA mask market signals, ASRA forget risk management and increased the indebtedness of farmers. This study aimed to empirically examine the validity of these criticisms.

Statistical methods, unit root tests, Johansen cointegration test and error correction model (VEC) were used to analyze the relationship between the dynamics of the supply of pork, pork prices and insurance program of agricultural income (ASRA). The latter is represented by the dynamics of the stabilized income. The data cover the period of 1982-2014.

The amount of covered pork ASRA is strongly correlated with the dynamics of stable income, and an annual average growth rate of over five percent. Testing of Augmented Dickey Fuller and Phillipe-Perron showed that all series have a unit root level and all are stationary after the first difference. The co-integration Johansen test determined a single cointegration relationship between the supply of pork, pork prices and the stabilized income.

The results show that producers take into account market signals in their production decision. In the short term, the effect of the market price on pig production decisions is lower than the Farm Income Stabilization Insurance Program (ASRA). This program is driving the sustained increase in hog production regardless of market conditions. However, unlike the dynamics of the short term, the results show that market signals predominate in long-term production decisions. The price has a statistically significant positive effect on the level of production, while revenue stabilized has a negative and statistically significant effect. This is caused by a learning effect and an accumulation of debts. Indeed, the producers are aware of the destructive effects of the program on the efficiency of the industry. They then seek to adjust to market conditions. This shows that in the long term, regardless of the level of stable income, that income will not affect production decisions because they are anchored on market conditions. That is the level of the market price determines the level of production.

To lessen the anchoring of the production decisions on short-term to ASRA program, we proposed an index of internalization of market conditions in this program. This I_{AB}^{t} noted compensation index that is equal to income stabilized weighted by market signals. This definition will force farmers to adjust their production according to market conditions, since this indicator, an unconditional increase in the level of production will lead to a decline in compensation regardless of the level of production costs. It is the internalization of market risk in the program. Over the last ten years, subsidies to pig production for an average of $ 96 million (Grenon, 2007). The proposed index will improves the efficiency of the pork industry and reduce government bills in compensation for producers.

It can be applied to other agricultural production sectors covered by the ASRA program, particularly the areas of piglet and cereals where the program intervention is almost regular. The study is detailed in determining the

optimum threshold level of compensation at which the government must intervene with *had hoc* programs. The short time period covered by our data (1982-2014) remains a limit to our study. However our results are consistent and robust

Acknowledgments

The authors express special gratitude to John Balanko Sumbo, Kwami Tchansi and Mazamasso Hodjo for copyediting. Special thanks to anonymous reviewers for helpful comments.

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Appendix

Table 6. Ljung-Box test for the residue of the supply equation

Date: 01/19/16 Time: 01:32
Sample: 1981 2014
Included observations: 32

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.168	-0.168	0.9965	0.318
		2	-0.147	-0.181	1.7844	0.410
		3	0.038	-0.023	1.8396	0.606
		4	-0.175	-0.211	3.0331	0.552
		5	-0.128	-0.224	3.6917	0.595
		6	0.230	0.099	5.9056	0.434
		7	-0.170	-0.196	7.1582	0.413
		8	0.083	0.031	7.4688	0.487
		9	0.047	-0.055	7.5715	0.578
		10	0.062	0.134	7.7619	0.652
		11	0.130	0.207	8.6416	0.655
		12	-0.009	0.063	8.6464	0.733
		13	-0.315	-0.189	14.333	0.351
		14	0.099	0.025	14.927	0.383
		15	-0.027	0.006	14.973	0.453
		16	0.052	0.077	15.160	0.513

Source: author's calculation

Table 7. Ljung-Box test for the residue of the stabilized income equation

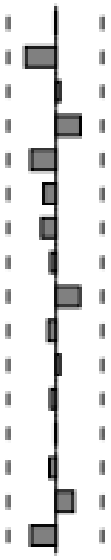
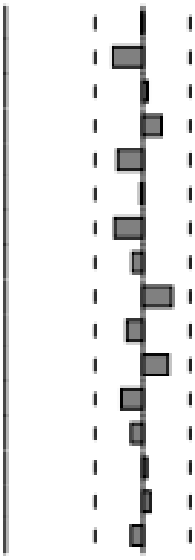
Date: 01/19/16 Time: 01:35
Sample: 1981 2014
Included observations: 32

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.029	0.029	0.0289	0.865
		2	-0.361	-0.362	4.7600	0.093
		3	-0.099	-0.085	5.1247	0.163
		4	-0.050	-0.205	5.2216	0.265
		5	0.031	-0.044	5.2611	0.385
		6	-0.061	-0.201	5.4192	0.491
		7	-0.024	-0.073	5.4453	0.606
		8	0.246	0.160	8.1993	0.414
		9	0.065	0.023	8.4011	0.494
		10	-0.320	-0.233	13.456	0.199
		11	-0.092	-0.043	13.897	0.239
		12	0.177	0.043	15.608	0.210
		13	0.028	-0.083	15.654	0.268
		14	-0.123	-0.151	16.576	0.279
		15	-0.156	-0.224	18.142	0.255
		16	0.175	0.042	20.222	0.210

Source: author's calculation

Table 8. Ljung-Box test for the residue of the price equation

Date: 01/19/16 Time: 01:34
Sample: 1981 2014
Included observations: 32

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.006	-0.006	0.0013	0.971
		2	-0.229	-0.229	1.8992	0.387
		3	0.035	0.034	1.9458	0.584
		4	0.191	0.146	3.3588	0.500
		5	-0.187	-0.184	4.7649	0.445
		6	-0.086	-0.015	5.0765	0.534
		7	-0.104	-0.206	5.5505	0.593
		8	-0.033	-0.081	5.6013	0.692
		9	0.184	0.218	7.1961	0.617
		10	-0.052	-0.117	7.3285	0.694
		11	0.038	0.190	7.4028	0.766
		12	-0.035	-0.160	7.4681	0.825
		13	-0.004	-0.083	7.4688	0.876
		14	-0.049	0.028	7.6140	0.908
		15	0.139	0.054	8.8521	0.885
		16	-0.185	-0.087	11.178	0.798

Source: author's calculation