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Output price risk, material input price risk, and price margins: Evidence from the US catfish industry

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Abstract

Aim/purpose – To develop a conceptual model for analyzing the impact of output price risk and material input price risk on price margins.

Design/methodology/approach – To analyze the combined effect of output price risk and material input risk on price margins, we use a series of comparative static analyses, GARCH models, and data ranging from 1990/01 to 2012/12.

Findings – The theoretical results indicate that the impact of output price risk and the impact of material input price risk on price margins are ambiguous and, to a great extent, hinge on the correlation between output price and material input price. The empirical results show that whole frozen catfish price risk and live catfish price risk negatively affect the price margin for frozen catfish. The empirical results, however, indicate that the risk of the price of live catfish affects markedly the price margin for frozen whole catfish in contrast to the impact of the risk of the price of frozen whole catfish.

Research implications/limitations – The empirical results have significant implications for managerial decision-making especially when crafting strategies for improving price margins. Accordingly, in order to beef up the price margin for frozen whole catfish, catfish processors may consider engaging in vertical integration. This paper has some limitations: first, it assumes that firms operate in competitive markets; second, it assumes that firms produce and sell a single product.

Originality/value/contribution – Unlike earlier studies that focused solely on the effect of output price risk on price margins, this paper analyzes theoretically and empirically the impact of output price risk and material input price risk on price margins.

Keywords: output price risk, material input price risk, price margin.
JEL Classification: D22, D81.

1. Introduction

Although the analysis of price uncertainty has been widely covered in the literature [e.g., Sandom 1971; Batra & Ulah 1974; Ishii 1977; Coyle 1992; Lence & Hayes 1998; Al Janabi 2009; Elder & Serletis 2009], little research has been carried out regarding the analysis of the behavior of a competitive firm facing a random demand for its output and a random supply of its material input. This paper attempts to examine theoretically and empirically the impact of output price risk and material input price risk on price margins.

Specifically, the paper extends Brorsen et al.'s model [1985] and Schroeter and Azzam's model [1991] to consider explicitly the interplay between output price risk and material input price risk and their combined effects on price margins. The starting point of our theoretical model is a competitive firm using a set of material inputs (e.g., labor, energy and capital) to convert a material input (e.g., live catfish) into a final output (e.g., processed catfish). The competitive firm's aim is to optimize the expected utility of its profit while facing simultaneously both a random demand for its output (e.g., processed catfish) and a random supply of its material input (e.g., live catfish).

The analysis of price risk is especially important when crafting managerial strategies for stabilizing prices and thus improving marketing margins, particularly for firms producing and selling perishable commodities such as agricultural, aquaculture, and seafood products. In that setting, the empirical analysis of this paper focuses on the US catfish industry because price uncertainty of processed catfish and especially live catfish play a pivotal role in determining the margin for processed catfish. Prices of live catfish, for instance, are volatile because of fluctuations in the supply of live catfish due primarily, among other factors, to off-flavors. Because off-favors can reduce sales of live catfish by 30% [see, Engle, Pounds & Van der Ploeg 1995], the price risk of live catfish (i.e., material input) cannot be ignored when analyzing the impact of price risk on price margins for processed catfish.

Unlike previous studies that reported a positive association between output price risk and expected price margins [see, for instance, Brorsen et al. 1985], our theoretical results showed that the effect of output price risk and material input risk have an ambiguous effect on price margins. This effect depends, to a great extent, on the correlation between output price and material input price. Consequently, the effect of output price risk and material input price risk on marketing margins is an open question that may be addressed using empirical analyses.

The remainder of this paper proceeds as follows: the next section derives the theoretical model and conducts a series of comparative static analyses; the second section provides the empirical application of the theoretical model along with quantitative risk analyses; the last section concludes the paper.

2. Research methodology

In order to analyze the combined effect of output price risk and material input risk on price margins, we first develop a theoretical model based on a competitive firm that seeks to maximize the expected utility of its profit while facing a random demand and a random supply. We then use comparative static analyses to examine the effect of output price risk and material input risk on price margins. Finally, the theoretical model is used to investigate the effect of the risk associated with the price of frozen whole catfish (output price risk) and the effect of the risk associated with the price of live catfish (material input price risk) on the price margin for frozen whole catfish.

2.1. Theoretical model

Consider a firm that converts a material input proportionately into an output. The firm purchases material input and sells its output in competitive markets. The i*th* competitive firm's aim is to maximize the expected utility of its profit; that is,

$$\text{Max } \mathrm{E}\left[\mathrm{U}\left(\pi_i\right)\right], \tag{1}$$

where π_i is the i*th* firm's profit. Assume the firm has the following utility function:

$$\mathrm{U}\left(\pi_i\right) = -e^{-\lambda_i \pi_i}, \tag{2}$$

where λ_i is the risk aversion parameter. Assume that the competitive firm faces a random demand for its output. Thus, the output price, *P*, is a random variable which is assumed to be normally distributed with mean E(*P*) and variance σ_p^2. Assume further that the competitive firm faces a random supply of its material input. Hence, the material input price, *w*, is a random variable which is assumed to be normally distributed with mean E(*w*) and variance σ_w^2.[1] Assuming the i*th* firm's profit, π_i, is normally distributed, equation (1) becomes:

$$\text{Max E}-\left[\exp\left(-\lambda_i \pi_i\right)\right] = \text{Max}\left[-\exp\left(-\lambda_i\left(\text{E}\left(\pi_i\right)-\frac{\lambda_i}{2}\text{var}\left(\pi_i\right)\right)\right)\right], \quad (3)$$

where $\text{E}\left(\pi_i\right)$ and $\text{var}\left(\pi_i\right)$ are the expected value and variance of the i*th* firm's profit, respectively. Maximization of (3) amounts to maximizing the following[2]:

$$\text{Max}\left[\text{E}\left(\pi_i\right)-\frac{\lambda_i}{2}\text{var}\left(\pi_i\right)\right]. \quad (4)$$

The profit of the *i*th firm can be written as:

$$\pi_i = \left(\text{P}-\text{k}\times\text{w}\right)\text{q}_i - \text{C}_i\left(.\right), \quad (5)$$

where q_i is the quantity of output sold; $C_i\left(.\right)$ is total processing cost; and *k* is the conversion factor. The expected value and variance of profit for the i*th* firm can be formulated, respectively, as:

$$\text{E}\left(\pi_i\right) = \left(\text{E}\left(\text{P}\right)-\text{k}\times\text{E}\left(\text{w}\right)\right)\text{q}_i - \text{C}_i\left(.\right). \quad (6)$$

$$\text{var}\left(\pi_i\right) = \left(\text{q}_i\right)^2\left[\sigma_p^2 + \text{k}^2\sigma_w^2 - 2\text{r}_{pw}\text{k}\sigma_p\sigma_w\right], \quad (7)$$

where r_{pw} is the coefficient of correlation between the output price and material input price. Substituting (6) and (7) into (4) yields:

$$\text{Max}\left[\left(\text{E}\left(\text{P}\right)-\text{k}\times\text{E}\left(\text{w}\right)\right)\text{q}_i - \text{C}_i\left(.\right) - \frac{\lambda_i}{2}\left(\text{q}_i\right)^2\left[\sigma_p^2 + \text{k}^2\sigma_w^2 - 2\text{r}_{pw}\text{k}\sigma_p\sigma_w\right]\right]. \quad (8)$$

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[1] The correlation between output price and material input price is not necessarily equal to zero; that is, $\text{Cov}\left(p, w\right) \neq 0$, where $\text{Cov}\left(p, w\right)$ is the covariance between output price and material input price. It should also be pointed out that $\text{Cov}(p, w) = \text{r}_{pw}\sigma_p\sigma_w$, where σ_p, σ_w and r_{pw} are the standard deviation of output price, the standard deviation of material input price, and the coefficient of correlation between the output price and material input price, respectively.

[2] It should be noted that if X is a normal variable then $\text{E}\left(e^{-\text{rX}}\right) = e^{-\text{r}\left(\text{E(X)}-\frac{\text{r}}{2}\text{var(X)}\right)}$, where E(X) and var(X) are the expected value and variance of X, respectively.

Assume the competitive firm chooses optimally its level of output. Thus, the first-order condition can be expressed as:

$$\left(\mathrm{E}\left(\mathrm{P}\right)-\mathrm{k}\times\mathrm{E}\left(\mathrm{w}\right)\right)-\mathrm{mpc_i}-\lambda_i q_i\left[\sigma_p^2+k^2\sigma_w^2-2r_{pw}k\sigma_p\sigma_w\right]=0, \qquad (9)$$

where *mpc*$_i$ is the *ith*'s firm's marginal processing cost. Rearranging, equation (9) becomes:

$$\mathrm{E}\left(\mathrm{M}\right)=\mathrm{mpc_i}+\sigma_p^2\lambda_i q_i+k^2\sigma_w^2\lambda_i q_i-2r_{pw}k\sigma_p\sigma_w\lambda_i q_i, \qquad (10)$$

where $E\left(M\right)=\left(E\left(P\right)-k\times E\left(w\right)\right)$ is the expected price margin and all the remaining variables are as previously defined. As in Schroeter and Azzam [1991], let $\delta_i=\left[\frac{\lambda_i q_i}{Q}\right]$, the margin equation becomes:

$$\mathrm{E}\left(\mathrm{M}\right)=\mathrm{mpc_i}+\sigma_p^2 Q\delta_i+\sigma_{wi}^2 k^2 Q\delta_i-2r_{pw}k\sigma_p\sigma_w Q\delta_i. \qquad (11)$$

To estimate the price margin at the industry level, we assume that firms have the same marginal cost. Hence, multiplying equation (11) by $\frac{q_i}{Q}$ and summing over the number of firms results in:

$$\mathrm{E}\left(\mathrm{M}\right)=\mathrm{mpc}+\phi\sigma_p^2 Q+\phi k^2\sigma_w^2 Q-\phi 2r_{pw}k\sigma_p\sigma_w Q, \qquad (12)$$

where $\phi=\frac{\sum_{i=1}^{n} q_i\times\delta_i}{Q}$ is the industry weighted average of risk aversion coefficient [see, Schroeter & Azzam 1991]. Hence, the price margin at the industry level is given by:

$$\mathrm{E}\left(\mathrm{M_t}\right)=\mathrm{mpc_t}+\phi\left(\sigma_p^2 Q\right)_t+\phi\left(k^2\sigma_w^2 Q\right)_t-\beta\left(2k\sigma_p\sigma_w Q\right)_t, \qquad (13)$$

where $\beta=r_{pw}\phi$. Equation (13) disentangles the expected price margin into four distinct components: a cost component (mpc); an output price risk component ($\phi\left(\sigma_p^2 Q\right)$); a material input price risk component ($\phi\left(k^2\sigma_w^2 Q\right)$); and an interaction component reflecting the combined effect of output price risk and material input price risk ($-\beta\left(2k\sigma_p\sigma_w Q\right)$).

2.2. Comparative static analyses

In this section we conduct a series of comparative static analyses. These static analyses are aimed at assessing the impact of output price risk and material price risk on price margins. Specifically, the impact of output price risk on price margins is obtained by differentiating the price margin (equation 13) with respect to output price risk, which is given by:

$$\left[\frac{dM}{d\sigma_p}\right] = 2\phi\left(\sigma_p Q\right) - \beta\left(2k\sigma_w Q\right) = 2\phi Q\left(\sigma_p - r_{pw} k\sigma_w\right) >=< 0 . \qquad (14)$$

According to equation (14), the impact of output price risk on price margins may be positive, negative or equal to zero. Such an impact hinges on the size of output price risk, the size of material input risk and the strength of the correlation between the output price and material input price. The following proposition summarizes the impact of output price risk on price margins.

Proposition 1: *The impact of output price risk on price margins depends primarily on the correlation between the output price and material input price. If the correlation is negative then an increase in output price risk would result in an increase in price margins. On the other hand, if the correlation is positive, the impact of output price risk on price margins depends on the strength of the coefficient of correlation between the output price and material input price, the size of output price risk, and the size of material input price risk.*

Similarly, the impact of material input price risk on price margins is obtained by differentiating the price margin (equation 13) with respect to material input price risk, which is given by:

$$\left[\frac{dM}{d\sigma_w}\right] = 2\phi\left(k^2\sigma_w Q\right) - \beta\left(2k\sigma_p Q\right) = 2\phi kQ\left(k\sigma_w - r_{pw}\sigma_p\right) >=< 0 . \qquad (15)$$

According to equation (15), the impact of material input price risk on price margins may be positive, negative or equal to zero. Such an impact hinges on the size of output price risk, the size of material input risk, and the strength of the correlation between the output price and material input price. The impact of material input price risk on price margins is summarized in proposition 2.

Proposition 2: *The impact of material input price risk on price margins depends primarily on the correlation between the output price and material input price. If the correlation is negative then an increase in material input price risk would result in an increase in price margins. On the other hand, if the correlation is positive, the impact of material input price risk on price margins depends on the strength of the coefficient of correlation between the output price and material input price, the size of output price risk, and the size of material input price risk.*

3. Empirical application

In this section the theoretical model derived previously is used to gauge the impact of the risk of the price of frozen whole catfish (output price risk) and the impact of the risk of the price of live catfish (material input price risk) on the price margin for frozen whole catfish. Catfish processing plants purchase live cattish and sell processed catfish in competitive markets[3]. The demand for frozen whole catfish and the supply of live catfish are assumed to be random. The starting point of our empirical application is the margin equation at the industry level (equation 13); that is,

$$E\left(M_t\right) = mpc_t + \phi\left(\sigma_p^2 Q\right)_t + \phi\left(k^2\sigma_w^2 Q\right)_t - \beta\left(2k\sigma_p\sigma_w Q\right)_t .$$

In order to estimate the parameters of the margin equation for frozen whole catfish, we use the following marginal processing cost function [see, Bouras & Engle 2007]:

$$mpc = \delta_{EE}v_E + \delta_{KK}v_K + \delta_{LL}v_L + 2\delta_{EK}\left(v_E v_K\right)^{1/2} + 2\delta_{EL}\left(v_E v_L\right)^{1/2} + 2\delta_{KL}\left(v_K v_L\right)^{1/2}, \quad (16)$$

where v_E, v_K and v_L are, respectively, the price of electricity, the bank prime interest rate, and hourly minimum wage; and δ's are parameters to be estimated. Plugging equation (16) into equation (13), rearranging and adding an error term results in:

$$\begin{aligned} E\left(M\right) = {} & \phi\left(\sigma_p^2 Q + k^2\sigma_w^2 Q\right) - \beta\left(2k\sigma_p\sigma_w Q\right) + \delta_{EE}v_E + \delta_{KK}v_K + \delta_{LL}v_L + \\ & 2\delta_{EK}\left(v_E v_K\right)^{1/2} + 2\delta_{EL}\left(v_E v_L\right)^{1/2} + 2\delta_{KL}\left(v_K v_L\right)^{1/2} + \varepsilon \end{aligned} \quad . \quad (17)$$

The parameters of the price margin (equation 17) are estimated using a two-step approach[4]. First, we estimate the risk of the price of frozen whole catfish; i.e., σ_p, and the risk of the price of live catfish; i.e., σ_w, using GARCH models. Second, these risk measures are used to estimate the parameters of the price margin for frozen whole catfish (equation 17)[5].

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[3] It is fair to assume that the market for catfish is competitive. For instance, Bouras & Engle [2007] using a conjectural model showed that the markets for live catfish and processed catfish are competitive. In a subsequent paper, Bouras et al. [2010] using a dynamic model reported that the US cattish industry is competitive both in the long and short run.

[4] The estimate of the conversion factor, *k*, is 1.61 [see, Silva & Dean 2001].

[5] To compute the expected margin for frozen whole catfish we use weighted averages of the price of whole frozen catfish and the price of live catfish using market shares as weights.

3.1. Data

To estimate the econometric models we use monthly data ranging from 1990/01 to 2012/12. The data used in the empirical estimations include: the bank prime interest rate (Federal Reserve of Saint Louis); the price of live catfish, and the price and quantity sold of frozen whole catfish (US Department of Agriculture); hourly minimum wage (US Department of Labor); and the price of electricity (US Department of Energy). Summary statistics is provided in Table 1.

Table 1. Descriptive statistics of the main variables

Variable	Min	Max	Mean	Standard deviation
Bank prime loan rate (%)	3.25	10.11	6.49	2.19
Price of live catfish ($/Lb)	0.53	1.28	0.75	0.14
Price of frozen whole catfish ($/Lb)	1.43	3.17	2.04	0.33
Quantity sold of frozen whole catfish (1,000 Lbs)	434.00	3173.00	1155.88	384.01
Electricity price (¢/kilowatt hour)	4.19	7.72	5.38	0.92
Hourly minimum wage ($/Hour)	3.35	7.25	5.27	1.06

Source: Own computations.

3.2. Price risk measurement

To measure the risk associated with the price of frozen whole catfish and the price of live catfish and following prior literature [e.g., Engle 2001], we use the Generalized Autoregressive Conditional Heteroskedastic model (GARCH). Towards this end, we first choose the appropriate GARCH specification using the Akaike Info Criterion. We then generate conditional variances. Our proxy for risk is obtained by taking the square root of conditional variances. According to the Akaike Info Criterion, the appropriate GARCH specification for the price of frozen whole catfish is GARCH (1, 2), which can be formulated as:

$$P_t = \alpha_0 + \alpha_1 P_{t-1} + \varepsilon_t . \tag{18}$$

And the corresponding conditional variance equation is given by:

$$h_t = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 h_{t-1} + \beta_3 h_{t-2} . \tag{19}$$

As for the price of live catfish, the appropriate GARCH specification is GARCH (3, 3), which can be expressed as:

$$W_t = \varphi_0 + \varphi_1 W_{t-1} + \varphi_2 W_{t-2} + \varphi_3 W_{t-3} + u_t . \tag{20}$$

And the corresponding conditional variance equation is given by:

$$h_t = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + \gamma_3 u_{t-3}^2 + \gamma_4 h_{t-1} + \gamma_5 h_{t-2} + \gamma_6 h_{t-3} . \tag{21}$$

3.3. Empirical estimation

Having measured the risk associated with the price of frozen whole catfish and that associated with the price of live catfish price, in the next step the measures of risk are used to estimate econometrically the parameters of the price margin equation for frozen whole catfish (equation 17). Table 2 contains the parameter estimates for the price margin equation. According to the empirical results, the risk aversion parameter, ϕ, is positive but is statistically insignificant. The parameter associated with the interaction term, i.e., β, is positive and is statistically significant at the 5% level thereby indicating the relevance of the interplay between the risk associated with the price of frozen whole catfish and that associated with the price of live catfish in determining the price margin for frozen whole catfish.

Table 2. Parameter estimates for the price margin equation

Parameter	Estimate	Standard Error
ϕ	0.02	0.014
β	0.04^{**}	0.016
δ_{EE}	-0.99^{***}	0.516
δ_{KK}	-0.09^{***}	0.048
δ_{LL}	−0.57	0.483
δ_{EK}	0.17^{***}	0.100
δ_{EL}	0.81^{***}	0.490
δ_{KL}	−0.07	0.081
R^2	69.41%	
Log-Likelihood	238.24	
F-statistic	1016.96^{*}	

Note: *, **, and *** represent 1%, 5%, and 10% significance level, respectively.

Source: Own computations.

The parameter estimates of the price margin equation, shown in Table 2, are used to estimate the components of the price margin for frozen whole catfish. These include: the frozen whole catfish price risk component, the live catfish price risk component, the interaction component reflecting the combined effect of frozen whole catfish price risk and live catfish price risk, and the marginal processing cost component. As shown in Table 3, while both the frozen whole catfish price risk component and live catfish price risk component have a positive effect on the price margin for frozen whole catfish, the interaction component has a negative effect on the price margin for frozen whole catfish and its magnitude largely outweighs the combined magnitudes of the frozen whole catfish price risk component and live catfish price risk component.

Table 3. Price margin decomposition for selected years

Year	Margin	FCRC	LCRC	INT	MPC
1990	0.5172	0.0528	0.0232	−0.1506	0.5918
1992	0.6347	0.0765	0.0293	−0.2031	0.7320
1994	0.6940	0.0408	0.0118	−0.0922	0.7336
1996	0.7211	0.0383	0.0067	−0.0696	0.7457
1998	0.8044	0.0303	0.0094	−0.0724	0.8372
2000	0.7989	0.0292	0.0110	−0.0784	0.8371
2002	0.8398	0.0347	0.0107	−0.0822	0.8767
2004	0.8169	0.0317	0.0146	−0.0933	0.8638
2006	0.8433	0.0330	0.0086	−0.0734	0.8751
2008	1.0262	0.0341	0.0111	−0.0828	1.0637
2010	1.1085	0.0195	0.0061	−0.0470	1.1299
2012	1.0937	0.0241	0.0190	−0.0823	1.1329
Average	**0.8282**	**0.0351**	**0.0128**	**−0.0894**	**0.8697**

Notes:
FCRC: refers to the frozen whole catfish price risk component.
LCRC: refers to the live catfish price risk component.
INT: refers to the interaction component reflecting the combined effect of frozen whole catfish price risk and live catfish price risk.
MPC: refers to the marginal processing cost component.

Source: Own computations.

3.4. Quantitative risk analysis

To further analyze the effect of the risk associated with both the price of frozen whole catfish and the price of live catfish on the price margin for producing and selling frozen whole catfish, we conduct a series of quantitative risk analyses. To do that, we compute the elasticity of the price margin for frozen whole catfish with respect to the frozen whole catfish price risk and the elasticity of the price margin for frozen whole catfish with respect to the live catfish price risk. Using equation (14), the elasticity of the price margin for frozen whole catfish with respect to the risk associated with the price of frozen whole catfish is given by:

$$E_{M\sigma_p} = \left[\frac{dM}{d\sigma_p}\frac{\sigma_p}{M}\right] = \left[2\phi\left(\sigma_p Q\right) - \beta\left(2k\sigma_w Q\right)\right]\left[\frac{\sigma_p}{M}\right]. \tag{22}$$

In the same vein, using equation (15), the elasticity of the price margin for frozen whole catfish with respect to the risk associated with the price of live catfish is given by:

$$E_{M\sigma_w} = \left[\frac{dM}{d\sigma_w}\frac{\sigma_w}{M}\right] = \left[2\phi\left(k^2\sigma_w Q\right) - \beta\left(2k\sigma_p Q\right)\right]\left[\frac{\sigma_w}{M}\right]. \tag{23}$$

Table 4 and Figure 1 provide the estimates of the elasticities of the price margin for frozen whole catfish with respect to frozen whole catfish price risk and live catfish price risk for selected years. Evaluated at the mean of the data, the point estimate of the elasticity of the price margin for frozen whole catfish with respect to the risk associated with the price of frozen whole catfish is −0.02. This indicates that if the risk associated with the price of frozen whole catfish increases by 1%, the price margin for frozen whole catfish will decrease by 0.02%. The point estimate of the elasticity of the price margin for frozen whole catfish with respect to the risk associated with the price of live catfish, on the other hand, is equal to −0.08. This indicates that if the risk associated with the price of live catfish increases by 1%, the price margin for frozen whole catfish will decrease by 0.08%. Although the empirical results show that both the risk associated with the price of frozen whole catfish and that associated with the price of live catfish have a negative effect on the price margin for frozen whole catfish, the risk of the price of live catfish affects markedly the price margin for frozen whole catfish in contrast to the impact of the risk of the price of frozen whole catfish. This empirical result has significant implications for managerial decision-making especially when crafting strategies for improving price margins. Accordingly, in order to beef up the price margin for frozen whole catfish, catfish processors should pursue strategies aimed at stabilizing the price of live catfish. Towards this end, catfish processors may consider engaging in vertical integration, downstream long-term contracts and supply arrangements with "captive" companies. In addition, the adoption of such operation strategies by catfish processors would, in turn, likely allow them to enjoy cost savings and margin maximization through value chain optimization and vertical economies of scope. Carolina Classics Catfish is a striking example of a vertically integrated catfish company that, in addition to processing and delivering catfish to its customers, raises its own catfish.

Table 4. Frozen whole catfish price risk and live catfish price risk effects on the price margin for frozen whole catfish for selected years

Year	$\mathbf{E_{M\sigma_p}}$ [a]	$\mathbf{E_{M\sigma_w}}$ [b]
1	*2*	*3*
1990	−0.09	−0.21
1992	−0.09	−0.25
1994	−0.01	−0.10
1996	0.01	−0.08
1998	−0.02	−0.07
2000	−0.02	−0.07
2002	−0.01	−0.07
2004	−0.04	−0.08
2006	−0.01	−0.06

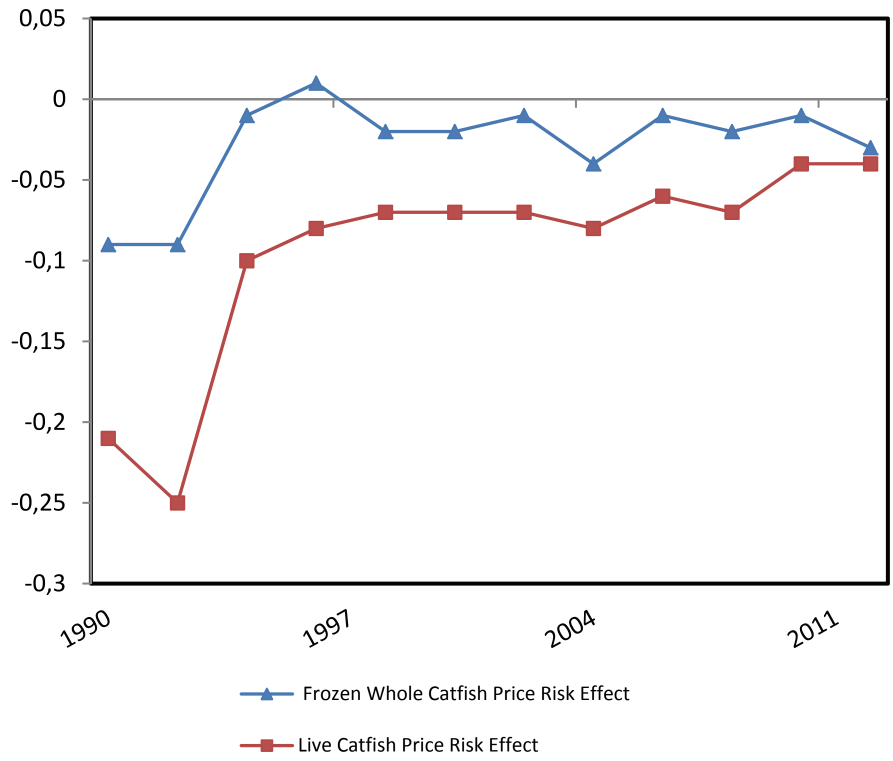
Table 4 cont.

1	*2*	*3*
2008	−0.02	−0.07
2010	−0.01	−0.04
2012	−0.03	−0.04
Mean	**−0.02**	**−0.08**

[a] The elasticity of the price margin for frozen whole catfish with respect to frozen whole catfish price risk.
[b] The elasticity of the price margin for whole frozen catfish with respect to live catfish price risk.

Source: Own computations.

Figure 1. Frozen whole catfish price risk and live catfish price risk effects on the price margin for frozen whole catfish for selected years



Source: Own computations.

4. Conclusions

Unlike earlier studies that focused on the effect of output price risk on price margins, this paper analyzes theoretically and empirically the impact of output price risk and material input price risk on price margins. Theoretically, the impact of output price risk and the impact of material input price risk on price margins are ambiguous and, to a great extent, hinge on the correlation between output price and material input price. It is suggested that the theoretical model developed in this paper may be used to examine empirically the effect of the price risk of any product. Empirically, the results show that the risk of the price of frozen whole catfish and the risk of the price of live catfish affect negatively the price margin for frozen whole catfish. The empirical results, however, indicate that the risk of the price of live catfish affects markedly the price margin for frozen whole catfish in contrast to the impact of the risk of the price of frozen whole catfish**.** It is suggested that the above price risks may be reduced with greater leverage on input prices.

This paper has, however, some caveats. First, the paper assumes that firms operate in competitive markets. Second, the paper assumes that firms produce and sell a single product. The paper may, therefore, be extended in many different ways. For instance, further research may be carried out to examine the effect of output price risk and material input price risk on price margins of firms operating in oligopolistic markets and/or oligopsonistic markets. The paper may also be extended by looking at the effect of price uncertainty on price margins for firms that produce several related products (e.g., substitute or complementary products).

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