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Review

Food scare crises and developing countries: The impact of avian influenza on vertical price transmission in the Egyptian poultry sector

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ABSTRACT

A bivariate smooth transition vector error correction model is applied to monthly poultry price data to analyze the effects that avian influenza has had on price transmission along the Egyptian poultry marketing chain. In order to reflect consumer awareness of the crisis, an avian influenza food scare information index is developed and used within the model as a transition variable. Our results suggest that price adjustments to deviations from the market equilibrium parity depend on the magnitude of the avian influenza crisis. Further these adjustments are found to have very different implications for market equilibrium: during the crisis retailers use their market power to increase marketing margins. In contrast, wholesaler margins are found to decline. Results also suggest that food safety information indices contribute to understanding the economic effects of food scare crises in developing countries.

Introduction

Food safety has become a key issue for consumers and, consequently, a relevant objective of food policy in many countries. The food scares that have been appearing over the last few years (for example dioxins, bovine spongiform encephalopathy (BSE), foot and mouth disease (FMD), avian influenza (AI)) have contributed to increased public awareness of food safety. The globalization of markets and the increasing speed of and access to information have amplified these concerns to a global scale. As consumers' sensitivity towards food safety and production standards has increased, they have changed their consumption habits. While this once was a phenomenon confined to developed countries, concerns over food safety have now spread to developing countries too, which often find addressing such issues even more problematic.

The AI outbreak originated in Southeast Asia and quickly spread worldwide. Defence mechanisms against food scares implemented in developed countries, mainly as a result of previous Mad Cow and the Foot and Mouth Disease episodes, helped to mitigate the impact of AI in these countries. However this was not the case in countries like Egypt which, with the advent of AI, faced a nationwide food scare for the first time.[1] The crisis dramatically affected the Egyptian animal production sector and, more specifically, the poultry sector that suffered the culling of more than 40 million birds. The poultry sector in Egypt is very relevant in that it represents the main and cheapest source of animal protein for Egyptian consumers who have average animal protein intakes quite below the world average (Hosny, 2006).

Apart from the obvious impact that AI has had on human health, there are also worries about the economic effects of the crisis. This paper is the first to assess the effects of AI on price transmission along the food marketing chain within the Egyptian poultry sector. The analysis by Saghaian et al. (2008) was the first to investigate the impact of AI on price transmission within the Turkish food marketing chain. These authors provided evidence that the AI crisis had had an impact on vertical price transmission processes. Despite their attempt to characterize price transmission responses to the AI food scare, they did not develop a Food Scare Information Index (FSII) to reflect consumer awareness of the AI crisis. While food scare information indices based upon a count of newspaper articles have been widely used to assess the economic effects of food contamination outbreaks in developed countries, ours is the first study that attempts to determine the impact of news on price behavior in developing economies.

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[1] While Egypt had been previously affected by other animal disease crises, they were all confined to particular regions of the country and did not gain massive mass media attention as it was the case with AI.

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Due to high illiteracy levels (29.7% in Egypt in 2006 (CAPMAS, 2006)) and low income levels precluding many people to buy newspapers, these indices may not be regarded as representative measures of developing countries' public awareness of the AI crisis.[2] The indices, however, are indeed a good approximation to consumers' awareness because of the high correlation between news in different information channels (TV, newspapers, mosques, etc.). This correlation is expected to be higher in a strictly regulated country such as Egypt, where all information channels are controlled by the Egyptian Ministry of Mass Media. This results in newspapers and other mass media sending very similar messages to the audience. Our study is the first attempt to test the validity of this type of index to assess the economic impacts of food scares in developing countries, thus shedding light on this interesting discussion.

To achieve our objective, we have estimated a bivariate smooth transition vector error correction model (STVECM) that enables capturing the long-run relationships between the variables of the model, the (possibly non-linear) adjustments toward long-run parity, as well as short-run dynamics. STVECMs are able to distinguish between different regimes that represent price behavior under different economic conditions. The FSII is used as the variable determining regime-switching, which allows us to investigate whether prices within the supply chain respond differently to distinct levels of food scares. To our knowledge, this is the first research that assesses the impacts of a food scare by using a STVECM.

The rest of the paper is organized as follows. Egyptian poultry sector and the AI crisis presents an overview of the Egyptian poultry sector and the AI crisis. A literature review is carried out in Literature review. The econometric methods are explained in Methods: smooth transition vector error correction models and food information indices. The data used, the construction of the information index and the results are described in Results. The paper ends with the concluding remarks section.

Egyptian poultry sector and the AI crisis

Egyptian poultry sector

The poultry sector is the second most important animal protein provider after the bovine sector in Egypt. Between 2003 and 2006 investment within the poultry sector reached 20 billion LE.[3] The sector employed about 2.5 million workers in permanent and casual jobs and produced 95 million chickens per year. Gross production in 2005 was on the border of 10 billion LE, which represents around 20% (7%) of total animal (agricultural) production (Ministry of Agriculture, 2006). Poultry production systems in Egypt are quite diverse, ranging from rural, very small-scale, free-range poultry production to highly intensive caged systems. Poultry production has been one of the fastest growing industries in Egypt during the1990s with an annual growth rate of 8.7% (Taha, 2003).

Hosny (2006) indicates that the founding of the National General Poultry Company (GPC) marked the beginning of the modern poultry industry in Egypt. This company aims both to guarantee high quality and inexpensive animal protein for the growing Egyptian population, and to industrialize poultry production by means of adopting modern technologies and skilled management techniques.

The Egyptian poultry sector has traditionally benefitted from government intervention in the form of the provision of subsidized feed ingredients, low-rate subsidized loans from the National Agricultural and Development Bank, or the allowance of a 10 year tax exemption period followed by low taxation rates. The industry has also benefitted from permissive measures such as the relaxation of regulations setting forth minimum distance requirements between different poultry farms, which made the implementation of bio security and disease controls nearly impossible. Furthermore, the government ensured high intervention levels for the Egyptian poultry industry by imposing strong restrictions on foreign poultry imports (including high tariffs or import bans). Subsidization and protectionist policies resulted in a very fragile sector with many inefficient farms housing hidden weaknesses. The AI crisis brought to light those weaknesses and forced many small and inefficient farms to exit the sector.

Before the AI crisis consumers usually purchased live chickens that the retailer or they themselves slaughtered. This tradition made it possible to eat meat throughout the day without the need to refrigerate it. However, this practice contributed to spreading the pandemic in Egypt due to the direct contact with live animals.

AI crisis

More than 200 million birds have died or been culled worldwide as a consequence of the AI subtype H5N1 since 2003 (FAO, 2006). According to the World Health Organization (WHO, 2006) "AI is an infectious disease of birds caused by type A strains of the influenza virus. The disease occurs worldwide. While all birds are thought to be susceptible to infection with AI viruses, many wild bird species carry these viruses with no apparent signs of harm". According to the WHO, up until February 17, 2010, there were 476 confirmed human cases of AI worldwide, of which 283 died; a fatality rate of 59%.

The first case of AI in Egypt took place in February 2006. From this date, 97 cases of infection in humans have been reported, out of which 27 were fatal. The WHO states that Egypt is the third most affected country by this crisis in the world, after Indonesia and Vietnam.

The consequences on the poultry sector have been evident. Chicken meat demand was reduced substantially, which generated a price reduction. Afterwards the market recovered, but there is still a common feeling of market fragility. Approximate estimations of the losses owing to AI in Egypt are above 2 billion LE, representing almost 25% of the production value (Ibrahim, 2006).

The Government policy instruments to deal with this crisis mainly comprise a media campaign through all possible communication channels aiming at providing advice to the population on how to deal with the food scare (Hosny, 2006) , the closure of live bird shops and the elimination of tariffs on imported poultry meat to compensate the production shortage.

Literature review

Understanding vertical price transmission allows for an approximation of the overall operation of the market (Goodwin and Holt, 1999). The recent development of econometric methods has greatly contributed to a better understanding of the functioning of market operations. A common finding of previous analyses is that different levels of the supply chain respond differently to distinct market shocks. In particular, upstream prices in the marketing chain are generally found to do all the adjustment, while consumer prices are sticky and slow to respond (Peltzman, 2000).

Within this context, recent studies have found that relevant food scares lead to different price adjustments within the supply chain. Lloyd et al. (2001) and Hassouneh et al. (2010) analyze the impact of the BSE outbreaks on vertical price transmission within the UK and Spain beef markets, respectively. Lloyd et al. (2001) find that information shocks are fairly transient in retail prices, but

[2] While TV could be considered as an alternative valid information source on the food scare crisis, records on the news published in this media are not publicly available.

[3] 1 US$ = 5.82 LE.

persist at the wholesale and farm levels. The analysis by Hassouneh et al. (2010) also suggests that BSE scares affect beef producers more profoundly than retailers. Serra (2011) assesses the impacts of BSE on price volatility transmission along the Spanish beef marketing chain and finds volatility links between producer and consumer prices to be altered as a result of the crisis.

Although the economic impact that the AI crisis has had on the poultry and animal production sectors in many countries worldwide has been substantial, only a few studies have tried to quantify this impact. Most of these analyses have focused on the effects of the AI outbreak on consumer behavior and willingness to pay and on public policy decision-making (see, for example, Akben et al., 2008). Beach et al. (2008) utilize scanner data to study the effect of AI news on consumer purchasing behavior in Italy and find a significant impact but within a limited duration. The analysis by Brown et al. (2007) investigates the impact of the AI outbreak on different agricultural sectors within the US market, finding that several different agricultural sectors were affected.

The aforementioned literature has paid little attention to the impact of AI on price transmission along the food marketing chain in developing countries. However, research conducted by Saghaian et al. (2008) is an exception: they analyze the effect of the AI crisis on producer and consumer prices within the Turkish poultry sector, providing evidence that the AI outbreak has had an impact on vertical price transmission processes.

Our paper makes use of a non-linear bivariate STVECM to assess the effects of AI on price transmission along the Egyptian poultry marketing chain.[4] We consider the bivariate STVECM a suitable methodology to assess price behavior because it allows for nonlinearities in price adjustment, different price behavior regimes depending on the predominant economic conditions, as well as for smooth transition of prices between these different regimes. The STVECM allows for assessment not only on how individual prices adjust to their long-run equilibrium parity, but also on short-run price dynamics. Further, it permits distinguishing between different price-behavior regimes, depending on the magnitude of the food scare crisis.

Previous literature has found that different degrees of food scares lead to different price adjustments within the supply chain. Hassouneh et al. (2010) use a Regime Switching Vector Error Correction Model (RSVECM) to capture the impacts of the BSE crisis on the adjustment of producer and retailer prices in the Spanish beef marketing chain. Their findings provide evidence that while consumer prices do not adjust to deviations caused by the crisis, producer prices are endogenous and do all the adjustments. These adjustments depend on the magnitude of the BSE crisis. The interesting analysis by Hassouneh et al. (2010) suffers from an important limitation: in using a RSVECM it assumes that transition between different price-behavior regimes occurs in a discontinuous and abrupt way.[5] Smooth transition models used in our analysis are less restrictive in that they allow for smooth shifting between regimes and contain discontinuous shifting as a special case. By developing an AI food scare index that is used as a transition variable within the non-linear STVECM, we can analyze to what extent different levels of the crisis can affect price behavior along the Egyptian food marketing chain.

Methods: smooth transition vector error correction models and food information indices

Smooth transition vector error correction models

Recent developments of time series analysis have greatly contributed to a better understanding of the dynamic behavior of economic variables which can be observed in the real world. Threshold models originally introduced by Tong (1978) are one of the most relevant families of non-linear time series models and have attracted the attention of many previous empirical studies (see, Chavas and Mehta, 2004; Goodwin and Piggott, 2001; Serra and Goodwin, 2004; Hassouneh et al., 2010; Serra et al., 2006). Threshold models allow for recognition of nonlinear price adjustments by considering different price behavior regimes that represent different price adjustment, depending on the prevailing economic situation. These models have been criticized since transition between regimes takes place in a discontinuous and abrupt fashion.

Smooth-transition type of models such as multivariate STVECM originally developed by Teräsvirta (1994) allow for transition to occur in a smooth fashion. STVECM also assess both the (possibly non-linear) price adjustments toward long-run equilibrium and the short-run price dynamics. Following van Dijk et al. (2002) a two-dimensional STVECM can be written as

$$\Delta P_t = \left(\mu_1 + \alpha_1 v_{t-1} + \sum_{j=1}^{p-1} \Phi_{1,j}\Delta P_{t-j} + \lambda_1 \Delta I_{t-j}\right)(1 - G(s_{t-d};\gamma,c)) + \left(\mu_2 + \alpha_2 v_{t-1} + \sum_{j=1}^{p-1} \Phi_{2,j}\Delta P_{t-j} + \lambda_2 \Delta I_{t-j}\right)(G(s_{t-d};\gamma,c)) + \varepsilon_t \quad (1)$$

where $P_t = (p_w, p_c)$ is a (2×1) vector of non-stationary prices containing wholesale, p_w, and consumer, p_c, prices. I is an FSII, μ_i $i = (1, 2)$ are (2×1) vectors of constant terms, α_i are (2×1) parameter matrices representing the speed of adjustment of each price to deviations from the long-run relationship, $v_{t-1} = \beta' P_{t-1}$ is a vector containing deviations from the long-run equilibrium relationship (error correction term), β (2×1) contains the parameters of the cointegration relationship, $\Phi_{i,j}$, $j = 1, ..., p-1$ are (2×2) parameter matrices representing short-run price dynamics and $\lambda_{i,j}$ measure the short-run impacts of food scares on price behavior. Details on how the FSII variable is developed are provided below. ε_t is a 2-dimensional vector white noise process with a mean zero vector and a (2×2) Σ covariance matrix.

$G(s_{t-d};\gamma,c)$ is the smooth transition function which is assumed to be continuous and bounded between zero and one. The transition function, which will be described in more detail below, depends on the transition variable s_{t-d}, as well as on the speed of transition and threshold parameters, γ and c respectively. The STVECM can be considered a regime-switching model that allows for two regimes associated with the extreme values of the transition function, $G(s_{t-d};\gamma,c) = 0$ and $G(s_{t-d};\gamma,c) = 1$. The transition from one regime to the other takes place in a smooth way. The transition function is specified using an exponential functional form (Teräsvirta, 1994).[6]

The exponential transition function can be expressed as follows:

$$G(s_{t-d};\gamma,c) = 1 - \exp\left(-\frac{\gamma(s_{t-d} - c)^2}{\sigma^2(s_{t-d})}\right), \quad \gamma > 0 \quad (2)$$

[4] Although structural models are more suited than time-series models in identifying the reasons underlying a certain form of revealed price behavior, characterizing the nature of price transmission among different market levels, which is the task accomplished by this article, is an important research agenda. Hence, when using time-series models, interpretation of research results should be based on profound knowledge of the market being analyzed, its structure, regulation, and other important characteristics.

[5] Serra et al. (2006) utilize both non-parametric regression and non-linear threshold models in order to study price transmission processes within EU pork markets after the implementation of the EU single market in 1993. They find that price transmission from one regime to another is likely to occur in a smooth way.

[6] While it is also usual to specify this function using a logistic form, model specification tests supported the use of an exponential function.

After combining (1) and (2) we obtain an exponential STVECM (ESTVECM). Parameter γ determines the speed of the transition from one regime to the other, c is the threshold between the two regimes, s_{t-d}, as noted, is the transition variable and $\sigma(s_{t-d})$ is the sample standard deviation of s_{t-d} used as a normalization variable. Under this approach, the adjustment is symmetric around the parameter c, but differs for large and small absolute values of s_{t-d}. In other words, $G(s_{t-d};\gamma, c)$ takes values close to zero for values of s_{t-d} near c, and when s_{t-d} takes relatively large values with respect to c, the transition function will be close to 1.

Since our paper focuses on the effects that AI had on price transmission along the Egyptian poultry marketing chain, a food scare index, based on the number of news articles published on the AI crisis, is developed and used as the transition variable s_{t-d}. In setting s_{t-d} equal to the food scare index, we assume that different levels of food scare can lead to different values of the transition function and different price behavior regimes.[7] A priori we expect the STVECM will allow for distinguishing between two extreme price behavior regimes: one characterized by relatively calm markets and the other characterized by tumultuous periods.

Teräsvirta (1994) suggests three important steps in order to estimate a STVECM. First, a linear vector error correction is estimated in order to determine the optimum lag of the predictors of the model. To do so, the AIC and SBC criteria are used. A test for linearity against a STVECM is then applied.

A test for linearity in equation (1) is equivalent to testing whether the following null hypothesis can be accepted: $H_0{:}\gamma = 0$. If this happens, the non-linear STVECM reduces to a linear VECM. A problem related to testing $H_0{:}\gamma = 0$ against $H_1{:}\gamma \neq 0$ is that equation (1) is not indentified under the null hypothesis. We follow Luukkonen et al. (1988) who solve this problem by replacing the transition function with a suitable Taylor series expansion. A system likelihood ratio statistic or an F-test can then be used in order to test for linearity. Finally, we select the optimal functional form for the transition function following the sequence of nested tests proposed by Teräsvirta (1994) and Luukkonen et al. (1988).

Food scare information index

Several methods have been introduced in order to construct a FSII based on a news count. More specifically, Smith et al. (1988) define the index as the actual number of articles published on the topic of interest in each period. Brown and Schrader (1990) propose a different technique, which does not ignore previously published articles, to construct a cholesterol information index for their study of shell egg consumption in the US They developed their index by accumulating the number of supporting articles (unfavorable news) minus the non-supporting articles (favorable news) using equal weights for these two types of articles. Chern and Zuo (1997) extend the cumulative method used by Brown and Schrader (1990) by building a new fat and cholesterol information index that considers a carryover weight for articles. The articles are also assumed to have a finite duration and lag distribution as a source of information. In our study we follow this method.[8]

The FSII based on Chern and Zuo (1997) can be expressed as:

$$FSII_t = \sum_{i=0}^{n} W_i NM_{t-i} \tag{3}$$

where NM_{t-i} is the number of relevant articles (both supporting and non-supporting) published during period $t-i$, W_i is the weight attributed to the lagged period, and n is number of lagged periods considered. This method not only allows for a carryover effect but also for a decay effect of news as a source of information. The carryover and decay effects are captured by specifying the weight function and the total lag period. Early literature has used the second order polynomial function for constructing food scare indices (Ward and Dixon, 1989). This function has been criticized since it generates symmetric weights (see Chern and Zuo, 1997 for further detail). To overcome this problem, Chern and Zuo (1997) propose the Cubic Weight Function (CWF):

$$W_i = \delta_0 + \delta_1 i + \delta_2 i^2 + \delta_3 i^3 \tag{4}$$

where the δs are parameters and i is the number of lagged periods. The values of these coefficients can be determined based on the following criteria. First, the maximum weight lies somewhere between the current period ($i = 0$) and the last lagged period ($i = n$). Second, the minimum weight occurs at $i = n + 1$ and is set to zero ($W_{n+1} = 0$). Finally, the sum of weights over the current and lagged periods is equal to 1 ($\sum_{i=0}^{n} W_i = 1$). Given these restrictions, the CWF can be rewritten as (Chern and Zuo, 1997):

$$\begin{aligned} W_i = {} & 2a/((n+1)b) + (12m/b)i - (6(n+1+m)/((n+1)b))i^2 \\ & + (4/((n+1)b))i^3 \end{aligned} \tag{5}$$

where $a = (n+1)^2(n+1-3m)$ and $b = (n+2)[(n+1)^2 - m(2n+3)]$. The lag period with the maximum weight is represented by m. Expression $(n+1-3m)$ is restricted to be positive. Both n and m can take any finite number.

Results

Our empirical model utilizes two series of monthly wholesale and consumer poultry prices obtained from the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS, 2008).[9] The average wholesale price equals 6.63 LE per kilogram with a standard deviation of 1.44, while the average retail price equals 7.20 LE per kilogram with a standard deviation of 1.38 (see Fig. 1). Our data set extends from January 2003 until December 2006, with a total number of 48 observations.[10]

In order to approximate consumer awareness of the AI crisis through a FSII, we carried out a monthly count of newspaper articles published in the most popular Egyptian newspaper, Alahram, from January 2003 to December 2006. We searched for those articles containing the keyword "avian influenza". The average number of published news pieces is 29 per month with a standard deviation of 40. The maximum number of news articles was 214 in March 2006, following confirmation of the first Egyptian AI case in February 2006. The minimum number of news articles is zero.

No discrimination between positive or negative messages (as in Verbeke and Ward, 2001; Liu et al., 1998; Smith et al., 1988, among others) is carried out because, as indicated by Mazzocchi (2006), such discrimination can be highly subjective. Furthermore, Smith et al. (1988) noted an extremely high correlation between news classified as positive and negative. This is due to the fact that media interest drives the volume of news and when coverage increases, both positive and negative news reports rise. A change in the

[7] Hassouneh et al. (2010) utilize a FSII as a threshold variable within a RSVECM and show that the degree to which price transmission is affected by a food scare crisis depends on the scale of the crisis.

[8] This particular FSII method has been used by Hassouneh et al. (2010), among others.

[9] Both wholesale and consumer prices refer to the whole chicken. The producer price level is not available at a monthly frequency.

[10] While a longer record for retailer prices is available at the monthly frequency, the only available monthly data for wholesale prices are the ones included in the analysis. It was thus not possible to obtain more than 48 observations. Data limitations are a usual problem in analyses focusing on developing countries. While it is better to assess the impacts of food scares on these countries than leaving the question unexplored, data limitations require careful interpretation of our results.

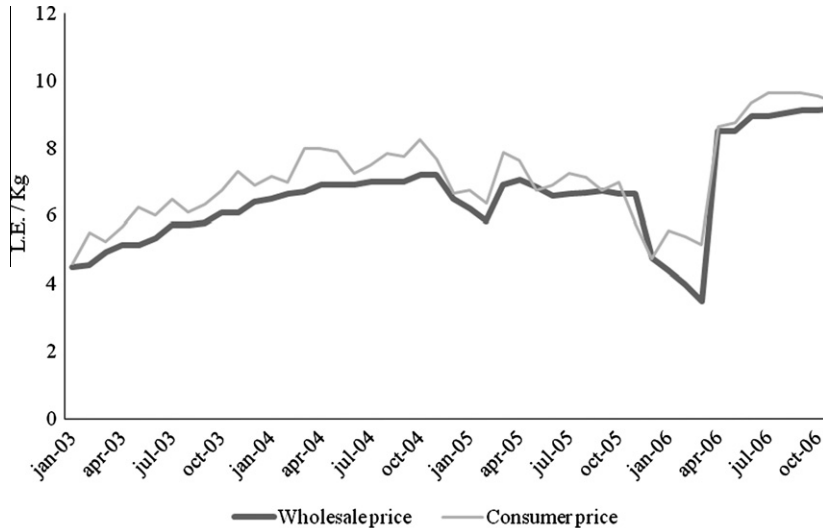

Fig. 1. Monthly poultry prices.

balance between positive and negative news could only be triggered by the disclosure of novel scientific evidence, which rarely happens in the short term. Articles have not been weighted to take into account the size of the article or the location of the article within the newspaper. Although this can be a limitation, this weighting process can be also highly subjective.

Having counted the number of news pieces, the second step is to build the index following Chern and Zuo (1997). The FSII is found to be non sensitive to different values for both the number of lags (n) and peak times (m). Based on these results, we select $n = 6$ which is consistent with the recommendation by Clarke (1976) and requires m to be equal to or less than two. Since the FSII is very similar independently of the chosen value for the peak time, we select $m = 2$. Fig. 2 presents the monthly FSII used in our analysis, where it can be observed that before 2006 the FSII is almost zero. Egypt's high self sufficiency rate in chicken meat production may have helped prevent early contamination. The FSII reaches its peak in March 2006, 1 month after the confirmation of the first Egyptian AI case in February 2006.

A preliminary analysis of the time series data was carried out to assess their time series characteristics. More specifically, standard augmented Dickey and Fuller (1979) tests, Phillips and Perron tests (1988) and Perron tests (1997) were applied to each price series in order to determine whether price series have a unit root. Results are presented in Table 1 and confirm the presence of a unit root in each price series.

Table 1
Unit root tests.

Price series	Test type	Test statistic (lag)	5% Critical value
Wholesale	ADF	−2.687 (0)	−3.447
	PP	−2.690 (0)	−3.447
	Perron	−4.198 (12)	−5.59
Consumer	ADF	−2.578 (0)	−3.447
	PP	−2.580(0)	−3.447
	Perron	−4.523 (3)	−5.59

Notes: The test statistic includes a constant and trend. Critical values for the ADF and PP are obtained from MacKinnon (1991). Critical values for the Perron test are obtained from Perron (1997). Results of the tests are maintained when using only a constant.

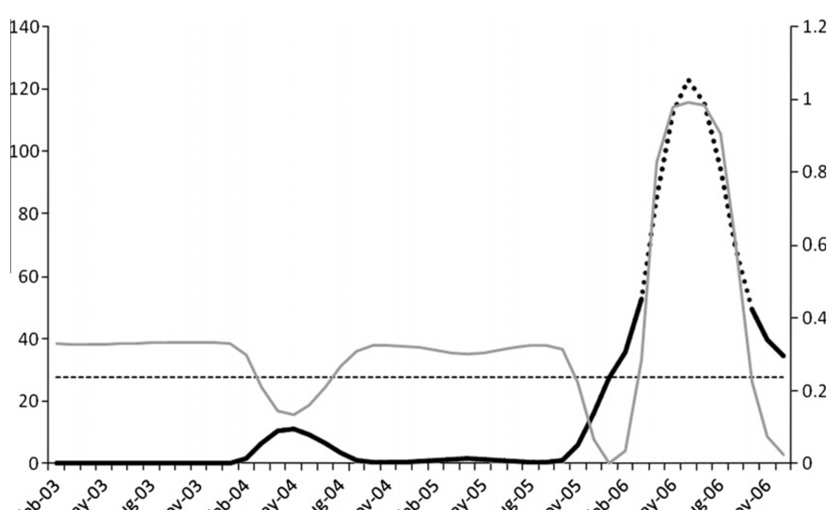

Fig. 2. Evolution of the food scare index, threshold variable and the value of the transition function over time. *Notes*: The transition function ($G(s_{t-d};\gamma,c)$) is represented by the silver line and is plotted on the right hand side axis. The transition variable (s_{t-d}), presented by the continuous thick black line when $G < 0.5$ and by the dotted thick black line when $G > 0.5$, and the threshold value (thin dotted line) are plotted on the left hand side of the axis.

Table 2
Johansen λ_{trace} test for cointegration and cointegration relationship.

Ho	Ha	λ_{trace}	P-value
$r = 0$	$r > 0$	30.841	0.001
$r \leqslant 1$	$r > 1$	3.973	0.428
Cointegration relationship (standard errors in parenthesis)			
$p_w - 1.136^{**}$		$p_c + 0.348^{**} = 0$	
(0.064)		(0.126)	

Note: r is the cointegration rank.
** Statistical significance at the 5% level.

Table 3
ESTVECM parameter estimates.

Parameters	Regime $G = 0$ ($i = 1$)		Regime $G = 1$ ($i = 2$)	
	Parameter estimate	Standard error	Parameter estimate	Standard error
Wholesale price equation				
μ_i	-0.083^{**}	0.025	0.239^{**}	0.078
α_i	0.555	0.417	-2.463^{**}	0.589
Φ_{i,P_w}	0.704^{**}	0.262	1.058^{*}	0.581
Φ_{i,P_c}	1.149^{**}	0.479	-2.210^{**}	1.005
λ_i	-0.011^{**}	0.003	0.011^{**}	0.004
Consumer price equation				
μ_i	-0.060^{*}	0.030	0.181^{**}	0.077
α_i	0.610	0.448	-1.379^{*}	0.766
Φ_{i,P_w}	-0.959^{**}	-0.331	1.241	0.885
Φ_{i,P_c}	0.883	0.557	-2.443	1.483
λ_i	-0.007^{**}	0.003	0.006	0.004
Transition function				
γ	0.645^{**}	0.271		
c	27.622^{**}	1.650		

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.

Once confirmed that price series are integrated of order one, $I(1)$, we applied the Johansen's (1988) test that supports the existence of a long-run relationship between wholesale and consumer price series (see Table 2). Weak exogeneity tests for long-run parameters were performed in the framework of this method and provided evidence that consumer prices are weakly exogenous. These results are in line with previous literature that has shown that while producer prices tend to adjust to their long-run parity, consumer prices are more sticky or slowly-responsive to price changes occurring in other levels of the marketing chain (Peltzman, 2000; Ben Kaabia and Gil, 2007; Goodwin and Holt, 1999; Serra and Goodwin, 2003; Hassouneh et al., 2010). The equilibrium relationship is thus normalized by the wholesale price. Hansen and Johansen's (1999) test for constancy of the cointegration parameters is also applied and suggests constancy of these parameters throughout the period studied.[11] Saghaian et al. (2008) have also found evidence of cointegration between producer and consumer prices in the Turkish poultry sector.

As already mentioned, in order to apply a STVECM, a linear vector error correction model is first estimated to determine the optimal number of lags in specifying short-run price dynamics. AIC and SBC criteria recommend the use of one lag. Before estimating a non-linear model, a test for linearity was conducted which suggested that linearity is strongly rejected against a STVECM.[12] Initial tests for STVECM specification support the use of an exponential function as the transition function (Teräsvirta, 1994).

[11] Engle and Granger (1987) cointegration test is also performed and suggests that the null hypothesis of no cointegration can be rejected at the 95% confidence level. Results are available from the authors upon request.
[12] Results are available from the authors upon request.

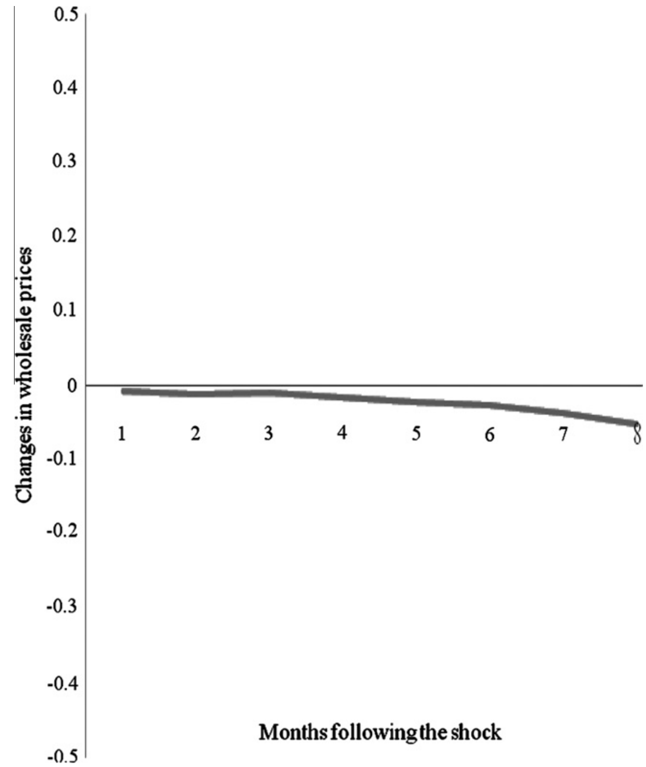

Fig. 3. Wholesale response to a FSII increase of 1. Equilibrium regime.

After initial specification tests, we proceeded to estimate the parameters of the ESTVECM model by using non-linear least squares (NLS).[13] Results are presented in Table 3. Relevant parameters in our non-linear ESTVECM are the speed of adjustment to disequilibrium from the long-run parity (vectors α_i, $i = 1, 2$), the speed of transition parameters (γ), the threshold parameter (c) and the short-run parameters λ_i that measure the impact on prices of an increase in the number of news articles.

Our results allow for distinguishing between two different price behavior regimes (see Fig. 2). The first regime, characterized by values of $G(s_{t-d}; \gamma, c)$ below 0.5, represents relatively calm periods when the crisis had not yet affected Egypt and news published on the topic only concerned AI affecting other countries. The second regime corresponds to $G(s_{t-d}; \gamma, c)$ values above 0.5 and represents price behavior when Egyptian markets were deeply immersed in the food scare crisis. In this latter regime, Egyptian newspapers widely reported on AI infecting poultry and humans in Egypt.

The speed of adjustment parameters (α) in the second regime representing turbulent markets suggest that, at the 5% significance level, wholesale prices respond to deviations from the long-run equilibrium parity. At the 10% significance level, the response of consumer prices to deviations from equilibrium can also be considered significant. These responses have very different implications for market equilibrium. While wholesale prices move to re-equilibrate the system, consumer prices move in the opposite direction. This suggests that, in times of economic distress, it is

[13] We use $\gamma = 0.5$ as a starting value for γ and values of S_{t-d} close to its mean as a starting value for the threshold parameter. The estimates of the linear model are used as starting values for the rest of the ESTVECM parameters. It is also important to note that all observations are included in the estimation of the parameters of each regime, but they are assigned different weights (through function) depending on how close they are to the particular regime being estimated.

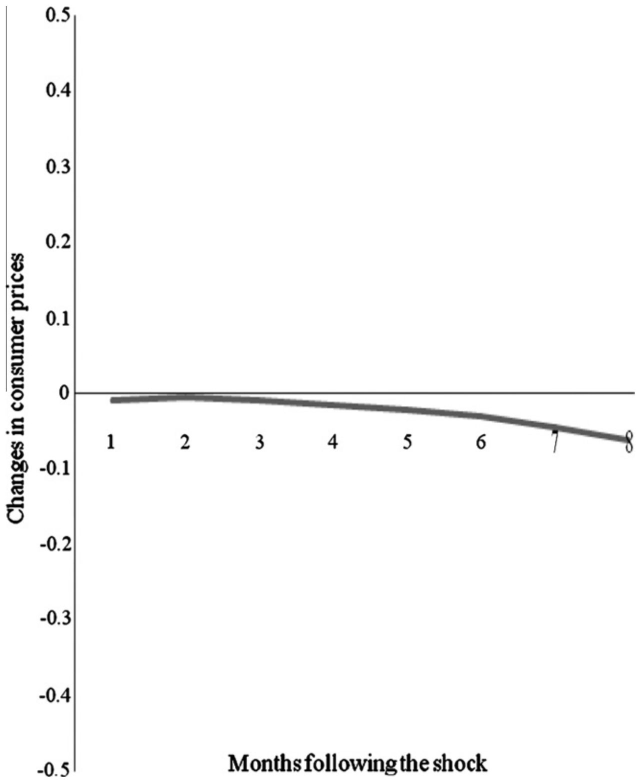

Fig. 4. Consumer response to a FSII increase of 1. Equilibrium regime.

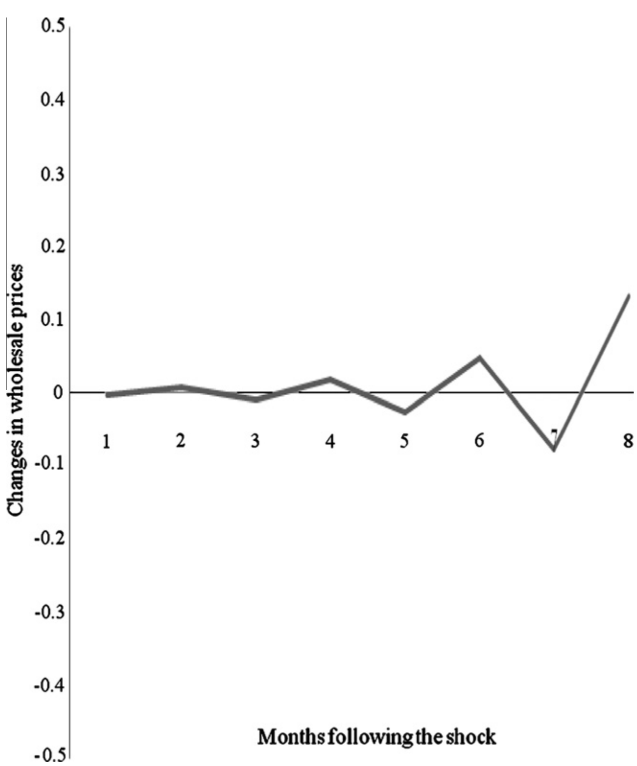

Fig. 5. Wholesale response to a FSII increase of 1. Disequilibrium regime.

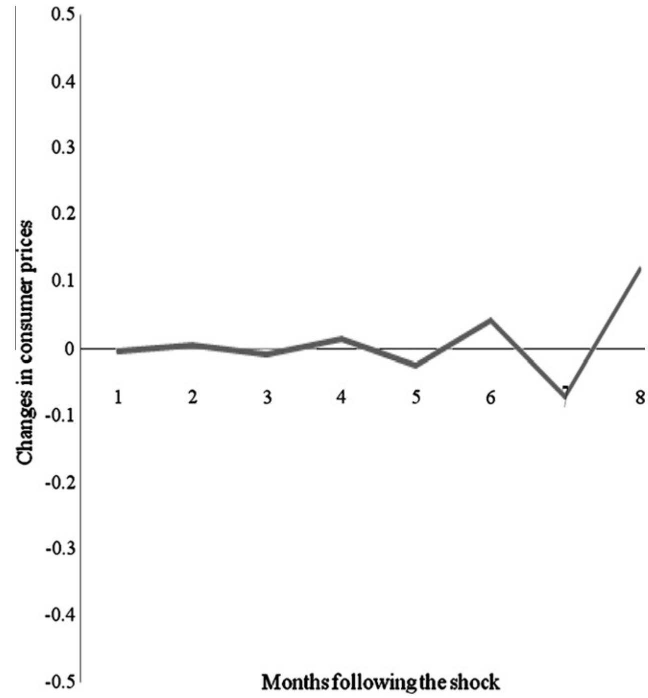

Fig. 6. Consumer response to a FSII increase of 1. Disequilibrium regime.

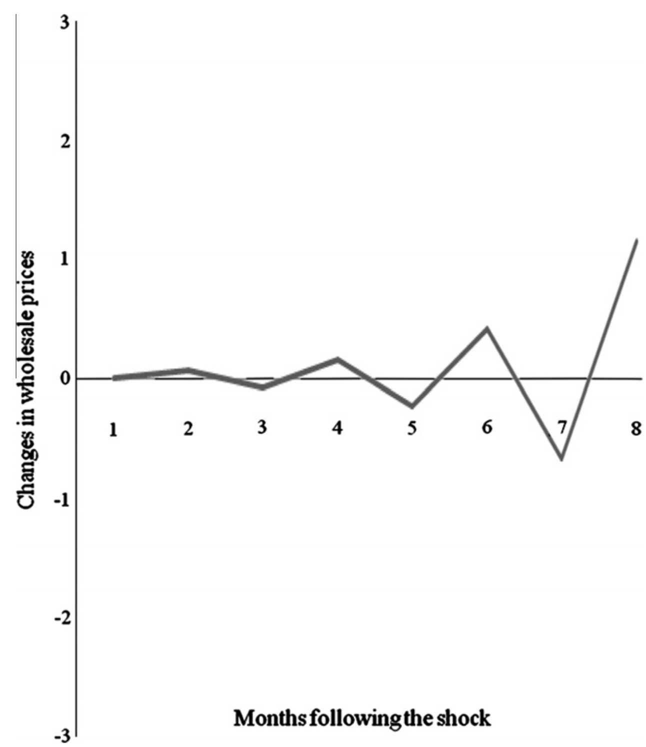

Fig. 7. Wholesale response to a FSII increase of 10. Disequilibrium regime.

likely that retailers make use of their market power to increase their marketing margins. This hypothesis is substantiated by the fact that regulations set forth by the government to respond to the crisis contributed to increase retailers' market power. Among these regulations is the obligation to slaughter chicken at slaughtering houses instead of retailer shops and using cold chain in chicken transportation. These obligations gave big retail chains the opportunity to gain more market share, benefit from their market power, and increase their marketing margins.

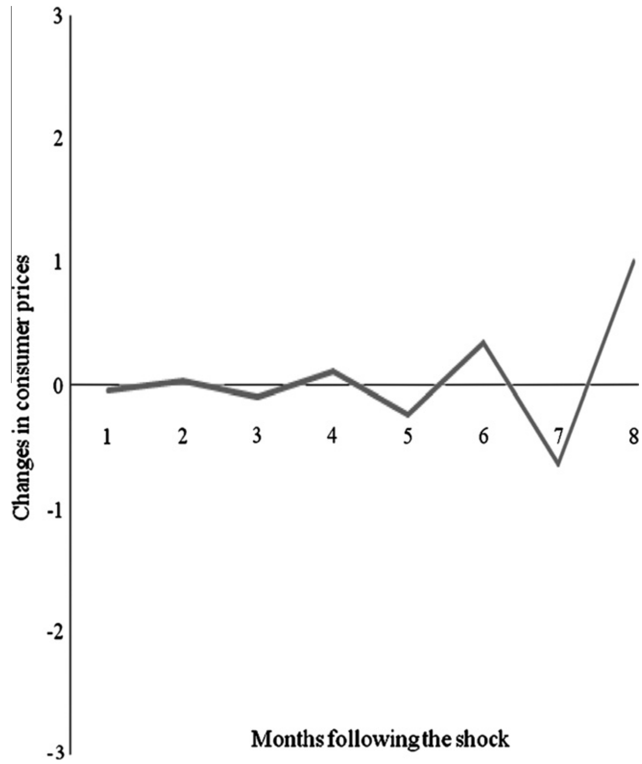

Fig. 8. Consumer response to a FSII increase of 10. Disequilibrium regime.

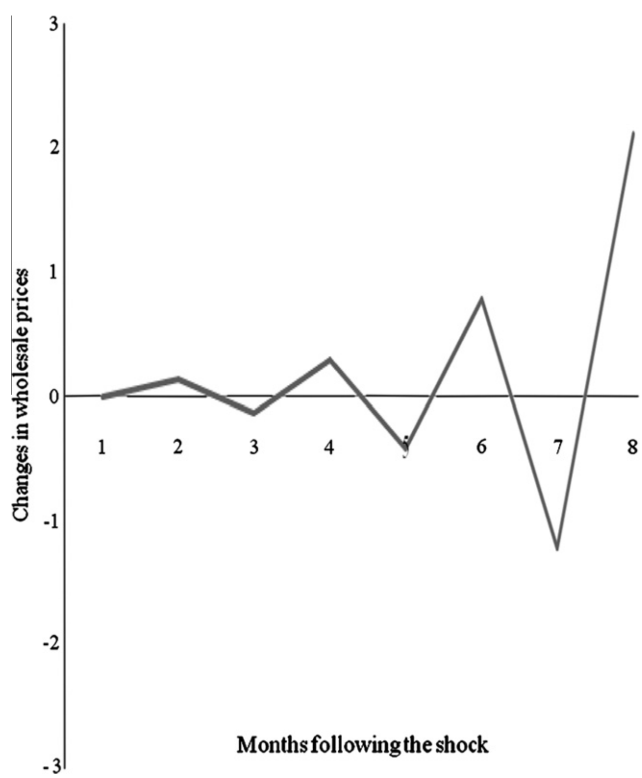

Fig. 9. Wholesale response to a FSII increase of 20. Disequilibrium regime.

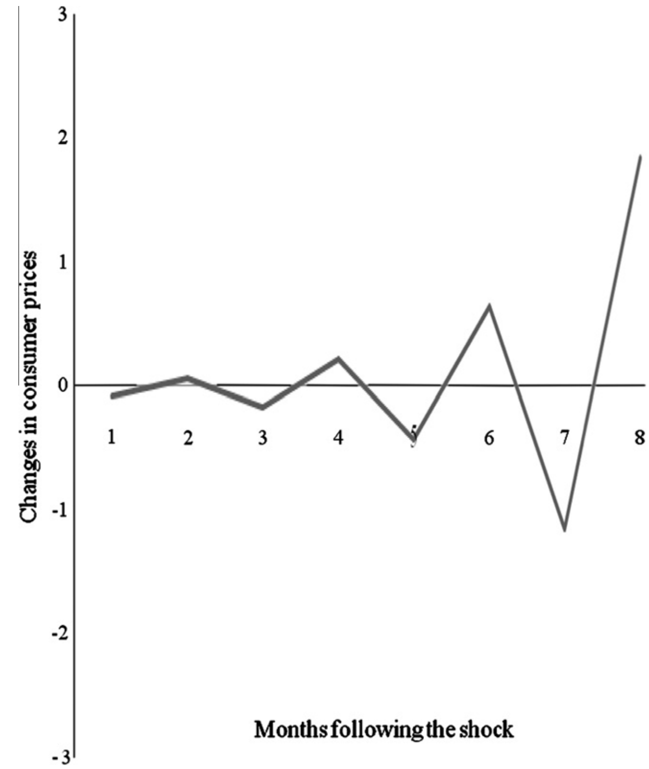

Fig. 10. Consumer response to a FSII increase of 20. Disequilibrium regime.

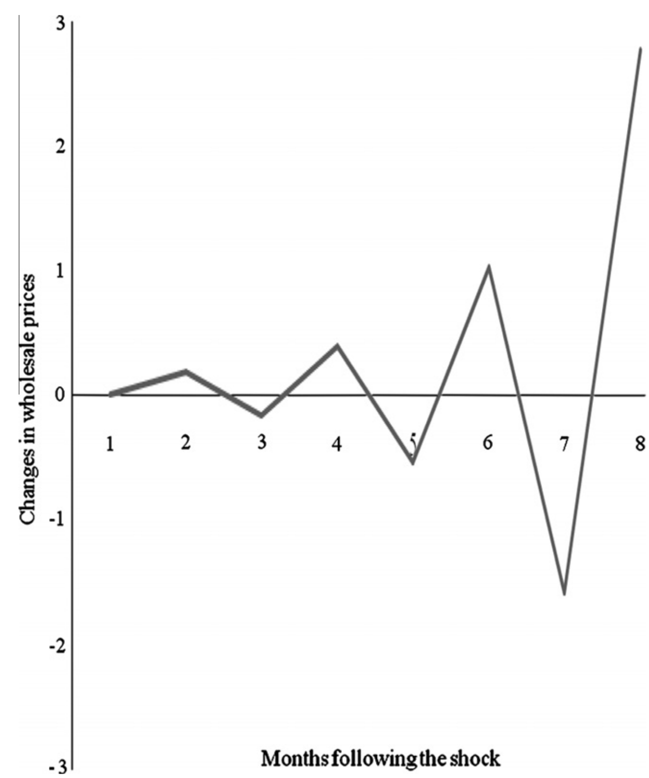

Fig. 11. Wholesale response to a FSII increase of 30. Disequilibrium regime.

When markets are relatively calm ($G(s_{t-d};\gamma,c) < 0.5$), wholesale and consumer prices do not adjust to deviations from the long-run equilibrium.[14] The absence of the response could be explained by both calm markets before the advent of the crisis and the high self-sufficiency rate of chicken meat in Egypt, which was around 100%. This high self-sufficiency rate increased consumer confidence and prevented Egyptian markets from adjusting

[14] These results are consistent with the concept of threshold error correction explained in Obstfeld and Taylor (1997).

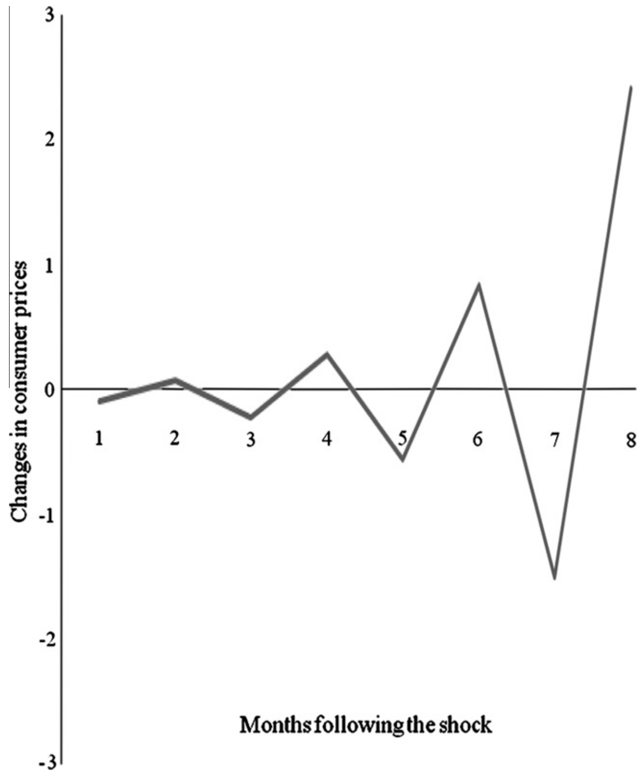

Fig. 12. Consumer response to a FSII increase of 30. Disequilibrium regime.

once Egyptian newspapers reported the presence of AI in other countries.

Compatible with previous research findings focusing on the impacts of food scares in developed economies, we find that the economic impacts of AI in Egypt depend on the magnitude of the food scare as measured by the FSII. As noted, error-correction only takes place in cases when perceptions of the crisis are relevant. Hence, while the characteristics of Egypt, such as a high level of illiteracy and a low income that does not allow most people to buy newspapers, could cast doubt on the capacity of news indices to identify the impacts of food scare crises in this country, our empirical results provide evidence against these arguments. The high correlation between news in different information channels is the most plausible explanation for FSII being able to identify the economic impacts of the AI food scare.

The short-run food scare index parameters (λ_i) indicate that when markets are relatively calm both prices respond negatively to an increase in consumer awareness of the AI crisis. Parameters also indicate that when $G(s_{t-d};\gamma,c) > 0.5$ wholesale prices increase in tandem with an increase in the number of news. The response of consumer prices is also positive though not statistically significant. Results are also consistent within the Egyptian context. The negative response of both consumer and wholesale prices to FSII increases when markets are calm is expected. The positive adjustment of prices when the transition function is $G(s_{t-d};\gamma,c) > 0.5$ is due to the supply shortage caused by the AI-triggered exit of many small and inefficient farms. This supply shortage, together with the recovery of consumption, resulted in higher prices relative to the pre-crisis period.

The threshold parameter (c) is statistically significant at the 95% confidence level and is equal to 27.62. This suggests a symmetric adjustment around a FSII on the order of 28 (see Fig. 2). The speed of transition parameter (γ) is statistically significant and equal to 0.64. Since the parameter γ can take any positive value (from zero to infinity), an estimate of 0.64 can be considered as a relatively slow transition speed and thus the transition from $G(s_{t-d};\gamma,c) = 0$ to $G(s_{t-d};\gamma,c) = 1$ occurs very smoothly. This smooth transition contrasts with the impacts of food scares in Europe and North America that often explode on markets rather quickly. Fig. 2 presents the evolution of the transition function over time, together with the transition variable and the estimated threshold. The figure illustrates that before 2006 regimes are associated with relatively low values of transition function. The highest transition function values are observed when the AI enters Egypt.

To better understand the potential impact of the AI crisis on wholesale and consumer prices, an Impulse Response Analysis is carried out. Impulse Response Functions (IRFs) provide an effective way to predict the time path of the response of a variable to shocks to the system (Lütkepohl, 2005). More specifically, we derive the IRFs showing the consumer and wholesale price adjustments to an increase in the FSII. The forecast horizon is set to $H = 8$ (the time span that the Egyptian avian market required to respond to the crisis – see Fig. 1). Results are presented in Figs. 3–12. Different magnitudes for the increase in the FSII are considered: 1, 10, 20 and 30. A small increase in the FSII on the order of 1 may occur both in the equilibrium and disequilibrium regimes. Its effects are thus studied within the two price regimes. Two points are selected for initialization: one representing the market before the advent of the crisis (April 2004) and another within the crisis period (April 2006). Bigger FSII increases on the order of 10, 20 and 30 mainly took place during the crisis and their impacts are thus assessed within the disequilibrium regime, taking April 2006 as the initialization point.

Consistently with the parameter estimate discussion presented above, a unit increase in the FSII when the market is calm causes a decline in both wholesale and consumer prices (see Figs. 3 and 4, respectively). The decline is of a very small magnitude (below 5% by the end of the adjustment period). Figs. 5 and 6 illustrate the results of simulating wholesale and consumer price responses, respectively, to a unit increase in the FSII during turbulent times. The increase generates a marked volatility in prices. This volatility eventually leads to higher wholesale and consumer price levels (the price increase is on the order of 14%). This price increase is consistent with the already mentioned supply shortage caused by the AI crisis, coupled with the recovery of consumption after an initial decline that resulted in a new market equilibrium characterized by higher price levels (see Fig. 1). Further, Figs. 5 and 6 show that wholesale and consumer prices follow similar patterns as a response to the shock, which reassures the existence of error-correction mechanisms within this price-regime.

Increases of the FSII of a higher magnitude (Figs. 7–12) generate results similar to the ones discussed above, but of a bigger size. For example, an increase in the FSII of 30 implies an increase in wholesale and consumer prices on the order of 260%. These results accurately reflect what happened during the crisis: from March to April 2006 there was an increase of the FSII on the order of almost 30, which involved an increase in wholesale and consumer prices between 250% and 260%.

Concluding remarks

In this paper, we assess the effects of AI on price transmission along the Egyptian poultry marketing chain. We also test whether information on the disease disseminated by mass media is relevant to explain the economic impacts of the crisis. While food scare information indices built upon a count of newspaper articles have been widely used to assess the economic effects of food contamination outbreaks in developed countries, this is the first study that focuses on a developing country.

Following the methodology proposed by Chern and Zuo (1997) we build our FSII upon a monthly count of newspaper articles published in the most widely read Egyptian newspaper. Our empirical model utilizes two series of monthly poultry prices (wholesale and consumer) and one monthly FSII series, which is used as transition variable within a STVECM that allows for nonlinear and smooth price behavior.

Cointegration tests provide evidence of a long-run equilibrium relationship between poultry prices at different levels of the food marketing chain. The estimated ESTVECM suggests that both wholesale and consumer prices respond to deviations from the long-run equilibrium relationship when the magnitude of the AI crisis is relatively large. Responses of these prices have, however, very different implications for market equilibrium: while wholesale prices respond to correct deviations from the equilibrium, consumer prices respond to increase retailers' marketing margins. This may increase the likelihood of wholesalers abandoning the sector when the magnitude of the crisis is substantially high and probably increases the need for public intervention if this is to be prevented. Conversely, when markets are relatively calm, disequilibriums from the long-run parity do not elicit price responses. These results are expected and are compatible with previous research (Hassouneh et al., 2010).

Results also suggest that food safety information indices representing the degree of food scare in developing countries are useful tools to explain the economic impacts of food crises in these countries. An interesting research finding is that an increase in news when markets are relatively calm has a negative effect on prices, which can help to recover consumption. The effects of an increase in news when markets are already immersed in the crisis results in a strong increase in price levels and volatility. This increase is explained by the supply shortage that AI caused in Egypt coupled with the recovery of consumption after an initial decline. This has important policy implications, since any news issued to recover consumer confidence and demand and thus prevent relevant negative economic effects from a food scare, may be more productive when circulated at the very beginning of the crisis, rather than later on when consumers are already confused and over-saturated by media.

Our analysis can be extended in several ways. One future research line could consist of analyzing the effect of AI on meat demand in Egypt. It would be interesting to test for the relevance of FSII in explaining demand changes. However the availability of the data needed to conduct this type of analysis is not guaranteed. Another interesting research opportunity would be to investigate the effect of food scares in other developing countries by using FSII. This would allow us to test to what extent our results can be generalized.

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