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

In recent years, health risks have received increasing attention among consumers and created interest in analysing the relationship between food scares, food consumption and market prices. One of the most relevant and recent food scares is the avian influenza that has had important effects not only on human and animal health, but also on the economy. We assess effects of avian influenza on price transmission along the Egyptian poultry marketing chain. Although Egypt has been one of the most affected countries by avian influenza, this article is the first attempt to understand this food scare's impacts on Egyptian poultry markets. In doing so, a multivariate smooth transition vector error correction model (STVECM) is applied to monthly poultry price data. 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. Results also suggest that food safety information indices, that have been widely used to assess the economic impacts of food scare crises in developed countries, also contribute to understanding the economic effects of food scare crises in developing countries.

Key words: Food scare, avian influenza, price transmission, Egypt.

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1. Introduction

Food safety has become a key issue in consumers' demand and, consequently, a relevant objective of food policy in many countries. The food scares that have been appearing over the last years (dioxins, Bovine Spongiform Encephalopathy (BSE), Food and Mouth Disease (FMD), Avian Influenza (AI), etc.) have contributed to increased public awareness of this problem. Also, the increasing globalisation and international opening of the markets, as well as the increasing speed of information dissemination, have amplified these concerns to a worldwide dimension. Resulting from an increased loss of confidence, consumers have become more critical and have changed their consumption habits. While this one was a phenomenon confined to developed countries, nowadays it has generalised to developing countries which usually have more difficulties than developed countries in addressing food security problems.

While Egypt was not affected by the food scares that shook Europe in the 1990s and at the beginning of the present decade, AI involved a hard reverse for the animal production sector of this country. The AI, originated in Southeast Asia, quickly extended worldwide. Defence mechanisms against food scares implemented in developed countries, mainly as a result of the Mad Cow and the Foot and Mouth disease outbreaks, helped mitigating the impact of AI in these countries. Nevertheless, this has not been the case in countries like Egypt which, with the advent of AI, faced a food scare for the first time.

The crisis dramatically affected the Egyptian animal production sector and, more specifically, the poultry sector which in 2005 generated around 10 billion LE[2], representing 20% of total animal production and 7% of total agricultural production.

[2] 1 US$ = 5.82 LE.

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. According to the World Health Organization (WHO), Egypt is the third most affected country by this crisis all over the world, after Indonesia and Vietnam, and the most affected country during 2009. The negative consequences on the poultry sector have been evident. Estimates of the economic damages owing to the AI in Egypt are above L.E. 2 billion. Apart from the obvious impact that AI has had on human health, there were also worries about the economic effects of the crisis.

This paper is the first to assess the effects of avian influenza 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 provide evidence that the AI crisis has 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 built 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 behaviour in developing economies.

Due to usually high illiteracy levels (29.7% in Egypt in 2006 (CAPMAS, 2006)), low income levels precluding most people to buy newspapers (there are only about 250,000 newspaper readers in Egypt), and a lack of trust in public authorities and media due to corruption, these indices may not be regarded as representative measures of developing countries' public awareness of the crisis. In contrast, one may argue that the indices are indeed a good approximation to consumers' awareness because of the high correlation between news in different information channels (TV, newspapers, mosques, etc.). Our study is the first attempt to test the validity of this type of indices 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 multivariate Smooth Transition Vector Error Correction Model (STVECM) that allows 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 allow distinguishing between different regimes that represent price behavior under different economic conditions. The FSII is used as the variable determining regime-switching, which allows 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 organised as follows. Section 2 presents an overview of the Egyptian poultry sector and the AI crisis. A literature review is carried out in section 3 and the main contributions of our research are outlined. The econometric methods are explained in section 4. The data used and the construction of our information index are described in section 5 before discussing the main results. The paper ends with the concluding remarks section.

2. Egyptian poultry sector and the avian influenza crisis

2.1. 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. 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 order 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).

Hosney (2006) indicates that the founding of the National General Poultry Company (G.P.C.) marked the beginning of the modern poultry industry in Egypt. This industry aims both at guaranteeing high quality and inexpensive animal protein for the growing Egyptian population, and at industrialising 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 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 control nearly impossible. Furthermore, the government assured high intervention levels for the poultry industry by imposing strong restrictions on foreign poultry imports (including high tariffs, or import bans). All this subsidisation and overprotection policies resulted in a very fragile sector with many inefficient farms and hidden weaknesses. The AI crisis brought to light these weaknesses and forced many small and inefficient farms to exit the sector.

Before the AI crisis, chicken meat was usually consumed in the form of live animals that were sacrificed by the retailer or the family. This is a tradition in this country that allows eating the meat throughout the day without the need to use refrigeration. However, this tradition turned out to help spreading the pandemic in Egypt through direct contact with live animals.

2.2. Avian influenza (AI) crisis

More than 200 million birds have died or been culled as a consequence of AI subtype H5N1 since 2003 (FAO, 2006). Following 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 to February, 17, 2010, there have been 476 confirmed human cases of AI worldwide of which 283 died with 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. Figure 1 presents the evolution of confirmed AI infections in humans and deaths in Egypt from 2006 until 2010. Following the WHO, Egypt is the third most affected country by this crisis all over the world, after Indonesia and Vietnam, and the most affected country during 2009.

The consequences on the poultry sector have been evident. Chicken meat demand was reduced substantially, which generated a price reduction. Afterwards the market slightly recovered, but there is a common feeling of certain 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).

3. Literature review

Understanding vertical price transmission allows an approximation to 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 slowly-responsive (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, and find that BSE scares affect beef producers more strongly than retailers.

A new relevant food scare occurred recently has been the AI crisis. Although the economic impact that the AI crisis has had on the poultry and animal production sectors in many countries in the world has been substantial, only a few studies have tried to quantify it. Most of these analyses have focused on the effects of the AI outbreak on consumer behaviour and willingness to pay, and on public policy decisions. Akben et al. (2008) use cross-sectional data within a probit model to estimate the impact of AI on consumers in Turkey. They find that informed consumers could play an important role in alleviating the impact of the pandemic on the poultry sector. They also find that the more concerned consumers are the more frequent, older and female consumers. Beach et al. (2008) utilize scanner data to study the effect of AI news on consumer purchasing behaviour in Italy and find a significant impact but with a limited duration. Beach et al.

(2007) propose an economic epidemiology framework to assess the impacts of farmer behaviour on the introduction and transmission of the disease and to assess the effects of public policy decisions under alternative scenarios. Brouwer et al. (2008) use a time series analysis of contingent values and models for migratory bird protection based on a contingent valuation survey. They test for the impact of the bird flu on public willingness to pay (WTP) for migratory bird protection. The analysis by Brown et al. (2007) investigates the impacts of the AI outbreak on different agricultural sectors within the US market and finds that several agricultural sectors were affected by the AI crisis.

The literature has paid small attention to the impact of AI on price transmission along the food marketing chain in developing countries. The research conducted by Saghaian et al. (2008) is an exception that analyzes the effect of the AI crisis on producer and consumer prices within the Turkish poultry sector. These authors provide evidence that the AI outbreak has had an impact on vertical price transmission processes.

Our paper contributes to the literature in different manners. It is the first research to use of a non-linear multivariate STVECM to assess the effects of avian influenza on price transmission along the Egyptian poultry food marketing chain. We consider the multivariate STVECM a suitable methodology to assess price behaviour because it allows for nonlinearities in price adjustment, different price behaviour regimes depending on the predominant economic conditions, as well as for smooth transition of prices between these different regimes. The STVECM allows assessing not only how individual prices adjust to their long-run equilibrium parity, but also price short-run price dynamics. Further, it also permits distinguishing between different price-behavior regimes, depending on the magnitude of the food scare crisis. To our knowledge, no previous study has assessed the impacts of food scare shocks by using smooth-transition types of models.

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 are found to 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-behaviour regimes occurs in a discontinuous and abrupt way. Smooth transition-type of models used in our analysis are less restrictive in that they allow for smooth shifting between regimes. Another contribution of our paper is the development of an AI food scare index that is used as a transition variable within the non-linear STVECM. This allows to analyze to what extent different levels of the crisis can affect price behaviour along the Egyptian food marketing chain. Our analysis is the first attempt to assess the validity of using a food safety index based upon a count of newspaper articles to explain the economic effects of food scares on developing countries. Finally, our analysis contributes to previous literature in that we focus on studying the effects of AI on price transmission along the Egyptian poultry marketing chain, a market that has not been investigated yet, although, as we have mentioned, it is one of the most affected countries.

4. Methods: Smooth transition vector error correction models and food information indices

4.1. Smooth transition vector error correction models

Recent developments of econometric time series methods has greatly contributed to a better understanding of the dynamic behaviour of the economic variables that can be observed in the real world. Threshold models originally introduced by Tong (1982) are one of the most relevant families of non-linear time series models and have brought up the attention of many previous empirical studies (see, Goodwin and Piggott, 2001; Chavas and Mehta, 2004; Serra and Goodwin, 2004; Serra et al. 2006; Hassouneh et al., 2010). Threshold models allow for nonlinear price behaviour by considering different price behaviour 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

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

where $P_t = (p_w, p_c)$ is a (2 x 1) vector of nonstationary prices containing wholesale, p_w, and consumer, p_c, prices. I is a FSII, μ_i i=(1,2) are (2 x 1) vectors of constant terms, α_i are (2 x r) parameter matrices representing the speed of adjustment of each price to deviations from the long-run relationships, $v_{t-1} = \beta' P_{t-1}$ is a vector containing deviations from the r long-run equilibrium relationships (error correction terms), β (2 x r) contains the parameters of the cointegration relationships, $\Phi_{i,j}$, j=1,...,p-1 are (2 x 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 FSII variable is developed are provided below. ε_t is a k-dimensional vector white noise process with a mean zero vector and a (2 x 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, that 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 usually specified using a logistic or an exponential functional form (Teräsvirta, 1994).

The logistic function can be expressed as follows:

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

from (1) and (2), we obtain what is called a logistic STVECM (LSTVECM). 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. $G(s_{t-d};\gamma,c)$ changes monotonically from 0 to 1 as s_{t-d} increases and takes the value of $G(s_{t-d};\gamma,c)=0.5$ at $s_{t-d}=c$. When $\gamma\to 0$ the transition function becomes a constant and thus the LSTVECM converges to a linear vector error correction model (VECM). Conversely, when $\gamma\to\infty$, the change of $G(s_{t-d};\gamma,c)$ from 0 to 1 becomes instantaneous resulting in a non-linear threshold vector error correction model (TVECM).

The exponential transition function can be expressed as follows:

$$G(s_{t-d};\gamma,c)=1-\exp\left(-\frac{\gamma(s_{t-d}-c)^2}{\sigma^2(s_{t-d})}\right),\ \gamma>0 \tag{3}$$

After combining (1) and (3) we obtain an exponential STVECM (ESTVECM). 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 take a value close to 1.

Since our paper focuses on the effects that avian influenza 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 transition function and different price behavior regimes.[3] A priori we expect the STVECM will allow distinguishing between two extreme price behavior regimes: one characterized by relatively calm markets and another 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 SBS 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. Luukkonen et al. (1988) solved 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.

Following the approach by Saikkonen and Luukkonen (1988) and using a first order Taylor series expansion of the ESTVECM we get the following re-parameterized model:

[3] Hassouneh et al. (2010) have utilized 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.

$$\Delta P_t = M_0 + A_0 z_{t-1} + \sum_{j=1}^{p-1} B_{0,j} \Delta P_{t-j} + \lambda_{0,j} \Delta I_{t-j}$$
$$+ M_1 s_{t-d} + A_1 z_{t-1} s_{t-d} + \sum_{j=1}^{p-1} B_{1,j} \Delta P_{t-j} s_{t-d} + \lambda_{1,j} \Delta I_{t-j} s_{t-d} \quad (4)$$
$$+ M_2 s_{t-d}^2 + A_2 z_{t-1} s_{t-d}^2 + \sum_{j=1}^{p-1} B_{2,j} \Delta P_{t-j} s_{t-d}^2 + \lambda_{2,j} \Delta I_{t-j} s_{t-d}^2 + \eta_t$$

where η_t includes the original error vector plus the errors that are derived from the Taylor series approximation. The corresponding linearity test can be denoted by $H_0 : M_1 = M_2 = A_1 = A_2 = B_{1,j} = B_{2,j} = \lambda_{1,j} = \lambda_{2,j} = 0$. We use F statistic to test for the null hypothesis.

On the other hand, a test for linearity in a LSTVECM involves using the following re-parameterized model:

$$\Delta P_t = M_0 + A_0 z_{t-1} + \sum_{j=1}^{p-1} B_{0,j} \Delta P_{t-j} + \lambda_{0,j} \Delta I_{t-j}$$
$$+ M_1 s_{t-d} + A_1 z_{t-1} s_{t-d} + \sum_{j=1}^{p-1} B_{1,j} \Delta P_{t-j} s_{t-d} + \lambda_{1,j} \Delta I_{t-j} s_{t-d} + \eta_t \quad (5)$$

and testing for the null $H_0 : M_1 = A_1 = B_{1,j} = \lambda_{1,j} = 0$. Finally, Teräsvirta (1994) shows that the selection between LSTVECM and ESTVECM can be done by using a sequence of tests nested within the null hypothesis of linearity when a Taylor series expansion of the non-linear model is carried out. Specifically, the null hypotheses to be tested are as follows:

$$H_{03}: M_3 = A_3 = B_{3,j} = \lambda_{3,j} = 0, j = 1,...., p-1$$
$$H_{02}: M_2 = A_2 = B_{2,j} = \lambda_{2,j} = 0 \mid M_3 = A_3 = B_{3,j} = 0, j = 1,...., p-1$$
$$H_{01}: M_1 = A_1 = B_{1,j} = \lambda_{1,j} = 0 \mid M_2 = A_2 = B_{2,j} = M_3 = A_3 = B_{3,j} = 0, j = 1,...., p-1$$

Luukkonen et al. (1988), show that the rejection of either H_{03} or H_{01} suggests that LSTVECM is a better choice, while the rejection of H_{02} indicates that ESTVECM is preferred. In general, an ESTVECM is chosen only if the p-value corresponding to H_{02} is the smallest among the three hypotheses.

4.2. 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 U.S. They develop their index by accumulating the number of supporting articles (unfavourable news) minus the non-supporting articles (favourable 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 differentiated carryover weight for supporting and non-supporting articles. Also, the articles are assumed to have a finite duration and lag distribution as a source of information. In our study we follow this method[4].

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

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

$$FSII_t = \sum_{i=0}^{n} W_i \ \mathrm{NM}_{t\text{-}i} \quad (6)$$

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 as a source of information. The carryover and decay effects are captured by specifying the weight function and the total lag period. Chern and Zuo (1997) utilize the cubic weight function (CWF) for constructing weights. Following this method, which generates asymmetric weights, the cubic weight function can be written as:

$$W_i = \delta_0 + \delta_1 i + \delta_2 i^2 + \delta_3 i^3 \quad (7)$$

where the δ s 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 $\left(W_{n+1} = 0\right)$. Finally, the sum of weights over the current and lagged periods is equal to 1 $\left(\sum_{i=0}^{n} W_i = 1\right)$. Given these restrictions, the CWF can be rewritten as (Chern and Zuo, 1997):

$$W_i = 2a/((n+1)b) + (12m/b)i - (6(n+1+m)/((n+1)b))i^2 + (4/((n+1)b))i^3 \quad (8)$$

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.

5. Empirical application

Our empirical model utilizes two series of monthly wholesale and retail live poultry prices obtained from the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS, 2008). The average wholesale price equals 6.63 L.E. per kilogram with a standard deviation of 1.44, while the average retail price equals 7.20 L.E. per kilogram with a standard deviation of 1.38 (see figure 2). Our data set extends from January 2003 through December 2006, with a total number of 48 observations.

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 key word: "avian influenza". The average number of published news is 28.71 per month, with a standard deviation of 40.19.The maximum number of news is 214 in March 2006, following confirmation of the first Egyptian AI case in February 2006. The minimum number of news is zero.

No discrimination between positive or negative messages (as in Smith et al., 1988; Liu et al., 1998; and Verbeke and Ward, 2001; 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 balance between positive and negative news could only be triggered by the disclosure of novel scientific evidence, which rarely happens in the short term. News have not been weighted taking 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.

Once having counted the number of news, 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. Figure 3 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 may have helped preventing early contamination. The FSII reaches its peak in March 2006, one month after the confirmation of the first Egyptian AI case in February 2006.

6. Results

As previously mentioned, our empirical analysis uses monthly wholesale and consumer chicken prices. A monthly FSII is also constructed to approximate the degree of consumer food scare. A preliminary analysis of the time series data was carried out to assess their time series characteristics. More specifically, standard Dickey and Fuller (1979) tests and their augmented version, Phillips and Perron tests (1988) and KPSS tests (Kwiatkowski et al., 1992) were applied on each price series in order to determine whether price series have a unit root. Tests confirm the presence of a unit root in each price series.[5]

Once confirmed that price series are integrated of order one I(1), we apply the Johansen's (1988) test to determine whether a long-run relationship exists between wholesale and consumer price series. Weak exogeneity tests are performed in the framework of this method and provide evidence that consumer prices are weakly exogenous. These results are in line with previous literature that has confirmed 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 (see Goodwin and Holt, 1999; Peltzman, 2000; Serra and Goodwin, 2003; Ben Kaabia and Gil, 2007; Hassouneh et al., 2010). The equilibrium relationship is thus normalized by the wholesale price. Standard Johansen (1988) tests provide evidence of a long-run equilibrium relationship between poultry prices at different levels of food marketing chain (see table 1). Hansen and Johansen (1999) test for constancy of the cointegration parameters is also applied and suggests constancy of these parameters throughout the period studied.[6] Saghaian et al. (2008) have also found evidence of cointegration between producer and consumer prices in the Turkish poultry sector.

The objective of this paper is to assess the effects that avian influenza had on price transmission along the Egyptian poultry marketing chain. A non-linear STVECM is applied where the FSII is used as a transition variable. This allows testing for possible non-linearities presumably caused by the AI outbreak. As already mentioned, in order to apply a STVECM a linear vector error correction model is first estimated to determine

[5] Results are available from the authors upon request.

[6] Engle and Granger (1987) cointegration test is also performed and suggests that the null hypothesis of cointegration cannot be rejected at the 95% confidence level. Results are available from the authors upon request.

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 is conducted and suggests that linearity is strongly rejected against a STVECM.[7]

Once linearity is rejected, we select between LSTVECM and ESTVECM by using the sequence of tests nested within the null hypothesis of linearity discussed above (Teräsvirta, 1994). Table 2 reports the results of these linearity tests. The p-values of the test sequence H_{03}, H_{02} and H_{01} strongly reject linearity in favor of non-linear models. Based on Teräsvirta's (1994) decision rules, an ESTVECM should be estimated since the p-value associated to H_{02} is the smallest.

After initial specification tests, we proceeded to estimate the parameters of the ESTVECM model by using non-linear least squares (NLS).[8] Results are presented in table 3. The most relevant parameters in our non-linear ESTVECM are the speed of adjustment to disequilibrium from the long-run parity (vectors $\alpha_i, i = 1, 2$), the speed of transition parameter (γ), the threshold parameter (c) and the short-run parameter λ_i that measures the impact on prices of an increase in the number of news.

Our results allow distinguishing between two different price behaviour regimes (see figure 4). The first regime, characterized by values of $G(s_{t-d}; \gamma, c)$ close to zero, 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

[7] Results are available from the authors upon request.

[8] 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.

corresponds to $G(s_{t-d};\gamma,c)$ values close to one and represents price behavior when Egyptian markets were deeply immersed in the food scare crisis. In this 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. In other words, in times of economic distress, retailers make use of their market power to further increase their marketing margins. In absolute values, adjustment parameters suggest that adjustments by wholesale prices are much more powerful that consumer prices' responses. This helps explaining why equilibrium between the two prices is maintained.

The bigger response of wholesale prices relative to consumer prices when values of the transition function are close to $G(s_{t-d};\gamma,c)=1$ is due to the regulations set forth by the government. Among these regulations there is the obligation to slaughter chicken at slaughtering houses instead of retailer shops and using cold chain in chicken transportation. These regulations resulted in increased retailer costs and justify retailers submitting their prices to smaller cuts than the ones affecting wholesale prices. Moreover, the obligation to slaughter chicken at slaughtering houses gives big retail chains the opportunity to gain more market share, benefit from their market power, and increase their marketing margins.

When markets are relatively calm, $G(s_{t-d};\gamma,c)=0$, wholesale and consumer prices do not adjust to deviations from the long-run equilibrium. The absence of the response when $G(s_{t-d};\gamma,c)=0$ could be explained by both calm markets before the advent of the crisis and the high self sufficiency rate of chicken meat in Egypt, around 100%. This high self-sufficiency rate increased confidence and prevented Egyptian markets from adjusting once Egyptian newspapers reported the entrance 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 for relatively big magnitudes of the crisis. Hence, while the characteristics of developing countries such as a high level of illiteracy, a low income that does not allow most people to buy newspapers, and a lack of trust in public authorities and media due to corruption, could cast doubt on the capacity of news indices to identify the impacts of food scare crises in these countries, our empirical results prove these arguments wrong. 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 $G(s_{t-d};\gamma,c)$ is close to 1, wholesale prices increase with an increase in the number of news. Conversely, consumer prices do not adjust. Results are also consistent with the Egyptian context. The negative response of both consumer and wholesale prices to FSII increases when G is close to zero is expected and can be explained by diminishing returns to news. The effect that a single piece of news has on market behavior is much more relevant at the beginning of the crisis than when citizens are already saturated with news on the scare (regime where G

is close to 1). The positive adjustment of wholesale prices when the transition function is close to $G(s_{t-d};\gamma,c)=1$ 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 at the wholesale level.

The threshold parameter (c) is statistically significant at the 95% confidence level and equal to 27.62. This suggests a symmetric adjustment when the number of articles published on AI crisis is around 27 (see figure 4). The speed of adjustment 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.

Figure 4 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. Noteworthy is the fact that the increase in the number of news that takes place in 2004 does not increase the value of the transition function, but instead reduces it. This is explained by the fact that the news circulated in 2004 were mostly positive and mainly transmitted the idea that, although AI was being detected in other countries, Egypt was safe. These news also informed the population that eating well cooked chicken meat from infected animals does not have any health effects. The highest transition function values are observed when the AI outbreak enters Egypt.

7. Concluding remarks

In this paper we assess the effects of avian influenza 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 county.

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 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 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 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. 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 instruments to explain the economic impacts of food crises. An interesting research finding is that the effect of news on prices is characterized by decreasing returns: while an increase in news when markets are relatively calm can have a strong negative effect on prices, the effects of an increase in news when markets are already immerse in a crisis may not be significant. This has important policy implications, since any news issued to increase consumer confidence and thus prevent relevant economic effects from a food scare, may be more productive when circulated at the very beginning of the crisis than later on, when consumers are already too confused and saturated.

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. Noteworthy is the fact that availability of the necessary data for conducting such type of analysis is not guaranteed. Another interesting future research line is to investigate the food scares effect in other developing countries by using FSII. This would allow testing to what extent our results can be generalized.

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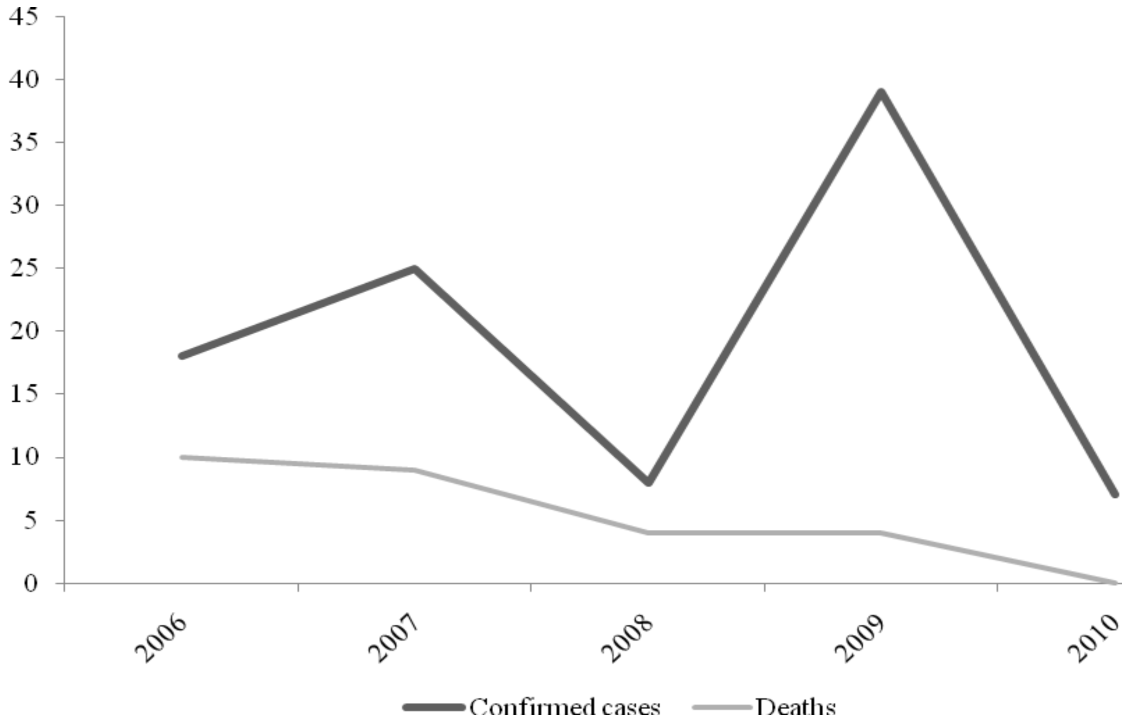
Figure 1

Evolution of confirmed human AI infections and deaths in Egypt (2006 - 2010)



Source: World Health Organization (WHO), 2010

Figure 2

Monthly poultry prices

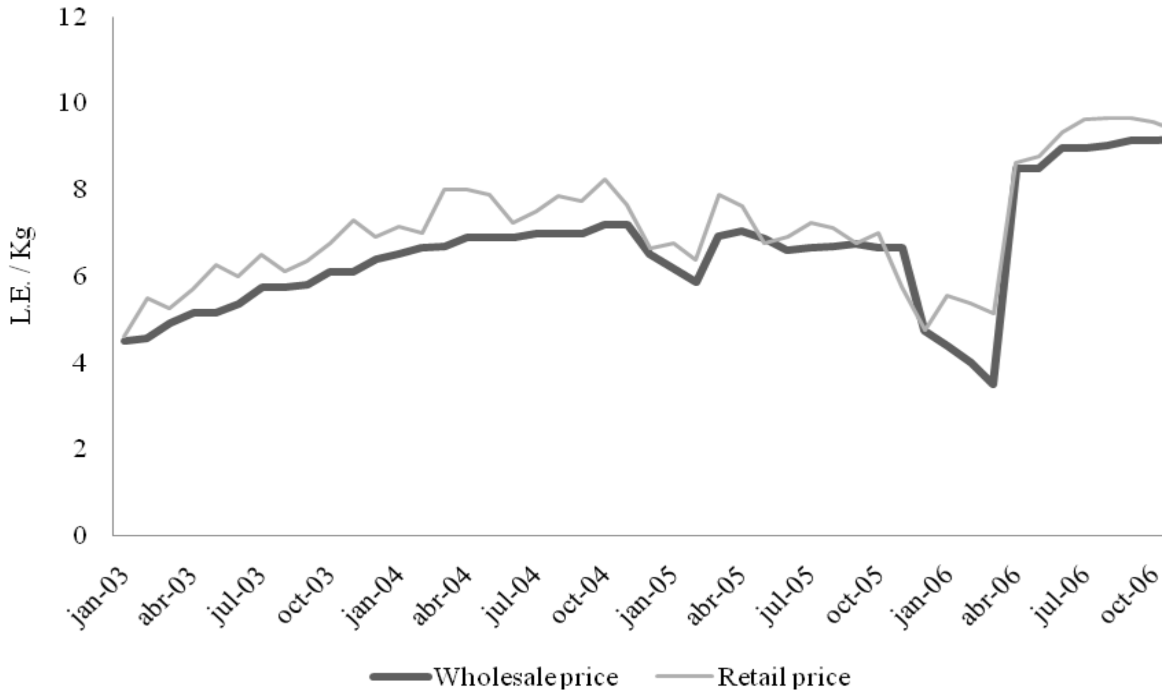


Figure 3

Food Safety Information Index

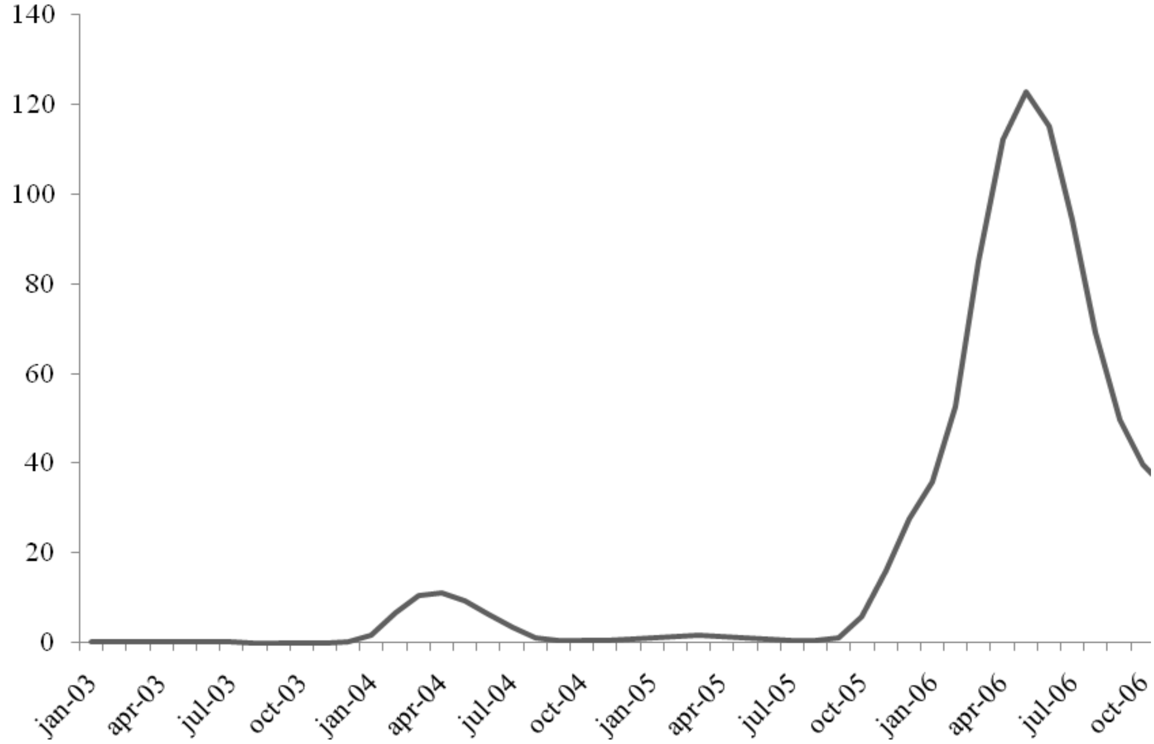
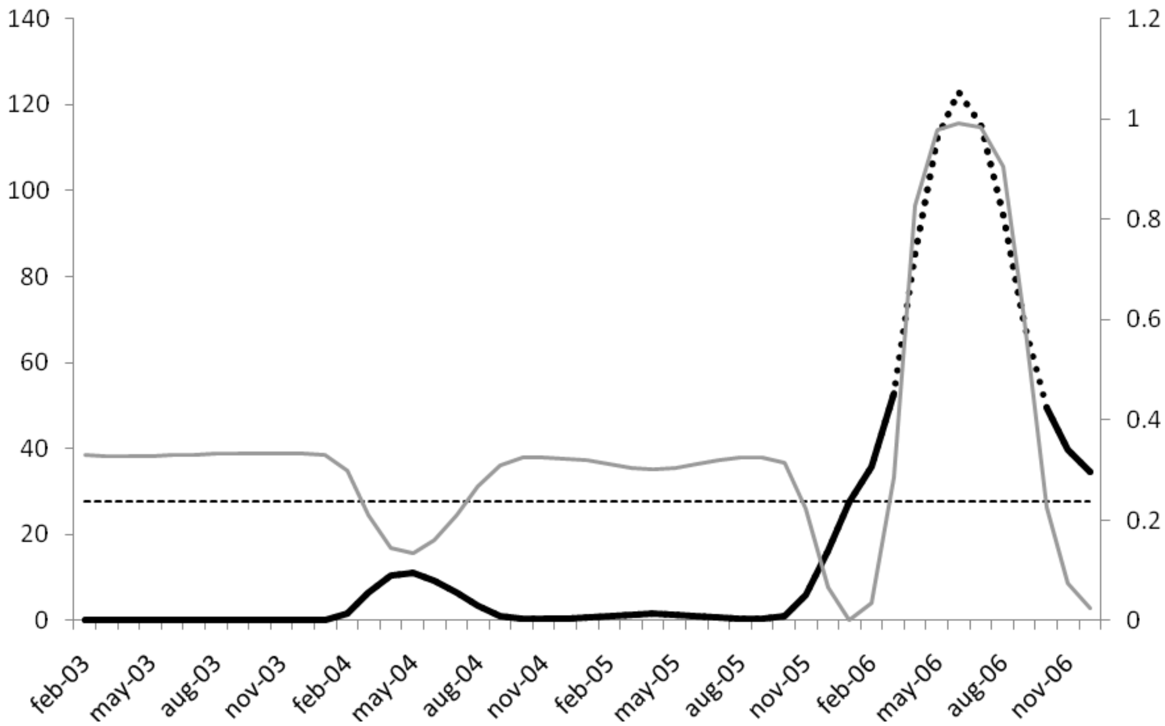


Figure 4

Evolution of the threshold variable and the value of the transition function over time



Notes: The transition function ($G(s_{t-d};\gamma,c)$) is presented 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 1

Johansen λ_{trace} test for cointegration and cointegration relationship

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

Note: r is the cointegration rank.

Table 2

Linearity tests: testing a LSTVECM against a ESTVECM

Transition variable	H_{03}	H_{02}	H_{01}
I_{t-1}	0.003	0.000	0.003

Note: the table reports p-values.

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**	-0.959	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	