Fear and Trust: How Risk Perceptions of Avian Influenza Affect the Demand for Chicken

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Abstract: *This article quantifies the impact of H7N9 bird flu on chicken demand and consumer willingness to pay (WTP) in China. The surveys were administered to the same group of respondents in April 2012 and 2013. In 2012 we asked generic questions regarding food safety in chilled chicken without any mentioning of bird flu and in 2013 in the midst of the outbreak we resurveyed the group again. Since these respondents were surveyed both times (before and after the bird flu outbreak), the data formed a "natural experiment". We measure risk perception, fear and trust against actual reduction in consumption and stated change in WTP for safe chicken between 2012 and 2013. Through a survey conducted in each year on the same Chinese urban consumers, we are able to construct a Marshallian-Hicksian elasticity measure signifying the relative welfare loss from a food risk. Furthermore, we found that: (1) like fear, the impact of distrust (especially the distrust in government) was negative for consumption; (2) macro fear of H7N9's spreading, and distrust in government enhanced the deviation of consumption and WTP; (3) stronger consumer heterogeneity in consumption existed in cities with higher number of incidences; (4) the sheer mentioning of H7N9 is more important and negative than whether it was associated with a risk-perception reducing or risk-perception elevating message given to consumers; and (5) unlike what the conventional theory would predict that upon the rising of a specific risk factor, demand will drop and WTP for safter products will increase, while consumption of chicken never increased after the emergence of H7N9 in 2013, WTP for safer chicken did not increase either relative to generic risks associated with consuming chicken in 2012.*

Keywords: *Risk Perception; Food Safety; H7N9 Avian Influenza; WTP; Consumer Behavior; Fear*

The elicitation of willingness to pay (WTP) in the food safety literature focuses largely on the amount of money a consumer is willing to give up in order to restore utility to some initial level. To a large extent the literature follows Hanemann (1991) and related literature by Shogren et al. (1995). Their articles considered the economic meaning of willingness to accept (WTA) in relation to WTP for the same exogenous shock, revealing two important concepts. The first is the idea that a particular good with many close substitutes will have a linear indifference curve so that WTP will converge to WTA generally. The second is a theory of divergence, in that WTA>WTP when the good in question has no clear market or non-market close substitutes, so that the indifference curves are nonlinear and convex to the origin.

Our study is different, but related. We do not measure WTA and WTP but measure WTP across two states of nature, as well as actual consumption. We have at our disposal changes in consumption and changes in WTP and our interest is in understanding why when consumption of a good (chicken) decreases under a health scare (H7N9 Avian Influenza), WTP increases, decreases or remains the same. Chicken will generally have many substitutes (e.g. fish, pork, beef) so one would expect under the standard theory that there would be a strong almost linear correspondence between WTP and changes in consumption. This we do not observe for consumers in our study which suggests that either chicken is a superior good to all possible substitutes (which is highly unlikely); or when faced with a food safety risk such as H7N9 the utility from health, (which has few public or private substitutes) overrides or dominates substitution between normal goods. However, since none of our respondents actually contracted H7N9, and the risk of contraction was very small, the utility of health adjustment can only be attributed to cognitive elements and risk perception. This is what we explore in this article.

On Feb 19, 2013 a new type of avian influenza (AI), H7N9, was reported in Shanghai, and once again Chinese consumers were faced with a food scare. Unlike the SARS (severe acute respiratory syndrome) epidemic 10 years ago, H7N9 virus showed no signs of human-to-human transmission, and the source of human infections was unclear with about 40% of the patients having no obvious contact with poultry. Up to May 2014, China reported more than 200 human H7N9 cases. According to the ministry of agriculture, the outbreak of the H7N9 virus caused a loss of more than 40 billion Yuan (6.5 billion US dollars) to China's poultry industry as demand for chicken plummeted. To date no vaccine has been launched, and many Chinese consumers are fearful of this unknown risk. It is difficult to assess the potential economic impact of AI because the H7N9 virus itself is not sufficiently understood and people’s response to an outbreak is uncertain. Following numerous food safety incidents in China, Ortega et al. (2011) note that consumer concerns are at an all-time high.

Although our focus is on Chinese consumers, understanding consumers’ behavioral and economic response to health risks, such as H7N9 is important to understanding food markets in general, including farm-to-fork linkages. Over the past two decades, China’s poultry consumption from the urban population increased by 214% from 3.42 kg per capita in 1990 to 10.75 kg per capita in 2012. Although China’s poultry production has grown from 12.08

million tons in 2000 to 17.09 million tons in 2011, it still cannot meet the growth in demand. China has imported more poultry products since it joined the WTO in 2001. For example, in 2012, the net import of poultry meat (HS code 0207) was 0.33 million tons (9.09 billion US dollars) compared to a deficit of -1.46 million tons in 1992. As a result, China's domestic poultry market is directly linked to the international market. Along with this large emerging consumption market, domestic poultry production is still dominated by small farmers. In 2011, there were 25.08 million small broiler chicken farmers whose scale per year was less than 2000 chickens and who are particularly vulnerable to systemic shocks such as Avian Influenza.

The particular problems at the industry level include the physical recall of contaminated product (e.g. Khanet al., 2001), damage to perceived reputation and quality, the costs of product liability litigation (Buzby et al., 2001; Lenain et al., 2002), the loss of market value of company stock (Salin and Hooker, 2001; Wang et al., 2002) and the loss of export markets (Nitsch and Schumacher, 2002; Scott, 2004). At the consumer level, fear, risk and vulnerability are important economic determinants of response to food safety. Fear is an emotional response of agitation and anxiety caused by the presence or imminence of danger; risk refers to the possibility of suffering harm or loss or some other measure of danger; vulnerability is the susceptibility of an individual, market or economy to physical, emotional or economic injury. By being susceptible, vulnerability encompasses a sense of likelihood. This likelihood establishes the risk of harm, and it is the risk of harm based on objective measures of probability, or the perceived risk of harm based on subjective probabilities, that gives rise to affect, a feeling of good or bad (Killias and Clerici, 2000; Slovic, 2002).

Risk perceptions as defined by Slovic (2001, 2004) are based on affective responses to risk assessments factors referred to as dread (catastrophe, fatalism, controllability, equitable distribution of risks, voluntariness, and risk to future generations) and unknown risks. Becker and Rubinstein (2004) base their economics (of terrorism) on a rational choice model in which marginal utility remains constant over risky states while fear changes the marginal utility in each state. In other words, 'fear depreciates utility from consumption' and by generating fear, even in low probability events, the economic impacts may not be inconsequential.

Investigating the impact of risk perceptions such as fear and trust on food consumption has been a topic of considerable interest to economists. Prevalent in the existing literature (e.g. Hayes et al., 1995; Brown et al., 2002; Wang et al., 2008; Ortega et al., 2012) are questions such as: do consumers respond to food safety risk differently? How do risk perceptions impact food demand? What is the role of governing authorities in communicating risk and restoring consumer trust? Are the economic costs of foodborne diseases of significant scale that sufficient public and private investment in identifying, mitigating, and regulating food safety are justified? Despite these efforts the dynamics of food consumption and the relationship between consumption shocks and food demand are still not well understood.

In this article we develop questions related to the consumption of chicken before and during the H7N9 epidemic in 2013. In 2012 we surveyed 860 consumers in seven Chinese cities to gain a general understanding of chicken consumption, food safety and by stated preferences, their WTP for safe chicken in the generic sense. With the onset of the epidemic in 2013 we contacted the same consumers, recording again their chicken consumption, but queried their WTP with specific wording related to H7N9. Through this two-round survey of Chinese consumers, we are able to measure with specificity the incremental impact of H7N9 on actual quantities of chicken consumed, and changes to their WTP for 'safe' chicken. That we can observe significant differences in consumption or WTP is largely because food safety has a strong credence component resulting from an ambiguous causality between eating a food product and getting sick (Caswell and Mojduska, 1996). With credence individuals need more than personal experience to judge the safety of a food item, and often rely on third party information (e.g. the supplier or government) to regain trust and reduce uncertainty (Bocker and Hanf, 2000; Lang and Hallman, 2005).

We are able to link these measures to local incident reports of H7N9; i.e., the local amplification of risk (Pidgeon et al., 2003) and the perception that with increased concentration of probability also comes an increased possibility of harm (Loewenstein et al, 2001). In many cases, how consumers respond to a food risk is a matter of judgment and affect with an effective response determined by how one perceives the goodness or badness about an event or stimulus (Finucane et al., 2000; Slovic et al., 2004), what images they form of the disease (Jackson, 2006) or the availability of risk (Tversky and Khaneman, 1973). In addition, with the 2013 survey we included a number of questions to measure risk perceptions (affect) along the lines of Kraus and Slovic (1988). While not often used to investigate risk perceptions related to food quality or food scares, Hallman et al. (2003) have used similar queries to understand consumer attitudes towards genetically modified food, Turvey et al. (2009) to investigate consumer response to Mad Cow disease, and Turvey et al (2010) to investigate risk perceptions on hypothetical incidents of agroterrorism and Bird Flu.

This article quantifies the effect of consumer risk perceptions induced by bird flu on their demand. It sheds light on these issues with several important contributions. First, we measure the actual reduction in consumption and stated change in WTP due to an observed contemporaneous AI shock. By exploiting the 2013 outbreak of H7N9 and replicating the 2012 survey with the same respondents, we provide a rare glimpse into consumer behavior that can't easily be replicated in a laboratory setting. Second, we take advantage of the change in measured WTP between 2012 and 2013 to investigate the relationship between Marshallian and Hicksian demands to identify relative welfare shifts amongst consumers. In our context WTP represents the maximum amount of income that the consumer is willing to give up to consume an amount of 'safe' chicken equivalent to what is normally purchased or consumed under normal conditions. Because the WTP captures the compensating variation required to return the consumer to a steady state chicken consumption level, the Hicksian measure reflects the relative change in utility between the 2012 and 2013 states of nature. It therefore captures an indirect and relative measure of welfare loss.

The third contribution, and perhaps most important, is the econometric investigation of the effects of risk perceptions and trust on changes in chicken consumption and changes in WTP. We find that with the introduction of H7N9 the correspondence between Marshallian and Hicksian demands is not conforming for some individuals, and that changes in consumption and changes in WTP can be linked directly to perceptions of risk. These results suggest that food safety cannot be remedied by market forces alone, and to consider problems of food safety in the absence of psychological considerations may prove fruitless. The fourth contribution is related to this, with a finding that consumers' heterogeneous responses to food safety risks in different cities appear to support psychological models of risk attenuation and amplification.

Theory and Methodology

One important aspect of affect is an inverse relationship between perceived costs and benefits (Finucane et al., 2000; Fischhoff et al., 1978; Alhakami and Slovic., 1994). Affect is determined in part not only by what people think about a stimuli but also what they feel about it (risk as feelings, Loewenstein et al., 2001). If for example people feel dread over the thought of a contaminated food then they will perceive that risk as being high and thus the benefits from consumption low. This response is independent of the actual probabilities that the stimulus is harmful or beneficial. These cognitive considerations have important implications for economic analyses, especially in the context of revealed preference and WTP.

It is generally believed that revealed preference as an axiom is sufficient grounds to construct a utility function (Varian, 1984), but how does one get there? For example, credence attributes about a product cannot determine the product's quality even after it is purchased because information is so imperfect that the markets for quality do not function well (Caswell and Mojduszka, 1996). Ellsberg (1961) comments that ambiguity refers to a quality depending on the amount, type, reliability and unanimity of information that gives rise to one's degree of confidence in an estimate of relative likelihoods; thus if each individual observes a risk situation that is independent of the risk situations observed by all other individuals then there will be as many measures of uncertainty as individuals and these may be widely dispersed. Pfeffer (1956; cf Houston 1964) keeps it rather simple' "Risk is a combination of hazards and is measured by probability; uncertainty is measured by a degree of belief. Risk is a state of the world; uncertainty is a state of the mind" (Houston 1964, page 514).

In our empirical investigation to follow we have two critical measures for 2012 and 2013. The first is the actual consumption of chicken as revealed by respondents and the second is WTP for safe chicken. We define price-quality pairs p,q for normal conditions in which chicken is deemed safe, p^*,q^* for generic food risks surveyed in 2012, and p^{**},q^{**} for the specific H7N9 food risk surveyed in 2013. The constant Marshallian food consumption is denoted by x_y with the y subscript indicating income; x_u refers to utility-constant Hicksian demand. The measured chicken consumption capture the Marshallian demand for chicken under market conditions including a quality differential which may be endogenous to price.

$$(1) \quad \Delta x = x_y^{2013}\left(p^{**}, q^{**}, y\right) - x_y^{2012}\left(p^{*}, q^{*}, y\right)$$

The change in consumption if due to price effects holding quality constant would be related to movements along a single demand curve, but if prices are relatively constant and the change is in quality then the change in demand will be shifting from one demand curve to another in price-quantity space.

The second measure is the change in WTP between 2012 and 2013 which captures changes in expenditure holding utility constant at some reference utility u with $du = 0$. It may be convenient to think of this utility function in the form of $u = u\left(p, q, x\left(p, q\right), X^{-1}\right)$ with $\left(x, X^{-1}\right)$ capturing the substitution between the reference good (chicken) and other goods, X.

$$\begin{aligned}
&\Delta WTP = WTP^{2013}\left(p^{**}, q^{**}, u\right) - WTP^{2012}\left(p^{*}, q^{*}, u\right) \\
(2) \quad &\Delta WTP = \left[e\left(p^{**}, q^{**}, u\right) - e\left(p\ , q, u\right)\right] - \left[e\left(p^{*}, q^{*}, u\right) - e\left(p, q, u\right)\right] \\
&\Delta WTP = e_{2013}\left(p^{**}, q^{**}, u\right) - e_{2013}\left(p^{*}, q^{*}, u\right)
\end{aligned}$$

Under baseline conditions the expenditures on chicken are given by $e\left(p, q, u\right)$ from which the envelop theorem provides the utility-constant Hicksian demand curve, $x_u\left(p, q, u\right)$. If utility is maximized under uneventful quality conditions the Hicksian demand will approximately equal the Marshallian demand, i.e. $x_u\left(p, q, u\right) \approx x_y\left(p, q, y\right)$. But this is not the case under the generic food safety WTP queried in 2012 or the specific H7N9 event in 2013. The change in ΔWTP is capturing the changes in the Hicksian demands as food quality changes relative to the utility maximizing initial condition, i.e. $\left[x_u^{**}\left(p^{**}, q^{**}, u\right) - x_u^{*}\left(p^{*}, q^{*}, u\right)\right]dp$; if there is no change in the Hicksian demand there will be no change in the WTP, but the larger the change in Hicksian demand to maintain initial utility the larger will be the change in WTP.

Changes in WTP

Crucial to our problem is the understanding of the factors involved in changes to WTP when a specific risk materializes (H7N9) in comparison to generic food safety risks. Our empirical analysis shows that a considerable number of consumers lowered their WTP in 2013, which suggests a lower perception of risk than the more ubiquitous generic risk asked in 2012. Here similar to Hu et al. (2011), we assume linear utility with random effects because of its simplicity and because it provides the means to assess changes in WTP in light of changes in food quality and risk perceptions.

We assume the utility is additively separable with a deterministic term and a random term. The 0-state is the status quo or normal conditions while the 1-state captures the risk concern; y is income, z is a vector of household characteristic, q is quality in either state, $\omega(q)$ is a vector of quality-conditional perceptions of risk perception, knowledge and trust, and ε is white noise that might affect choice in either state. The $\omega(q)$ vector is critical to any psychometric measure of WTP. The elements of ω are not demographic or related variables but specific variables related to fear and trust and knowledge. How these materialize in terms of WTP depends largely on characteristics of q which is quality metric, and how q is observed by, and/or communicated to the respondent; q is exogenous to the consumer but factors about q such as the frequency, intensity, duration, or lethality of a outbreak will impact or interact with risk perceptions. In a multitude of ways, $\omega(q)$ is largely unobservable without direct questioning. The utilities are captured by

(3) $u_0\left(y, z, q_0, \omega_{0,}\varepsilon_0\right) = v_0\left(y, z, q_0, \omega_0\right) + \varepsilon_0$

(4) $u_1\left(y - WTP, z, q_1, \omega_1, \varepsilon_1\right) = v_1\left(y - WTP, z, q_1, \omega_1\right) + \varepsilon_1$

and it is assumed that $u_1\left(y - WTP, z, q_1, \omega_1, \varepsilon_1\right) \geq u_0\left(y, z, q_0, \omega_0, \varepsilon_0\right)$. Assuming linear utility, in the Hicksian domain utilities in each state must be equal. Hence, to determine WTP,

(5) $\alpha_1 z + \gamma_1 \omega\left(q_1\right) + \beta\left(y - WTP\right) + \varepsilon_1 = \alpha_0 z + \gamma_0 \omega\left(q_0\right) + \beta y + \varepsilon_0$

and

(6) $$WTP = \frac{(\alpha_1 - \alpha_0)z + (\gamma_1 \omega(q_1) - \gamma_0 \omega(q_0)) + (\varepsilon_1 - \varepsilon_0)}{\beta} \geq 0$$

We now add in the refined states, that is, instead of a generic food safety risk, the risk is specifically identified (in our case H7N9),

(7) $$u_1^*\left(y - WTP^*, z, \omega_1^*, q_1^*, \varepsilon_1^*\right) = \alpha_1^* z + \omega_1^*\left(q_1^*\right) + \beta\left(y - WTP^*\right) + \varepsilon_1^*$$

Solving for WTP^* against the 0-state as was done in (5)

(8) $$WTP^* = \frac{\left(\alpha_1^* - \alpha_0\right)z + \left(\gamma_1^* \omega_1^*\left(q_1^*\right) - \gamma_0 \omega_0\left(q_0\right)\right) + \left(\varepsilon_1^* - \varepsilon_0\right)}{\beta} \geq 0$$

And then subtracting (6) from (8)

(9) $$\Delta WTP = WTP^* - WTP = \frac{\left(\alpha_1^* - \alpha_1\right)z}{\beta} + \frac{\left(\varepsilon_1^* - \varepsilon_1\right)}{\beta} + \frac{\left(\gamma_1^* \omega_1^*\left(q_1^*\right) - \gamma_1 \omega_1\left(q_1\right)\right)}{\beta}$$

As a welfare metric, ΔWTP is a crucial measure. With WTP non-negative in general, the change in WTP can be either positive or negative depending on the relationships between the marginal utilities of the explanatory factors as the nature of risk changes. Because all 3 terms are additive, any combination of utility change can cause ΔWTP to be positive or negative. We will return to using generic food safety risk (2012) and H7N9 (2013) in this discussion. The α, γ and β parameters capture the marginal utilities of being (household and demographic), of the food safety risk (generic or H7N9) and income respectively. The marginal utility of income is assumed constant for each individual, but could differ across individuals so it is possible changes in income can be attributed in part to income effects, with higher marginal utilities for income leading to lower change in WTP, all other things being equal. It is also possible that changes in demographics and household characteristics can affect ΔWTP. It is also possible that no changes took place either within the household, in the environment, or in the perception of risk. Thus $\alpha_1^* - \alpha_1 = \varepsilon_1^* - \varepsilon_1 = \gamma_1^* \omega_1^*\left(q_1^*\right) - \gamma_1 \omega_1\left(q_1\right) = 0$ and $\Delta WTP = 0$.

The term $\gamma_1^* \omega_1^*\left(q_1^*\right) - \gamma_1 \omega_1\left(q_1\right)$, however, is central to our analysis and the underlying economics. In terms of quality for example, if the marginal (dis)utility from the H7N9 state relative to that of the generic state exceeds the quality quotient of the initial state over the

H7N9 state, i.e. $\frac{\gamma_1^*}{\gamma_1} > \frac{\omega_1(q_1)}{\omega_1^*(q_1^*)}$, then WTP will increase. This is the credence value discussed in Caswell and Modjudka (1996). If $\gamma_1^*\omega_1^*(q_1^*) > \gamma_1\omega_1(q_1)$ the consumer perceives the risks of H7N9 greater than the generic risk and WTP will increase. This can occur even if such concerns are not rational from a biomedical point of view. Non-linearity can also enter the relationship through $\frac{\partial\omega_1^*(q_1^*)}{\partial q_1^*}$ or $\frac{\partial\omega_1(q_1)}{\partial q_1}$ which can be of any sign and determined by risk communication, hype, or ignorance. Knowledge can attenuate the risks in multiple dimensions to create fear and dread and perhaps mistrust of authorities. On the other hand, $\gamma_1^*\omega_1^*(q_1^*) < \gamma_1\omega_1(q_1)$ suggests that that knowledge of H7N9 actually decreases the perception of risk. This could be due to the ambiguity of risk. If one considers the generic nature of the 2012 inquiry it is possible that the respondents considered many unknown risks, including bird flu but not knowing when, where and to what degree any particular risk might appear, the ambiguity amplifies the perception of risk. Then as risks are announced, respondents might consider the parameters of communication and revise the risks accordingly. Being notified specifically that H7N9 is a health concern, but coupled with a message that it is not endemic in a consumer's hometown can lead to a reverse amplification, in which probabilities of affliction are downwardly revised, causing risk perceptions to actually decrease.

The term $(\varepsilon_1^* - \varepsilon_1)$ captures other unobservable (white noise) factors. Generally speaking $E(\varepsilon_1^* - \varepsilon_1) = 0$ but with an inter-temporal nature to information flows and economic conditions this may not hold true. Seemingly unrelated factors such as economic growth, consumer confidence, natural disasters, and others can inadvertently impact WTP in non-systematic ways.

Relative welfare measures

We combine these various concepts to provide a measure of the percentage change in the Marshallian demand given a percentage change in WTP. This elasticity measure is given by

$$\eta = \frac{\dfrac{x_y^{2013}\left(p^*,q^*,y\right)-x_y^{2012}\left(p,q,y\right)}{x_y^{2012}\left(p,q,y\right)}}{\dfrac{WTP^{2013}\left(p^{**},q^{**},u\right)-WTP^{2012}\left(p^*,q^*,u\right)}{WTP^{2012}\left(p^*,q^*,u\right)}}$$

(10)

$$= \frac{\dfrac{x_y^{2013}\left(p^*,q^*,y\right)-x_y^{2012}\left(p,q,y\right)}{x_y^{2012}\left(p,q,y\right)}}{\dfrac{\left[e\left(p^{**},q^{**},u\right)-e\left(p^*,q^*,u\right)\right]}{\left[e\left(p^*,q^*,u\right)-e\left(p,q,u\right)\right]}}$$

With boundaries, $\eta \in \left(-\infty,\infty\right)$ this elasticity provides a measure of relative (in comparison to absolute) welfare loss from a food risk. In the standard theory this ratio would be negative, that is an increase in WTP would correspond with a decrease in quantity consumed, and this might be linear to some scale. However, the Hicksian demand, or expenditures derived from Hicksian demand are actually comprised of an additional demand component, health. Thus the expenditures do not only represent a demand for a return to consumption of chicken, but also include, endogenously, a demand for safe and health food. While chicken has close substitutes priced in a market, health itself is a non-tradable, non-market good for which a near-linear indifference curve cannot be expected. Substitutability for health can only be expressed through consumption changes in chicken, but the intensity of fear about poor health will be captured in the WTP.

The denominator of equation (10) measures the relative change in incremental expenditures consumers are willing to make in order to reduce risk to the initial welfare measure (in 2012). Thus the elasticity measure captures the relative change in observed Marshallian demand to unobserved Hicksian demand (at least to the extent that the Hicksian demand is obtained by the derivative of the expenditure function with respect to price). If $\eta = 0$ demand response to the new H7N9 information is Marshallian neutral, and if it is undefined, $\Delta WTP = 0$, it is Hicksian neutral. We do find amongst our respondents situations in which $WTP^{2013}\left(p^{**},q^{**},u\right)-WTP^{2012}\left(p^*,q^*,u\right)\leq 0$ which is a curious outcome, especially since we find no consumer willing to increase consumption in the presence of H7N9. If this holds with a strict equality then consumers are not differentiating the risk from H7N9 from other generic food safety risk, and the elasticity measure is undefined because of Hicksian indifference. But if WTP decreases, this could signify that consumers do not perceive H7N9 as being more risky than generic food safety risks. This would be indicated by a non-negative elasticity measure for $\Delta x \leq 0$. If $\eta = 0$ then $\Delta x = 0$, which indicates that consumers have not reduced consumption or changed Marshallian demand, even though there is a change in Hicksian demand. When $\eta = -1$ the percentage change in WTP exactly offsets the change in Marshallian demand. However, because of the integrability condition this should not be interpreted as 1:1 tradeoff between Hicksian and Marshallian demand but rather as demand falls consumers would be willing to pay an equivalent amount to restore consumption to initial levels. For $-1 < \eta < 0$ the change in Marshallian demand is less than the change in WTP indicating that for consumers in this region the utility loss from quality exceeds the utility loss from consumption. They are less likely to consume chicken. In contrast if $\eta < -1$, the change in consumption exceeds the change in WTP for safety. To varying degrees these consumers will have a guttural response to food safety and their own personal health well in excess of their WTP for reduced risk.

These economic considerations give rise the behavioral and psychological (fear, trust) aspects of the analysis which follows. Without imposing bounds on behavior or beliefs, considerations that are common in laboratory settings, there are countless combinations of changes in consumption and WTP expressing a range of utilities (direct and indirect) that are largely dependent on behavioral factors beyond price changes. Thus, how consumers perceive the risks, how risk is mitigated or communicated, trust, and knowledge are all important considerations that need to be explored in food safety studies. The following analysis based on our event-based surveys from 2012 and 2013 aims to explore some of the factors in relation to these economic considerations.

The role of risk perceptions in economic analyses

Feeling goodness or badness about a particular risk is referred to by Slovic et al. (2004) as “affect”. If fear is defined at the level of cognition, then affect represents an impact that can exacerbate or countervail the more logical reasoning of cognition. The effect is measured by its degree of amplification which may or may not be attenuated or rational (Pidgeon et al., 2003) and may linger far longer than the life of the stimuli. In other words the economic implication of a food safety incident is dynamic (Liu et al., 1998; Caswell and Mojduszka, 1996) and may display properties of hysteresis (Turvey et al., 2010).

Animal disease epidemic and consumer food safety concerns can negatively influence meat markets. Much research has been conducted on this topic, including, for example, Burton and Young (1997) on bovine spongiform encephalopathy (BSE) in the beef market in Great Britain, Lim et al. (2013) on a similar issue in Canada, and the AI in the U.S. by Turvey et al. (2009). Some studies showed that the marginal impact of risk on meat demand was small, with short-lived lagged effects on demand (Smith et al., 1988; Dahlgran and Fairchild, 1987; Robenstein and Thurman, 1996; Lusk and Schroeder, 2004; Piggott and Marsh, 2004). Dahlgran and Fairchild (1987) tested the marginal effect of negative information about salmonella contamination on chicken demand, and found the effects were less than 1%, with rapid recovery of consumer's demands. In the United States, the recent cases of mad cow revealed lower fear or higher trust amongst consumers and very little affect as markets rapidly returned to the initial equilibrium states (Schilling et al., 2004; Turvey et al., 2010). However, the limited effect may have been due to the low risk level. For example, Setbon et al. (2005) found a strong correlation between the perceived risk associated with consuming beef during the BSE crisis in France and the perceived risk reduced beef consumption.

Recently, studies have integrated risk perceptions such as trust and fear into economic models (e.g. Meijboom et al., 2006; Hassouneh et al., 2012). Heterogeneous consumer risk perceptions have been suggested and tested in the existing literature. Pennings et al. (2002) found that differences in risk perceptions and attitudes about BSE led to different variations in beef consumption by consumers in the U.S., the Netherlands and Germany. Another study carried by Yang and Goddard (2011) found that consumer groups in Canada responded differently to a perceived BSE food safety issue. The aggregate beef consumption of BSE impacts in Canada was different than those in the United Kingdom, Germany, and Japan (Burton and Young, 1996; Verbeke and Ward, 2001; Mazzocchi et al., 2008; Lim et al. 2013).

Furthermore, food safety risk perceptions are not only related to socioeconomic characteristics, experiences and culture but also to trust in various information sources including product labels, government, academic researchers, dieticians and physicians (Dosman et al., 2001; Lobb et al., 2007; Mazzocchi et al., 2008; Tonsor et al., 2009; Lang and Hallman, 2005). As noted by Kornelis et al. (2007), the availability of multiple sources of information does not imply that every consumer equally weights or even uses the same sources. Consumers' risk behavior is influenced by the information providers (Slovic, 1993, 1999). Some studies investigating food safety use a single food safety index (e.g. Burton and Young, 1996). In contrast, we measure consumer risk perceptions of food safety resulting from different types of fear and different sources of trust which may differ amongst individuals and markets.

Survey for Food Safety (2012) and H7N9 (2013)

The main purpose of this article was to discuss the impact of China's bird flu (H7N9) on consumer demand for chilled chicken (rather than live chicken) in 2013. In doing so, we compared consumers' behavior "without AI" in 2012 and "with AI" in 2013. The survey was fielded in seven Chinese cities including: Nanjing, Changzhou, Zhenjiang, Lianyungang, Linyi, Zaozhuang, and Chengdu. In 2012, a total of 1000 people were surveyed , and 86% of them replied. In 2013, 94% of the 860 samples (surveyed in 2012) also replied to a follow up survey. In total, we use a final sample size of N=802 participants. The attrition is mostly due to lack of time to answer all the questions. All individuals in the sample indicated that they ate chilled chicken before the outbreak of H7N9. In return for participating, each subject was offered a payment of 50 Yuan in both 2012 and 2013.

The surveys were administered to the same group of respondents in April 2012 and 2013. In 2012 we asked generic questions regarding food safety in chilled chicken without any mentioning of bird flu and in 2013 in the midst of the outbreak we resurveyed the group again. Since these respondents were surveyed both times (before and after the bird flu outbreak), the data formed a "natural experiment". The survey in 2012 was a "food safety" survey which contained questions regarding the WTP for a "safe chicken", actual consumption of chicken per week, education, income and other demographic information (e.g. gender, age). The survey in 2013 was in April which was within 60 days of the 2013 bird flu outbreak. In addition to the WTP for a "safe chicken" and actual consumption of chilled chicken per week, the questionnaire in 2013 also contained the question about the information, knowledge, fear and trust regarding H7N9.

In order to calculate the WTP, we assumed that there were two types of chilled chicken on the market. One was ordinary chicken, which had an average chance of being contaminated. The other was safe chicken which was treated by ozone disinfection, a substance mainly used to control bird flu. The latter is a relatively new product which is usually sold at higher price than traditional chicken but tastes no different. Both surveys began with moderators providing each subject with a neutral description of the food irradiation process. We labeled the ordinary chilled chicken at 30 RMB per chicken (1.5 kg). This represented the average chilled chicken price in the supermarkets of the seven cities. Then we asked the WTP for "safe chicken". Respondents were asked to indicate a value among 0, 10, 20 and 30 RMB above the ordinary chilled chicken price which is the "usual price difference".

In the 2013 survey, the same respondents (contacted by telephone) were asked whether they were willing to pay for an increased price of "safe" chilled chicken. In the face of the AI outbreak, the respondents were presented the same WTP questions as were in 2012. Respondents were also allowed to enter an amount they would be willing to pay. All those who did not choose from the offered premiums indicated a higher amount. The mean of the higher amount was around 42.8 RMB and the standard deviation was about 19.8 RMB (min=35 RMB and max=70 RMB).

In the original 2012 survey, surveyors interviewed respondents at random in front of major supermarkets during both weekends and week days. Stratified sampling is applied. We selected two supermarkets in every city, one being a low end domestic supermarket (e.g. Suguo), the other being a high end international supermarket (e.g. Carrefour). About 60 consumers were surveyed randomly in each supermarket. The sampling strategy for conducting interviews in the downtown area of the seven cities does not allow the sample results to be generalized to the Chinese population as a whole; however, such a sample may be appropriate for studying risk perceptions.

Up to April 17, 2013, a total of 77 cases of H7N9 human infection had been confirmed, including 16 deaths. A total of 30 cases, including 11 deaths, were confirmed in Shanghai; 20

cases, including two deaths, were in Jiangsu province; 21 cases, including two deaths, were in Zhejiang province; three cases, including one death, were in Anhui province; one case was in Beijing; and two cases were in Henan province. Chinese officials actively responded to the infection, and introduced preventative and control measures. Shanghai, Nanjing, and some other cities suspended live poultry transactions and prohibited the entry of exotic live poultry. According to outbreaks of H7N9 in 2013, we divided the seven cities (where we have surveyed in both years) into three types: cities in the “high incidence” province (Nanjing, Changzhou, Zhenjiang, and Lianyungang), cities in the “low incidence” province (Linyi and Zaozhuang) and cities in the “zero incidence” province (Chengdu). Nanjing, Chengdu and Linyi were selected to represent larger cities, Changzhou and Lianyungang represented medium-sized cities, and Zhenjiang and Zaozhuang for smaller cities. There were 129, 110, 99, 109, 129, 100, and 126 observations in Nanjing, Changzhou, Zhenjiang, Lianyungang, Linyi, Zaozhuang, and Chengdu respectively.

Surveyors (students from local colleges) were trained to collect data at supermarkets in April 2012. In April 2013, the surveyors carried out a 15~30 minute follow-up telephone interview with the consumers who were intercepted in 2012 and whose contact information was kept. Repeated calls were placed until respondents agreed to participate again in 2013.

In the survey of 2013, we added questions about fear and trust for H7N9 (see table 1). In accordance with Kraus and Slovic (1988), we designed seven questions with answer 1 to 5 (strongly agree=5, agree=4, Neutral=3, disagree=2, strongly disagree=1) to reflect the characteristics of fear: (1) *I would not eat any other new food*; (2) *Consuming AI infected chicken would kill me immediately*; (3) *AI risk cannot easily be reduced or controlled*; (4) *AI risk is increasing*; (5) *AI can kill many people*; (6) *AI is contagious among humans*; and (7) *I am personally at risk of contracting AI*. In table 1, most of respondents thought it is fatal if they eat infected chicken (mean of question “*consuming AI infected chicken would kill me immediately*” is 4.04), but personally believe they are not at risk (mean of question “*I am personally at risk of contracting AI*” is 2.56).

To determine how specific information sources may influence consumer behavior, consumer trust (strongly trust=5, trust=4, Neutral=3, mistrust=2, strongly mistrust =1) on nine information sources were surveyed, they were (1) ministry of agriculture, (2) ministry of health, (3) research institutes, (4) local government, (5) TV news, (6) network news, (7) scholars, (8) friends/family/relatives, and (9) chicken sales staff. We found that, research institutes and ministry of health were relatively trusted by consumers and chicken sales staffs were always distrusted.

We also investigated consumer knowledge in 2013 by asking five knowledge questions about N7H9. That is, where does H7N9 virus come from? How long is the dormant period of H7N9? What are the common symptoms of human H7N9 infection? Do you know the antigenic variation of H7N9? What are the transmission routes of H7N9? Generally each respondent answered more than two questions correctly. Each time consumers answered a question correctly, a counter variable takes one. The mean and standard deviation of the counter variable are 2.39 and 1.27 respectively.

Furthermore, a subset of participants was randomly subjected to one of three information treatments. The first provided no additional information on H7N9. The two other treatments were designed to communicate positive and negative images of H7N9 which could either decrease or increase risk perceptions. For the risk-perception reducing information respondents were told that experts pointed out that, in general, "*the AI virus is not strong enough to resist the external environment, high temperature, UV light, various disinfectants, and is easy to be killed. The virus can be eliminated in one minute at 100 ^{o}C. The chicken can be safe to eat after being cooked thoroughly*". Risk-perception elevating information included the statement "*the incubation period of the H7N9 virus is generally less than 7 days. The disease can progress rapidly, although transmission of H7N9 virus between human beings has not been reported yet, there is a risk that mutations in the virus could ease the spread*". As a hypothesis, risk reducing information was to build trust while risk-perception elevating information was generally associated with fear. The risk-perception reducing and risk-perception elevating treatments were each assigned to 20% of the samples, while the remaining 60% were not provided with any new information about H7N9. In every supermarket, there is only one surveyor. He/she was asked to finish 15 questionnaires per day. Every day, he/she took 5 "risk-perception reducing treatment" questionnaires, 5 "risk-perception elevating treatment" questionnaires, and 5 "no treatment" questionnaires. All 15 questionnaires were sorted randomly by the organizer in advance. The surveyors deployed the questionnaires (from the 1st to the 15th) accordingly.

In our survey, over 40% of respondents were main shoppers in their households. About half were female and the average age was 38.73. Nearly half of the respondents (47%) had 13 to 16 years of education. The average monthly pre-tax income per adult in 2013 was 4579 RMB ($U.S. 727). The average family size was about 4 persons.

In this section we provide an overview of results related to changes in chicken consumption and WTP between 2012 and 2013. With the exception of H7N9 in 2013, the economic and food safety conditions were unremarkably similar, so that as an 'event' the emergence of avian influenza can be viewed as a systemic treatment effect. This treatment effect is later modified in the econometric analyses to capture local effects at cities in which AI was endemic and those where no bird flu was recorded. Table 2 cross-tabulates the actual change in chilled chicken consumption per week (one chicken is 1.5 KG). The first observation is that no individual surveyed increased chicken consumption over the period. Only 18.2% (N=146) remained at the same consumption level. Overall, the effects of H7N9 caused approximately 82% of the consumers decreasing chicken consumption, with 56% (N=449) halting consumption entirely.

Table 3 compares WTP for the two years. Since the price of regular chicken was 30 RMB, an indication of 30RMB implies a 0 premium for safe chicken. In the upper off-diagonal and in the last column it is shown that 47% (N=377) of respondents increased their WTP, including some 31.1% (N=250) who's WTP exceeded 60RMB. Along the diagonal approximately 25% (N=202) of respondents did not change WTP between 2012 and 2013 and in the lower off-diagonal 29% (N=233) actually reduced their WTP.

Table 4 combines the relationships in Tables 2 and 3 by matching chicken consumption in 2012 with WTP in 2013. Virtually all categories indicated decreased consumption between 2012 and 2013 with the only exception of the 30 RMB (zero premium) for the 0.25 chicken category. This is because of a reduction in other categories, e.g. from 1 chicken to 0.25 chicken. The critical observation, however, is in the 0-chicken column which shows that 449 consumers would not choose to consume chicken, even though they had a positive WTP for safe chicken. Of these, 55.7% (N=250 or 31.2% of all consumers) would be willing to pay more than 60 RMB, a premium of more than 30 RMB above market prices for safe chickens.

Econometric Specification

The characteristic demand theory presented by Lancaster (1971) assumes that products are consumed because of the utility derived from their characteristics. Food safety is an attribute valued by consumers (Antle, 1996; Wang et al., 2008). Consumers' actual consumption and stated WTP for each attribute (e.g. safety) can therefore be isolated.

At first, we used a simple linear model to analyze the impact of fear and trust on actual consumption. $Cons_{2013}$ is the consumption for chicken in 2013. *Fear* and *Trust* are vectors of observable characteristics of individual risk perceptions respectively. *Z* is the vector of control variables such as: (1) knowledge about the AI; (2) new information about the AI; (3) city dummies for controlling the AI incidence and price differences; (4) other basic characteristics including gender, age, family size, the proportion of children, the proportion of elder, education and income; and (5) lagged consumption and WTP to identify the initial demand. μ is a random variable accounting for unobservable characteristics. The model can be written as:

$$(11) \quad Cons_{2013} = \beta_0 + \beta_1 \cdot Fear + \beta_2 \cdot Trust + \beta_3 \cdot Z + \mu_1$$

Second, we calculated the stated WTP and also used a linear model to analyze the effect of fear and trust. WTP_{2013} is the WTP for safe chicken in 2013. The independent variables in equation (12) are the same as in last equation.

$$(12) \quad WTP_{2013} = \beta_4 + \beta_5 \cdot Fear + \beta_6 \cdot Trust + \beta_7 \cdot Z + \mu_2$$

Estimated Results

White's test indicated heteroskedasticity (due perhaps to subgroup differences), so we estimated the models using FGLS (feasible generalized least squares) but found that the results did not change materially from OLS estimation techniques (see Appendix A).

Table 5 presents the result for consumption and WTP in 2013 and the change in consumption and change in WTP between 2012 and 2013. Because the estimated coefficients (marginal effects) are virtually identical using either consumption in 2013 or the change of consumption Cons (Δx in equation 1) between 2012 and 2013 as the dependent variable, we discuss only the results for the actual consumption in 2013. The same argument applies for WTP.

We would generally expect a variable to have opposite signs in consumption and WTP, and this is what we find for the most part. Three risk perception variables were significant: "*Eating AI infected chicken will immediately kill me*" is a measure of dread. The more consumers believed in this statement, the lower consumption (β=-0.045) and the higher WTP (β=2.718) was. Respondents who perceived the incident to be on the rise would decrease consumption and increase WTP (β=-0.018, β=3.913). A rising incidence of AI might signify loss of control by consumers and the government. Duration and intensity might also be captured by "*AI is contagious among humans*" which led to a decrease in consumption, but had no effect on WTP. Variables "*AI can kill many people*" and "*I am personally at risk of contracting AI*" were not significant in either equation, suggesting that consumers might find it difficult to internalize risk, or even death, from AI. This is quite different from the significant variable "*Eating AI infected chicken will immediately kill me*" which was conditioned on actually eating infected chicken. In other words, while consumers might believe that eating an infected chicken would lead to death, this might not be the same perception as the more ubiquitous risk of harm without the knowledge of consumption.

The extent by which consumers trusted information and information sources could also be important determinants of consumption and WTP. However, our results did not reveal this relationship. Consumers who generally trusted the research institutes, friends and relatives would consume less. This might signify a loss in confidence in these sources. Likewise, significant reductions in WTP, not actual consumption, were related only to trust in local government.

What appeared to be the most significant effect was the amplification of risks associated with specific cities. In the high incidence cities of Nanjing, Changzhou, Zhengjiang and Lianyungang, consumption was negatively affected by being in these cities compared to being in the zero-incidence city Chengdu (the omitted category in the regression). In Zhengjiang the amplification of risk actually led to an increase in WTP (β=19.345) compared to those in Chengdu. The impact on WTP was not significant for Nanjing and Changzhou, but negative for Lianyungang (β=-11.300). For low incidence cities Linyi, there was no significant impact on consumption compared to Chengdu, but significant reductions in WTP (β=-30.220). Although somewhat mixed, relative to expectations, the results are generally supportive of an amplification response to consumption and WTP due to the different levels of exposure to AI in the cities studied.

Relative to no additional statement at all, providing either risk-perception reducing information or risk-perception elevating information had negative impact on consumption (β=-0.049 and -0.033 respectively). It appeared that providing any details about H7N9, whether positively or negatively led to heightened perception of risk thus lower consumption. The group seeing additional information did not change their WTP. Knowledge about H7N9 appeared to have no effect on consumption or WTP.

Robustness Checks

We conduct a number of robustness checks on results in Table 5. These include endogeneity, parsing of variables, change-in-form of dependent variable, and principal components.

Endogeneity and heteroskedasticity

In Table 5, we found that lagged consumption had a significant positive effect on $Cons_{2013}$, while lagged WTP did not impact WTP_{2013}. However, in the survey, we did not query whether consumers with a higher WTP decreased consumption, or whether those with decreased consumption had a higher WTP. To check for endogeneity we used the Hausman test which failed to indicate an endogenous relationship between WTP and consumption. To support this we provided results from a 3SLS analysis in appendix B with $Cons_{2013}$ and WTP_{2013} as endogenous variables. The 3SLS model showed that $Cons_{2013}$ and WTP_{2013} did not impact each other simultaneously. Furthermore, the 3SLS model did not qualitatively change the main results in Table 5.

In Appendices C-F we presented restricted variable models on consumption, WTP and changes. In Models I, VI, XII and XVI we restricted the models only to include demographic variables, and found virtually no explanatory power. The Wald test showed at best a weak relationship and the R-square values never exceeded .035. The statistical evidence confirms our view that consumption, WTP and their changes could not simply be explained by demographics alone.

In Models II, VII, XIII and XVII we restricted the risk perception variables to be zero. In all cases the Wald statistic indicated the collective significance of these variables but the R^2 statistic dropped in all equations compared to those in Table 5. An important observation in models with risk perceptions unrestricted and with trust, cities, and stimulus variables restricted, the signs and significance of the risk perception variables remained the same. Thus, we conclude that the risk perception variables were robust to model specification.

Models III, VIII, XIV, and XVIII restricted the trust variables, and again in all models the Wald statistic indicates that collectively, trust contributes to the explanatory power of the regressions, although we note that the drop in R-square from the baseline regression in Table 5 is significantly smaller. Indeed, as with the baseline results in Table 7, when various variable groupings were excluded the trust variables did not materially improve in explaining consumption and WTP. This confirms our previous conclusion that trust may not be as powerful an influence on food consumption and WTP as the risk perception variables.

The city incidence variables are also important. Collectively restricting the city dummy variables to zero (Models IV, IX, XV, XIX) affects the explanatory power of the base regression (Wald statistics are significant). The respective R-square for base model and restricted regression across models are (0.624, 0.496), (0.240, 0.100), (0.513, 0.151), and (0.231, 0.049) respectively. These results show the robustness of our main results. In combination with the risk perception variables the evidence is clear, and robust to model specification that when it comes to food consumption and WTP risk perceptions and the social amplification of risk as measured by the endemic nature of H7N9 dominate choices.

Models V, X, XV and XX removed the risk perception reducing and elevating variables, to find little effect on model fit.

Parsing dependent variables

There could be nine situations for the change of consumption and WTP: ΔCons<0 &

ΔWTP<0, ΔCons<0 & ΔWTP=0, ΔCons<0 & ΔWTP>0; and ΔCons=0 & ΔWTP<0, ΔCons=0 & ΔWTP=0, ΔCons=0 & ΔWTP>0; and ΔCons>0 & ΔWTP<0; ΔCons>0 & ΔWTP=0; ΔCons>0 & ΔWTP>0. The three cases associated with ΔCons>0 did not exist in our data. Some of these cases are straightforward, but some need attention. For example, when ΔWTP=0, the shock elasticity in equation (10) is not defined.

To better understand the relationship between consumption and WTP as well as the shock elasticity, Table 6 parses the different possible combinations in ΔWTP and ΔCons into the 6 possibilities observed in our data. We present a multinomial model relative to the ΔWTP=0 and ΔCons=0 group. This is a convenient pairing since consumers with ΔWTP=0 and ΔCons=0 would exhibit both Hicksian neutral and Marshallian neutral demands. The results were very much consistent with those in Table 5 for ΔCons<0. However, for ΔCons=0 we found very little significance on the risk perception and WTP variables with *AI Risk cannot be easily controlled* and *AI is contagious among humans* being the exceptions. We did find that in terms of trust, if they trusted the ministry of agriculture, consumers were more likely to be in the ΔCons=0 group, regardless of WTP. We also noted that consumers who trusted the ministry of agriculture decreased consumption but increased WTP.

The city incidence variables also provided some interesting results, the most striking being that none of the incidence variables were significant for consumers who increased WTP but did not change consumption. For those individuals whose WTP in 2012 was lower, their WTP in 2013 increased. Yet, there was an increased likelihood that consumers with a decrease in WTP and no change in consumption came from high incidence cities. Similar levels of significance applied to the other Logit groupings (other situations). However this same regression showed that consumers with higher WTP in 2012 were included, so this may actually be a revision downwards.

Likewise, risk-perception reducing or elevating information had virtually no influence on membership of the two ΔCons=0 groups while having much stronger influence on the likelihood of being in the ΔCons<0 groups. Knowledge of H7N9 did not appear to have a strong or consistent influence on group membership.

Habit formation also had an influence on group membership. The higher the WTP observed for safe food in 2012 the less likely that membership would belong to ΔWTP>0, and would be more likely to be in the ΔWTP<0 group. This suggested that with the revelation of H7N9, consumers actually would reassess their WTP. In other words, if WTP in 2012 was high, the change in WTP would be smaller, probably because "food safety" in 2012 already took AI into overall considerations of food-related risks. Similarly, the more chicken consumed in 2012 the more likely the consumers would be in the ΔCons<0 groups.

Relative elasticity regressions

Finally we calculated relative (shock) elasticity (Eq 10) and results are given in Table 7. Here we take the absolute value of the elasticity (i.e. $|\eta|$) so that an increase in the regression coefficient would indicate increases in elasticity. A regular (irregular) elasticity is one in which an increase in WTP coincided with a decrease (increase) in consumption. There were 419 samples with a regular elasticity (denominator≠0 & $\eta \leq 0$) which came from the groups of $\Delta Cons<0$ & $\Delta WTP>0$; $\Delta Cons=0$ & $\Delta WTP<0$; and $\Delta Cons=0$ & $\Delta WTP>0$. We found that trust seemed not to be important for the shock elasticity, but $Fear_2$ (*Eating AI infected chicken will immediately kill me*) significantly enhanced the shock elasticity. There were 191 samples with an irregular elasticity (denominator≠0 & $\eta>0$) which came from the group of $\Delta Cons<0$ & $\Delta WTP<0$. We found that trust in network news would cause the irregular elasticity to increase while $Fear_2$ (*Eating AI infected chicken will immediately kill me*) had an opposite effect.

Factor analysis and principal components

Taking into account the possible existence of multi-collinearity, we extracted fear and trust factors by Principal Component Analysis. First, we calculated the Z-value for each fear and trust variables. Two "fear" factors were extracted. The KMO (Kaiser-Meyer-Olkin) value was 0.706, and the Chi-Square for Bartlett's Test was 889.336. The Eigenvalues of the first two components were greater than 1. These two factors explained 50.725% of the total variance. We defined the first factor of fear as micro-fear (or fear related to getting sick) which was composed of $Fear_6$ (score=0.719), $Fear_7$ (score=0.608), $Fear_1$ (score=0.593) and $Fear_5$ (score=0.511), and we defined the second factor of fear as macro-fear which was composed of $Fear_4$ (score=0.716), $Fear_3$ (score=0.705) and $Fear_2$ (score=0.676).

We extracted three trust factors. The KMO value was 0.818, and the Chi-Square for Bartlett's Test was 2608.522. The Eigenvalues of the first three components were greater than

1. These three factors explained 67.321% of the total variance. We defined the first factor of trust as “official-trust” which was composed of $Trust_1$ (score=0.832), $Trust_2$ (score=0.823), $Trust_4$ (score=0.764), $Trust_3$ (score=0.750) and $Trust_7$ (score=0.647); the second factor of trust was defined as “private-trust” which was composed of $Trust_8$ (score=0.775), $Trust_6$ (score=0.746) and $Trust_5$ (score=0.547); and the third factor of trust was “supplier-trust” which was composed of $Trust_9$ (score=0.932). Table 8 displays the result of the fear and trust factors to consumption, WTP as well as shock elasticities.

In the $Cons_{2012}$ and WTP_{2012} equation, both of the micro and macro fear showed significantly negative effect on $Cons_{2012}$ (β= -0.107 and β= -0.115) and significantly positive effect on WTP_{2012} (β= 7.245 and β=7.450). Official and private trust showed negative effect on $Cons_{2012}$, while trust in supplier showed positive effect on $Cons_{2012}$. In addition, the score of trust did not affect WTP_{2012}.

In the multinomial logistic regression, we found that no matter how WTP responded, fear in general would reduce Chinese consumers’ actual chicken consumption. At the same time, the reactions in their WTP were heterogeneous. This suggests that the greater the perceived risk, the more complex consumers may behave; that is, some would keep their WTP unchanged, some would be willing to pay higher premium to buy safe chicken, and some would decrease their WTP because of the mistrust in food safety. For the last case, the possible reason is that somebody may treat the so called “safe chicken” as a “Giffen good” or inferior good because they did not believe it could be as safe as it was claimed. These individuals would decrease their consumption and WTP simultaneously.

For shock elasticities, while trust may have only minimal effect, fear factors on the other hand had significant effect moving consumers to different shock elasticity groups.

Conclusion

In this article we examined the psycho-economic impact of H7N9 avian influenza on Chinese consumer demand and WTP for safe chicken. Our sample of 802 consumers were first surveyed in 2012 before the emergence of H7N9 in 2013, and then resurveyed after the

H7N9 discovery. Two key pieces of information gathered were actual chicken consumption and WTP for safe chicken. In addition, the 2013 survey queried consumers on various aspects of knowledge, risk perceptions, and trust. In addition, the cities where respondents were located were identified, allowing for an assessment related to the intensity of infection.

The most interesting observation from an economic point of view is that while consumption never increased for consumers between 2012 and 2013, the emergence of H7N9 did not lead to an increase in WTP relative to generic food-related risks in 2012. We found from these natural conditions that the WTP did not necessarily increase with reductions in consumption as standard WTP results would suggest (e.g. Hanemann, 1991 or Shogren et al., 1994). This is an interesting observation. Chicken, which generally have many close substitutes, suggests that the iso-utility indifference curve would be linear and it is from this premise that the proposition that $\frac{\Delta x}{\Delta WTP} < 0$. But this is not found generally, suggesting that Hicksian demand does not always follow Marshallian demand when it comes to food quality and safety. Instead, we show that psychological factors related to risk perception can affect the relationship between Δx and ΔWTP in many different ways, positive or negative. On this point our analysis is in agreement with Hanemann (1991) and Shogren et al. (1994) that when health is considered as a credence attribute of food, the non-substitutability of health in private or public markets adds varying degrees of curvature to the indifference curves leading to $\frac{\Delta x}{\Delta WTP}$ relationships that are not linear in scale.

From the behavioral point of view, our results, which hold across various robustness checks, can be explained by behavioral factors rooted in social psychology. The perception of risk generally led to a decrease in quantity demanded and increased WTP, but the risks perceived were not necessarily the same for either. Trust did not appear to be a strong determinant of consumer response in consumption or WTP but risk amplification did. Consumers in cities in which H7N9 was endemic were far more responsive than those in cities that had low or no incidence.

Our results are similar to some previous studies. For example, Haab et al. (2010) stated that consumers, in order to protect their health from the risk of seafood, would decrease their consumption of seafood. Yang and Goddard (2011) and Lim et al. (2013) found that consumers were willing to pay more for safe beef to avoid the risk associated with BSE in Canada. Thus fear is found to be the impetus for consumers to eat less and pay a higher premium for safe chicken.

We also believed that trust and fear may work simultaneously but with opposite roles (Bocker and Hanf, 2000; Meijboom et al., 2006), but we find no meaningful relationship to support this. Perhaps this is because our survey timeframe was within 60 days post H7N9 epidemic which was the peak period of this round, and so consumer ambiguity and uncertainty may dominate any messages from trusted sources. This has also important policy implications for information from private sources but more specifically public sources such as the government and scholars. The findings from Ortega et al. (2011) indicates that while the trust in the government may seem to be eroding in the face of recent food safety scandals, consumers were less confident on non-government food safety controls than government-led control measures, and this seems to be consistent with our findings. It takes a long time to regain consumers' confidence and demand when consumers are already confused and oversaturated by the media (Hassouneh et al., 2012).

Our results differ from previous studies in other ways. For example, Wessells et al. (1996) and Parsons et al. (2006) found that seafood consumption decreased with negative information and increased with some types of positive information. Smith et al. (1988), Brown and Schrader (1990), Lin and Milon (1993) found that negative food safety information tends to decrease consumption, while positive information does not necessarily have the opposite effect. We find that reinforcing any information about H7N9, positive or negative, reinforced negative consumption and perceptions. Perhaps this is because trust in positive information is still not high in China (Sirieix et al., 2011; Chen, 2013). For example, Wu et al. (2012) found that the WTP for certified traceable food in China was very "limited". This therefore suggests that government and private entities involved in food safety labeling, information and consumer education have a substantial amount of work to do to gain the trust of the Chinese consumers.

Finally, with the evidence at hand we recommend that further research explore changes in consumption and WTP from a psychological point of view. It seems on the surface that the change in consumption might well be an emotional response to risk, while the changes to

WTP a rational response to risk. Recent models in psychology based on this dual process in a utility framework (Kahneman, 2011; Schulze and Wansink, 2012; Loewenstein and O'Donoghue, 2004; Mukherjee, 2010) could possibly add clarity to the complex interactions of food safety, and risk perceptions. Schulze and Wansink (2012), for example, show consumers' responses to perceived risk as a mix of proportional and dichotomous (safe/unsafe, good/bad) responses that are relatively more continuous in situations where deliberation is possible, and more dichotomous in emotional or stressful circumstances. Their dual-process model seems to reconcile what is observed in our data. For example our findings that different aspects of risk perceptions affect consumption, while other affect WTP suggest that a more complex model may be at play.

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Tables

Table 1 Fear and Trust in 2013

Questions	Mean	Std. Dev.
Fear questions (strongly agree=5,agree=4, Neutral=3, disagree=2, strongly disagree=1)		
$Fear_1$: I would not eat any other new food	2.99	1.11
$Fear_2$: Eating AI infected chicken will immediately kill me	4.04	1.13
$Fear_3$: AI risk cannot easily be controlled	3.07	1.07
$Fear_4$: AI risk is increasing	3.76	1.09
$Fear_5$: AI can kill many people	2.68	0.94
$Fear_6$: AI is contagious among humans	3.05	1.14
$Fear_7$: I am personally at risk of contracting AI	2.56	1.10
Trust questions (strongly trust=5, trust=4, Neutral=3, mistrust=2, strongly mistrust =1)		
$Trust_1$: I trust ministry of agriculture	3.17	1.05
$Trust_2$: I trust ministry of health	3.40	1.06
$Trust_3$: I trust research institutes	3.40	1.00
$Trust_4$: I trust local government	3.00	1.18
$Trust_5$: I trust TV news	3.22	0.97
$Trust_6$: I trust network news	3.15	0.93
$Trust_7$: I trust scholars	3.09	1.09
$Trust_8$: I trust friends and relatives	3.32	0.96
$Trust_9$: I trust chicken sales staff	1.98	0.96

Table 2 Samples' Actual Consumption per Week in 2012 and 2013

$Cons_{2012}$\$Cons_{2013}$		Cons in 2013						Total
		0 chicken	0.25 chicken	0.5 chicken	1 chicken	2 chickens	3 chickens	
Cons in 2012	0.25 chicken	180	70	0	0	0	0	250
	0.5 chicken	155	21	26	0	0	0	202
	1 chicken	78	108	30	26	0	0	242
	2 chickens	35	0	41	3	18	0	97
	3 chickens	1	0	0	2	2	6	11
Total		449	199	97	31	20	6	802

Table 3 Samples' Stated WTP in 2012 and 2013

WTP_{2012}\\WTP_{2013}		WTP in 2013					Total
		30 RMB	40 RMB	50 RMB	60 RMB	>60 RMB	
WTP in 2012	30 RMB	68	37	7	8	78	198
	40 RMB	75	65	33	11	52	236
	50 RMB	57	13	32	31	80	213
	60 RMB	60	11	17	27	40	155
Total		260	126	89	77	250	802

Table 4 Dynamic of Consumption and WTP

WTP\Cons	0 chicken		0.25 chicken		0.5 chicken		1 chicken		2 chickens		3 chickens	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
>60 RMB	0	250	0	0	0	0	0	0	0	0	0	0
60 RMB	0	23	42	29	29	16	54	3	29	5	1	1
50 RMB	0	36	61	28	58	15	64	7	30	3	0	0
40 RMB	0	35	77	50	67	24	65	9	22	6	5	2
30 RMB	0	105	70	92	48	42	59	12	16	6	5	3
Total	0	449	250	199	202	97	242	31	97	20	11	6

Table 5 FGLS regression on Cons and WTP

Variables	$Cons_{2013}$	WTP_{2013}	$\Delta Cons$	ΔWTP
Fear in 2013				
$Fear_1$: I would not eat any other new food	-0.003	-0.163	0.013	-1.011
$Fear_2$: Eating AI infected chicken will immediately kill me	-0.045***	2.718***	-0.068***	3.426***
$Fear_3$: AI risk cannot easily be controlled	0.000	0.037	0.0003	0.320
$Fear_4$: AI risk is increasing	-0.018***	3.913***	-0.069***	4.439***
$Fear_5$: AI can kill many people	0.002	2.452***	-0.034**	2.738**
$Fear_6$: AI is contagious among humans	-0.025***	-0.280	-0.018	0.395
$Fear_7$: I am personally at risk of contracting AI	0.001	-0.329	0.008	-0.394
Trust in 2013				
$Trust_1$: I trust ministry of agriculture	-0.006	-0.606	-0.001	1.512
$Trust_2$: I trust ministry of health	0.011	0.607	0.016	0.744
$Trust_3$: I trust research institutes	-0.016**	-0.525	0.023	-1.039
$Trust_4$: I trust local government	0.004	2.480**	0.010	2.520**
$Trust_5$: I trust TV news	-0.006	-1.037	-0.046***	-1.995
$Trust_6$: I trust network news	-0.002	0.643	0.011	1.193
$Trust_7$: I trust scholars	0.005	0.352	-0.023	-1.231
$Trust_8$: I trust friends and relatives	-0.014**	0.482	-0.038***	0.583
$Trust_9$: I trust chicken sales staff	0.010	-1.242	0.021	-2.139*
High incidence city dummy				
Nanjing	-0.039	3.708	-0.105*	-5.656
Changzhou	-0.043*	-0.371	-0.156**	-7.181*
Zhengjiang	-0.069**	19.345***	-0.194**	17.862***
Lianyungang	-0.022	-11.300***	0.035	-21.501***
Low incidence city dummy				
Linyi	0.009	-30.220***	0.104*	-40.649***
Zaozhuang	0.053*	4.900	-0.249***	-9.326*
New stimulus dummy in 2013				
Risk-perception reducing information	-0.049***	2.472	-0.130***	2.225
Risk-perception elevating information	-0.033**	2.581	-0.006	1.170
Knowledge in 2013				
Cognitive level about AI	0.002	0.637	-0.019*	0.387
Lagged WTP				
WTP in 2012	0.000	0.165**	——	——
Lagged consumption				
CONS in 2012	0.276***	-0.450	——	——
Gender				
Male	-0.010	-1.715	-0.035	-2.296
Age in 2013				
Age	-0.0002	0.018	-0.0002	0.010
Family type in 2013				
Total household population	-0.009*	-1.817***	0.006	-0.780

The proportion of children	-0.065	17.251***	-0.114	13.573*
The proportion of elder	0.057	2.023	-0.168*	4.296
Education dummy in 2013				
10~12 years	-0.012	0.868	0.030	0.377
13~16 years	-0.018	7.517**	-0.018	5.902*
>16 years	0.073**	3.703	0.141	0.887
Income dummy in 2013				
1501~3000 RMB	0.003	-1.112	0.106*	-0.580
3001~4500 RMB	-0.026	-1.568	0.016	-1.785
4501~6000 RMB	-0.025	-2.182	0.012	-0.495
6001~7500 RMB	-0.059*	-1.324	-0.076	-2.563
>7500 RMB	-0.023	-5.006	-0.067	-6.653
Constant	0.476***	24.030***	0.316**	-9.320
Observation	802	802	802	802
Adj R^2	0.458	0.835	0.641	0.278
F statistics	17.53***	100.26***	37.76***	8.91***

Note: Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at the 10%, 5% and 1% significance levels respectively.

Table 6 Multinomial Logistic Regression (Base Case: ΔWTP=0 & ΔCons=0)

Variables	Conditions				
	ΔWTP>0 & *ΔCons*=0	*ΔWTP<0* & *ΔCons*=0	*ΔWTP=0* & *ΔCons*<0	*ΔWTP>0* & *ΔCons*<0	*ΔWTP<0* & *ΔCons*<0
Fear in 2013					
$Fear_1$: I would not eat any other new food	0.045	0.244	0.228	0.083	0.248
$Fear_2$: Eating AI infected chicken will immediately kill me	0.417	0.423	1.005^{***}	1.042^{***}	0.892^{***}
$Fear_3$: AI risk cannot easily be controlled	0.693^{*}	0.025	-0.135	-0.156	-0.144
$Fear_4$: AI risk is increasing	-0.349	-0.263	0.451^{**}	0.471^{***}	0.537^{***}
$Fear_5$: AI can kill many people	0.241	-0.100	0.012	0.039	-0.206
$Fear_6$: AI is contagious among humans	-0.535	-0.529^{*}	0.159	0.277	0.390^{**}
$Fear_7$: I am personally at risk of contracting AI	-0.683	0.327	-0.123	0.044	-0.120
Trust in 2013					
$Trust_1$: I trust ministry of agriculture	1.712^{**}	0.622^{*}	0.583^{**}	0.491^{**}	0.394
$Trust_2$: I trust ministry of health	-1.706^{**}	-0.259	-0.404	-0.213	-0.066
$Trust_3$: I trust research institutes	0.882^{*}	-0.029	0.421	0.074	0.010
$Trust_4$: I trust local government	-0.453	-0.754^{**}	-0.263	-0.131	-0.290
$Trust_5$: I trust TV news	0.251	0.719^{*}	-0.103	0.292	0.523^{*}
$Trust_6$: I trust network news	0.175	-0.190	0.230	0.097	-0.054
$Trust_7$: I trust scholars	-0.208	0.146	-0.009	-0.224	0.037
$Trust_8$: I trust friends and relatives	0.040	-0.239	0.034	0.131	0.142
$Trust_9$: I trust chicken sales staff	-0.176	0.160	0.058	-0.112	-0.070
High incidence city dummy					
Nanjing	-0.029	2.781^{**}	2.767^{***}	1.320^{**}	2.287^{***}
Changzhou	-0.949	2.703^{**}	1.894^{**}	0.484	1.725^{**}
Zhengjiang	-17.469	2.666^{*}	0.754	0.800	1.303^{*}
Lianyungang	-0.701	3.605^{***}	2.451^{***}	0.025	1.878^{**}
Low incidence city dummy					
Linyi	0.249	3.845^{***}	2.243^{***}	-0.693	2.655^{***}
Zaozhuang	-0.030	-12.782	0.228	0.343	1.021
New stimulus dummy in 2013					
Risk-perception reducing information	0.654	1.127^{*}	1.652^{***}	1.270^{***}	1.018^{**}
Risk-perception elevating information	0.865	0.662	1.335^{***}	1.085^{**}	0.045
Knowledge in 2013					
Cognitive level about AI	-0.149	-0.286	-0.381^{**}	-0.193	-0.042
Lagged WTP					
WTP in 2012	-0.131^{***}	0.118^{***}	-0.036^{*}	-0.004	0.098^{***}
Lagged consumption					
CONS in 2012	-0.375	0.501	0.758^{**}	0.473^{*}	0.458
Gender					
Male	0.042	-0.670	0.708^{*}	0.025	-0.183

Age in 2013					
Age	-0.046	-0.058**	-0.001	-0.024*	-0.021
Family type in 2013					
Total household population	0.051	-0.123	-0.322**	-0.051	0.131
The proportion of children	0.325	0.053	2.050	0.820	1.795
The proportion of elder	-0.104	-0.137	0.111	0.403	0.267
Education dummy in 2013					
10~12 years	-0.999	-1.133	0.823	-0.056	0.149
13~16 years	-0.769	-0.516	-0.210	0.102	0.066
>16 years	-0.653	-1.126	-1.188	-0.931	-1.985**
Income dummy in 2013					
1501~3000 RMB	16.455	0.235	0.575	0.192	0.506
3001~4500 RMB	16.205	-0.133	0.904	0.621	1.044
4501~6000 RMB	15.587	-1.468	0.627	-0.014	-0.061
6001~7500 RMB	16.344	-16.075	2.172*	1.459	2.194*
>7500 RMB	16.133	-0.170	1.034	0.311	0.795
Constant	-12.196	-6.054*	-7.624	-5.906***	-13.94***
Observation	802				
R^2	0.343				

Note: Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at the 10%, 5% and 1% significance levels respectively.

Table 7 Estimation of Shock Elasticity (dependent variable is $|\eta|$)

Variables	η≤0	η>0
Fear in 2013		
$Fear_1$: I would not eat any other new food	-0.172***	-0.072
$Fear_2$: Eating AI infected chicken will immediately kill me	0.167**	-0.222**
$Fear_3$: AI risk cannot easily be controlled	0.020	0.000
$Fear_4$: AI risk is increasing	0.028	0.177*
$Fear_5$: AI can kill many people	0.069	-0.051
$Fear_6$: AI is contagious among humans	0.027	-0.009
$Fear_7$: I am personally at risk of contracting AI	0.048	-0.045
Trust in 2013		
$Trust_1$: I trust ministry of agriculture	-0.004	-0.094
$Trust_2$: I trust ministry of health	0.008	0.118
$Trust_3$: I trust research institutes	0.024	-0.058
$Trust_4$: I trust local government	0.032	0.010
$Trust_5$: I trust TV news	-0.156	-0.102
$Trust_6$: I trust network news	0.012	0.224*
$Trust_7$: I trust scholars	-0.001	0.128
$Trust_8$: I trust friends and relatives	0.061	-0.104
$Trust_9$: I trust chicken sales staff	-0.065	0.077

Note: Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at 10%, 5% and 1% respectively.

Table 8 Robustness Check with Score of Fear and Trust

Variables	$Cons_{2012}$	WTP_{2012}	Multinomial logistic regression (base outcome: $\Delta WTP=0$ & $\Delta Cons=0$)					*Shock elasticity*	
			$\Delta WTP>0$ & $\Delta Cons=0$	$\Delta WTP<0$ & $\Delta Cons=0$	$\Delta WTP=0$ & $\Delta Cons<0$	$\Delta WTP>0$ & $\Delta Cons<0$	$\Delta WTP<0$ & $\Delta Cons<0$	$\eta\leq 0$	$\eta>0$
$Fear_{MICRO}$	-0.107***	7.245***	-0.333	-11.746	0.861***	1.075***	0.954***	0.054	-0.152*
$Fear_{MACRO}$	-0.115***	7.450***	0.332	0.155	1.058***	1.244***	1.071***	0.266***	-0.040
$Trust_{OFFICIAL}$	-0.047***	1.865	0.182	0.058	0.295	0.266*	0.402**	-0.052	0.082
$Trust_{PRIVATE}$	-0.040***	1.255	0.111	0.105	0.082	0.272*	0.290*	-0.001	0.052
$Trust_{SUPPLY}$	0.021*	-0.311	-0.224	-0.001	0.102	-0.052	-0.065	-0.013	0.073

Note: Asterisk (*), double asterisk (**) and triple asterisk (***) denote variables significant at the 10%, 5% and 1% significance levels respectively.