



CEM WORKING PAPER SERIES

QUANTIFYING THE POTENTIAL IMPACTS OF AN AVIAN INFLUENZA OUTBREAK IN THE PHILIPPINES

by

U-Primo E. Rodriguez, Reynaldo L. Tan and Yolanda T. Garcia

Working Paper No. 2009-09

College of Economics and Management
University of the Philippines Los Baños
College, Laguna
Philippines
January 2009

The studies in the CEM Working Paper Series are preliminary and designed solely for the purpose of eliciting comments and suggestions. These do not necessarily reflect the opinions and views of the college and/or university.

QUANTIFYING THE POTENTIAL IMPACTS OF AN AVIAN INFLUENZA OUTBREAK IN THE PHILIPPINES

U-Primo E. Rodriguez¹, Reynaldo L. Tan² and Yolanda T. Garcia³

Abstract

This paper seeks to examine the likely economywide impacts of an avian influenza outbreak in the Philippines. Using a CGE model, it analyzes the effects of production and consumption shocks in the poultry sector on other industries, sectors and the economy as a whole. This paper finds that these shocks can cause a significant decline in aggregate output. It also argues that, especially in the case of the production shocks, the impacts of an avian influenza outbreak are widespread. Moreover, it shows that industries closely related to poultry are likely to be among the most severely affected.

Keywords: Avian influenza, CGE models, TARFCOM model

1. Introduction

Avian influenza is a serious global concern. Caused by the H5N1 virus, the World Health Organization (2006) reports that the disease has affected bird populations in at least 50 countries since 1996. The disease has also infected humans in nearly 9 countries in Asia and the Middle East.

Existing studies stressed three economic effects of an avian influenza outbreak among birds. First, the direct impact was usually felt on the poultry sector. This was due to the death of infected birds and the culling of otherwise healthy birds in order to contain the disease. Second, the impacts of such an event often go beyond the poultry sector. The decline in poultry production and stocks generally led to reduction in the demand for poultry inputs like animal feeds (see Brahmabhatt, 2005; Verbiest and Castillo, 2004). These in turn affected sectors and industries that consume poultry products like households, restaurants and hotels. Third, the aggregate losses were quite significant. McLeod et al. (2005), for example, estimated that the 2003-4 outbreaks in Vietnam led to losses ranging from 0.3 to 1.8 percent of its GDP. Moreover, Verbiest and Castillo (2004)

¹ Associate Professor, Department of Economics, University of the Philippines Los Baños (UPLB)

² Associate Professor, Department of Agribusiness Management, UPLB

³ Associate Professor, Department of Economics, UPLB

⁵ The OEF is a macroeconometric model that does not disaggregate among the various industries. On the other hand, the Asia-Pacific G-Cubed has six industries in which poultry is subsumed under the agricultural sector.

argued that an outbreak can exert greater pressure on countries that face serious fiscal constraints. The authors attributed this to the need for the government to extend financial assistance to affected farmers.

While the extent of human infections have not, or at least not yet, reached the proportions of the recent SARS (Severe Acute Respiratory Syndrome) outbreak, there is growing concern that the virus could mutate into one that can be transmitted from one human being to another. This possibility has stimulated studies involving a global pandemic of avian influenza.

Bloom et al. (2005) argued that an avian influenza pandemic will have effects on both the demand and supply sides of the economy. On the demand side, the authors noted the potentially adverse effects on consumer confidence and social patterns. On the supply side, the disease could potentially affect the availability of labor due to illness and death (see also McKibbin and Sidorenko, 2006).

Results from past model simulations suggested that the impacts of a pandemic can be significant. Bloom et al. (2005) found that the supply and demand shocks can reduce GDP growth rate of Asia by 0.3 and 2.3-6.5 percentage points, respectively. On the other hand, McKibbin and Sidorenko (2006) estimated the costs of a pandemic to be anywhere between 0.80 to 12.6 percent of global GDP.

The Philippines has been fortunate enough not to have experienced any outbreaks of avian flu. However, the country is constantly at risk because of the international trade in poultry products and the migratory behavior of wild birds. In fact, such a threat has prompted the authorities to adopt precautionary measures to address any likely outbreaks in the future. These include occasional and selective bans on poultry imports, intensified border controls and information campaigns.

This paper examines the potential short run impacts of an avian influenza outbreak in the Philippines. In particular, it uses a computable general equilibrium (CGE) model to quantify the aggregate, sectoral and industry effects of an outbreak in the country's bird population.

The analysis in this paper is relevant for the following reasons. First, it is the first formal quantitative analysis of the economywide effects of an avian flu outbreak on poultry production in the country. The existing literature in the Philippines focuses more

on the impacts of the disease among humans (see McKibbin and Sidorenko, 2006; Bloom et al., 2005). Since there is no evidence yet of the virus being transmitted from one human being to another, this study therefore, addresses the more immediate threat, i.e., economic slowdown. Second, unlike existing studies, this paper uses a highly disaggregated model in the analysis. It therefore offers more insights into the effects of an outbreak on specific industries.

The model simulations in this paper assume that an avian influenza outbreak has two direct effects on the poultry sector. The first is a production shock which is represented by a reduction in the output of the poultry sector. This attempts to capture the impact of an outbreak in which birds die either through the disease or culling. The second is a consumption shock which tries to depict the reaction of consumers to the news of an outbreak.

This paper is organized as follows. Section 2 provides a brief description of the model that was used in the analysis. Section 3 discusses the results from incorporating production shock in the model. Section 4 describes the impacts of a consumption shock. Lastly, Section 5 concludes the paper.

2. The TARFCOM Model

The tool that was used in the analysis is the TARFCOM model. This is a highly disaggregated CGE (Computable General Equilibrium) model of the Philippines⁵. Patterned after the ORANI-G model of Australia, it has been used for the analysis of macroeconomic and sectoral shocks addressing market competition and trade policies.⁶

The TARFCOM is useful in the analysis for the following reasons. First, the model accounts for three industries within the poultry sub-sector. These are chicken (*21Chicken*), eggs (*22HensEggs*) and other poultry products (*23OthPoultry*).⁷ This allows the direct implementation of production and consumption shocks in the analysis. Second, like any other CGE model, it contains equations that explicitly link poultry sales, production and trade to other industries in the economy. Finally, the model computes macroeconomic variables (e.g. GNP, imports and exports, etc.) that allow an overall assessment of the impacts.

⁶ For a more detailed discussion of the features and applications of the model, see Cabalu and Rodriguez (2006), Rodriguez and Cabalu (2006, 2005), Horridge et al. (2001) and Horridge (2001).

⁷ Items in the parentheses are product codes used in the TARFCOM model.

The model is composed of 229 industries/commodities. Having the most disaggregated production side among existing CGE models of the Philippines, 28 of its industries belong to the *Agriculture, Fishery & Forestry* sector. On the other hand, the *Industry* sector accounts for 145 industries/commodities. The rest of the industries/commodities belong to the *Services* sector.

The model has four economic agents; namely, households, firms, government and foreign agents. Households act as consumers of goods and services. Firms use primary and intermediate inputs in the production of goods and services. Government collects taxes, buys goods and services and provides government services. Finally, foreign agents transact with local agents through exports and imports.

The key relationships in the model are represented by (a) input demand equations, (b) commodity supply equations, (c) household demand equations, (d) government demand equations, (e) market clearing conditions for commodities and primary factors, (f) macroeconomic relationships, and (g) other identities.

The input demand equations are drawn from a multi-staged optimization framework. In the first stage, a representative firm produces output by combining intermediate inputs and a primary factor composite using fixed proportions technology. This generates equations in which changes in the demand for the intermediate inputs and the primary factor composite are proportional to changes in output.

The second stage involves the formulation of the specific equations for the primary factors; namely, land, labor and capital. These equations are generated by assuming that a firm seeks to find the combination of inputs that will minimize the costs of purchasing a given level of the primary factor composite. As the technology is represented by a Constant Elasticity of Substitution (CES) function, the resulting factor demand equations are functions of relative prices and the quantity of the primary factor composite.

Each industry is assumed to produce more than one commodity. It is generated through a mechanism in which the industry seeks to find the quantities of the commodities that maximizes revenues given a pre-determined level of its output. Since the commodities and industry output are related through a Constant Elasticity of Transformation (CET) function, the commodity supplies per industry are determined by

commodity prices and the industry output. The aggregate supply of commodity is then determined by taking the sum of the commodity supplies from each industry.

There is an additional stage in the model that determines the destination of commodities. This generates the commodity supply equations for domestic use and export. However, this mechanism is currently inactive in the model. Taking its place is a series of demand equations in which the quantity of exports is a function of relative prices.

As consumers of goods and services, households are assumed to maximize their utility subject to a budget constraint. This generates household demand equations which are functions of relative prices and total expenditure.

The TARFCOM differentiates the demand for commodities by source. In other words, a commodity sourced from a domestic firm is perceived to be different from its imported counterpart. The equations for domestic demand and imports are determined through another optimization process. In the case of households, for example, it assumed that upon the determination of the demand for a commodity, the next problem is to ascertain how much of this commodity is sourced domestically or from abroad. The model assumes that the household seeks to find the combination of domestic and foreign goods that will minimize the cost of acquiring the commodity.

The data for the TARFCOM is based primarily on the 1994 Input-Output table of the Philippines. Elasticities and other data were also obtained from the GTAP data base (McDougall et. al., 1998), other Australian CGE models, the National Statistics Coordination Board and the Tariff Commission of the Philippines.

There are a number of closures rules that can be used in solving the model. One rule allows the real wage rate to adjust to an exogenously determined level of aggregate employment. This represents a long run scenario in which an economy is assumed to operate under full employment. Another closure rule imposes an exogenously determined real wage rate accompanied by an endogenous level of aggregate employment. This is a short run setting which effectively assumes the existence of unemployed resources. The second closure rule was used in all the experiments of the study. Hence, all results should be treated as representative of the short run impacts of an avian influenza outbreak.

3. Production shock

3.1 Description of the experiment

Production shocks take the form of exogenously determined declines in the output of the poultry sector. Representing death of birds due to the disease and culling, an issue that arises in the implementation of the experiments is the magnitude of the shock. Broadly speaking, this depends on the speed with which the disease spreads in the bird population and the effectiveness of measures to address an outbreak. While analyzing all these issues is without a doubt important, the task veers away from the objectives of this paper. As such, the strategy adopted in this paper is to draw from the experiences of other countries with avian influenza.

Table 1 shows the impacts of an outbreak on nine Asian countries. In this sample, avian influenza causes an average decline of 3.86 percent in the output of the poultry sector. However, this value was heavily influenced by the effects observed in Thailand and Viet Nam. On average, these two countries experienced a 14.43 percent decline in poultry output. In contrast, the remaining countries in the sample only experienced an average decline of 0.34 percent.

The cursory analysis of the impacts on nine Asian countries gave rise to three possible values that was used in the experiments of the study. The first represents a “mild” outbreak in which the output of the poultry sector is projected to decline by 0.34 percent. This assumes that the Philippines will experience an outbreak similar to the seven countries in the sample. The second represents a “severe” outbreak in which the output of the sector declines by 14.43 percent. This assumes that the country will experience an outbreak similar to Vietnam and Thailand. Finally, the third scenario is a “moderate” outbreak in which the poultry output of the Philippines declines by 3.84 percent. As cited in the previous paragraph, this represents the average impact for all the countries in the sample.

3.2 Impacts

The experiment can be represented by leftward shift in the supply curve of poultry products (Figure 1). This is expected to cause an increase in the price of poultry products. Holding other variables constant, this is also projected to reduce aggregate output. However, these must be interpreted only as first round effects because of the failure to

explain how changes in the poultry market affect other industries and sectors in the economy. These also ignore the feedback effects on poultry of the induced changes in the other markets. The discussion below overcomes these inherent weaknesses.

The simulation results suggest that the production shock is expected to cause a decline in aggregate economic activity in the Philippines. This is indicated by the 0.03 to 1.07 percent fall in real GDP from the “mild” to the “severe” scenarios (Table 2). With aggregate capital stock being exogenously determined, these coincide with a 0.06 to 2.69 percent decline in aggregate employment.

The production shock is also expected to raise prices as a whole. This is shown by the increases in the GDP deflator (from 0.14 to 5.83 percent) and Consumer Price Index (from 0.12 to 5.25 percent). This is consistent with the fact that the production shock causes a leftward shift in the supply curve for poultry products. Other things held constant, this causes higher prices of poultry products.

While the macroeconomic impacts appear small, these nonetheless highlight the potentially far reaching economic effects of an avian influenza outbreak. In the base dataset of the model, the poultry sub-sector accounts for about 2 percent of real GDP. This means that a 3.86 percent decline in its output under the moderate scenario causes about a 0.08 percentage point decline in real GDP.⁸ Hence, the 0.21 percentage point difference [= -0.29-(-0.08)] between the simulation results and this value is accounted for by the net decline in the outputs of the other industries in the economy.

A sectoral breakdown of the results provides a clearer picture of the widespread effects of an avian influenza outbreak. Table 2 also shows that an outbreak is expected to reduce the output of *Agriculture, Fishery & Forestry (AFF)*, *Industry* and *Services sectors*. Similarly, the results also show that the output of both *Industry* and *Services* are expected to contract. As shown later in the text, these are explained by the findings that a large majority of the industries are expected to experience a decline in output. Moreover, the relatively sharp contraction of *AFF* is due to the presence of the poultry industry in this sector.

⁸ The discussion in the paper makes no distinction between industry output and value added. The reason is the assumption in the model that value added and intermediate goods are combined to produce output using a Leontief technology. In the absence of technological change, which is the case in all the experiments, this assumption makes percentage change in value added equal to percentage change in output.

A finer disaggregation of the sectors reveals a few other interesting results. First, all other sectors (at least at the level of aggregation adopted in this study) are expected to contract (Table 2). This reinforces the earlier assertion that an avian influenza outbreak has widespread effects. Second, and consistent with what is widely believed, *Poultry* is expected to be the most severely affected sub-sector. Third, *Meat Preparations* is the second most severely affected sub-sector.

The widespread impacts are also apparent from the result that a “moderate” outbreak reduces the outputs of 218 out of the 229 industries in the model (Annex 1). Consistent with earlier findings, the three industries (*21Chicken*, *22HensEggs*, and *23OthPoultry*) which makeup the poultry sub-sector are expected to experience the largest losses (Figure 2).

Among the 10 most adversely affected industries are those which are closely related to poultry. These include users of poultry products like slaughter houses (*38Slaughtering*), meat processing (*39MeatProcessing*) and restaurants (*224Restaurants*). These industries are expected to experience a decline in output amounting to 1.06, 1.40 and 1.48 percent, respectively. Another industry that is included in this list is animal feeds (*59AnimalFeeds*). An important input in the production of poultry products, this industry is expected to experience a 1.28 percent decline in output. While not included in the 10 most adversely affected sectors, the 0.50 and 0.09 projected declines in the outputs of the corn (*2Corn*) and hogs (*19Hogs*) are also worth noting. The lower output of corn arises because it is an input in the production of *59AnimalFeeds*. The analysis for the hogs industry requires a closer examination of the sources of demand. The lower domestic price of this industry (Annex 1) actually induces a 0.15 percent increase in its household consumption. This in effect captures the substitutability between hog and poultry products. However, hogs are also inputs of slaughter houses (*38Slaughtering*). The decline in the output of this industry translates into a fall in the intermediate demand for hogs. Since the intermediate demand accounts for slightly more than half of the total demand for hogs, its decline overcomes the impact of the increase in household consumption.

4. Consumption shock

4.1. Description of the experiment

Consumption shocks take the form of exogenous declines in the consumption of poultry products. The experiment is based on the idea that an actual or perceived outbreak will discourage households from purchasing these commodities as a defense against the disease. As in the previous section, the strategy adopted for identifying the magnitude of the potential shocks is to examine the experience of affected countries.

Table 3 shows estimates of the decline in poultry demand arising from avian influenza outbreak in Asia and Europe. On the average, the reported impact was 42.41 percent contraction in consumption. The most severe response was observed in Greece, where the demand for poultry products declined by 80 percent. In contrast, relatively mild reductions in consumption were observed for Germany, France and Hungary.

Notwithstanding potential differences in the behavior of Filipinos and the mostly European consumers in the sample, this paper implements three experiments to represent consumption shocks. The first is a “mild” response in which households will reduce poultry consumption by only 20 percent. This effectively assumes that Filipinos respond in the same way as the Germans, French and Hungarians. The second experiment (i.e., “moderate” case) uses the average decline in demand for the sample. Finally, the third experiment (representing the “severe” case) assumes that Filipinos respond in a manner similar to Italian and Turkish consumers.

4.2 Impacts

The experiment can be represented by leftward shift in the demand curve for poultry products (Figure 3). This is expected to cause a decrease in the price of poultry products. Holding other variables constant, this is also projected to reduce aggregate output. For reasons similar to the previous experiment, this should only be interpreted as first round effects; the weaknesses of which are overcome by the use of the CGE model.

The simulation results show that the consumption shock is expected to cause a contraction in aggregate output. This is indicated by the 0.09 to 0.31 percent projected decline in real GDP (Table 4). With aggregate capital stock being exogenous in the experiment, this is consistent with the 0.27 to 0.94 percent fall in aggregate employment.

Reflecting the idea that the consumption shock represents a downward shift in the demand curve, the simulation results also indicate a decline in the general price level. The consumer price index, for example, is expected to fall by 0.05 to 0.16 percent.

At this point, it is worth noting that the impacts of the decline in consumption appear to be smaller than those from the production shocks. This is evident from the comparison of the results of the “severe” cases from both experiments. Under the severe production shock, a 14.43 percent decline in poultry output generates a 1.07 percent contraction in aggregate output. On the other hand, under the severe consumption shock, a 70 percent decline in poultry demand generates a decline in aggregate output that is slightly less than a third (i.e., 0.31 percent vs 1.07 percent) of what was generated by the production cut.

Apart from the relatively smaller impacts on output, the adverse impacts of a consumption shock do not appear to be as far reaching as the production shock. A sectoral breakdown of the results indicates that only the output of the *Agriculture, Fishery & Forestry* sector is expected to decline. In fact, the simulations suggest that the outputs of the *Industry* and *Services* sectors are expected to expand.

The same conclusion is obtained with a finer disaggregation of the sectors. Table 4 shows that only the output of the *Poultry* sub-sector is expected to contract in the experiments. This implies that, at this level of aggregation, the contraction in *Agriculture, Fishery & Forestry* is solely due to the poultry sub-sector. The changes in the other sub-sectors simply dampen its impact. Moreover, the results also suggest that the decline in the demand for poultry products tends to induce a substitution towards the *Other Meat* sub-sector, which includes pork, fish and beef.

It is interesting to note that the contraction of real GDP can be explained almost exclusively by the decline in the output of the poultry sub-sector. Noting that the sector accounts for about 2 percent of aggregate output, the 19.72 percent decline in the output of poultry sector under the moderate case scenario implies 0.39 ($=19.72 \times 0.02$) percentage points decline in real GDP. However, since the projected decline in real GDP was only 0.19 percent in this experiment, then the net impact on the rest of the economy is expected to be positive.

The disaggregated results also provide an explanation for the expansion in the *Industry* and *Services* sectors. The level of disaggregation in Table 4 shows that all sub-

industries in the *Industry* sector (i.e., *Meat Preparations*, *Other Food Processing* and *Other Industry*) are expected to expand. An even finer level of disaggregation in Annex 1 indicates that 116 out of the 146 industries in this sector are expected to have higher outputs.⁹ The explanation for the higher output of the *Services* sector follows the same line of reasoning as 49 out of the 56 industries in this sector are expected to expand.¹⁰

Based on Annex 1, the consumption shock is expected to cause a contraction in the outputs of 39 out of the 229 industries in the model. As with the production shock, the most severely affected industries belong the poultry sub-sectors. The declines range from 27.99 (*22HensEggs*) to 14.17 (*24OthPoultry*) percent (Figure 4). The results also show that the adverse impacts on poultry production are considerably lower than the decline in consumption (42.41 percent). This may be explained in part by the fact that only a fraction of the output of the poultry sector is allocated to consumption. Moreover, it also incorporates the other adjustments that take place across the economy. The *22HensEggs* industry for example is expected to experience an increase in its intermediate demand. This, in turn, may be explained by the increase in the outputs of the industries that use this commodity as an input.¹¹

59AnimalFeeds and *2Corn* are also found to be among the most adversely affected industries. The *59AnimalFeeds* industry is expected to experience a 4.85 contraction in output. On the other hand, the output of *2Corn* is expected to decline by 3.37 percent. As with the production shocks, this suggests that the decline in poultry consumption is likely to hurt industries which supply inputs to the poultry sector.

Unlike the results for the production shock however, there are a number of downstream industries that are expected to gain from the consumption shock. These are *38Slaughtering* (1.77 percent), *39MeatProcessing* (1.27 percent) and *224Restaurants* (1.25 percent). The increase in the output of *38Slaughtering* is partly explained by the decline in the price of this commodity, which stimulates domestic and export demand for fresh meat. The increase in the outputs of *39MeatProcessing* and *224Restaurants* may also be explained using the same line of reasoning.

⁹ In Annex 1, the composition of the *Industry* sector is from *28GoldSilvrMin* to *173Water*.

¹⁰ In Annex 1, the composition of the *Services* sector is from *174WholslRtlTrd* to *229PublicAdmin*.

¹¹ The dataset of the model indicates that *52BakeryProds*, *61FlavorColors* and *224Restaurants* account for about 91.60 percent of the total intermediate demand for *22HensEggs*. In the consumption shock, these intermediate users are expected to experience an increase in their respective outputs.

5. Concluding remarks

This paper evaluates the potential impacts of an avian influenza outbreak in the Philippines. Using a CGE model, it implements the analysis through production and consumption shocks on the poultry sector.

Results of the simulation experiments suggest the following. First, shocks on the production and consumption sides of the poultry sector are likely to reduce aggregate output. Moreover, as indicated by the results of the production shocks, most of the decline in aggregate output can come from industries outside of the poultry sector. Second, an avian influenza outbreak can have widespread effects on the economy. This is especially so in the case of the production shocks where a large majority of industries in the economy are expected to contract. Third, while it appears that poultry remains the most adversely affected sector, the simulation results suggest that its sources of inputs and destinations of outputs are also likely to suffer. This can be seen from the declines in the outputs of the animal feeds and corn industries resulting from production and consumption shocks. In the case of users of poultry products, however, the net effect largely depends on the strength of the production shocks relative to the consumption shocks.

The results also point to the importance of taking a broad view of the potential impacts of an outbreak. It emphasizes the potential dangers from using simple ‘back-of-the-envelope’ approaches in evaluating the impacts. The finding that the effects to beyond the poultry sector can mislead policy makers and stakeholders regarding the urgency of formulating measures to address the potential adverse impacts from an outbreak.

In illustrating the potential costs of an avian influenza outbreak, the paper reinforces the need for measures to prevent the disease from entering the country. It also strengthens the need to immediately address the problem should an outbreak occur. Finally, this paper emphasizes the need to focus the prospective attempts by the government to address the impacts of an outbreak beyond the poultry sector. The concerns of other industries, especially those closely related to the poultry sector should also be given due attention.

ACKNOWLEDGEMENT

The authors are grateful to the institutions and individuals who have supported and helped in the preparation of this paper. First, we wish to thank the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) for funding this project. Second, we are also grateful to the Philippine Tariff Commission and the AusAid for allowing us to use the TARFCOM model. Third, we appreciate the comments of Drs. Arsenio Balisacan, Donato Antiporta, Roehlano Briones, Tirso B. Paris, Helen Cabalu, Agham Cuevas and the faculty members of the Department of Economics (UPLB) for their comments on an earlier presentation and on previous drafts. Finally, we wish to thank Ms. Angelica Bunao for her assistance. The usual disclaimer applies.

REFERENCES

- Bloom, E., V. de Wit, M. Carangal-San Jose, 2005. Potential Impact of an Avian Flu Pandemic on Asia, ERD Policy Brief Series No. 42, Asian Development Bank, Manila, Philippines
- Brahmbhatt, M., 2005. Avian Influenza: Economic and Social Impacts, World Bank, <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPHEANUT/0,,contentMDK:20663668~menuPK:503067~pagePK:34004173~piPK:34003707~theSitePK:503048,00.html>
- Cabalu, H. and U. Rodriguez, 2006. When Policymakers Don't Get it Right: Evidence from the Philippine 2005 Tariff Reform, Working Paper 2006/02, John Curtin Institute of Public Policy, Curtin University of Technology
- EMPRES Transboundary Animal Diseases, 2004. About the Poultry Sector in Affected Asian Countries, Bulletin No. 25
- Horridge, M., 2001. ORANI-G: A Generic Single-Country Computable General Equilibrium Model, Center of Policy Studies, Monash University, edition prepared for the Philippine Tariff Commission
- Horridge, M., J. Giesecke, H. Cabalu, M. Mendoza and U. Rodriguez, 2001. TARFCOM: A CGE Model of the Philippines, Institute for Research into International Competitiveness (IRIC), Curtin University of Technology, Western Australia
- McKibbin, W. and A. Sidorenko, 2006. Global Macroeconomic Consequences of Pandemic Influenza, Lowy Institute for International Policy, Sydney, Australia
- McLeod, A., N. Morgan, A. Prakash and J. Hinrichs, 2005. Economic and Social Impacts of Avian Flu, Food and Agriculture Organization, downloadable at <http://www.fao.org/ag/againfo/subjects/en/health/diseases-cards/cd/documents/Economic-and-social-impacts-of-avian-influenza-Geneva.pdf>

- Rodriguez, U. and H. Cabalu, 2006b. An Assessment of the Economywide Impact of Philippine Tariff Changes in the Early 2000s, John Curtin Institute of Public Policy, Western Australia
- Rodriguez, U. and H. Cabalu, 2005. A User's Guide to the TARFCOM Model, John Curtin Institute of Public Policy, Western Australia
- Verbiest, J. and C. Castillo, 2004. Avian influenza: An Economic Assessment of Selected Developing Countries in Asia, ERD Policy Brief Series No. 24, Asian Development Bank, Manila, Philippines
- World Health Organization, 2006. H5N1 Avian Influenza: Timeline, downloadable at http://www.who.int/csr/disease/avian_influenza/en/index.html

Table 1. Decline in Poultry Output due to the Avian Flu, January-June 2004.

Country	Estimated Losses	
	Heads	Share of total population (percent)
Cambodia	36,495	0.15
China (Mainland)	9,127,600	0.19
Indonesia	7,000,000	0.52
Japan	270,473	0.09
Korea	405,968	0.39
Laos	150,092	0.65
Thailand	27,554,689	13.90
Vietnam	38,000,000	14.96
Average		3.86
Average (excluding Thailand and Vietnam)		0.34

Source: EMPRES Transboundary Animal Diseases (2004)

Table 2. Macroeconomic Effects of the Production Shocks, in percent deviation from base.

Item	Scenario		
	Mild	Moderate	Severe
Real GDP at factor cost	-0.03	-0.29	-1.07
Aggregate Employment	-0.06	-0.72	-2.69
Consumer Price Index	0.14	1.56	5.83
GDP Deflator	0.12	1.40	5.25
Components of GDP			
Agriculture Fishery & Forestry (AFF)	-0.05	-0.54	-2.03
Industry	-0.03	-0.28	-1.06
Services	-0.02	-0.18	-0.66
Components of GDP – detailed			
Poultry	-0.34	-3.86	-14.43
Other Meat	0.00	-0.04	-0.14
Other Agri. & Forestry	-0.03	-0.33	-1.24
Meat Preparations	-0.08	-0.94	-3.50
Other Food Processing	-0.03	-0.30	-1.10
Other Industry	-0.02	-0.23	-0.85
Services	-0.02	-0.18	-0.66

Table 3. Decline in the demand for poultry due to avian flu, in percent as of 2006.

Country	Decline
France	20.0
Germany	20.0
Italy	70.0
Turkey	70.0
Greece	80.0
Hungary	20.0
India	25.0
Average	42.4

Sources: Reuters, CNN.com, MeatProcess.com, FOODProductionDaily.com, all articles as of 2006

Table 4. Macroeconomic Effects of Consumption shocks, in percent deviation from base values.

Item	Scenario		
	Mild	Moderate	Severe
Real GDP at factor cost	-0.09	-0.19	-0.31
Aggregate Employment	-0.27	-0.57	-0.94
Consumer Price Index	-0.05	-0.10	-0.16
GDP Deflator	-0.04	-0.09	-0.14
Components of GDP*			
Agriculture Fishery & Forestry (AFF)	-0.75	-1.58	-2.62
Industry	0.11	0.24	0.39
Services	0.06	0.12	0.20
Components of GDP – detailed*			
Poultry	-9.30	-19.72	-32.55
Other Meat	0.09	0.19	0.32
Other Agri. & Forestry	0.05	0.10	0.16
Meat Preparations	0.63	1.34	2.21
Other Food Processing	0.21	0.44	0.73
Other Industry	0.04	0.09	0.15
Services	0.06	0.12	0.20

* This aggregation is adopted for expositional purposes only. The values were computed as the share weighted average of the output responses of the industries reported in the Annex.

Figure 1. Projected impacts of the supply shock on the poultry sector

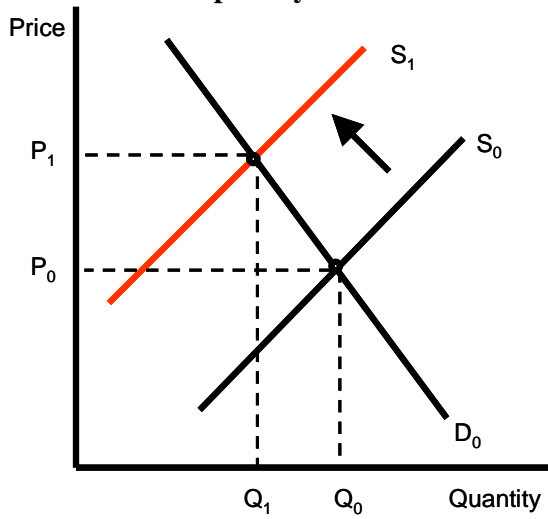
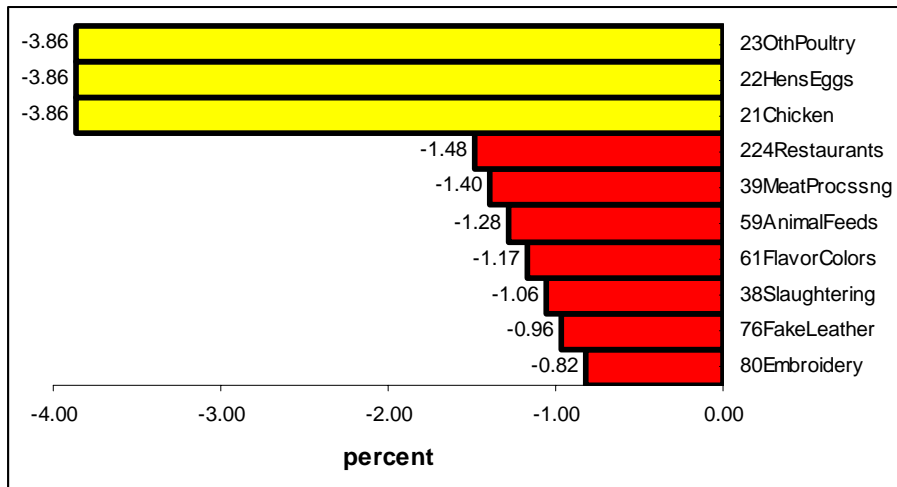


Figure 2. Ten most adversely affected industries in the production shock, percent decline in output.



Source: Annex 1

Figure 3. Projected impacts of the demand shock on the poultry sector

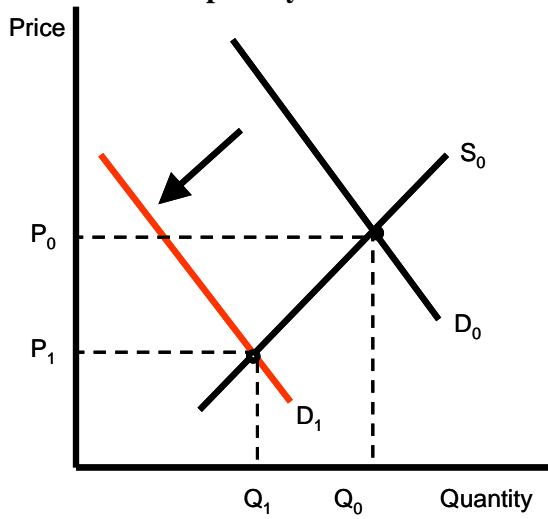
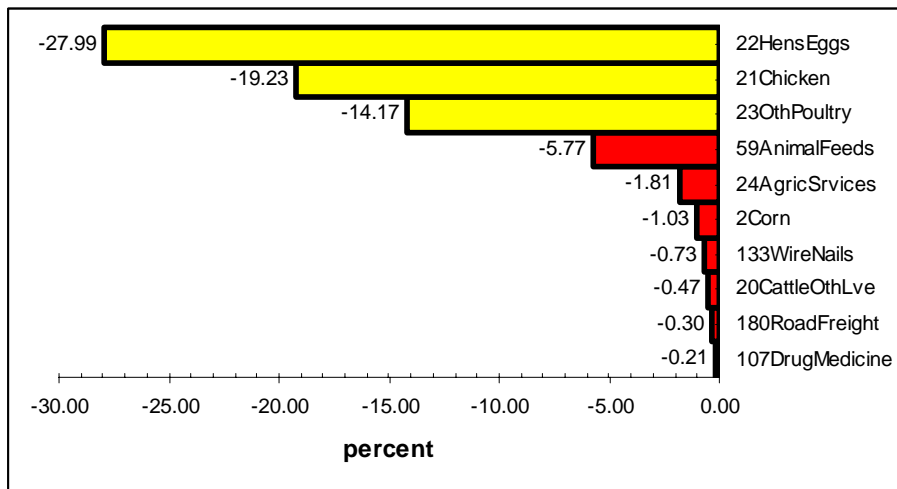


Figure 4. Ten most adversely affected industries in the consumption shock, percent decline in output.



Source: Annex 1

ANNEX 1

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
1Palay	0.89	-0.08	3.21	0.67
2Corn	-0.09	-0.50	-3.37	-1.03
3Vegetables	0.29	-0.45	0.00	0.11
4RootsTubers	0.78	-0.32	1.14	0.60
5Banana	0.24	-0.67	-0.03	0.41
6Pineapple	0.30	-0.52	0.19	0.40
7Mango	0.22	-0.43	0.42	0.30
8CitrusFruits	0.50	-0.69	0.13	0.75
9FruitsNuts	0.51	-0.35	0.73	0.53
10Coconut	0.23	-0.40	0.01	0.21
11Sugarcane	0.40	-0.29	0.65	0.38
12Tobacco	0.09	-0.49	0.20	0.05
13Abaca	0.39	-0.78	-0.18	0.22
14OthFiberCrop	0.54	-0.44	-0.09	-0.02
15Coffee	0.47	-0.28	1.21	0.29
16Cacao	1.01	-0.20	0.66	0.74
17Rubber	0.30	-0.43	0.11	0.11
18OthAgricProd	0.31	-0.21	0.36	0.17
19Hogs	-0.09	-0.07	1.51	0.56
20CattleOthLve	1.62	0.95	0.97	-0.47
21Chicken	34.37	-3.86	-41.21	-19.23
22HensEggs	34.04	-3.86	-61.27	-27.99
23OthPoultry	34.81	-3.86	-38.50	-14.17
24AgricSrvices	0.32	-0.42	-4.72	-1.81
25Fishing	0.17	-0.24	0.84	0.19
26Aquaculture	0.08	-0.22	0.25	0.14
27Forestry	-0.92	-0.28	0.20	0.04
28GoldSilvrMin	0.04	-0.38	-0.01	0.00
29CopperMin	0.07	-0.38	-0.01	-0.01
30NickelMin	0.06	-0.44	-0.01	0.02
31ChromiteMin	0.05	-0.38	-0.01	-0.01
32OthMetalMin	0.02	-0.22	-0.01	0.01
33CoalMining	0.18	-0.44	0.06	0.03
34CrdPetNatGas	0.00	-0.18	0.04	0.01
35StoneClayMin	0.47	-0.23	0.10	0.05
36SaltMining	1.02	-0.12	1.99	0.64
37OthNonMtlMin	0.09	-0.54	0.01	-0.01
38Slaughtering	6.11	-1.06	-4.18	1.77
39MeatProcssng	2.12	-1.40	-0.66	1.27
40MilkProcssng	0.34	-0.40	0.44	0.57
41ButterCheese	0.28	-0.25	0.81	0.57
42IceCream	0.65	-0.07	2.64	0.85
43OthDairyProd	0.43	-0.13	1.56	0.33

ANNEX 1 (Continued)

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
44CanVegFruit	0.29	-0.52	0.41	0.27
45CannedFish	0.22	-0.30	0.52	0.01
46DryFshOthSea	0.27	-0.46	0.39	0.05
47CocoOilCopra	0.11	-0.48	0.05	-0.19
48CrudeVegOil	0.25	-0.41	0.11	0.09
49EdblOilRefin	0.16	-0.36	0.21	0.39
50RiceCornMill	0.66	-0.08	3.83	0.75
51FlourOthGrns	0.13	-0.33	1.47	0.89
52BakeryProds	2.30	-0.35	-1.41	1.47
53Noodles	0.03	-0.32	1.20	0.29
54SugarMill	0.39	-0.29	0.87	0.39
55CocoaChocCnf	0.26	-0.23	0.63	0.16
56DryCoconut	0.18	-0.77	0.01	0.01
57IceExcDryIce	0.53	-0.09	1.13	0.69
58CoffeeProc	0.47	-0.42	0.83	0.42
59AnimalFeeds	-0.42	-1.28	-4.85	-5.77
60StarchProds	0.26	-0.47	0.32	0.44
61FlavorColors	1.24	-1.17	-1.31	1.97
62MiscFoodProd	0.47	-0.43	0.02	0.41
63WineSpirits	0.28	-0.16	0.67	0.31
64BeerMalt	0.40	-0.08	1.75	0.31
65SoftDrinks	0.57	-0.10	1.66	0.58
66Cigarettes	0.62	0.03	1.50	0.73
67CigarsTbacco	0.39	-0.10	0.66	0.62
68TobaccoLeaf	0.19	-0.64	0.14	0.06
69SpinWeaveFin	0.09	-0.41	0.03	0.02
70KnittedFabrc	0.03	-0.23	0.08	0.04
71KnittedGrmnt	0.09	-0.56	0.07	0.08
72TexNonGrmnt	0.11	-0.44	0.03	0.06
73CarpetsRugs	0.37	-0.20	0.58	0.55
74CordsRopeNet	0.30	-0.52	-0.22	-0.14
75NativeProds	0.22	-0.30	0.32	0.21
76FakeLeather	0.09	-0.96	0.03	0.04
77PaddingCoir	0.10	-0.30	0.29	0.14
78Tailoring	0.53	-0.18	0.87	0.41
79RdyMdClothng	0.03	-0.25	0.07	0.00
80Embroidery	0.13	-0.82	0.06	0.11
81OthClothing	0.02	-0.42	0.00	0.02
82TanLeather	0.05	-0.80	-0.03	0.24
83LeatherProds	0.16	-0.53	0.12	0.17
84LeatherShoes	0.07	-0.63	0.01	0.05
85Sawmills	-0.11	-0.16	0.10	0.02
86VeneerPlywd	-0.01	-0.15	0.06	-0.01

ANNEX 1 (Continued)

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
87ParticlBoard	0.15	-0.24	0.09	0.03
88WoodDrying	0.09	-0.27	0.04	0.01
89WoodMillwork	0.06	-0.44	0.01	-0.03
90WoodenWare	0.07	-0.37	0.03	-0.02
91WoodCarvings	0.17	-0.63	0.09	0.07
92MiscWoodProd	0.06	-0.41	0.05	0.01
93WoodFrniture	0.24	-0.36	0.28	0.14
94CaneFrniture	0.08	-0.33	0.07	0.05
95OthrFrniture	0.29	-0.40	0.25	0.30
96PulpPaperBrd	0.07	-0.24	0.18	0.08
97PaperContnrs	0.10	-0.32	0.08	0.06
98PaperArticle	0.14	-0.26	0.19	0.10
99Newspapers	0.58	0.08	0.52	0.98
100Books	0.44	-0.24	0.47	0.33
101JobPrinting	0.30	-0.28	0.12	0.12
102BasicChemicl	0.03	-0.22	0.03	0.01
103Fertilizer	-0.02	-0.21	0.06	0.03
104SynthResins	-0.01	-0.20	0.02	0.00
105Pesticides	0.00	-0.20	0.19	0.08
106Paints	0.20	-0.25	0.11	0.12
107DrugMedicine	0.33	-0.33	-0.29	-0.21
108SoapDetergnt	0.69	-0.06	1.60	0.35
109Cosmetics	0.37	-0.16	0.73	0.37
110MiscChemPrd	0.08	-0.25	0.10	0.06
111PetrolRefnry	0.09	-0.20	0.20	0.14
112TarsLubesEtc	0.22	-0.34	0.06	0.07
113RubberTires	0.05	-0.30	0.12	0.06
114RubberFootwr	0.28	-0.37	0.23	0.25
115OthRubberPrd	0.28	-0.46	0.18	0.26
116PlasFtwrFurn	0.11	-0.26	0.21	0.10
117PotteryChina	0.13	-0.24	0.17	0.05
118FlatGlass	0.06	-0.25	0.04	0.01
119GlassContnrs	-0.05	-0.19	0.28	0.07
120OthGlassProd	0.11	-0.48	0.06	0.08
121Cementmfr	0.21	-0.12	0.18	0.04
122StrucClayPrd	0.17	-0.28	0.05	0.01
123StrucConcPrd	0.36	-0.17	0.12	0.03
124OthNMtlMinPr	0.08	-0.47	0.00	0.02
125IronSmelting	0.01	-0.27	0.00	-0.01
126IronFoundry	0.01	-0.23	0.01	-0.04
127NFerSmelting	0.02	-0.30	-0.01	-0.01
128NFerFoundry	0.04	-0.48	0.00	-0.02
129CutleryTools	0.03	-0.41	0.03	0.03

ANNEX 1 (Continued)

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
130StrucMetlPrd	0.12	-0.55	0.00	-0.01
131MetalContnrs	0.11	-0.38	0.14	0.14
132MetalStampng	0.11	-0.30	0.11	0.09
133WireNails	-0.07	-0.40	-0.75	-0.73
134NIWireProds	0.03	-0.36	-0.01	0.08
135NElcLiteHeat	0.19	-0.68	0.03	-0.04
136FabMetalPrds	0.08	-0.41	0.01	0.01
137AgricMachine	0.18	-0.70	0.00	0.00
138MtalWoodMchn	0.11	-0.64	0.00	-0.03
139NTrnsEngines	0.09	-0.35	-0.01	0.00
140OfficeMchnes	0.12	-0.68	0.01	-0.04
141PumpsBlowers	0.06	-0.42	-0.01	0.00
142OthNEIMchnry	0.16	-0.50	0.07	0.07
143ElecMachinry	0.03	-0.27	-0.01	0.00
144RadioTVsCDs	0.07	-0.34	0.04	0.03
145CommsEquipmt	0.07	-0.37	0.01	-0.02
146ElctrncParts	0.08	-0.60	0.00	0.01
147HshldApplncs	0.10	-0.27	0.12	0.06
148Batteries	0.05	-0.21	0.17	0.06
149InslatedWire	0.04	-0.37	0.00	-0.06
150WiredDevices	0.03	-0.31	0.00	-0.01
151ElecLampsEtc	0.10	-0.75	-0.10	-0.10
152ShipsBoats	0.07	-0.30	0.00	0.00
153MotorVhicles	0.07	-0.45	0.02	0.05
154RebuildMV	0.44	-0.45	0.35	0.48
155MVPartsAcces	0.02	-0.51	-0.01	-0.01
156Cycles	0.14	-0.33	0.12	0.10
157TrainsPlanes	0.01	-0.37	-0.01	0.01
158ScientifEquip	0.12	-0.39	0.00	0.01
159PhotoOptInst	0.04	-0.36	0.01	0.01
160ClockWatches	0.13	-0.68	0.03	0.05
161MtlFurniture	0.11	-0.57	0.04	0.01
162Jewelry	0.16	-0.63	0.09	0.05
163MusicInstrm	0.14	-0.61	0.01	-0.04
164SportingProd	0.05	-0.41	0.00	-0.01
165MedicalSpplly	0.12	-0.66	0.00	0.00
166Spectacles	0.10	-0.52	0.04	0.05
167NonPlasToys	0.07	-0.44	0.02	0.00
168OfficeSupply	0.09	-0.43	0.05	0.02
169MiscManufact	0.09	-0.53	0.02	0.03
170Construction	0.76	-0.07	0.04	0.02
171Electricity	-0.21	-0.20	0.48	0.08
172Steam	-1.91	-0.20	1.33	0.08

ANNEX 1 (Continued)

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
173Water	0.62	-0.15	1.18	0.32
174WholslRtlTrd	0.29	-0.19	0.13	0.03
175RailTransprt	0.70	-0.26	0.11	0.19
176BusTransport	0.73	-0.17	0.32	0.08
177Taxis	0.57	-0.25	0.50	0.38
178JeepneyEtc	0.81	-0.11	0.82	0.54
179TourBusCars	0.13	-0.55	0.02	-0.03
180RoadFreight	0.11	-0.58	-0.40	-0.30
181OceanTranspt	0.30	-0.40	-0.18	0.19
182IslandShips	0.81	-0.20	0.12	0.16
183Stevedoring	0.51	-0.41	0.06	0.02
184AirTransport	0.36	-0.33	0.15	0.10
185TravelAgency	0.28	-0.73	0.10	-0.03
186CustomsBrokr	0.19	-0.32	0.04	0.00
187Storage	0.20	-0.33	0.24	0.03
188Telephone	0.10	-0.13	0.47	0.06
189Telegraph	0.18	-0.31	0.07	0.01
190PostalEtc	0.11	-0.18	0.21	0.03
191Banking	0.18	-0.34	0.14	0.05
192NBnkFinSrvcs	0.00	-0.19	-0.22	-0.04
193Pawnshops	1.17	0.03	1.65	0.83
194LifeInsurnce	1.14	-0.02	2.37	0.50
195OthInsurance	0.08	-0.29	-0.20	-0.04
196RealEstDevel	0.71	-0.10	1.68	0.30
197RealEstLease	0.25	-0.15	1.11	0.17
198OwnDwellings	1.27	0.00	4.65	0.00
199LegalSrvices	0.52	-0.43	0.20	0.09
200Bookkeeping	0.71	-0.36	-0.03	0.00
201ArchEngSrvcs	0.34	-0.42	0.04	0.03
202Advertising	0.59	-0.42	0.31	0.17
203EquipLeasing	0.22	-0.33	0.10	0.04
204JobAgencies	0.77	-0.17	0.63	0.22
205BusRsrchSrvc	0.14	-0.29	0.02	0.01
206SecuritySrvc	0.78	-0.23	0.13	0.07
207OthBusSrvces	0.27	-0.41	0.04	0.02
208SanitarySrvc	0.78	-0.22	0.20	0.07
209PrvEducation	1.11	-0.04	1.26	0.74
210PrivHospital	1.12	-0.03	0.77	1.10
211PrivClinics	0.96	-0.04	0.81	0.31
212OthSocialSvc	1.06	0.00	1.23	0.88
213FilmMaking	0.87	0.01	0.89	0.91
214FilmShowing	0.91	-0.03	1.03	0.83
215RadioTVprogs	0.36	-0.40	0.22	0.13

ANNEX 1 (Continued)

**Impacts of production and consumption shocks on industry prices and outputs
(in percent deviation from base values).**

Industry code**	Production shock		Consumption shock	
	price	output	price	output
216Theatrical	0.42	-0.60	0.15	0.07
217OthRecSrvces	0.14	-0.34	0.11	0.04
218MVRepairs	0.58	-0.24	0.30	0.20
219OthRepairs	0.77	-0.16	0.39	0.23
220LaundryDryCl	0.81	-0.23	0.88	0.55
221HairBeauty	0.97	-0.04	1.51	0.65
222Photographer	1.11	0.10	1.11	0.55
223OthPersSrvce	1.01	-0.06	1.27	0.54
224Restaurants	1.39	-1.48	-0.53	1.25
225HotelsMotels	0.04	-0.51	-0.06	-0.13
226OthLodgings	0.86	-0.16	0.42	0.12
227PublicEducat	1.36	0.00	-0.06	0.01
228PublicHealth	1.40	0.00	-0.31	0.04
229PublicAdmin	1.13	0.00	0.01	0.00

* The values reported here are for the “moderate” cases of the shocks.

** A description of the industry codes is available in Rodriguez and Cabalu (2005)