

行政院國家科學委員會專題研究計畫成果報告

台灣豬隻口蹄疫情之動態一般均衡分析

A Dynamic CGE Analysis

of the Foot-and-Mouth Disease Event in Taiwan

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主持人：徐世勳 臺灣大學農業經濟學系

計畫參與人員：林欣穎 臺灣大學農業經濟學系

吳佳勳 臺灣大學農業經濟研究所

一、中文摘要

行政院農委會於民國八十六年三月二十日證實我國豬隻感染口蹄疫，並依國際慣例發佈疫情，全面暫停包括豬肉及偶蹄類相關肉品出口，對於年產量連續兩年(八十四、八十五)均逾一千四百萬頭，年產價值約為新台幣 890 億元，位居農畜產品總產出價值首位的養豬業而言，撲殺染疫豬隻、外銷市場失據、國內肉品市場紛亂幾近崩盤等，無疑是莫大的打擊。對國內畜產業及週邊關聯產業影響甚鉅，我國一向享譽國際的畜產業因此受到了嚴重打擊。

正因為毛豬產業是本省農業中最重要且居最高產值的一項產業，此次口蹄疫爆發後，農政、學術、研究等單位相關之研究評論接踵而至。然而豬隻在市場上具有落遲性，若能加上動態機制，也就是納入生產者之預期行為，必能更詳細刻畫出豬隻產業與其他產業間之關聯。為能詳細刻劃豬隻產業與其相關聯產業之關係進而評估因豬隻口蹄疫爆發導致總體經濟之變動，本計畫擬建立以台灣豬隻產業與其他相關聯產業為特質的動態可計算一般均衡分析模型 (Computable General Equilibrium Model, 簡稱 CGE 模型)，以澳洲 MONASH 為基礎，搭配主計處新編 85 年產業關聯表及相關資料，針對本研究所需，模擬分析因豬隻口蹄疫爆發，導致豬肉消費下降及豬肉出口停止後對總體經濟與相關產業之影響。

關鍵詞：動態可計算一般均衡(CGE)，豬隻口蹄疫情，預測，政策模擬

Abstract

The purpose of this project is an economy-wide analysis of the outbreak of the foot-and-mouth disease (FMD) in Taiwan. Since the impacts of FMD are not confined to the hog industry only and expectations are important for an insightful analysis, we employed a dynamic CGE analysis of the impacts of FMD and possible structural changes. We first review the hog industry and its development during last 30 years in Taiwan. We also provide a literature review on the economic evaluation of FMD impacts. Our model is a dynamic computable general equilibrium (CGE) model of the Taiwan's economy, developed specifically with an emphasis on Taiwan's hog industry and its related industries. The model is derived from the ORANI model (Dixon, Parmenter, Sutton and Vincent, 1982) and the MONASH model.

Keywords: Dynamic CGE Analysis, Foot-and-Mouth (FMD) Disease, Policy Simulation, Prediction

二、緣由與目的

The hog industry in Taiwan has expanded very fast since 1960's. Since then the total production and export to Japan increase dramatically. Starting from 1992 the export value of pork to Japan was over 1 billion US dollars. It hits a historical record of 1.6 billion dollars in 1996. According to the statistics the hog industry has been one of the most important industries in agricultural sector since 1986. The total

production value is 88.6 billion NT dollars and has a largest share (21%) of total agricultural production.

Unfortunately, on March 14, 1997 the first case of foot-and-mouth disease (FMD) was reported on a farm located in the northwest section of the island. At the beginning of May, the infected area was extended to cover the whole main island. By June 4, 6,143 farms had been affected. The number of exposed susceptible animals reached 4.66 million head, the number of cases was 1 million and 3.85 million animals were slaughtered (Shieh, 1997). The pork export to Japan was totally halted since the outbreak of FMD.

This study aims to provide an economy-wide analysis of the outbreak of FMD in Taiwan. Since the impacts of FMD are not confined to the hog industry only and expectations are important for an insightful analysis, we employed a dynamic CGE analysis of the impacts of FMD and possible structural changes. We first review the hog industry and its development during last 30 years in Taiwan. We also provide a literature review on the economic evaluation of FMD impacts. Our model is a dynamic computable general equilibrium (CGE) model of the Taiwan's economy, developed specifically with an emphasis on Taiwan's hog industry and its related industries. The model is derived from the ORANI model (Dixon, Parmenter, Sutton and Vincent, 1982) and the MONASH model.

According to Ekboir (1999), the value of the losses caused by a FMD outbreak consists of four components: (1) the direct cost of dealing with the outbreak (cleaning and disinfection, compensation to producers, quarantine enforcement, etc.), (2) production losses, (3) induced price changes, and (4) the effect on other sectors of the economy. Different ways to estimate the value of losses have resulted in four methodologies: accounting methods, cost-benefit analysis, welfare analysis, and input-output (I/O) models.

All firms purchase primary inputs and intermediate inputs and sell outputs from other economic agents (firms, households, etc.). These agents, in turn, buy and sell products inducing additional economic activities that spread to the rest of the economy. Through these direct, indirect and induced linkages, a FMD outbreak not only affects the infected premises but the whole economy. Input-output (I/O) analysis estimates the direct and

indirect cost of the outbreak to the whole economy.

Garner and Lack (1995) is an example of input-output analysis. They evaluate four control options (stamping-out, dangerous contacts slaughter, and early or late ring vaccination) for FMD in three different regions of Australia. A stochastic disease simulation model was used to generate FMD outbreak scenarios, and an I/O model converted outbreak effects on farming and processing operations and subsequent effects of control programs into estimates of total economic impacts. The results show considerable regional variation according to ecological and productive conditions.

However, the main limitations of I/O analysis are that it does not include price effects and resources are unrestricted. Models which attempt to capture all these FMD interdependencies require two types of data: input-output tables and behavioral parameters. I/O analysis, because they include only direct interdependencies between components of the economy, require as data only input-output tables.

Theoretical Framework

In this study we employed a dynamic CGE model and input-output table to analyse the economy-wide impacts of FMD outbreak in Taiwan and induced possible structural changes.

A modern computable general equilibrium is usually formulated as a set of behavioral equations and identities which describe the economic behavior of the agents identified in the model and the technological and institutional constraints facing them. The behavioral equations are usually derived as the solutions to explicit constrained-optimisation problems assumed to drive the economic behavior of a representative agent from each component of the model economy, e.g., a typical producer in a given industrial sector, a typical household of given socioeconomic or demographic characteristics, or a typical importer or exporter. I/O analysis can be derived as special case of computable general equilibrium analysis.

Our model is a dynamic computable general equilibrium (CGE) model of the Taiwan's economy, developed specifically with an emphasis on Taiwan's hog industry and its related industries. The model is derived from the ORANI model (Dixon, Parmenter, Sutton and Vincent, 1982) and the MONASH model. MONASH is a multisectoral, computable general equilibrium

(CGE) model of the Australian economy descended from the well-known ORANI. ORANI was originally designed for comparative-statics, i.e., for projecting what difference a shock would make to the economy *at a point in time*. MONASH is capable of projecting the development of the economy *through time*, i.e., year-to-year patterns of growth over medium-run periods.

As a by-product of the historical simulations, we estimate detailed patterns of changes in technology and household tastes over the historical period. We use these estimates as the starting point for formulating forward-looking scenarios of changes in technology and tastes for forward-looking simulations. Our forward-looking, or forecasting, simulations allow us to project prospects for the agricultural, industrial and occupational structures of the economy and also for income distribution.

The growth path for the economy projected in a forecasting simulation can also be used as a control path from which to make deviations showing the effects of FMD impacts, policy changes or other shocks of interest. Policy analysis conducted by projecting deviations from an explicit control path is much richer than the comparative-static exercises commonly undertaken with CGE models. It allows us, for example, to analyze adjustment problems associated with policy changes as well as just the final effects of the changes.

For the decomposition closure of the model, we choose a short-run macro environment where on the supply-side we fixed the level of capital usage by fixing capital in each industry. On the demand side, we fixed domestic absorption (i.e., real household consumption, aggregate real investment, aggregate real other demands, and aggregate real inventories). The shocks to the economy include -30% to the household taste change towards pork consumption and -100% to the pork export (i.e., no pork export).

三、結果與討論

Foot-and-mouth disease, a significant threat to animal health and welfare, is not considered transmissible to humans, and poses no food safety threat. However, the new outbreak in the United Kingdom, along with others in France and Holland, have raised concerned that new FMD outbreak could occur around the world. Methods to estimate the potential economic costs of a FMD outbreak,

including animal health costs, production losses, and export restrictions, are important for policy suggestions.

This study provides an economy-wide analysis of the outbreak of FMD in Taiwan. Decomposition results show that nominal GDP decreases by -0.25% (the first year), -0.15% (the second year) and -0.06 (the third year). The reduction in nominal GDP is mostly due to price reduction effect. The GDP deflator drops by -0.23% (the first year), -0.13% (the second year) and -0.04 (the third year). The real GDP decreases insignificantly. The output loss in hog industry is mostly compensated from the production increase in poultry and beef industries. The poultry production increases by 0.56% (the first year), 0.34% (the second year) and 0.13 (the third year). Although most hog-related industries (e.g., slaughtering, soybean oil, feed, etc.) incur a loss, other industries like livestock medicine, food processing, etc., benefit.

The CGE estimates clearly demonstrate that economy-wide analysis is more complete than those of partial equilibrium analysis. Over-estimating the losses due to the FMD disease event without taking into account of positive effects to other related industries would provide incomplete information for policy evaluation.

The cost of the stamping-out policy would explode with the number of depopulated premises. The alternative policy of vaccination could reduce the number of animals destroyed but would delay the return of Taiwan to the FMD-free market. However, the number of destroyed animals at which stamping-out ceases to be the optimal policy is unknown.

According the recent report of Buzby, et al. (2001), given the disadvantages of FMD vaccines, the United States, the European Commission, and individual E.U. member states do not believe widespread vaccination is an appropriate first step against the disease. In particular, APHIS (Animal and Plant Health Inspection Service, USDA) believes that there is no need to vaccinate against a disease when no animals are affected - especially when strict import restrictions and surveillance policies are in place.

四、計畫成果自評

本研究為國內外首見的台灣豬隻口蹄

疫情之動態一般均衡分析。藉由我國動態 CGE 模型的修正與研發，可與澳洲 MONASH 大學的 Center of Policy Studies (CoPS) 建立合作關係，增進交流。歷史模擬的研究結果可提供主計處、農委會或相關政府單位更新投入產出表、技術係數等資料之參考。台灣豬隻口蹄疫病的經濟影響評估研究結果可供農委會、經濟建設委員會等政府單位作為農業政策、產業結構調整與相關經建規劃時之參考。參與之研究人員將可獲得對建立我國動態 CGE 模型的理論研發、軟體程式設計與操作之訓練與實務經驗。研究結果將可發表在國內外學術期刊。

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