Effects of Continued Opening of Japan’s Agricultural Sector on Prices, Wages, Employment and Welfare From 2000 to 2005

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For Presentation at the 47th Annual Meeting of the Japan Section of the Regional Science Association International, National Graduate Institute for Policy Studies.

October 10th, 2010

1 Introduction

Debates over the economic merits of free trade have recently surfaced. Trade tends to bring about what Ohta and Nakagawa (2008) called the ‘worsening terms of exchange,’ which is a more intra-national than international phenomenon. Yet this more intra-national, distributional conflict comes out as a stumbling block to international trade as suggested almost three score and ten years ago by Stolper and Samuelson (1941) (SS). An enormous amount of subsidy is reportedly poured into the adversely affected sectors, agriculture in particular. Further increased open trade will be an important factor in raising average living standards of people in the country. However, agricultural trade liberalization has remained controversial and should be debated. Sound agricultural policies eliminating market distortions would be based on an economic rather than a political rational.1

The huge costs of agricultural protection were reported by the the Organization for Economic Cooperation and Development (OECD, 1998); Producer subsidy equivalent (PSE), a measure of the value of total support to agricultural producers as a percent of the value of agricultural production, averaged 35 percent of the value of production in the OECD countries in 1997; In the recent OECD estimates (OECD, 2007), for all OECD countries, the PSE averaged 28 percent in 2005 and 23 percent in 2007. For Japan, the PSE was 54 percent in 2005 and 45 percent in 2007. The benefits of agricultural liberalization were also discussed in a recent book by Southgate et al. (2007). Japan is no exception in its resistance to ongoing agricultural liberalization.

This paper extends the underlying theoretical developments in Ohta (2004), Ohta (2005), Ohta (2006), Ohta and Nakagawa (2008) to build an em-

1The same Paul Samuelson went on even further to say, “comparative advantage cannot be counted on to create... net gains greater than the net losses from trade Business-Week (2004).” His concern, among other prominent trade experts, seems to be high-skilled workers in the developed countries rather than the low skilled, who are going to be “exposed to international competition.” They may turn poor under free trade, “although it’s not clear how much it will hurt their wages,” as Jagdish Bhagwati is quoted as saying.

2Irwin (1996) and Bhagwati (2002) have debated the economic merits of free trade. The negative effects of protectionism are well documented by Bhagwati (1988). Krugman (1987) has stated: “...the case for free trade is currently more in doubt than at any time since the 1817 publication of Ricardo’s Principles of Political Economy...” However, he also noted that “…free trade is not passe…. Its status has shifted from optimum to reasonable rule of thumb. There is still a case for free trade as a good policy, and as a useful target in the practical world of politics,...”

3Herrmann (2007) discusses the linkages between agricultural support measures in developed countries and food security in developing countries. He argues that “A credible phasing-out of agricultural support should receive priority in multilateral trade negotiations.”

4The costs of agricultural protection and some misconceptions about agricultural trade liberalization were discussed in Tokarick (2008).
empirical model which improves upon the earlier versions in Kawano (2007), Ohta and Kawano (2008) and Kawano (2009). For the empirical model construction, a two-sector applied general equilibrium model is used as a framework to measure the impact of further opening of the agricultural sector on wages, employment, and welfare in Japan. Further opening of trade volume can be theoretically explained by many possible causes, as in Deardorff and Hakura (1994). The model was kept simple to best match the task at hand.

For the empirical characterization, calibration is achieved through the use of year 2005 Japan’s 32-sector input-output data (Statistics Department, Ministry of Public Management, Home Affairs, Posts and Telecommunications, 2009). The data is grouped into two sectors. One is the agricultural sector, classified as code 001 in the data, defined as industry 0. The other is a highly aggregated non-agricultural sector, defined as industry 1. Also incorporated is Leontief type input-output accounting data. The model closure is a small open economy with free capital inflow and outflow, so that the balance of payments is balanced. In this way, the original input-output data was used without modification.

A crucial step in the empirical characterization of an applied general equilibrium model (AGE) is calibration, defined as “the requirement that the entire model specification be capable of generating a base-year equilibrium observation as a model solution” (Shoven and Whalley, 1992). An AGE model is a very powerful framework for analysis of policy reforms that could be instituted for Pareto improvements in the current state of the economy. An important development since Scarf (1967) has been the use of observed data, such as that in an input-output table, in developing an AGE model.

The solution procedure for coding the model follows Shoven and Whalley (1992) by reducing the dimensionality of the solution space to the number of factors of production in this general equilibrium structure. The solution algorithm used for calibration is a fixed-point algorithm originally developed by Kimbell and Harrison (1986) and modified by Kawano (2003). In his recent paper (Kawano, 2006), four alternative fixed point algorithms were compared. Among the four alternatives, the modified Kimbell-Harrison approach was shown to be the best for an AGE modeling.

This paper revisits the same simple model of computable or applied general equilibrium with trade in Ohta (2005) and Ohta (2006) to probe the orthodox Heckscher-Ohlin (HO) and Stolper- Samuelson (SS) theorems for shedding some new light on each. Set forth against the HO orthodoxy was an H.O. heresy to introduce heterogeneity in tastes rather than endowments/technologies as a theoretical framework to interpret the simulation results. If Japan is reasonably assumed to be relatively capital-rich, then the H.O. heresy does better explain the empirical results than the HO theorem does. Therefore, the earlier claim that the Leontief paradox is no more a paradox than the H.O. heresy is empirically supported. First, we review changes in the industrial structure from 2000 to 2005 and then measure the possible economy-wide effects of further opening of the agricultural sector.

First, notable changes in the structure of the economy during the five years between 2000 and 2005 were examined. The aggregate effects of all 13 parameters’ changes over the five years were the followings: 1) both labor employment and labor income in the agricultural sector increased by 26.9 percent, but capital employment and capital income in the same sector decreased by 26.5 percent; 2) consumption and production in the agricultural sector decreased by 18.4 percent and 15.9 percent; 3) capital-labor ratio in the agricultural sector decreased by 42.0 percent; 4) the national welfare was reduced by 8.9 trillion yen in CV and EV measures. In sum, these imply 1) the agricultural sector became less capital-intensive than before; 2) labor employment and labor income increased in the agricultural sector, but capital employment and capital income decreased in the same sector; 3) still the agricultural sector continued to decrease in size, in terms of both decreased final consumption and production in the agricultural sector; 4) the Hicksian technical innovation in the non-agricultural sector in particular, increased factor employment and income in the agricultural sector; 5) the national welfare declined during the five years between 2000 and 2005.

Second, with the use of year 2005 Japan input-output data, the major simulation results of a balanced budget 79.8% import expansion of the agricultural sector lead to the following conclusions: (1) the total national income is increased by 0.23% (the CV and EV measures of the welfare increase are 1.285 trillion yen and 1.287 trillion yen, respectively); (2) both wage and capital income in the

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5 Among the causes are tariff cut on imports, the foreign expansion of import-competing goods, technical progress in exporting goods at home, technical progress at home in import-competing goods, and rise in expenditure at home. The main message of their examples is that there are many possible reasons for the volume of trade increase.
agricultural sector are decreased by 20.68%; (3) employment in the agricultural sector is decreased by 20.68%; (4) the Stolper-Samuelson effect, which deals precisely with the effects of trade on wages and other factor prices, is demonstrated, since real return to labor \(w_p / p_0\) and \(w_p / p_1\) increase by 0.18% and 0.12%. In addition, real return to capital \(r_p / p_0\) and \(r_p / p_1\) decrease by 0.07% and 0.13%, respectively. Meanwhile the relative price of capital-intensive commodity \(p_0 / p_1\) decreases by 0.24%. In brief, the major simulation results of a balanced budget and import expansion of the agricultural sector lead to the following conclusions: 1) Japan, with any further opening of her agricultural sector, will have an increasingly higher wage rate; 2) The agricultural sector turns out to be increasingly more capital-intensive; 3) The aggregate GDP gains of 1.29 trillion yen (more than US$ 10 billion) a year can further raise the general welfare of the population.

Third, the proposed theoretical framework of heterogeneity in tastes rather than endowments/technologies does better explain the empirical results than the traditional Hecksher-Ohlin theorem does. Therefore, Ohta’s earlier claim that the Leontief paradox is no more a paradox is empirically supported.

This experiment was programmed in C-language, and conducted on the gcc version 2.6.0 compiler using Intel’s 333 MHz Pentium II processor. The verified reliability of the simulation results in double precision (\(1.0e - 15\)). The converged equilibrium values in this benchmark model were obtained through 51 iterations over the entire model.

Section 2 reviews the underlying theories: the orthodox Heckscher-Ohlin (HO) versus a heretical H.O. Section 3 reviews the main features of an AGE model. Section 4 reviews the structural change occurring between 2000-2005. In section 5, the major simulation results are presented. The conclusion follows in section 6.

2 The Underlying Theoretical Developments

2.1 The HO Orthodoxy

We now summarize the underlying theories developed over the years in Ohta (2004), Ohta (2005), Ohta (2006), Ohta and Nakagawa (2008), starting with the HO Orthodoxy. Consider two countries, labeled N and B, each producing two commodities, called nuts and bananas. Assume that N is endowed with more capital and less labor than B to produce nuts and bananas, labeled N and B, respectively. The two nationals share the same tastes for the produces under consideration. The production functions for each good \((i = N, B)\) are identical between the two countries and are linear homogeneous with variable factor proportions. Derived from these basic assumptions are the following autarky equilibria identified as \(E^{NA}\) and \(E^{BA}\) on the production possibilities frontier (PPF) of the Nutties and that of the Bananans.

2.2 A H.O. Heresy.

We now turn to the H.O. heresy in Figure 2 that is predicated on the same assumptions as HO’s but one: tastes are different between the two trading nations. Then it follows that the familiar HO theorem remains to be unaltered if only the taste differences between the two nations remain small enough. But if and when tastes become sufficiently
different for the two nationals as illustrated by Figure 2, then the HO theorem is reversed. It is its labor-intensive sector (Good B) that is to be the capital-rich Country N’s export sector, and capital-intensive goods N are to be imported. This may make the Leontief paradox no more a paradox than the H.O. heresy is, should it sound paradoxical. This H.O. heresy is used here as a theoretical framework to interpret the simulation results.

### 3 The Empirical Structure of the Model

The objective of the present AGE simulation model is to measure the impact of import expansion of the agricultural sector on wages and employment in Japan; a two-sector applied general equilibrium model is used as a framework. Expansion of trade volume can be theoretically explained by many possible causes, as in Deardorff and Hakura (1994). In this paper, regardless of the causation of the volume of import increase, the impact of import expansion of the agricultural sector on wages, employment, and the total welfare changes is measured.

The empirical model was kept very simple. For example, both domestic and international prices were assumed to move together and that both were the same for the simplicity of the model. The supply side of a theoretical general equilibrium model is made more empirically plausible by incorporating the Leontief type input-output accounting data. An important step in building an empirical model is to incorporate flow of intermediate goods into the model structure. The flow of intermediate goods among different sectors is built into the model as part of production activity in the economy. The overview of the theoretical structure of the model with the case of current account surplus is presented in Figure 3.

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<sup>6</sup>For example, assuming that both domestic and international prices move together, we use only a price for each commodity and do not introduce any distortion in the model economy.

<sup>7</sup>Both domestic and international prices converge as all import restrictions like tariffs and quotas are gradually removed to open up the agricultural sector.

### 4 Structural Change Occurring Between 2000-2005

During the five years between 2000 and 2005, the aggregate effects of all 13 parameters’ changes over the five years in simulation ex-14.c in Table 5 were the followings: 1) both labor employment and labor income in the agricultural sector increased by 26.9 percent, but capital employment and capital income in the same sector decreased by 26.5 percent; 2) consumption and production in the agricultural sector decreased by 18.4 percent and 15.9 percent; 3) capital-labor ratio in the agricultural sector decreased by 42.0 percent; 4) the national welfare was reduced by 8.9 trillion yen in CV and EV measures. In sum, these imply 1) the agricultural sector became less capital-intensive than before; 2) labor employment and labor income increased in the agricultural sector, but capital employment and capital income decreased in the same sector; 3) still the agricultural sector continued to decrease in size, in terms of both decreased final consumption and production in the agricultural sector; 4) the Hicksian technical innovation in the non-agricultural sector in particular, increased factor employment and income in the agricultural sector; 5) the national welfare declined during the five years between 2000 and 2005.

### 5 Simulation Results for Import Expansion

If and when tastes become sufficiently different for the two nationals as illustrated in the H.O. heresy, then the HO theorem is reversed. In this empirical study, it is its relatively labor-intensive non-agricultural sector that is to be the capital-rich Japan’s export sector, and capital-intensive agricultural goods are to be imported. This is contrary to a common belief that agricultural goods are labor-intensive. If Japan is reasonably assumed to be relatively capital-rich, then the H.O. heresy does better explain the empirical results than the HO theorem does. Therefore, the earlier claim that the Leontief paradox is no more a paradox than the H.O. heresy is empirically supported.

As a comparative statics exercise summarized in Table 6, the major simulation results of a balanced budget 79.8% import expansion of the agricultural sector are the following: (1) the total national income is increased by 0.23% (the CV and EV measures of the welfare increase are 1.285 tril-
lion yen and 1.287 trillion yen, respectively); (2) both wage and capital income in the agricultural sector are decreased by 20.68%; (3) employment in the agricultural sector is decreased by 20.68%; (4) the Stolper-Samuelson effect, which deals precisely with the effects of trade on wages and other factor prices, is demonstrated, since real return to labor \( w/p_0 \) and \( w/p_1 \) increase by 0.18% and 0.12%. In addition, real return to capital \( r/p_0 \) and \( r/p_1 \) decrease by 0.07% and 0.13%, respectively. Meanwhile the relative price of capital-intensive commodity \( p_0/p_1 \) decreases by 0.24%. These comparative statics results are illustrated in Figures 6 and 7, where the small-boxed values indicate the increased values from the benchmark results in Figures 4 and 5.

The simulation results imply that the more the capital-intensive agricultural sector shrinks, the higher the factor payment to its sector’s non-intensive factor of labor. In other words, the shrinking capital-intensive agricultural sector releases labor and capital. Then these factors are reemployed in the expanding labor-intensive non-agricultural sector over time. Labor becomes increasingly scarcer than capital does. As a result, the value of the marginal product of labor and the corresponding real wage rate tend to increase, which in turn increases the capital intensity of the labor-intensive non-agricultural sector (Relatively more capital than labor is used in production). In the end, the overall economy-wide capital intensity tends to increase as the labor-intensive non-agricultural sector expands and the capital-intensive agricultural sector becomes smaller. Therefore, both sectors become more capital-intensive, which also implies increasingly scarce labor and a higher wage rate (or increasingly abundant capital and a lower rental rate) in the economy.

6 Conclusion

This paper revisits the same simple model of computable or applied general equilibrium with trade in Ohta (2005) and Ohta (2006) to probe the orthodox Heckscher-Ohlin (HO) and Stolper-Samuelson (SS) theorems for shedding some new light on each. Set forth against the HO orthodoxy was an H.O. heresy to introduce heterogeneity in tastes rather than endowments/technologies as a theoretical framework to interpret the simulation results. If Japan is reasonably assumed to be relatively capital-rich, then the H.O. heresy does better explain the empirical results than the HO theorem does. Therefore, the earlier claim that the Leontief paradox is no more a paradox than the H.O. heresy is empirically supported.

First, we reviewed changes in the industrial structure from 2000 to 2005 and also to measure the possible economy-wide effects of further opening of the agricultural sector. Notable changes in the structure of the economy during the five years between 2000 and 2005 were examined. In sum, these imply 1) the agricultural sector became less capital-intensive than before; 2) labor employment and labor income increased in the agricultural sector, but capital employment and capital income decreased in the same sector; 3) still the agricultural sector continued to decrease in size, in terms of both decreased final consumption and production in the agricultural sector; 4) the Hicksian technical innovation in the non-agricultural sector in particular, increased factor employment and income in the agricultural sector; 5) the national welfare declined during the five years between 2000 and 2005.

Second, with the use of year 2005 Japan input-output data, we conducted the simulation of a balanced budget and import expansion of the agricultural sector which lead to the following conclusions: Japan, with any further opening of her agricultural sector, will have an increasingly higher wage rate as both agricultural and non-agricultural sector become increasingly more capital intensive with a portion of scarce labor relocating from the shrinking capital-intensive agricultural sector to the expanding labor-intensive non-agricultural sector. The agricultural sector, which contrary to common belief turns out to be increasingly more capital-intensive, is reduced by import expansion. However, the aggregate GDP gains of 1.29 trillion yen (more than US$ 10 billion) a year can further raise the general welfare of the population. The agricultural sector needs to be further exposed to international competition.

References


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