

Price Pass-Through, Household Expenditure and Industrial Structure: The Case of Taiwan

Kuo, Biing-Shen* and Peng, Su-Ling**

Abstract

The pass-through caused by global commodity prices has substantial impacts on the Taiwan economy and results in shifts in household expenditure patterns and the industrial structure. While the price pass-through coefficients for food follow the global trends, the coefficients for energy-related prices are higher in the domestic prices to core CPI which may result from the energy-related industries being either oligopolistic or monopolistic and the Taiwan government adopting subsidies when the fluctuations in energy-related prices were large. Shifts in energy-related products for the household expenditures are only slight, however, because energy-related items are almost inelastic demand, and are also heavily subsidized. The impacts of commodity price shocks on the industrial structure are evident in both the primary industries and secondary industries due to food and energy being intermediate inputs, and their impacts are reduced due to the technology innovations in food processes, energy-saving improvements, and a reduction in energy-dependency.

Keywords: Price Pass-Through, Household Expenditure, Industrial Structure

* Professor, Department of International Business, National Chengchi University

** Associate Research Fellow, Center for Economic Forecasting, Chung-Hua Institution for Economic Research, 75 Chang-Hsing St., Taipei, Taiwan 106, R.O.C. E-Mail: slpeng@cier.edu.tw

I. Introduction

The pass-through caused by global commodity prices has substantial impacts on the Taiwan economy and has resulted in shifts in household expenditure patterns and the industrial structure. Globalization links the world through a network of increasingly close relationships, and causes each economy to be intertwined with the world market. The pass-through caused by global commodity prices is also evidence of this situation. Taiwan is a unique small open economy that is lacking in natural resources¹. Since Taiwan behaves as a price-taker in international markets, the price pass-through effect caused by changes in global commodity prices has a substantial impact on the domestic economy.

Price pass-through can convulse an economy. Not only may it give rise to incentives to innovation and investment in technology as well as reflect market efficiency, but it may also inevitably worsen the income distribution, and fuel speculation.

The degrees of price pass-through in food and energy appear to differ in the levels of economic development². Taiwan's economy has taken off since the 1970s. Taiwan's per capita GNP was about \$393 in 1970, and reached \$17,524 in 2008 while her household expenditure patterns and industrial structure have been radically transformed as shown in Table 1. Household expenditure patterns have been changing in Taiwan with the proportion of expenditure on food dropping from 50% in 1970 to about 24% in

¹ Taiwan has to import about 99.9% of her crude oil. The value of imports of crude oil far exceeded Taiwan's trade surplus (25.2 billion in US dollars) in 2007.

² According to the IMF (2008), the estimated coefficients for 25 advanced economies and 21 emerging economies show that food-related price pass-through in advanced economies was found to be higher than in developing economies, whereas energy-related price pass-through was found to be lower in developing economies. The sample was obtained from the IMF (2008).

2008. The expenditures on food-related goods and energy-related items³ are accorded a weight of 52% over the disposable income of the lowest 20% of households⁴. The higher the price pass-through effect, the more adverse is its effect on low-income households⁵.

The ratio of the secondary industry GDP to total GDP was around 36% in 1970, and reached 46% in 1980. Yet, the ratio of the secondary industry GDP to total GDP gradually fell to about 25.0% in 2008, being caused by Taiwan's expansion plans in the service sector in the past twenty years as well as low production costs in China, which has attracted many of Taiwan's manufacturing businesses. It needs to be asked if pass-through effects will result in distinct impacts as an economy is transformed and its household expenditure patterns and industrial structure are transformed as in Taiwan?

As for the factors that might affect the extent of price pass-through, some studies have focused on institutional factors such as Imbs (2006) and Balakrishnan et al. (2009), who placed emphasis on financial integration, while some have focused on the relationship between monetary policy and exchange rate orientation with pass-through, such as Engel (2009), Ito and Sato (2008), the IMF (2008), Monacelli (2005), and so on. According to the IMF (2008), more than 80% of emerging and developing economies around the world still maintain heavily-managed exchange rate regimes in order to anchor inflationary expectations more easily, but this also restricts the ability of monetary policy to respond⁶.

³ The food-related goods include food, beverages, and tobacco. The energy-related goods and services comprise rent, water, electricity, gas and other fuels.

⁴ The expenditures on food, rent, water, electricity, gas and other fuels account for less than 40% of disposable income for the highest 20% of households, according to the "Survey on Household Income and Expenditure in Taiwan," published in 2007.

⁵ According to OECD and FAO (2008), the weights of the food-related prices relative to the consumer price index are around 39.3% in developing economies and 16.2% in the developed economies, respectively.

⁶ See the IMF (2008, pp. 105~106).

Taiwan is an export-oriented economy. The central bank of Taiwan has also carefully managed the exchange rate regime and thereby facilitated merchandise exports even though Taiwan has adopted a managed independently floating exchange rate policy since the mid-1980s. The influence of the monetary side on price pass-through has been restricted. Besides, the household expenditure patterns and transformation of the industrial structure have been more important than inflation to Taiwan's economy since the 1990s owing to Taiwan's businesses having moved to China, which has evidently speeded up the transformation of the industrial structure.

Moreover, due to the constraints on data availability, both the United Nations and the IMF have omitted Taiwan's statistics; there are also no empirical results for Taiwan in studies such as De Gregorio, Landerretche and Neilson (2007), IMF (2008), and Jongwanich and Park (2008). We thus focus on Taiwan as a case study both to make up for this omission and to serve as a source of reference for other economies.

We focus our analysis more on the inner structural and distribution effects in Taiwan. Based on the data availability and the features of the Taiwan economy, we look at this issue by placing emphasis on the relationship between a commodity's price pass-through with distribution effects on the real side and focus on consumers and producers.

As a result, while the price pass-through coefficients for food follow global trends, the coefficients for energy-related prices are higher in terms of domestic prices to core CPI which may result from the industrial structure factors in energy-related industries and government policies. However, shifts in the energy-related products that help make up the household expenditures are only slight because the supply of energy-related services is inelastic, and they are heavily subsidized. The impacts of commodity price

shocks on the industrial structure are also reduced, resulting from the technology innovations in food processes, energy-saving improvements, and a reduction in energy-dependency.

We start with a fundamental analysis of Taiwan's price transmission channel and engage in empirical estimation to calculate the degree of price pass-through. Then we use the results to analyze the characteristics of the Taiwan economy and compare them with global trends. Then by adopting various scenarios we go further down to the demand side and the supply side in order to consider the economic outlook for Taiwan to see how the global commodity price fluctuations impact both consumers and producers.

Table 1 The Economic Performance of Taiwan during the Price Fluctuations

The GDP in Taiwan has increased four-fold since 1972 and the industrial structure has been upgraded

Period (average)	Per capita GNP(US\$)	Household expenditure on food-related items(%)	Household expenditure on energy-related items(%)	2ndind.GDP / GDP (%)	Oil price (WTI)¹
1972~74	722	49.2	19.9	40.9	19.6
1979~81	2360	40.9	23.1	43.2	109.0
1989~91	8451	28.9	30.4	38.7	72.3
1999~01	13935	24.1	29.7	28.9	82.9
2004~07	16275	24.0	29.2	27.4	194.8
2008	17524	24.0	28.0	25.0	328.5

Notes: 1. oil-price is denoted by the Texas Spot price index which is obtained from the IFS.

Data source: Own calculations based on DGBAS and AREMOS datasets.

II. The Commodity Price Pass-Through in Taiwan

1. The transmission mechanisms and empirical procedures for price pass-through

The fluctuations in global commodity prices have impacts on the business cycles of small economies. As for Taiwan, the annual growth rates of the CPI (consumer price index) were higher during the oil crisis in 1973 and the energy crisis in 1979. Nevertheless, the fluctuations in the prices of food-related items which were used in the

calculation of the CPI were relatively moderate compared with the fluctuations in the prices of oil-related items which were used in the calculation of the CPI from the 1980s onward. This kind of situation was similar to the global trend.

Figure 1 depicts the transmission channels and empirical procedures for the fluctuations in global commodity prices transmitted to Taiwan's domestic prices and their impacts on Taiwan's economy. The fluctuations in the global commodity prices affect the domestic prices by means of the trade sectors and domestically-produced processes, and result in changes in relative prices. They may influence consumers' choices and reflect shifting household expenditure patterns. Thus, the various kinds of goods and services should be adjusted over time and thus the degrees of variation might be diversified. However, the changes in relative prices are not adjusted immediately and completely for there is usually a time lag. The degrees of global price pass-through are related to the industrial structures and consumers' expenditure patterns. Hence, the fluctuations in global commodity prices will result in changes in consumer behaviors, the costs of production, and the impacts on different goods and services.

In order to calculate the pass-through effect from international commodity prices to domestic prices in Taiwan, and evaluate the impact on household expenditure patterns and the industrial structure, we have conducted an empirical study with a focus on Taiwan.

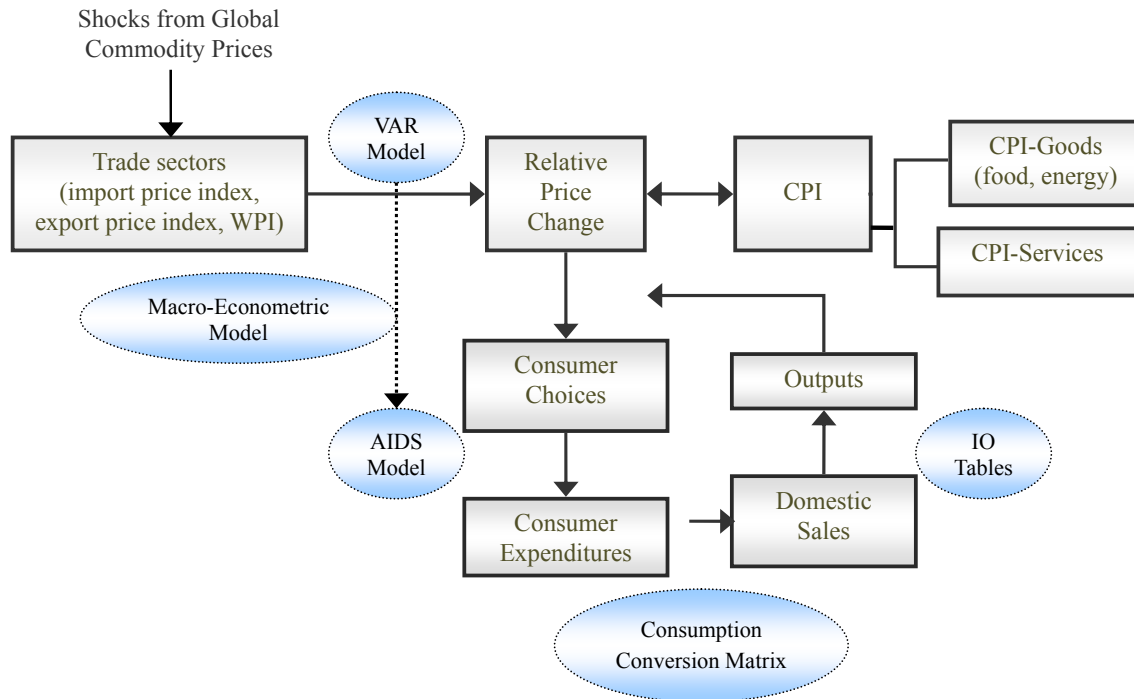
The empirical procedures involve first calculating the degree of price pass-through by means of the VAR model, then utilizing AIDS, a consumption conversion matrix and input-output tables to distribute the impacts of price pass-through effects to consumers and producers. To transmit the price pass through effects to consumers and producers, we need bridges to access the linkages. The bridges must capture the characteristics of the Taiwan economy and depict the interactions and transmissions of the price indexes. A macro-econometric model is an excellent solution⁷. The details of the empirical

⁷ Although a macro-econometric model is criticized for the non-stationarity of time series data and suffers from the problems of spurious regression, a macro-econometric model can capture the

procedures are referred to in the appendices and the technical details are referred to on the Web.

Figure 1 The Price Transmission and Empirical Prodecures Flow Chart

The fluctuations in global commodity prices transmitted to Taiwan's domestic prices and their impacts on Taiwan's economy.



2. Estimating Commodity Price Pass-Through

There are two steps involved in assessing the potential impacts of the changes in the global commodity price pass-through on the core CPI in Taiwan. The first step is to link the changes in the domestic prices with the changes in global commodity prices. The second step is to link the core CPI inflation with the changes in the fuel and food

characteristics of the Taiwan economy and depict the interactions and transmissions of price indexes. Besides, according to Park and Philips (1988, 1989), the traditional estimated methodology and asymptotic normality t test are still available if the residuals are $I(0)$ and even if the model is a mix of $I(1)$ and $I(0)$. Furthermore, Hsiao (1997) also demonstrates that, despite variables that are integrated, the fundamental issues regarding structural equation modeling raised by the Cowles Commission remain valid and standard estimation and testing procedures can still be applied.

prices in terms of domestic prices by controlling the changes in the Phillips curve output gap, respectively⁸.

The estimated results of the price pass-through in Taiwan are illustrated in Figure 2 and displayed in Table 2. The coefficient of price pass-through for food-related items in Taiwan, from global commodity prices to domestic prices, is 0.1346 and from domestic prices to core CPI is 0.1894. The IMF (2008) has stated that the estimated coefficients of price pass-through from global commodity prices to domestic prices for advanced economies and developing economies are about 0.09 and 0.15, respectively, while Taiwan's lies somewhere in the middle. In addition, the estimated coefficients of price pass-through from domestic prices to core CPI in advanced economies and developing economies are about 0.18 and 0.48, respectively, while Taiwan's still lies in between.

On the other hand, the coefficient of price pass-through for energy-related items from global commodity prices to domestic prices is 0.1733 and from domestic prices to core CPI is 0.1921 for Taiwan. The IMF (2008) reported the estimated coefficients of global commodity prices to domestic prices in advanced economies and developing economies as being 0.23 and 0.12, respectively. Taiwan's is again still in between these two groups. Nevertheless, the estimated coefficients of price pass-through from domestic prices to core CPI in advanced economies and developing economies are 0.01 and almost 0, respectively. Here, Taiwan's is, however, higher than both that for advanced economies and that for developing economies, but is similar to the advanced economies (0.21) over the 1970-1995 period.

As Figure 2 illustrates, the two price pass-through estimated coefficients, from international prices to domestic prices and domestic prices to core inflation in food-related items, is higher in emerging economies than in advanced economies during

⁸ The equations used for the estimation are in a simple VAR form. The technical details are listed in the appendices which are available in the Web-version.

the period from 1995 to 2008, which indicates the influence that food-related goods price changes have on other goods (except fuel-related goods) is more price sensitive in emerging economies.

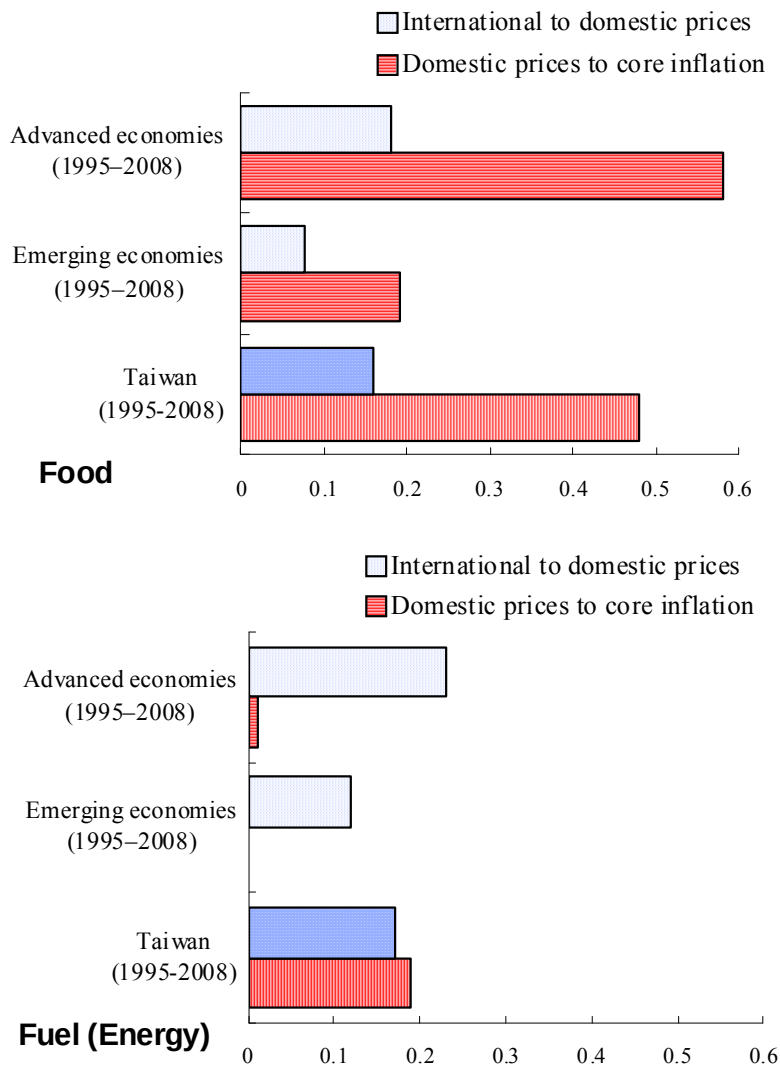
The pass-through from international to domestic prices and from domestic prices to core inflation for fuel-related items is substantially lower in emerging economies than it is in advanced economies. We can explain that this may result from declining energy intensity, price controls in emerging economies and energy-saving incentives as well as high fuel taxes in advanced economies.

We define the total pass-through effects as the product of the two stages of the estimated coefficients, with the total price pass-through effects being equal to the pass-through from the global price index to the domestic price index multiplied by the pass-through from the domestic price to core CPI. The total food-related price pass-through for Taiwan lies between that for advanced economies and for developing economies, but the total energy-related price pass-through for Taiwan is found to be significantly higher than for advanced economies and developing economies during the 1995-2008 period. In addition, Taiwan's energy pass-through is slightly higher than the food price pass-through.

Notwithstanding that Taiwan is lacking in natural resources, such as oil, soybeans or wheat, depending on foreign supplies, the estimated coefficients of price pass-through in Taiwan approximately follow the global trends except the price pass-through from domestic prices to core CPI for energy-related price items. The price pass-through for energy-related items is found to be slightly higher than for food-related items. We explain that this is because energy-related industries are almost public utility services and characterized by inelastic supply, the industrial structures are either monopolies or oligopolies. Taiwan's government mostly adopts subsidy-related

treatments⁹ when fluctuations in energy-related prices become excessively large. Furthermore, energy shortages and a low degree of substitution in energy as well as guaranteed profits for certain companies all result in the higher price pass-through in Taiwan.

Figure 2 the Price Pass-Through Estimation



Data sources: 1. Calculation based on IMF (2008)
2. Own calculations based on estimation results.

⁹ The price control may cut down the price pass-through effects, but the subsidy may have positive effects to encourage the pass-through effects.

Table 2 The Price Pass-through for Core CPI in Taiwan

Dependent Variable		Independent Variables	Sample Period: 1995Q1-2008Q3
Step 1	Domestic price (CPI_FOOD)	(a) Global commodity price-Food	0.1346
	Domestic price (CPI_ENERGY)	(b) Global commodity price-Energy ¹	0.1733
Step 2	core CPI	(c) Domestic price (CPI_FOOD)	0.1894
		(d) Domestic price (CPI_ENERGY)	0.1921
Total Price Pass-Through	Food	(e)=(a)*(c)	0.0255
	Energy	(f)=(b)*(d)	0.0333

Note: 1. In the IFS database, the world price index for energy starts from 1992Q2.

Data source: Own calculations based on estimation results.

As we wondered whether the price pass-through may be different for domestic prices with export prices in the export-oriented economies such as Taiwan, we examined the price pass-through effects of global prices to import prices and export prices. We extended the work of the IMF (2008) to estimate price pass-through in the MPI (import price index) and XPI ¹⁰(export price index). The estimated results are shown in Table 3. The global price pass-through for the XPI was lower than it was for the MPI for both food and energy prices. We suggest that these results are attributed to Taiwan's entrepreneurial strength. The lower the XPI, the higher the world competitiveness. To benefit from international competition, Taiwan may mostly pass through the fluctuations in global commodity prices to the domestic market, but keeps the XPI more stable than it would otherwise have been.

Since there is no PPI (Produce Price Index) in Taiwan, we use the WPI (Wholesale Price Index) instead of PPI, which is composed of XPI, MPI and DSPI (the domestic sales excluding imports price index). We compare our estimated results with core CPI and the WPI, and find the pass-through from the global commodity prices to the WPI is higher than it is to core CPI. These findings are similar to the 2008 study by Jongwanich

¹⁰ The XPI and MPI which are denoted as price indexes are expressed in terms of US dollars, while the others are expressed in terms of NT dollars. We have added the exchange rate index to remove the effect of the exchange rate. However, the results are similar regardless of whether there is an exchange rate index or not.

and Park (in which Taiwan is somehow omitted), which states that the pass-through coefficients tend to be lower for consumer prices than producer prices, implying that the gap between these two price indices depends on the ability of firms to pass higher costs on to consumers. In the face of intense market competition, as the global commodity prices increase dramatically, the private producers may cut their marginal profits instead of immediately charging higher prices to consumers to keep their market shares. In addition, Taiwan's government policies such as price controls, energy-saving incentives, and other regulations might be implemented to reduce or delay the pass-through to CPI.

Table 3 The Price Pass-through for Other Prices in Taiwan

Dependent Variable	Independent Variables		Sample Period: 1995Q1-2008Q3
Import Price Index (MPI)	Food	Global commodity price-Food	0.4233
	Energy	Global commodity price-Energy ¹	0.1904
Export Price Index (XPI) ²	Food	Global commodity price-Food	0.2252
	Energy	Global commodity price-Energy ¹	0.0961
Domestic Sales Excluding Imports Price Index(DSPI)	Food	Global commodity price-Food	0.2588
	Energy	Global commodity price-Energy ¹	0.0713
WPI ³	Food	Global commodity price-Food	0.3004
	Energy	Global commodity price-Energy ¹	0.1193

Notes: 1. In the IFS database, the world price index for energy starts from 1992Q2.

2. There is no energy-related index in the XPI (export price index), so we can not calculate the price pass-through for energy goods in the XPI.

3. The WPI is composed of MPI (weighted 32.7%), XPI (weighted 36.5%), and DSPI (weighted 30.8%).

Data source: Own calculations based on estimation results.

III. The Impacts of Price Pass-Through

The price pass-through might have distinct distribution impacts on the content of household expenditures and the industrial structure¹¹. To evaluate the distribution effects of the pass-through via the macro-econometric model of Taiwan's economy, we

¹¹ Hamilton (2009) stated that, regardless of whether oil price shocks are primarily caused by physical disruptions in supply or caused by strong demand, the consequences for the economy appear to have been very similar.

quantify the results from price pass-through to household expenditure patterns and the industrial structure, and the impact on household expenditure patterns is treated as the demand side, while the impact on the industrial structure is represented as the supply side. To observe whether the impacts change as time passes by, there are two scenarios as shown below:

(1) Scenario 1: Assume the food-related price shock and energy-related price shock both occurred in 1993¹². That is, we consider how much of an impact these had on the Taiwan economy in the 1990s as the food-related price index and energy-related price index both rose sharply in 1993.

(2) Scenario 2: Assume that the food-related price shock and energy-related price shock both occurred in 2004. That is, we consider how much of an impact these had on the Taiwan economy in the 21st century as the food-related price index and energy-related price index both rose sharply in 2004.

1. Price Pass-Through Distribution Effects upon Consumers

When we evaluate the household expenditure patterns, we re-classify the categories of household expenditure patterns from 12 classifications to 4 classifications, which are referred to as “food-related expenditures” which includes different kinds of food, beverages, and tobacco, “energy-related expenditures” which is composed of fuel, gas, light, rent, and water charges, “entertainment-related expenditures” which is made up of recreation, entertainment, education and cultural services, and “other goods and services expenditures” which includes various kinds of clothing, transport, communications, and so on.

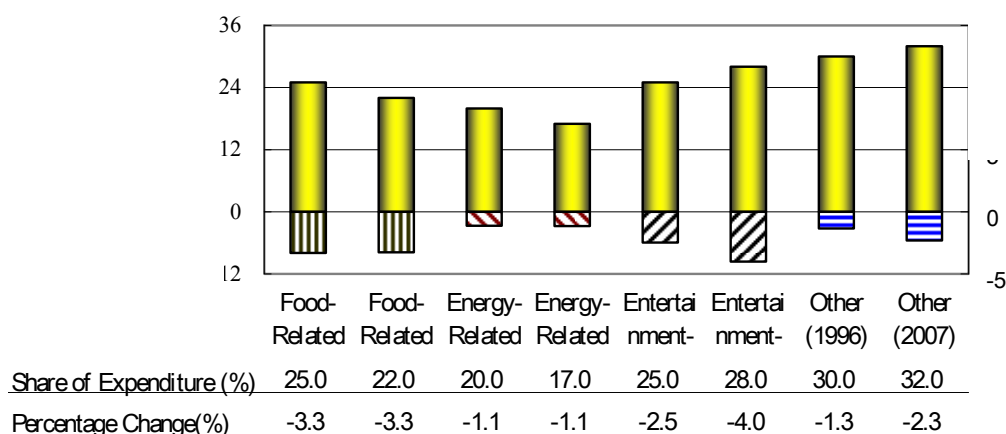
Figure 3 indicates that the impacts on energy-related expenditures are smaller as shocks occur. Knowing the energy-related items are inelastic demand and the Taiwan

¹² The energy index in IFS starts with the year 1992 and this results in the historical data covering fewer years than for the food index which starts from the 1960s. When we set the scenario, we refer to the food index rather than the energy index. We assume that the annual growth rate of the commodity price shocks, as measured by both the food and energy indexes, rose by 80% of the growth rate of the food price index in 1973.

government mostly adopts subsidy-related treatments as the fluctuations in energy-related prices are noticeably large. As for food-related expenditures, they are for living necessities, and the elasticity of price is generally low. However, as diversities of food selections increase and the beverages, which are included in food-related items and whose ratio was around 10% in 2008, are more price flexible and we think those might be the reasons why the food-related impacts are greater than the energy-related impacts. In addition, the impact on entertainment-related expenditures is the severest due to their being luxuries and their income elasticity is also higher.

Figure 3 Price Pass-through and Household Expenditure Patterns

The upper parts are the share of each kind of expenditure over total expenditures. The lower parts are the percentage changes as commodity price shocks occur which are based on Scenario 1 and Scenario 2.



Data source: Based on estimated results.

2. Price Pass-Through Distribution Effects upon Producers

We employ the consumption conversion matrix to project the 12 categories of goods and services into 161 industries. The consumption conversion matrix and the input-output tables are based in the years 1996 and 2007¹³, respectively.

In general, the input-output model is excellent at describing the industrial structure¹⁴, and it may be the best tool that we can use to analyze the impacts of

¹³ The 2007 Input Output Table is also extended using 2004 as the base by means of RAS which is provided by Professor Hao-Yen Yang.

¹⁴ The frequency for the input-output tables in Taiwan is every 5 years. Owing to the data availability, we

industrial shocks which result in final demand such as household expenditures, and export-oriented and promotional policies. We apply the input-output tables to analyze and describe the price pass-through from household expenditure patterns to industrial structure that is caused by the global food and energy price shocks.

Although the input-output tables for 1996 and 2007 classify industries into 161 industries¹⁵, based on considerations of keeping the analysis concise, we have re-classified them into 9 industries and renamed them as “agriculture and minerals,” “manufacturing-traditional industries,” “manufacturing-chemical and petroleum-related industries,” “manufacturing-heavy industries,” “construction,” “electricity, gas and water,” “transportation, telecommunications, wholesale and trading,” “finance, insurance and real estate services,” as well as “other services”.

The food-related goods and energy-related goods are the main intermediate inputs for “agriculture and minerals,” and manufacturing industries. The manufacturing industries are described in more detail because of the differences in technology level, energy intensity, and energy efficiency. They are separated into “traditional industries,” which include processed foods, beverages, tobacco, textile mill products, wearing apparel and accessories, leather & leather products, wood & wood products, paper & paper products & printed matter, and so on; “chemical and petroleum-related industries,” which comprise chemicals, artificial fibers, plastic, plastic & rubber products, miscellaneous chemical manufactures, and petroleum refining products; and “heavy industries,” which might be treated as hi-tech industries and include iron and steel products, metallic products, machinery, electronic products, information products, communications equipment, electronic components & parts, electrical machinery, etc.

In Table 4, we calculate the industrial linkage effect by means of forward linkages

can only link the tables in different eras to capture the trends. If more data were available, we could have expressed them in terms of a dynamic process, but this is not possible here.

¹⁵ Although the shocks lasted for a period more than one year, they have ceased to be felt as time passes by. The variation in the real sector is close to zero in the 4th year after the shocks occurred, and the price deflators respond more quickly than the real sector. Due to the national incomes and input-output tables being compiled annually, we calculate their impacts by using weighted averages¹⁵, and take the base years as 1996 and 2007.

and backward linkages for the global commodity price shocks. In Scenario 1, based on final demand, the top 3 industries ranked by percentage changes are “agriculture and minerals,” “electricity, gas and water,” and “manufacturing-traditional industries,” whose percentage changes are all over -2.5%. In Scenario 2, the ranks are similar to those in Scenario 1 except that the “manufacturing-traditional industries,” is replaced by “electricity, gas and water,”

“Agriculture and minerals” include food-related goods and crude oil, which suffer seriously due to the direct effects caused by the commodity price shocks. The “electricity, gas and water” are regarded as intermediate inputs for almost all industries and their energy intensity is also higher. Therefore, the impacts are sharp as if the shocks had occurred. “Manufacturing-traditional industries” are lower in terms of energy technology investment, and include processed food industries that are using food-related goods as intermediate inputs; therefore the final demand is also likely to be affected.

Among the manufacturing industries, the higher the technology level, the smaller the impacts. The impacts on the “manufacturing-traditional industries,” are the most critical, followed by those on “manufacturing-chemical and petroleum-related industries.” Although “manufacturing-heavy industries,” are relatively energy-intensive, they are also higher in terms of energy efficiency and in terms of being energy-saving. Therefore, the impacts could be smaller than in the case of the traditional industries and petroleum-related industries. The services industries are also affected as commodity shocks occur by means of the industrial linkage effect. However, the impact is smaller than that of the “agriculture and minerals industries,” and manufacturing industries.

By comparing the results from Scenario 1 (based on 1996) with those from Scenario 2 (based on 2007), in terms of final demand, the gaps which take differences in terms of percentage changes between 1996 with 2007 are extremely small. Those industries such as “agriculture and minerals,” “manufacturing - chemical and

petroleum-related industries,” “electricity, gas and water,” as well as “finance, insurance and real estate services,” for which the negative effects of price shocks have become smaller in 2007 than in 1996, almost all use food-related or energy-related items as intermediate inputs. The first three industries are all highly correlated with global commodity shocks. The reduced impacts may result from technology innovations in food processes, energy-saving improvements, and reductions in energy-dependency. The impacts on “finance, insurance and real estate services” are also reduced; these might be correlated with the de-regulation and globalization in the financial sector since the mid-1990s.

The gaps are amplified in “other services,” “manufacturing-traditional industries,” “transportation, telecommunications, wholesale and trading,” and “manufacturing-heavy industries.” The “other services,” which include information services, education services, medical services, broadcasting, recreational and cultural services, etc. and “transportation, telecommunications, wholesale and trading,” are highly related to reductions in expenditure on entertainment,” the entertainment-related industries saw a bigger reduction in 2007 than in 1996.

The “manufacturing-traditional industries” and “manufacturing-heavy industries” are also deepened because their technology related to energy efficiency and energy-saving has been upgraded more slowly than the improvement in energy intensity. In addition, the traditional industries have been hollowed out to mainland China since the mid-1990s.

The impacts on the industrial structure in terms of output and value added are similar with final demand. While the results have been analyzed, the impacts on output and value added appear to be superfluous; we do not reproduce them here.

Table 4 Simulation Results in Input-Output Tables

Final Demand (Percentage Change (%))	1996 Base	(a)Scenario 1	2007 Base	(b)Scenario 2	(c)=(b)-(a)
No. Industries	(millions)	(1996)	(millions)	(2007)	
1 Agriculture and Minerals	263012	-4.952	412417	-4.037	0.915
2 Manufacturing-Traditional Industries	1213545	-2.534	1412253	-2.746	-0.212
3 Manufacturing-Chemical and petroleum-related industries	583044	-0.600	1701082	-0.532	0.068
4 Manufacturing-Heavy Industries	3232880	-0.130	7564001	-0.194	-0.065
5 Construction	861800	0.000	1081775	0.000	0.000
6 Electricity, Gas and Water	87044	-2.911	155599	-2.254	0.658
7 Transport, Telecom & Trading	1483245	0.038	2925416	-0.069	-0.106
8 Finance, Insur. & Real Estate Services	1317928	-1.576	2745917	-1.477	0.099
9 Other services	1928251	-0.792	2975259	-1.346	-0.554
Total	10970749	-0.816	20973719	-0.788	0.028
Output (Percentage Change (%))	1996 Base	(a)Scenario 1	2007 Base	(b)Scenario 2	(c)=(b)-(a)
No. Industries	(millions)	(1996)	(millions)	(2007)	
1 Agriculture and Minerals	488894	-7.753	687090	-7.331	0.422
2 Manufacturing-Traditional Industries	1690809	-2.917	1893071	-3.463	-0.546
3 Manufacturing-Chemical and petroleum-related industries	1662753	-1.508	3931377	-1.253	0.254
4 Manufacturing-Heavy Industries	4060134	-0.439	8596517	-0.541	-0.101
5 Construction	1013445	-0.121	1251176	-0.152	-0.032
6 Electricity, Gas and Water	366281	-1.731	623621	-1.652	0.079
7 Transport, Telecom & Trading	2894714	-0.329	4288290	-0.458	-0.129
8 Finance, Insur. & Real Estate Services	1523656	-2.092	4175374	-1.512	0.580
9 Other services	2549009	-1.092	4496904	-1.451	-0.359
Total	16249695	-1.273	29943420	-1.242	0.031
Value Added (Percentage Change (%))	1996 Base	(a)Scenario 1	2007 Base	(b)Scenario 2	(c)=(b)-(a)
No. Industries	(millions)	(1996)	(millions)	(2007)	
1 Agriculture and Minerals	180714	-10.893	335824	-8.070	2.823
2 Manufacturing-Traditional Industries	455928	-2.637	456809	-3.562	-0.925
3 Manufacturing-Chemical and petroleum-related industries	492224	-1.206	883516	-1.325	-0.119
4 Manufacturing-Heavy Industries	1083427	-0.337	1928870	-0.511	-0.174
5 Construction	350008	-0.097	289792	-0.181	-0.084
6 Electricity, Gas and Water	174621	-1.371	251572	-1.554	-0.183
7 Transport, Telecom & Trading	2053243	-0.307	2611210	-0.475	-0.167
8 Finance, Insur. & Real Estate Services	1051525	-2.100	3042128	-1.391	0.708
9 Other services	1714111	-0.975	2836047	-1.431	-0.455
Total	7555801	-1.180	12635768	-1.303	-0.123

Data source: Own calculations based on simulation results.

IV. Conclusion

In order to calculate the price pass-through effect from international commodity prices to domestic prices and evaluate the impacts on household expenditure patterns and the industrial structure, we have conducted an empirical study which focuses on Taiwan.

Being a small, open, export-oriented, price-taker economy and lacking natural resources, the price pass-through effect caused by global commodity prices has a substantial impact on Taiwan's economy. In particular, Taiwan's household expenditure patterns and industrial structure have gradually been transformed and upgraded since her economy took off in 1972.

The commodity price shocks will affect the Taiwan economy by means of the price pass-through effect. How significant are the impacts? This will depend on the degree of pass-through, household expenditure patterns and industrial structures. We apply a case study to calculate the extent to which global commodity prices are passed through to domestic prices for a small, open, price taker and developing economy like Taiwan in order to evaluate their impact on distribution effects such as household expenditure patterns and the industrial structure.

The price pass-through also results in distinct impacts on household expenditure patterns and industrial output by means of distribution effects. The effects of cuts in household expenditures on fuel and power and transportation and communications are slightly less pronounced than in the food-related industries, although the global price pass-through effects on domestic prices included in core CPI are similar. These findings reflect diversification in food purchases for households and the government's subsidy treatments for energy-related items.

Regarding the impacts of commodity shocks on the industrial structure, the food-related goods and energy-related goods mostly belong to the "agriculture and minerals" sectors and will be affected directly, so the impact will be most serious

regardless of whether it is accounted for in final demand, output or value added. The impacts are evident in the primary industries and in secondary industries which treat foods and energy as the main intermediate inputs. Nevertheless, the lessening of the impacts on food-related industries and energy-related industries results from technology innovations in food processes, energy-saving improvements, and the reduction in energy-dependency.

For the empirical procedures, we employ a VAR model to estimate the coefficients of price pass-through. Since the specifications of the VAR model take the possible control variables into account by means of the log dependent variables, it may not be necessary to add more control variables if there are no specific issues of concern.

We do not emphasize the response of the pass-through to monetary policy, but have looked closely at the relationship between the pass-through and distribution effects in terms of household behavior following the shocks. In particular, the household expenditure patterns and transformation of the industrial structure have been more important than inflation to Taiwan's economy since the 1990s resulting from Taiwan's firms moving to China that has resulted in a rapid transformation of the industrial structure.

In taking the labor market into account, we have considered generalized Phillips curve equations in the price pass-through equations which are treated as the supply side effect. Furthermore, the labor market in Taiwan is characterized by almost full employment. The unemployment rate is almost always under 4.5% except during the bursting of the dot.com bubble in 2002~2003.

We focus on the relationship between structural transformation such as household expenditure patterns and the industrial structure with price pass-through effects. Since we consider the pass-through in terms of the overall effect, the estimation results for the price pass-through obtained from the VAR model should be regarded as a total effect based on the changing tax policy, exchange rate and so on. Much more complicated

modeling would be involved and more detailed data would need to be collected for the purpose of isolating each individual effect. These items may be regarded as limitations in this study.

References

- Balakrishnan, Ravi, Stephan Danninger, Selim Elekdag, and Irina Tytell (2009), "The Transmission of Financial Stress from Advanced to Emerging Economies," *IMF Working Paper WP/09/133*.
- Bergstrom V., and A. Vredin (1994), *Measuring and Interpreting Business Cycles*. Oxford: Clarendon Press.
- Bouakez, Hafedh, Nooman Rebei and Désiré Vencatachellum (2008), "Optimal Pass-Through of Oil Prices in an Economy with Nominal Rigidities," *Cahiers de recherche/Working Paper 08-31*.
- Chen, Yu-Chin, Kenneth Rogoff and Barbara Rossi (2008), "Can Exchange Rates Forecast Commodity Prices?" *Working Paper 13901*.
- Chow, Gregory C. (1993), "Capital Formation and Economic Growth in China," *Quarterly Journal of Economics*, CVIII (3): 809-842.
- Cooley, Thomas F. (1995), *Frontiers of Business Cycle Research*. New Jersey: Princeton University Press.
- Corrado C. A. (1986), "Reducing Uncertainty in Current Analysis and Projections: The Estimation of Monthly GNP," *Board of Governors of the Federal Reserve System Special Studies Section Discussion Paper: 209*, pp.54.
- Corrado C. A. and M. N. Greene (1987), "Reducing Uncertainty in Short-Run Projections: Linkage of Monthly and Quarterly Models," *Board of Governors of the Federal Reserve System Special Studies Section Discussion Paper: 207*, pp.54.
- De Gregorio, Jose, Oscar Landerretche, and Christopher Neilson (2007), "Another Pass-Through Bites the Dust? Oil Prices and Inflation," Working Paper No. 417 (Santiago: Central Bank of Chile).
- David K. Backus and Mario J. Crucini, "Oil Prices and the Terms of Trade," *Journal of Monetary Economics*, 50, pp. 185-213.
- Engel, Charles (2009), "Pass-Through, Exchange Rates, and Monetary Policy," *Journal of Money, Credit, and Banking*, 41, pp.177-85.
- Fair, Roy C. (1984), *Specification, Estimation and Analysis of Macroeconometric Models*: Harvard.
- Gallant, A. Ronald (1997), *An Introduction to Econometric Theory*. New Jersey: Princeton University Press.
- Greene M. N., E. P. Howrey and S. H. Hymans (1986), "The Use of Outside Information in Econometric Forecasting," in Belsely and Kuh (ed.), *Model*

- Reliability*, MIT Press, pp.90-116.
- Groen, Jan J.J and George Kapetanios (2008), "Revising Useful Approaches to Data-Rich Macroeconomic Forecasting," *Federal Reserve Bank of New York Staff Reports* no.327.
- Hall, R. E. (1993), "Macro Theory and the Recession of 1990-91," *American Economic Review Papers and Proceedings*, 83(2), 275-279.
- Hamilton, James (2009), "Causes and Consequences of the Oil Shock of 2007-08," *Brookings Papers on Economic Activity*.
- Hsiao, C. (1997), "Cointegration and Dynamical Simultaneous Equation Models," *Econometrica*, 65, 647-670
- International Monetary Fund (2008), "Is Inflation Back? Commodity Prices and Inflation," www.imf.org/external/pubs/ft/weo/2008/02/pdf/c3.pdf.
- Imbs, Jean (2006), "The Real Effects of Financial Integration," *Journal of International Economics*, Vol. 51, pp. 296-324.
- Ito, Takatoshi and Sato, Kiyotaka (2008), "Exchange Rate Changes and Inflation in Post-Crisis Asian Economies: Vector Autoregression Analysis of the Exchange Rate Pass-Through," *Journal of Money, Credit, and Banking*, 40, pp.1407-38.
- Johansen, S. (1989), *Likelihood Based Inference on Cointegration: Theory and Application, Lecture Notes*. Institute of Math Statistics, University of Copenhagen.
- Johansen, S. (1991), "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*.
- Jongwanich, Juthathip and Donghyun Park, (2008), "Inflation in Developing Asia: Demand-Pull or Cost-Push?" *Asian Development Bank, ERD Working Paper No.121*
- Kalchbrenner J. H. and P. A. Tinsley (1977), "On Filtering Auxiliary Information in Short-run Monetary Policy," *Journal of Monetary Economics*, 7(0), Supplementary Series, pp.39-84.
- Klein L. R. and S. Sojo (1990), "Combinations of High and Low Frequency Data in Macroeconometric Models," in Klein and Marquezed (ed.), *Economics in Theory and Practice: An Eclectic Approach*, Boston Kluwer Academic Publishers, pp.3-16.
- Klein L. R. and J. Y. Park (1993), "Economic Forecasting at High-Frequency Intervals," *Journal of Forecasting*, Vol.12 pp.301-319, 1993.
- Klein L. R. and J. Y. Park (1995), "The University of Pennsylvania Model for High-Frequency Economic Forecasting," *Economic and Financial Modeling*, 2 (3), Autumn.
- Lucas, R. E. Jr. (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 3-42.
- Lucas, R. E. Jr. (1993), "Making a Miracle," *Econometrica*, 61, 251-72.
- Hooker, Mark A., (1996), "What Happened to the Oil Price-Macroeconomy Relationship?" *Journal of Monetary Economics*, 38, pp.195-213
- Hooker, Mark A., (2002), "Are Oil Shocks Inflationary? Asymmetric and Nonlinear

- Specifications versus Changes in Regime,” *Journal of Money, Credit, and Banking*, Vol. 34, No.2.
- Monacelli, Tommaso, (2005), “Monetary Policy in a Low-Through Environment,” *Journal of Money, Credit, and Banking*, Vol. 37, No.6, pp. 1047-66.
- Park, J.Y. and P.C.B. Phillips, (1988), “Statistical Inference in Regressions with Integrated Processes, Part 1,” *Econometric Theory*, 4, 468-497.
- Park, J.Y. and P.C.B. Phillips, (1989), “Statistical Inference in Regressions with Integrated Processes, Part 2,” *Econometric Theory*, 5, 95-131.
- Romer, P. (1990), “Endogenous Technological Change,” *Journal of Political Economy*, 98, S71-S102.
- Romer, P. (1993), “The Origins of Endogenous Growth,” *Journal of Economic Perspectives*, 8, 3-22.
- Stock, James H. and Watson, Mark W. (1991), “A Probability Model of the Coincident Economic Indicators,” in: G. Moore and K. Lahiri, eds., *The Leading Economic Indicators: New Approaches and Forecasting Records* (Cambridge University Press, Cambridge), 63-90.
- Stock, James H. and Watson, Mark W. (2001), “Macroeconomic Forecasting Using Diffusion Indexes,” *Journal of Business and Economic Statistics*, 20, 147-162.
- Stock, James H. and Watson, Mark W. (2005), “Implications of Dynamic Factor Models for VAR Analysis,” *NBER, Working Paper*.
- Sims, Christopher A. (1980), “Macroeconomics and Reality,” *Econometrica*, 48(1), 1-48.

Appendices: The Empirical Procedures for Price Pass-Through, Household Expenditure and the Industrial Structure: The Case of Taiwan

In order to clarify the pass-through effect from global commodity prices to domestic prices, we evaluate the distribution effects of the pass-through on household expenditure patterns, which is treated as the demand side, and on the industrial structure, which is represented as the supply side.

The empirical procedures can be divided into two parts. In the first part, we follow the IMF (2008) to employ simple VAR models to estimate the coefficients of price pass-through, which are described as mentioned above. In the second part, we utilize AIDS, a consumption conversion matrix and input-output tables to distribute the impacts of the price pass-through effects.

I. The VAR Model for Commodity Price Pass-Through

We modified De Gregorio, Landerretche and Neilson (2007) and IMF (2008) to calculate the price pass-through coefficients for Taiwan. There are two steps involved. The first step traces the changes in domestic prices to the changes in global commodity prices. The first step employs simple regressions of the following form:

$$\pi_t^{domestic} = \alpha + \sum_{i=1}^4 \beta_i \pi_{t-i}^{domestic} + \sum_{i=0}^4 \delta_i \pi_{t-i}^{world} + \varepsilon_t \quad (1)$$

Here, π is denoted as the annualized quarter-over-quarter log difference (in percent) in food or fuel prices (we also include seasonal dummies). The reported pass-through coefficients are calculated as:

$$price\ pass - through = \frac{\sum_{i=0}^4 \delta_i}{1 - \sum_{i=1}^4 \beta_i} \quad (2)$$

The second step for pass-through from domestic (food and fuel) prices to core CPI is estimated using the following generalized Phillips curve equations:

$$\pi_t = \alpha + \sum_{i=1}^4 \beta_i \pi_{t-i} + \sum_{i=0}^4 \gamma_i (y_{t-i} - y_{t-i}^*) + \sum_{i=0}^4 \phi_i \pi_{t-i}^{food} + \sum_{i=0}^4 \varphi_i \pi_{t-i}^{fuel} + \varepsilon_t \quad (3)$$

The price pass-through can be defined as:

$$food\ price\ pass - through = \frac{\sum_{i=0}^4 \phi_i}{1 - \sum_{i=1}^4 \beta_i} \quad (4)$$

$$fuel\ price\ pass - through = \frac{\sum_{i=0}^4 \varphi_i}{1 - \sum_{i=1}^4 \beta_i} \quad (5)$$

Here π stands for the annualized quarter-over-quarter log difference (in percent) in

core, food, and fuel prices, while y and y^* denote the annualized quarter-over-quarter log difference (in percent) in, respectively, real and potential output¹⁶ (the equations also include seasonal dummies). To eliminate contamination of the estimates by endogenous factors, the price pass-through from domestic commodity prices to core inflation is estimated using predicted values from the first-step.¹⁷

II. The Macro-Econometric Model of Taiwan's Economy

To feed the parameters for evaluating the distribution effects of the pass-through on household expenditure patterns, we employ a macro-econometric model for reference purposes. The macro-econometric model can be treated as a conduit to transfer the price pass through effect to consumers and producers.

The features of such a macro-econometric model of the Taiwan economy are listed as follows:

First, the model provides detailed descriptions of the GDP deflator, WPI, MPI, XPI, CPI and the private consumption deflator. For the settings of the price functions, we consider the transmission mechanism and co-movement between price indices. Second, the model is demand driven¹⁸. Third, as for the composition of GDP on the expenditure side, each of its components has its own behavioral equations except for the government sector, which we treat as exogenous. Fourth, the household expenditures are classified into 12 categories based on the characteristics of the goods and services,

¹⁶ We follow the IMF (2008) by employing the Hodrick-Prescott filtered trend to estimate potential GDP.

¹⁷ In this way, domestic food and fuel prices reflect only the variation that is due to changes in international prices and the lagged effects of domestic price developments, rather than movements in labor, transportation, and retailing costs that may have common origins with overall inflation.

¹⁸ Due to the labor market being stable in Taiwan, for example, the unemployment rate is almost under 4.5% except in 2002~2003, the rigidities in the labor market is not so serious, and we have added a term representing the gap between actual output and potential output is which denoted as $(y-y^*)$ in the price pass-through equations, which are denoted as the generalized Phillips curve equations, and is also treated as a proxy for the supply side effect. In view of this, we model the labor market as simply as possible.

which can be described in more detail¹⁹. Based on the transmission processes, feedback effects and related theories, we specify and capture the variables' interactions.

Based on the transmission processes and feedback effects, we capture the variables' interactions. In the processes of selecting the behavioral functions, the independent variables are specified and recognized as their related theories. Moreover, each equation must satisfy the statistical diagnosis. The technical details are available on the Web. (<http://www.nber.org/confer//2009/ease09/program.html>).

We find that the global commodity price shocks will pass away as time passes. The changes in Real GDP will be close to zero in the 5th year. The paths for the changes in the price indexes, such as the CPI, XPI and MPI, will respond more quickly than the real sectors. They will tail off as time passes by. That is, by comparing the change and trend from real GDP (or the real sectors) with the CPI (or the price index), we learn that the price indexes respond more quickly. The price index almost responds perfectly within a period of two years. Then the negative effect tails off.

If we compare the simulation results for the only food-related price shock with the only energy-related price shock, we find that the food-related shock has a heavier impact even though the pass-through effect is higher. Owing to the energy-related price fluctuating more frequently, the government mostly adopts subsidy-related treatments. Besides, there is a gearing effect related to the domestic food-related prices. That is, it is easier for the food-related prices in the domestic market to rise than it is for them to fall. Therefore the food-related price shock has a more serious impact on the Taiwan economy.

19 We have adopted the suggestions proposed by the referee to re-estimate the macro-econometric model and the AIDS model using the sample periods from 1992Q2 to 2008Q3, and so the estimated equations' sample period could coincide with the simulation results. We also conducted structural break tests such as the Chow test, and only little evidence was found for the structural break.