forthcoming: *Applied Economics Letters*

THE TRANSMISSION OF IMPORT PRICES TO DOMESTIC PRICES: AN APPLICATION TO INDONESIA*

Peter Warr

Australian National University

July 2005

Abstract

The manner in which the landed prices of imports affect domestic prices is central to trade policy analysis. This paper clarifies the relationship between two methods of modeling this relationship. These are the pass-through elasticity and the 'Armington' elasticity of substitution in demand between imported and domestically produced goods. The pass-through approach is used by empirical trade analysts. The Armington treatment is commonly used within applied general equilibrium models. The properties of these models are sensitive to the assumed valued of these elasticities, but empirical estimates of Armington elasticities are rare.

The theoretical relationship between the pass-through elasticity and the Armington elasticity is derived from a simple supply and demand model which incorporates Armingtion assumptions. The relationship is then illustrated empirically in the context of rice imports into Indonesia. Even though imported and domestically produced rice are considered relatively close substitutes in demand within Indonesia, time series econometric estimates of the pass-through elasticity imply Armington elasticities no greater than about 5. The Armington elasticities implied by the estimates of the pass-through elasticity presented here are well within the range of parameter estimates normally assumed within applied general equilibrium models.

* Helpful discussions with Peter Dixon and the research assistance of Arief Ramayandi are gratefully acknowledged.

1. Introduction

The quantitative effect that changes in the landed prices of imports have on domestic prices is central to applied trade policy analysis (Corden 1974). There are two ways of looking at this linkage. One approach is to look directly at the empirical relationship between them for a particular commodity, using the concept of a 'pass-through' elasticity. Applied trade analysts tend to use this concept, especially in empirical work. The second is to focus on the degree to which the imported and domestically produced versions of a good substitute for one another in demand, a treatment often referred to as the 'Armington assumption' after a classic paper by Armington (1969). Applied general equilibrium models frequently use this concept (Dixon *et al* 1982). Empirical estimates of Armington elasticities are rare. Kapuscinski and Warr (1999) is an exception. Assumed values of Armington elasticities are normally imposed within these models, but the assumed values usually lack any empirical foundations.

These two approaches are clearly related in that the higher the Armington elasticity, the higher the implied value of the pass-through elasticity, other things being equal. But the precise link between them has often been unclear in the literature. This paper attempts to clarify this relationship. We begin by showing the relationship, at a theoretical level, between the pass-through elasticity and the Armington elasticity for a particular commodity. This is done by deriving the pass-through elasticity from a simple supply and demand model which incorporates the Armington assumption on the demand side. We then provide an empirical estimation of a pass-through elasticity, taking the example of the price of rice in Indonesia. Then we use these estimates to illustrate the quantitative relationship between the Armington and pass-through elasticities.

The application to Indonesia is important. Indonesia is the world's largest importer of rice, but policy with respect to these imports is politically very sensitive within Indonesia. The manner in which the landed (tariff-inclusive) price of rice imports affects the domestic price has been central to debate over rice import policy within Indonesia (Timmer 1996) and more generally this issue has been crucial in the analysis of the effects that trade policy has on poverty incidence (Winters, McCulloch and McKay 2004).

2. The 'Pass-through' elasticity and the 'Armington' elasticity

The relationship between the pass-through elasticity and the Armington elasticity can be derived as follows. Drawing on the Armington treatment of the demand for imports of a particular good *vis a vis* the domestically produced good, the proportional change in the demand for the domestically produced good is given by

$$q_d^D = q^D + \sigma S_m (p_m - p_d). \qquad (1)$$

Lower case Roman letters are used to denote proportional changes of variables defined in levels. Thus q_d^D is the proportional change in the demand for the domestically produced good (superscript *D* denotes demand and subscript *d* denotes domestic production), q^D denotes the proportional change in demand for the composite of the domestically produced and imported version of the good, where the shares in expenditure are S_d and $S_m = 1 - S_d$, respectively, σ denotes the Armington elasticity of substitution between the imported and domestically produced good and p_m and p_d denote the proportional changes in the consumer prices of the imported and domestically produced good, respectively.

The proportional change in the demand for the composite good, q^D, depends on the prices of the imported and domestically produced version, each weighted by

their shares in expenditure, 'other' consumer prices, and consumer income, which is held constant for this discussion.[1] Thus

$$q^D = \eta^D(S_m p_m + S_d p_d) + \varphi^D p_o, \qquad (2)$$

where $\eta^D \leq 0$ is the elasticity of demand for the composite good with respect to its own price, φ^D is the elasticity of demand for the composite good with respect to 'other' consumer prices, and p_o is the proportional change in an index of 'other' prices.

The supply of the domestically produced good depends on its own price, holding other producer prices constant, and is given by

$$q_d^S = \xi_d^S p_d, \qquad (3)$$

where $\xi_d^S \geq 0$ is the elasticity of supply of the domestically produced good with respect to its own price. Substituting (2) into (1) and then equating (1) and (3), (that is, equating proportional changes in supply and demand for the domestically produced good), gives

$$\xi_d^S p_d = \eta^D(S_m p_m + S_d p_d) + \varphi^D p_o + \sigma S_m(p_m - p_d). \qquad (4)$$

We can now rearrange this expression and rewrite it as

$$p_d = H_m p_m + H_o p_o, \qquad (5)$$

where H_m and H_o are the elasticities of the domestic price of the good with respect to the import price and 'other' prices, respectively.

The former, the partial equilibrium form of the 'pass-through elasticity' of interest, is given by

[1] The analysis here is 'partial equilibrium' in the sense that it holds consumer incomes constant.

$$H_m = S_m(\sigma + \eta^D)/(\xi_d^S + \sigma S_m - \eta^D S_d). \quad (6)$$

By inspection, we expect $H_m \leq 1$ and for H_m to be an increasing function of the Armington elasticity, σ.

3. Estimating the 'Pass-through' elasticity

Time series econometric analyses of Pass-through elasticities need to allow for the fact that, over time, the domestic price of a commodity and the landed price of imports commonly trend together in nominal terms. Allowance for this fact is a feature of the analysis which follows. Data series were constructed for the following three price variables: $\ln P_d$, where P_d is the domestic price of milled rice in Rupiah; $\ln P_m = \ln P^* + \ln E$, where P_m is the landed *cif* price of imported rice in Rupiah, calculated as the international price of rice in \$US, P^*, adjusted by the Rupiah/\$US exchange rate, E; and an index of 'other' prices, $\ln P_o$, where P_o is the Indonesia-wide consumer price index. The data were monthly, covering the period January 1985 to August 2003.

The data are summarized in **Figure 1**. The period of the Asian crisis, from November 1997 to January 1999, was one of severe price instability and this period was consequently omitted from the data set. There are therefore three periods covered by the data, the third of which is simply the pooling of the first two:

- Period I – *Pre crisis*: January 1985 to October 1997
- Period II: *Post crisis*: February 1999 to August 2003
- Period III: *Whole non-crisis period*: January 1985 to August 2003, except for November 1997 to January 1999.

Dickey-Fuller tests were performed on each of the three price variables covering the periods concerned. The null hypothesis of a unit root failed to be rejected in any case. The variables concerned were each non-stationary, raising the possibility of spurious regression if this non-stationarity was ignored. Two types of regression analyses were performed. First, estimates of the likely long-term relationship were obtained by estimating the equation

$$\ln P_d = a + b \ln P_m + c \ln P_o + \varepsilon, \quad (7)$$

where ε is a residual. The results are shown in **Table 1**. The resulting estimates of the pass-through elasticity were 0.222 (pre-crisis), 0.445 (post-crisis) and 0.272 (whole non-crisis period).

The residuals were in each case found to be stationary and non-trending (the null hypothesis of a unit root was strongly rejected), suggesting that spurious regression is not an issue. However, this test is not conclusive and a better means of controlling for non-stationary series is to use an error correction model.

This was done by estimating the regression equation

$$\Delta \ln(P_d)_t = a\Delta \ln(P_m)_t + b\Delta \ln(P_d)_{t-1} + c\Delta \ln(P_o)_t + e\{\ln(P_d)_{t-1} - f - g \ln(P_m)_{t-1} - h \ln(P_o)_{t-1}\} + \varepsilon. \quad (8)$$

The term in brackets {.} is the assumed long term relationship. The estimates for the long term pass-through elasticity are shown in **Table 2** and were 0.251 (pre-crisis), 0.701 (post-crisis) and 0.369 (whole non-crisis period). In short, these results suggest pass-through elasticities in the pre-crisis period of between 0.2 and 0.3 and in the post-crisis period of between 0.4 and 0.7. Over the entire period, the results suggest a pass-through elasticity of between 0.27 and 0.37.

4. Implied value of the Armington elasticity

The numerical relationship between the pass-through elasticity, as estimated above, and the Armington elasticity can now be explored. Taking parameter values approximately relevant for the market for rice in Indonesia, we set $\xi_d^S = 0.3$, $\eta^D = -0.3$, $S_m = 0.1$, and $S_d = 0.9$. The implied relationship between H_m and σ is shown in Figure 2. These results confirm that 'pass-through' elasticities of between 0.27 and 0.37 are consistent with Armington elasticity values of between 2.6 and 4.1, respectively. Exploring elasiticies of demand in the range - 0.2 to - 0.4, as shown in Figure 2, the range of implied Armington elasticities expands to 2.0 to 5.0. These are typical values of Armington elasticities assumed in applied general equilibrium models.

5. Conclusions

This paper has attempted to clarify the relationship between two methods of modeling the relationship between the landed prices of imports and domestic prices. These are the pass-through elasticity and the 'Armington' elasticity of substitution between imported and domestically produced goods. The relationship is illustrated empirically in the context of rice imports into Indonesia. Even though imported and domestically produced rice are considered relatively close substitutes in demand within Indonesia, time series econometric estimates of the pass-through elasticity imply Armington elasticities no greater than 5. The Armington elasticities implied by the estimates of the pass-through elasticity presented here are well within the range of parameter estimates normally assumed within applied general equilibrium models.

References

Armington, P.S., 1969. A theory of demand for products distinguished by place of production. IMF Staff Papers, 16, 159-178.

Corden, W. M., 1974. Trade Policy and Economic Welfare, Oxford: Clarendon Press.

Dixon, P.B., B.R. Parmenter, J. Sutton and D.P. Vincent, 1982. ORANI: A Multisectoral Model of The Australian Economy, Amsterdam: North-Holland.

Kapuscinski, Cezary A. and Peter Warr, 1999. Estimation of Armington elasticities: An application to the Philippines', Economic Modelling, 16, 257-278.

Timmer, C. Peter, 1996. 'Does BULOG stabilize rice prices in Indonesia? Should it try? Bulletin of Indonesian Economic Studies, 32, 45-74.

Winters, L. Alan, Neil McCulloch and Andrew McKay, 2004. Trade liberalization and poverty. Journal of Economic Literature, 42, 72-115.

Table 1 Estimates of the long-term relationship

Period	Variable	Coefficient	t-stat	Prob.
Dependent variable $\ln P_d$				
	a (constant)	1.301	17.805	0.000
I:	$\ln P_m$ (log of international price)	0.222	9.298	0.000
	$\ln P_o$ (log of cpi)	0.861	26.359	0.000
	ADF Test for residuals	-0.074	-2.768	0.006
	a (constant)	2.765	4.771	0.000
II:	$\ln P_m$ (log of international price)	0.445	6.098	0.000
	$\ln P_o$ (log of cpi)	0.315	6.636	0.000
	ADF Test for residuals	-0.25	-3.009	0.003
	a (constant)	0.726	11.416	0.000
III:	$\ln P_m$ (log of international price)	0.272	9.616	0.000
	$\ln P_o$ (log of cpi)	0.926	29.419	0.000
	ADF Test for residuals	-0.061	-3.226	0.001

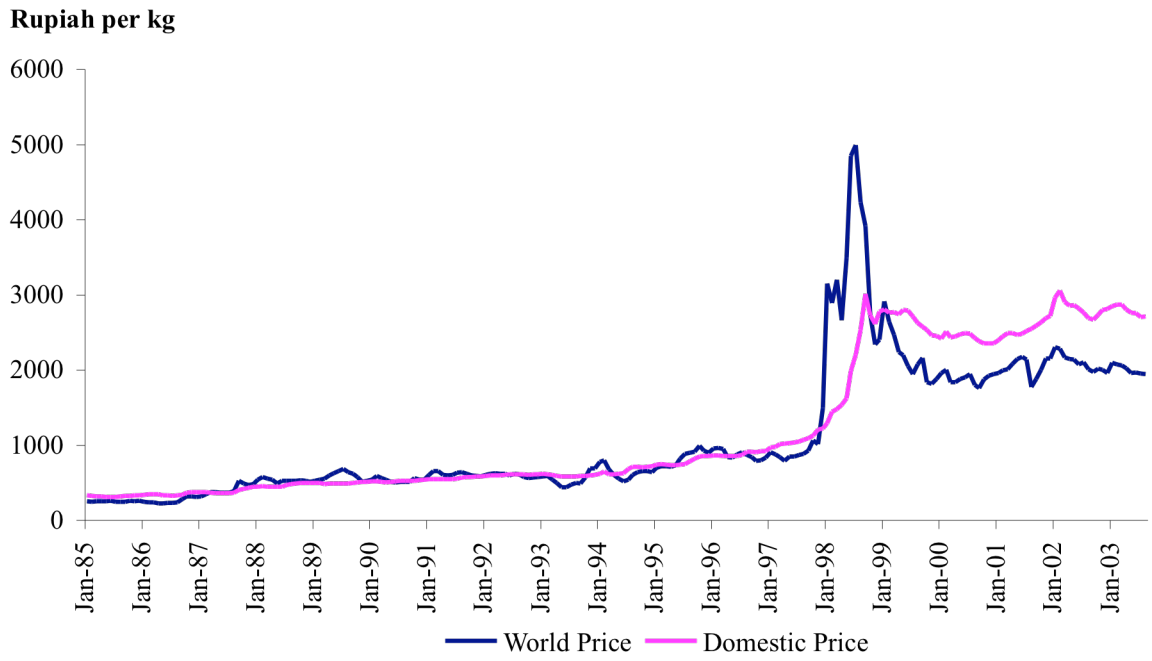
Note:
Period I: 1985:01 - 1997:10
Period II: 1999:02 - 2003:08
Period III: Whole period (except 1997:11 - 1999:01)

Table 2 Estimates of error correction model

Period	Variable	Coefficient	t-stat	Prob.
Dependent variable $\ln P_d$				
I:	f (constant)	0.922	2.007	0.047
	$\ln P_m$ (log of international price)	0.253	1.847	0.067
	$\ln P_o$ (log of cpi)	0.912	4.940	0.000
	e (Error correction coeffieicnt)	-0.052	-2.153	0.033
II:	f (constant)	0.759	0.526	0.601
	$\ln P_m$ (log of international price)	0.701	3.718	0.000
	$\ln P_o$ (log of cpi)	0.326	3.228	0.002
	e (Error correction coeffieicnt)	-0.211	-3.533	0.001
III:	f (constant)	0.704	2.187	0.029
	$\ln P_m$ (log of international price)	0.369	2.521	0.012
	$\ln P_o$ (log of cpi)	0.789	4.773	0.000
	e (Error correction coeffieicnt)	-0.046	-2.868	0.005

Note:
Period I: 1985:01 - 1997:10
Period II: 1999:02 - 2003:08
Period III: Whole period (except 1997:11 - 1999:01)

Figure 1 World price and domestic price of rice, Indonesia, monthly, 1985 to 2003



Note: "World price" means c.i.f. import price of milled rice in $US converted to Rupiah in current prices using market exchange rate. "Domestic price" means market price in Jakarta of milled rice in Rupiah, current prices.
Source: *Bulog* (rice prices) and Central Bureau of Statistics, Jakarta. (exchange rates).

Figure 2 Relationship between 'Pass-through' elasticity and Armington elasticity