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On the Transmission of World Agricultural Prices

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Two questions are asked about the relationship between domestic prices and world prices of agricultural commodities: are variations in world prices transmitted to domestic prices, and do these variations in world prices constitute an important component of variations in domestic prices? Domestic prices are regressed on world prices in various forms, taking into account the possible effects of exchange rates and inflation. The empirical analysis is based on data from the Food and Agriculture Organization of the United Nations for 58 countries for 1968–78 and for the countries of the European Community for 1961–85. The results show that most of the variations in world prices are transmitted and that they constitute the dominant component in the variations of domestic prices.

Agricultural products are on the whole tradable, and every country trades in some agricultural products. In the absence of intervention it is expected that domestic prices of such products will vary with world prices. It is well known, however, that agriculture is subjected to considerable intervention, which creates a gap between world prices and domestic prices and which generates cross-country variations in agricultural prices (see, for example, McCalla 1969; Johnson 1973; Bale and Lutz 1981; Australia 1985; Anderson, Hayami, and Honma 1986; World Bank 1986). This is perhaps why it is sometimes claimed that world prices are irrelevant for the development of agriculture in countries that intervene in the pricing of their agricultural products; see, for instance, the implicit debate in Mellor and Ahmed (1988), Valdés and Siamwalla (1988), and Ahmed (1988). It is therefore natural to ask to what extent such an intervention reduces the influence of world prices on domestic prices.

In this article we examine two major questions. First, what proportion of the variations in world prices is transmitted to domestic prices? Second, what proportion of the variations in domestic prices can be attributed to variations in world prices? Not independently, we also examine empirically the revealed relationships between world prices and the degree of intervention. The outcome of this analysis is crucial for understanding the relationships between domestic and

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world markets, and it has several ramifications. The facts and the ramifications are two distinct subjects, however, and it is important to deal with them separately. This article deals mainly with the empirical analysis.

I. THE FRAMEWORK

The framework draws on the law of one price, where the domestic price of commodity i in year t, P_{it}, is expressed as a product of the world price, P^*_{it}, the nominal exchange rate, E_t, and the tax policy $S_{it} = (1 + \tau_{it})$, where τ is the tax rate (or, if negative, the subsidy). Because countries engage in nontariff market interventions, including quantitative import restrictions, the tax policy term here includes the tariff equivalent of any restriction on domestic prices. The equation for the domestic price is

$$P_{it} = P^*_{it} E_t S_{it}. \tag{1}$$

This formulation ignores differences in product qualities and in transportation, storage, and marketing costs, as well as other domestic nontradable inputs. Also, the equation is based on the assumption that the exchange rate is neither under- nor overvalued so that the difference between domestic and foreign inflation rates is fully reflected in E. To allow for deviations from this assumption and for the effects that are not included in the equation, a disturbance term, denoted by U, is added to the equation.

Equation 1 is rewritten with lowercase letters indicating logs:

$$p_{it} = p^*_{it} + e_t + s_{it} + u_{it} \tag{2}$$

where $u \sim IID(\mu, \sigma^2)$ and $E(eu) = E(su) = E(p^*u) = 0$. The mean of the disturbance, μ, is not necessarily 0, for the reasons given above.

The answer to both questions posed above is obtained, in principle, by computing the following regression:

$$p_{it} = \alpha + \beta p^*_{it} + \gamma e_t + \epsilon_{it}. \tag{3}$$

Equation 2 can be expressed in terms of equation 3, subject to the restrictions H_1: $\beta = 1$, and H_2: $\gamma = 1$. The coefficient β is the elasticity of the domestic price with respect to the world price, to be referred to as the elasticity of transmission. The value of this elasticity is the answer to the first question. A value of 1 implies that the variations in world prices are fully transmitted to the domestic prices, whereas a value of 0 implies no transmission at all. There are several reasons why this elasticity would differ from unity. First, omitted variables, specifically tax-policy variables (s), are correlated with the world price. Second, there may be measurement errors in the world price. Such errors may reflect the fact that the world price used in a given study differs from the one pertinent for the particular country. Third, if the economy is closed, the world price is irrelevant. Of course, very few countries are completely closed, but many countries are partially closed by means of trade policies, and this may affect the value of the estimate.

The contribution of world prices, measured in domestic currencies, to the variations in domestic prices is given by the value of R^2 of the regression of equation 3. This answers the second question: a low value means that only a small proportion of the variations in domestic prices are accounted for by world prices and exchange rates. The marginal contribution of world prices conditional on the exchange rate is given by the square of the partial correlation coefficient between world and domestic prices.

The foregoing discussion dealt with proportional changes, but it says nothing about differences in levels. This information is contained in the intercept, which need not equal 0. Under the restrictions H_1 and H_2, $\alpha = s_{..} + \mu$, where $s_{..}$ is the sample average, over commodities and time, of s_{it}. Thus the intercept reflects the tax policy and the quantitative importance of the omitted variables from equation 2. More generally, when H_1 or H_2 are not maintained, or if the explanatory variables are measured with error, the intercept will be affected.

II. The Data

The regression was first computed for 58 countries for the period 1968–78, and the sample covered some 60 products. The number of products varied by country. Products not produced in a country were excluded from the analysis. The domestic prices are those given by the Food and Agriculture Organization of the United Nations (FAO) and described by the FAO as follows:

> Farm prices are in theory determined by farmgate or first point-of-sale transaction, when farmers participate in their capacity as sellers of their own products. Of course, data may not always refer to the same selling points, depending on the prevailing institutional setup in the countries. Also, different practices may prevail in regard to individual commodities (FAO 1987, p. 23).

There is a common belief that FAO prices are subject to many problems. This may be the case, but we are unfamiliar with any study that indicates the sources of errors in the FAO data and their quantitative importance, or that substantiates this belief in any other way. One way to have a rough check on the data is to see, as we are doing here, to what extent they are correlated with world prices. If the empirical results showed weak relationships between the domestic and world prices, this could be explained in terms of measurement errors. This is not the case, however, and therefore we think that these data are indeed informative. To double-check, we repeat the analysis in section IV for the European Community, using prices of the U.S. Department of Agriculture reported in Herlihy and others (1989) for 1960–85.

The world price is an export-unit value calculated in nominal U.S. dollars. It is a ratio of the total world value of exports for each of the commodities divided by the total world exported quantities for the corresponding commodities. We use the framework developed in section I to examine and verify the pertinence of this variable. The exchange rates are annual averages as published by the International Monetary Fund.

III. Results Using FAO Data

In a cross-commodity comparison, the deviation from unitary transmission elasticity is surprisingly small. The time-series analysis for individual commodities yields somewhat lower values, suggesting that policy does have some smoothing effect. In all cases, the relatively high values of R^2 indicate that world prices constitute a major source of domestic price variations.

Table 1. *Estimated Transmission and Exchange Rate Elasticities, 1968–78*

	Nominal values			*Real values*		
Country	*World prices*	*Exchange rates*	R^2	*World prices*	*Exchange rates*	R^2
Argentina	0.98	0.97	0.94	0.97	0.42	0.71
Australia	0.92	0.63	0.82	0.93	1.04	0.80
Austria	0.98	1.08	0.87	0.98	1.11	0.86
Bangladesh	0.74	0.82	0.66	0.70	0.15	0.50
Belgium and Luxembourg	0.97	1.05	0.79	0.97	1.08	0.79
Brazil	0.87	1.25	0.83	0.86	−1.54	0.69
Burundi	0.87	2.30	0.77	0.88	1.87	0.76
Cameroon	0.89	0.47	0.74	0.88	0.71	0.72
Canada	1.00	−0.20	0.85	1.01	0.35	0.84
Chile	0.94	0.98	0.96	0.95	0.67	0.63
Colombia	0.94	0.85	0.76	0.93	0.60	0.69
Costa Rica	0.93	0.45	0.85	0.92	2.22	0.83
Cyprus	0.92	0.73	0.68	0.93	0.76	0.66
Denmark	1.02	0.81	0.83	1.02	0.86	0.82
Ecuador	1.02	0.07	0.72	0.99	0.53	0.67
Egypt	1.24	2.22	0.74	1.21	−0.04	0.71
El Salvador	0.90	n.a.	0.80	0.89	0.28	0.79
Finland	0.99	3.08	0.89	0.99	1.52	0.88
France	0.95	1.04	0.72	0.95	1.02	0.70
Germany, Fed. Rep. of	0.99	1.23	0.83	0.99	1.29	0.83
Greece	0.90	1.29	0.72	0.90	1.01	0.67
Guatemala	0.90	n.a.	0.82	0.91	1.00	0.80
India	0.77	−0.61	0.71	0.75	0.75	0.66
Ireland	1.02	0.98	0.86	1.03	1.28	0.84
Israel	1.01	0.84	0.78	1.00	0.83	0.67
Italy	0.92	0.68	0.74	0.92	1.47	0.69
Japan	0.89	−0.20	0.79	0.88	0.33	0.76
Kenya	1.07	0.80	0.83	1.08	1.00	0.82
Korea, Rep. of	0.91	1.32	0.74	0.90	−1.03	0.69
Malawi	0.90	−0.86	0.75	n.a.	n.a.	n.a.

Initial Results

Because the variables are in logs, their sample variations represent relative changes. Therefore, the variables have no units, and it is possible to pool the data over all commodities for all years. The estimates of equation 3 appear in the first three columns of table 1. The t ratios are all very high (double digits) and therefore are not reported here.

The estimated transmission elasticity (from the world-prices column) varies between 0.74 and 1.24, with a median of 0.952. The values for 49 out of 57 countries fall in the range of 0.85 to 1.07. Thus the discrepancy from 1 is indeed very small. This indicates that the variations in world prices are almost fully transmitted to domestic prices. This is the answer to the first question. Turning to the second question, the values of R^2 vary between 0.66 and 0.96, which

Table 1. *(continued)*

	Nominal values			*Real values*		
Country	*World prices*	*Exchange rates*	R^2	*World prices*	*Exchange rates*	R^2
Malaysia	0.84	0.58	0.77	0.84	0.78	0.76
Mauritius	1.03	1.50	0.90	1.03	0.30	0.88
Mexico	1.02	0.56	0.79	1.02	1.04	0.75
Netherlands	0.98	1.09	0.76	0.98	1.09	0.76
New Zealand	1.03	0.21	0.76	1.04	0.90	0.74
Norway	0.98	1.23	0.89	0.97	1.11	0.88
Pakistan	0.82	0.44	0.76	0.79	−0.02	0.69
Panama	0.93	n.a.	0.77	0.95	0.84	0.75
Peru	0.86	0.98	0.77	0.85	0.58	0.65
Philippines	0.83	0.58	0.75	0.81	0.58	0.69
Portugal	0.96	1.02	0.79	0.97	1.15	0.76
South Africa	0.98	0.37	0.87	0.99	1.51	0.85
Spain	0.93	1.29	0.77	0.93	1.11	0.74
Sri Lanka	0.84	0.67	0.76	0.83	0.58	0.73
Sweden	0.95	2.35	0.82	0.95	1.87	0.82
Switzerland	1.01	0.68	0.74	1.01	0.68	0.73
Syria	0.98	4.79	0.76	0.97	0.86	0.72
Tanzania	0.97	1.41	0.81	0.98	1.16	0.79
Thailand	0.89	−0.86	0.80	0.89	0.75	0.78
Trinidad	1.01	1.04	0.66	1.01	1.05	0.63
Turkey	0.96	0.94	0.76	0.93	0.10	0.69
United Kingdom	0.96	0.75	0.89	0.96	1.37	0.88
United States	1.01	n.a.	0.82	1.02	0.00	0.81
Uruguay	0.81	0.98	0.94	0.79	0.97	0.72
Venezuela	0.94	5.13	0.71	0.92	−2.02	0.69
Yugoslavia	1.01	1.00	0.83	1.01	1.06	0.79
Zambia	0.89	1.56	0.86	0.89	1.56	0.84
Zimbabwe	0.97	1.69	0.88	0.96	1.55	0.87

n.a. Not applicable.

Note: The values in the table are the estimated coefficients from a regression using data pooled over all commodities (the sample covered 60 products, which vary by country) and over all years (1968–78).

Source: Authors' calculations, using data from FAO (various issues).

indicates that a high proportion of the variations in domestic prices are accounted for by the variations in world prices.

There are no estimates of the exchange-rate elasticity for the United States or for Panama, Guatemala, and El Salvador, which used dollar-linked currencies. However, the values of the transmission elasticity for these countries are in line with those obtained for the other countries.

The median of the exchange-rate elasticity, with these four countries excluded, is 0.97, but the estimates vary greatly across countries. The variability in the exchange-rate elasticity reflects the problem of determining the appropriate measure of exchange rate for this analysis. In many countries this variable is volatile because of inflation and changes in exchange-rate regimes. When the exchange rate changes during the year, the rate that was applicable to a particular commodity depends on the seasonality of that commodity and may differ from the variable used in the regression. A similar problem arises when there are multiple exchange rates, where whatever alternative is used represents a compromise.

The effect of inflation on the results can be reduced by examining the identity in equation 2 in terms of the real exchange rate:

$$(p_{it} - \bar{p}_t) = (p^*_{it} - \bar{p}^*_t) + (e_t + \bar{p}^*_t - \bar{p}_t) + s_{it} + u_{it} \tag{4}$$

where $\bar{p}_t$ and $\bar{p}^*_t$ are the logs of domestic and world price deflators, respectively, and the terms in parentheses represent real values. The estimation of equation 3 is repeated, with the real values replacing the nominal values. We deflate the domestic and world prices by the domestic and U.S. consumer price index, respectively. The results appear in the last three columns of table 1. The results for the regressions in real and nominal values should be the same under H_1 and H_2. Indeed, the transmission elasticity is changed very slightly; its median value is 0.947. The median of the exchange-rate elasticity is 0.86, but for some countries the estimate differs significantly from the respective nominal-value regressions, and the cross-country variability still exists.

Eliminating the effect of the exchange rate. Because we are interested largely in the transmission elasticity, it is desirable to eliminate the effect of the exchange rate. We consider two options. First, we compute within-year regressions (that is, regressions with year dummies). Such regressions use the price differences between commodities for each year, and those do not reflect the exchange rate. In this case, the regression equation takes the form

$$(p_{it} - p_{.t}) = \alpha + \beta(p^*_{it} - p^*_{.t}) + \epsilon_{it} \tag{5}$$

where $p_{.t} = \Sigma_i p_{it}/I$, the time-price average over commodities, with I being the number of commodities. We use generic notations α, β, and ϵ for the intercept, the coefficient of world prices, and the disturbance term, respectively, although their values are expected to vary from one equation to another. The prices in equation 5 are also real, but unlike those in equation 4 they are deflated by their own sample averages. In this case there is no difference between the nominal and real variables. If we let $\bar{p}_t$ be the consumer price index used to convert nominal to real values, then the real domestic price to be used in equation 5 is $[(p_{it} - \bar{p}_t) - (p_{.t} - \bar{p}_t)] = (p_{it} - p_{.t})$, which is the nominal value. The same holds for real world prices. The results appear in the first column of table 2. The median value is 0.967, and on the whole the results are similar to those of the pooled regression with exchange rates included.

The second alternative is to express domestic prices in dollars:

$$(p_{it} - e_t) = \alpha + \beta p^*_{it} + \epsilon_{it}. \tag{6}$$

This approach was taken in an earlier version of this article, Mundlak and Larson (1990). The results of the estimation of equation 6 appear in the second column of table 2. They convey the same information as the previous regressions: the median value of the estimated transmission elasticity is 0.945.

Estimation results with all countries pooled together. The world price is the export unit value and, as such, it is not an average of domestic prices. After all, world trade constitutes only a small fraction of world production. To determine the extent to which the world price used here represents the domestic country price, the regression is estimated with all countries pooled together. In such an analysis the individual countries serve as repeated observations because they all face the same world price. The results are: 0.933 for R^2, 0.941 for the transmission elasticity, and 1.02 for the exchange-rate elasticity. The comparable estimates for real prices are 0.964, 0.943, and 0.980, respectively. It is thus concluded that the world prices used in the analysis are indeed representative of domestic prices.

The Policy Bias

The aforementioned regressions do not include a measure of the tax, s, as a variable because it is simply unobserved. This omission adds a component to the equation disturbance, and thus it reduces the R^2, which measures the importance of world prices in explaining the variations in domestic prices. More important, the omission may bias the transmission elasticity. It is often stated that countries pursue policies aimed at stabilizing domestic prices. Stabilization requires tax reductions when world prices are high and tax increases when world prices are low, which implies a negative correlation between world prices and taxes. Such a relationship is captured by

$$s_{it} = \pi_0 + \pi p^*_{it} + v_{it} \tag{7}$$

where v is the error of this equation and $E(p^* v) = 0$. Combining equations 7 and 3, the regression equation for domestic prices is

$$p_{it} = (\alpha + \pi_0) + (\beta + \pi) p^*_{it} + \gamma e_t + \zeta_{it} \tag{8}$$

where $\zeta = \epsilon + v$. For convenience, we refer to π as the policy elasticity. Under

Table 2. *Estimated Transmission Elasticities from Regressions Excluding the Exchange Rate, 1968–78*

Country	*With year dummies*	*With domestic prices in dollars*	*With commodity-means*[a]
Argentina	0.990	0.966	1.000
Australia	0.933	0.930	0.944
Austria	0.984	0.979	1.007
Bangladesh	0.710	0.715	0.731
Belgium and Luxembourg	0.973	0.972	0.993
Brazil	0.853	0.902	0.871
Burundi	0.884	0.862	0.901
Cameroon	0.881	0.890	0.900
Canada	1.018	0.999	1.033
Chile	0.970	0.878	0.785
Colombia	0.944	0.922	0.972
Costa Rica	0.931	0.908	0.944
Cyprus	0.934	0.925	0.948
Denmark	1.025	1.037	1.049
Ecuador	1.012	0.987	1.036
Egypt	1.231	1.208	1.271
El Salvador	0.904	0.903	0.925
Finland	1.000	0.967	1.026
France	0.953	0.949	0.968
Germany, Fed. Rep. of	0.995	0.989	1.037
Greece	0.906	0.912	0.925
Guatemala	0.971	0.907	0.972
India	0.774	0.737	0.794
Ireland	1.030	1.022	1.045
Israel	1.012	0.972	0.989
Italy	0.940	0.909	0.957
Japan	0.888	0.942	0.914
Kenya	1.090	1.064	1.112
Korea, Rep. of	0.904	0.926	0.907
Malawi	0.923	0.888	0.950

equation 2, $\beta = 1$ and the policy contributes to a discrepancy from 1. If we attribute all of the discrepancy of the estimated elasticity from 1 to the policy, then a value of 0.95 for the transmission elasticity implies a value of -0.05 as an estimate for π, which is indeed very small.

Equation 7 assumes a uniform policy for all commodities and all years. This assumption is too strong and should therefore be weakened by generalizing the equation. This can be done by allowing commodity-specific policy elasticity, denoted by π_i, and a tax level, denoted by π_{0i}:

$$s_{it} = \pi_{0i} + \pi_i p^*_{it} + v_{it} \tag{7a}$$

where $E(p^*v) = \text{cov}(\pi_{0i}, p^*_{it}) = \text{cov}(\pi_i, p^*_{it}) = 0$ for all t. The effect of this extension can be evaluated through the computation of between-commodity and

Table 2. *(continued)*

Country	*With year dummies*	*With domestic prices in dollars*	*With commodity-means*[a]
Malaysia	0.842	0.858	0.863
Mauritius	1.033	1.041	1.048
Mexico	1.040	0.985	1.058
Netherlands	0.989	0.985	1.016
New Zealand	1.051	1.029	1.068
Norway	0.976	0.977	1.006
Pakistan	0.804	0.744	0.829
Panama	0.970	0.937	0.971
Peru	0.852	0.868	0.902
Philippines	0.826	0.804	0.842
Portugal	0.970	0.959	0.982
South Africa	1.005	0.972	1.028
Spain	0.932	0.928	0.948
Sri Lanka	0.827	0.814	0.833
Sweden	0.955	0.930	0.986
Switzerland	1.018	1.039	1.043
Syria	0.977	0.978	1.002
Tanzania	0.989	0.977	1.012
Thailand	0.892	0.897	0.915
Trinidad	1.011	1.015	1.036
Turkey	0.943	0.952	0.961
United Kingdom	0.967	0.951	0.971
United States	0.958	1.005	0.958
Uruguay	0.800	0.796	0.809
Venezuela	0.933	0.910	0.963
Yugoslavia	1.020	1.011	1.041
Zambia	0.898	0.893	0.921
Zimbabwe	0.969	0.956	0.994

a. This column gives the values for the coefficient of world prices when using the between-commodity regression equation, in which the commodity price is an average over time and the world price is the only explanatory variable.

Source: Authors' calculations, using data from FAO (various issues).

within-commodity regressions. The appendix summarizes the formal relationships between the various estimators.

Between-commodity regressions. Averaging the variables over time we obtain

$$p_{i.} = (\alpha + \pi_{0i} + \gamma e_{.}) + (\beta + \pi_i)\, p^*_{i.} + \zeta_{i.} \tag{9}$$

where $p_{i.} = \Sigma_t p_{it}/T$, the commodity-price average over time, T is the number of years, and $e_{.} = \Sigma_t e_t/T$. The exchange rate is thus subsumed into the intercept and the between-commodity regression has only the world price as an explanatory variable. Its regression coefficient is

$$b(i) = \Sigma p_{i.}(p^*_{i.} - p^*_{..}) \;/\; \Sigma(p^*_{i.} - p^*_{..})^2. \tag{10}$$

Taking expectation using equation 9:

$$Eb(i) = \beta + \Delta(i) \tag{11}$$

and

$$\Delta(i) = \Sigma\lambda_i\pi_i \tag{12}$$

where $\lambda_i = (p_{i.}^* - p_{..}^*)^2 \,/\, \Sigma(p_{i.}^* - p_{..}^*)^2$ is the weight assigned to π_i. Thus $\Delta(i)$ is a weighted average of the commodity-specific policy elasticity, π_i. The values obtained for the coefficient of world prices, $b(i)$, appear in the third column of table 2. The median value is 0.971, so that it differs very little from that of the pooled regression. This implies that the weighted average of the policy elasticities is quite small.

Table 3. *Estimated Transmission and Exchange Rate Elasticities from within-Commodity Regressions, 1968–78*

		Nominal values		*Real values*	
Country	*World prices (U.S. dollars)*	*World prices*	*Exchange rates*	*World prices*	*Exchange rates*
Argentina	0.759	0.868	0.989	0.614	0.995
Australia	0.847	0.977	0.623	0.964	1.092
Austria	0.792	0.931	1.143	0.733	1.196
Bangladesh	0.630	1.094	0.604	0.911	0.938
Belgium and Luxembourg	0.828	0.921	1.145	0.750	1.154
Brazil	1.094	0.825	1.280	0.936	0.960
Burundi	0.579	0.585	1.466	0.257	1.233
Cameroon	0.873	0.903	1.057	0.671	1.063
Canada	0.797	0.962	−0.152	0.894	0.595
Chile	0.600	0.938	0.981	−0.010	1.376
Colombia	0.648	0.665	1.555	0.319	1.242
Costa Rica	0.655	0.500	2.367	0.404	1.308
Cyprus	0.826	0.820	−0.131	0.479	−0.142
Denmark	0.948	1.007	1.010	0.944	1.074
Ecuador	0.719	0.833	1.225	0.548	1.136
Egypt	0.964	0.600	−1.314	0.317	−1.901
El Salvador	0.759	0.759	2.413	0.618	1.408
Finland	0.636	0.769	2.263	0.713	1.582
France	0.846	0.939	1.305	0.817	1.255
Germany, Fed. Rep. of	0.748	0.979	1.252	0.935	1.369
Greece	0.845	0.746	1.451	0.667	1.164
Guatemala	0.697	0.972	0.000	0.869	1.350
India	0.437	0.272	2.783	0.218	1.487
Ireland	0.806	0.971	0.892	0.951	0.947
Israel	0.767	1.025	0.831	0.643	1.130
Italy	0.688	0.620	1.349	0.448	1.158
Japan	1.144	1.205	0.905	1.107	1.072
Kenya	0.750	0.634	1.739	0.532	1.107
Korea, Rep. of	1.006	0.846	1.190	0.767	1.106
Malawi	0.488	0.829	−1.162	n.a.	n.a.

Within-commodity regressions. The basic underlying equation for the within-commodity regression is obtained by subtracting equation 9 from equation 8, with π_{0i} and π_i replacing π_0 and π, respectively:

$$(13)\qquad p_{it} - p_{i.} = (\beta + \pi_i)(p^*_{it} - p^*_{i.}) + \gamma(e_t - e_.) + \zeta_{it} - \zeta_{i.}.$$

The within-commodity estimates were derived for the nominal and real versions with the exchange rate included and for the domestic variables in dollar prices. The results appear in table 3. The median of the transmission elasticities for the nominal prices, 0.937, is significantly higher than the corresponding values of 0.78 and 0.713 for the dollar prices and real prices, respectively.

To examine the source of this difference in the estimates, we simplify the

Table 3. *(continued)*

Country	World prices (U.S. dollars)	Nominal values: World prices	Nominal values: Exchange rates	Real values: World prices	Real values: Exchange rates
Malaysia	0.837	1.010	1.291	1.008	1.430
Mauritius	0.989	0.822	1.503	0.868	1.052
Mexico	0.646	0.904	1.091	0.452	1.131
Netherlands	0.819	0.992	1.208	0.973	1.245
New Zealand	0.764	0.939	0.207	0.883	0.958
Norway	0.801	0.974	1.381	0.880	1.388
Pakistan	0.367	1.285	0.144	0.531	1.287
Panama	0.604	0.969	0.000	0.633	−1.527
Peru	0.782	0.931	1.032	0.516	1.071
Philippines	0.597	1.078	0.578	0.465	1.222
Portugal	0.800	0.820	1.351	0.663	1.165
South Africa	0.626	0.922	0.325	0.721	1.972
Spain	0.816	0.822	1.227	0.682	1.108
Sri Lanka	0.686	1.205	0.367	1.004	0.895
Sweden	0.579	0.775	1.898	0.493	1.588
Switzerland	1.054	1.099	0.844	1.209	0.945
Syria	0.872	0.843	1.633	0.764	1.219
Tanzania	0.765	0.635	1.745	0.516	1.094
Thailand	0.769	0.781	1.206	0.506	1.087
Trinidad	0.866	0.887	1.784	0.771	1.272
Turkey	0.904	1.046	0.966	0.810	1.094
United Kingdom	0.781	0.943	0.671	0.864	0.518
United States	0.817	0.955	0.000	0.860	0.000
Uruguay	0.730	0.893	0.953	0.594	1.033
Venezuela	0.599	0.669	2.186	0.202	1.758
Yugoslavia	0.851	0.549	1.855	0.657	1.089
Zambia	0.713	1.003	0.988	0.736	1.940
Zimbabwe	0.697	0.969	1.280	0.832	1.191

n.a. Not applicable.
Source: Authors' calculations, using data from FAO (various issues).

exposition by ignoring the term with the exchange rate and writing the regression coefficient for commodity i as if it were a simple regression:[1]

$$(14) \qquad b_i = \Sigma_t p_{it}(p^*_{it} - p^*_{i.}) \;/\; \Sigma_t(p^*_{it} - p^*_{i.})^2$$

and express the within-commodity estimator, $w(i)$, as

$$(15) \qquad w(i) = \Sigma\Sigma p_{it}(p^*_{it} - p^*_{i.}) \;/\; \Sigma\Sigma(p^*_{it} - p^*_{i.})^2 = \Sigma_i b_i \omega_i$$

where $\omega_i = \Sigma_t(p^*_{it} - p^*_{i.})^2 \;/\; \Sigma\Sigma(p^*_{it} - p^*_{i.})^2$. Thus the within-commodity estimator is a weighted average of the regression coefficients for commodity i. Taking expectation using equation 13:

$$(16) \qquad Ew(i) = \beta + \Sigma_i\, \omega_i \pi_i.$$

The difference between equations 16 and 11 is in the way the commodity-specific slopes are taken into account. In equation 11 only one observation per commodity is used, and the exchange rate is eliminated from the equation. In equation 16 there are as many observations as years. If the difference of the transmission elasticities from 1 is considered as a weighted average of the commodity-specific policy elasticity, then the results suggest some variability in policy elasticity among commodities. We therefore examine this possibility more closely by presenting results for individual commodities and discussing possible sources of variations between the various estimates.

A similar analysis can be conducted for an alternative specification that allows for systematic variations of policy over time. This is discussed in Mundlak and Larson (1990), where it is shown that at the median the time effect on the policy elasticity, derived for domestic dollar prices, is −0.04. It seems that the variability over commodities is more important. To deal with the variability over time, a longer time series is needed.

Specific Commodities

Mundlak and Larson (1990) present transmission elasticities for wheat, coffee, and cocoa derived from equation 6, where the domestic prices are measured in dollars. The results are reproduced here in table 4. Wheat is chosen because it is often stated that staple foods are more susceptible to intervention that insulates domestic markets from world prices. Coffee and cocoa are internationally traded under cartel arrangements, and as such they may show a larger gap in the variations of domestic and world prices.

The median value of the transmission elasticity for wheat is approximately 0.65, with only 9 out of the 58 countries having a coefficient smaller than 0.5.

1. In practice b_i is obtained from the following regression:

$$p_{it} = a_i + b_i p^*_{it} + c_i e_t + \text{error}.$$

Equations 14 and 15 still apply when the prices are netted of the linear effect of e_t. This adjustment does not affect the interpretation.

The median value for coffee is 0.68; for cocoa it is above 0.84. The reason for concentrating on the estimates of equation 6 is that, with only 11 observations and a correlation between exchange rates and world prices, the results of the full equation 3 with an additional coefficient are less stable. This problem is overcome by pooling all countries together. The estimates of equation 3 for wheat with country-pooled data are 0.69, 1.03, and 0.969 for the transmission elasticity, exchange rate elasticity, and R^2, respectively. Interestingly, the value of the transmission elasticity is very close to the median value of table 4.

The policy elasticities for wheat, coffee, and cocoa are negative and larger in absolute value than those obtained for the pool of commodities. Still, for most countries, about 70 to 80 percent of the variations in world prices, depending on the commodity, are transmitted to domestic prices. Furthermore, the values of R^2 are on the whole quite high, indicating that world prices are the main source of variations in domestic prices.

The relationships between the within- and between-commodity estimates are illustrated in figure 1, where domestic dollar prices, measured in natural logs, are plotted against the log of world prices. Lines ac and bc represent regression lines with slopes $\beta + \pi_a$ and $\beta + \pi_b$ fitted to observations on two commodities, where both slopes are less than 1. Ellipsoids mark the clusters of observations

Figure 1. *Relationship between Within-Commodity and Between-Commodity Estimates*

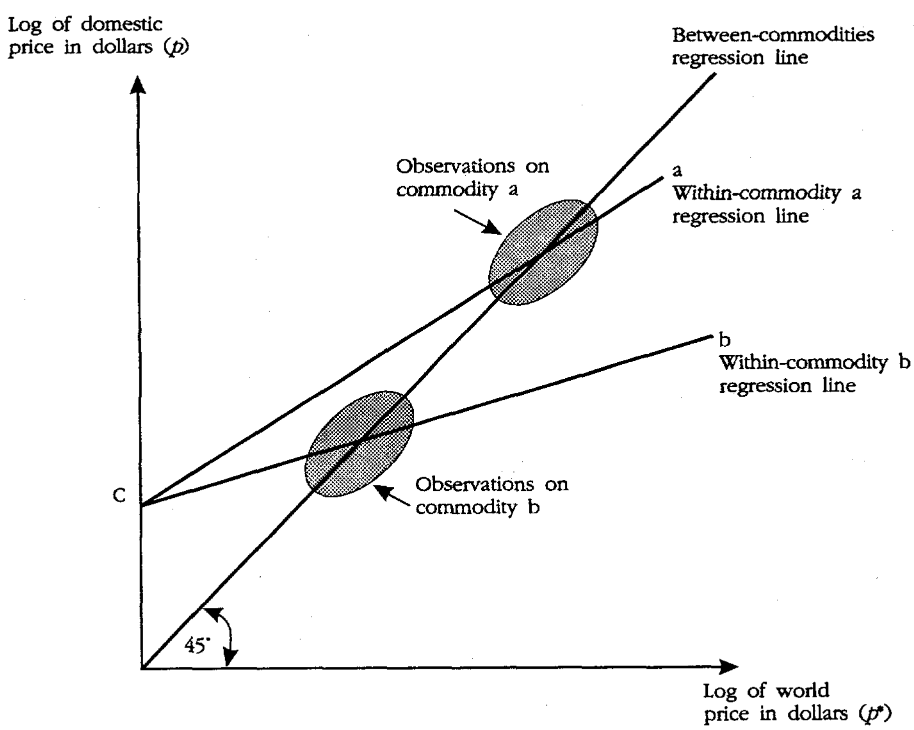

Table 4. *Estimated Transmission Elasticities for Wheat, Coffee, and Cocoa, 1968–78*

	Wheat		*Coffee*		*Cocoa*	
Country	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2
Argentina	0.701	0.46	0.00	0.00	0.00	0.00
Australia	0.905	0.76	n.a.	n.a.	n.a.	n.a.
Austria	0.588	0.85	n.a.	n.a.	n.a.	n.a.
Bangladesh	0.655	0.37	n.a.	n.a.	n.a.	n.a.
Belgium and Luxembourg	0.626	0.81	n.a.	n.a.	n.a.	n.a.
Brazil	0.814	0.88	0.652	0.22	1.192	0.85
Burundi	0.518	0.31	0.680	0.99	n.a.	n.a.
Cameroon	0.152	0.68	0.530	0.88	0.615	0.86
Canada	0.954	0.66	n.a.	n.a.	n.a.	n.a.
Chile	0.836	0.29	n.a.	n.a.	n.a.	n.a.
Colombia	0.620	0.85	0.619	0.95	0.612	0.91
Costa Rica	0.554	0.93	0.940	0.99	1.075	0.94
Cyprus	0.477	0.86	n.a.	n.a.	n.a.	n.a.
Denmark	0.892	0.87	n.a.	n.a.	n.a.	n.a.
Ecuador	0.529	0.82	0.629	0.78	0.979	0.89
Egypt	0.562	0.86	n.a.	n.a.	n.a.	n.a.
El Salvador	0.621	0.78	1.054	0.93	0.927	0.69
Finland	0.413	0.83	n.a.	n.a.	n.a.	n.a.
France	0.582	0.85	n.a.	n.a.	n.a.	n.a.
Germany, Fed. Rep. of	0.646	0.87	n.a.	n.a.	n.a.	n.a.
Greece	0.715	0.83	n.a.	n.a.	n.a.	n.a.
Guatemala	0.687	0.83	0.862	0.96	0.975	0.91
India	0.405	0.85	0.142	0.39	n.a.	n.a.
Ireland	0.707	0.79	n.a.	n.a.	n.a.	n.a.
Israel	0.821	0.96	n.a.	n.a.	n.a.	n.a.
Italy	0.655	0.90	n.a.	n.a.	n.a.	n.a.
Japan	1.113	0.71	n.a.	n.a.	n.a.	n.a.
Kenya	0.780	0.81	1.006	0.99	n.a.	n.a.
Korea, Rep. of	0.903	0.81	n.a.	n.a.	n.a.	n.a.
Malawi	0.500	0.66	0.430	0.75	n.a.	n.a.

for the sample years for each commodity. The intercept of the price line of an individual commodity indicates a systematic difference between domestic and world prices or simply the level of distortion for the particular commodity. Thus we can have a slope of 1 and an intercept larger or smaller than 0, indicating a protection or tax, respectively. The lines are drawn with a common intercept so as to keep the same distortion rate. This is not essential, and other configurations are admissible.

The commodity-specific regressions estimate the slopes of these lines, and the within-commodity regression provides estimates of a weighted average of these commodity slopes. However, the between-commodity regression line is a statistical fit to commodity averages, labeled $\bar{p}$, and, unlike the within-estimator, the between-commodity estimator does not use the information represented in indi-

Table 4. *(continued)*

	Wheat		*Coffee*		*Cocoa*	
Country	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2
Malaysia	1.008	0.97	0.837	0.76	0.844	0.94
Mauritius	0.692	0.82	n.a.	n.a.	n.a.	n.a.
Mexico	0.586	0.88	0.858	0.80	0.835	0.88
Netherlands	0.584	0.84	n.a.	n.a.	n.a.	n.a.
New Zealand	0.701	0.78	n.a.	n.a.	n.a.	n.a.
Norway	0.601	0.82	n.a.	n.a.	n.a.	n.a.
Pakistan	0.097	0.08	n.a.	n.a.	n.a.	n.a.
Panama	0.497	0.77	0.425	0.79	1.023	0.98
Peru	0.704	0.86	0.732	0.83	1.046	0.85
Philippines	0.609	0.85	1.018	0.87	0.754	0.92
Portugal	0.422	0.93	n.a.	n.a.	n.a.	n.a.
South Africa	0.454	0.93	n.a.	n.a.	n.a.	n.a.
Spain	0.546	0.90	n.a.	n.a.	n.a.	n.a.
Sri Lanka	0.586	0.64	0.809	0.71	1.085	0.82
Sweden	0.482	0.84	n.a.	n.a.	n.a.	n.a.
Switzerland	0.910	0.85	n.a.	n.a.	n.a.	n.a.
Syria	0.687	0.84	n.a.	n.a.	n.a.	n.a.
Tanzania	0.634	0.69	0.616	0.50	0.498	0.79
Thailand	0.995	0.84	0.461	0.86	n.a.	n.a.
Trinidad	0.729	0.81	0.604	0.75	0.702	0.97
Turkey	0.705	0.77	n.a.	n.a.	n.a.	n.a.
United Kingdom	0.708	0.77	n.a.	n.a.	n.a.	n.a.
United States	0.958	0.73	0.831	0.86	n.a.	n.a.
Uruguay	1.153	0.88	n.a.	n.a.	n.a.	n.a.
Venezuela	0.805	0.84	0.051	0.09	0.504	0.62
Yugoslavia	0.626	0.84	n.a.	n.a.	n.a.	n.a.
Zambia	1.187	0.96	0.715	0.52	n.a.	n.a.
Zimbabwe	0.624	0.84	0.434	0.75	n.a.	n.a.

n.a. Indicates not applicable.
Source: Authors' calculations, using data from FAO (various issues).

vidual commodity observations.

Because there is a large between-commodity spread in the prices, the slope of the between-commodity regression differs from the slopes of the individual commodities. An elasticity of 1 for the between-commodity estimate indicates that what is relatively expensive in the world market is also relatively expensive at home, or, more specifically, that the relative prices at home and abroad are, on average, the same. A slope smaller than 1 indicates that the more expensive the commodity is, the lower the tax rate or the larger the subsidy is.

Decomposition of the Pooled Regression Results

The pooled regression is a weighted average of the within- and between-commodity regressions (see the appendix), where the weights depend on the variance components of the world prices. Table 5 presents a decomposition of the variations in world prices to the commodity and time components. The between-commodity variations dominate the within-commodity variations, and therefore estimates based on data pooled across time and commodities (first three columns of table 1) largely reflect the between-commodity variations. Thus the transmission elasticity of the pooled regression is close to the between-commodity value and close to 1 even though the commodity elasticities are smaller than 1.

A slope smaller than 1 for an individual commodity in this framework is consistent with a stabilization policy implemented by changing tax rates. But is a deviation from 1 for an individual commodity an exclusive outcome of policy? The answer is probably no. There are two important effects that are likely to

Table 5. *Sum of Squares of World Prices, 1968–78*

		Within			*Between*	
Country	(1) (*Total*)	(2) *Commodities* (*i*)	(3) *Time* (*t*)	(4) *Commodities and time* (*it*)	(5) *Commodities* (*i*)	(6) *Time* (*t*)
Argentina	562.8	81.3	493.0	11.5	481.5	69.8
Australia	511.0	75.1	446.6	10.6	436.0	64.5
Austria	426.4	57.2	373.2	7.7	370.4	53.4
Bangladesh	401.2	62.9	349.3	11.0	338.3	51.9
Belgium and Luxembourg	414.7	58.9	358.6	9.2	357.6	56.8
Brazil	576.0	91.8	499.3	17.5	483.6	77.0
Burundi	385.4	46.1	346.8	7.5	339.3	38.6
Cameroon	475.8	63.6	418.7	13.0	413.0	57.9
Canada	370.0	53.1	323.6	6.6	316.9	46.4
Chile	386.1	68.8	325.1	9.8	318.7	61.1
Colombia	538.3	82.3	469.5	13.5	456.1	68.8
Costa Rica	442.4	59.2	390.4	11.5	384.1	52.4
Cyprus	363.2	56.0	310.7	7.8	309.8	53.0
Denmark	297.1	48.5	249.5	7.9	250.9	48.3
Ecuador	542.9	83.4	473.6	14.1	459.5	69.3
Egypt	369.1	75.3	304.4	10.6	293.8	64.7
El Salvador	457.3	64.7	401.3	12.5	393.2	56.5
Finland	273.2	39.6	235.3	6.2	235.0	38.4
France	459.2	69.2	399.2	9.9	388.7	60.1
Germany, Fed. Rep. of	429.8	55.6	375.0	10.3	371.9	56.7
Greece	507.6	78.5	439.7	10.9	427.6	68.0
Guatemala	437.6	58.9	386.1	11.2	379.2	51.9
India	519.8	84.0	449.0	15.1	436.6	70.9
Ireland	296.2	35.1	268.1	5.8	268.5	28.1
Israel	404.6	72.5	338.3	10.9	330.5	67.1
Italy	453.3	84.5	377.8	11.0	370.0	75.6
Japan	562.8	78.4	494.6	12.6	486.5	68.3
Kenya	430.2	70.3	471.1	12.9	459.8	59.2
Korea, Rep. of	482.4	63.0	425.1	7.8	424.7	57.7
Malawi	375.8	50.1	334.7	9.0	325.8	41.1

bias the estimates downward: tradability and "measurement error."

Tradability. Although agricultural products are largely tradable, their domestic prices also reflect domestic inputs such as marketing, finance, storage, and transportation. (For an analysis of this subject, see Mundlak, Cavallo, and Domenech 1990.) To incorporate this extension, equation 2 is rewritten:

$$p_{it} = \tau_i(p^*_{it} + e_t + s_{it} + u_{it}) + (1 - \tau_i)p^d_t \tag{17}$$

where p^d_t is the natural log of the aggregate price of the domestic input, assumed to be the same for all products, and τ_i is the share of the tradable component in the price of commodity i. Under equation 17, the slope of the individual commodity price line is smaller than 1. The empirical transmission elasticity is now an estimate of $\tau_i + \pi_i$. As p^d_t is omitted from the regression, this estimate is

Table 5. *(continued)*

		Within			*Between*	
Country	(1) (*Total*)	(2) *Commodities* (*i*)	(3) *Time* (*t*)	(4) *Commodities and time* (*it*)	(5) *Commodities* (*i*)	(6) *Time* (*t*)
Malaysia	446.4	58.2	394.3	13.1	390.3	53.0
Mauritius	301.9	36.0	272.1	6.3	265.9	29.8
Mexico	522.9	92.6	440.5	14.8	433.2	82.8
Netherlands	322.3	56.1	269.1	7.5	268.7	53.6
New Zealand	400.1	51.5	355.3	6.7	348.6	44.8
Norway	274.5	38.8	236.1	6.9	234.6	39.6
Pakistan	411.6	75.2	346.2	11.6	337.2	65.5
Panama	320.5	40.2	286.7	8.4	280.5	34.0
Peru	556.7	90.0	483.0	16.9	462.6	74.3
Philippines	445.0	65.4	388.9	13.2	377.8	57.1
Portugal	516.6	69.9	453.9	12.2	448.0	63.2
South Africa	525.9	72.8	465.1	12.1	453.1	60.7
Spain	568.2	85.8	493.2	13.6	483.0	75.4
Sri Lanka	443.6	57.3	396.0	9.7	386.3	46.7
Sweden	365.1	53.2	310.5	10.7	315.1	56.4
Switzerland	351.6	46.5	310.8	6.4	301.3	41.0
Syria	397.4	71.8	335.9	9.7	325.6	61.7
Tanzania	535.0	78.2	469.3	14.5	457.3	65.8
Thailand	404.4	58.5	357.6	11.9	348.3	47.3
Trinidad	388.6	47.6	345.3	10.9	341.8	44.1
Turkey	455.6	78.6	387.2	10.2	377.0	68.4
United Kingdom	341.8	45.9	298.6	8.2	292.1	44.2
Uruguay	383.0	65.0	326.5	8.5	318.0	56.5
United States	528.0	81.5	457.8	13.2	445.8	70.5
Venezuela	420.8	64.3	367.0	11.3	355.0	53.9
Yugoslavia	488.1	76.7	420.6	9.2	411.4	67.5
Zambia	400.9	47.8	363.6	7.6	359.7	37.3
Zimbabwe	426.0	54.1	378.8	8.8	372.0	47.3

Source: Authors' calculations, using data from FAO (various issues).

biased. It is likely that the omitted variable, which is closely related to domestic inflation, is positively correlated with the exchange rate and that hence the bias is positive. Therefore, the deviation from 1 cannot be fully attributed to policy.

We can carry this analysis a step further and rewrite equation 17 as

$$p_{it} - p_t^d = \tau_i(p_{it}^* + e_t + s_{it} + u_{it}) - \tau_i p_t^d. \tag{18}$$

If we assume that the price of the domestic input can be approximated by the overall price level, then the dependent variable is real domestic price in the sense of equation 4. The difference is that in equation 18 the world price is nominal, whereas in equation 4 it is real, as well. If we ignore this difference, however, the estimates of equation 4 can be viewed as an approximation of the estimate of equation 18, with the last term omitted. But now the bias is negative, because the coefficient of p_t^d has a negative sign. Indeed, the estimates of the real regressions give somewhat smaller estimates for the transmission elasticities. The values of the within-commodity estimates are 0.937 for the nominal, 0.78 for the dollar prices, and 0.713 for the real. It is interesting to note that the effect of converting to dollars is similar to that of deflating by the overall price level. In terms of our discussion, the nominal estimate is biased upward, and the real is biased downward. Hence the difference from 1 obtained from the regression with real values can be viewed as an upper bound for an estimate of the sum of the share of the nontradable component and the policy elasticity, whereas the nominal regression provides a lower bound.

Measurement error. There are two good reasons to think about measurement error of a conceptual rather than mechanical nature. First, the basic equation 2 is applicable at a time when a trade takes place. Trade is not carried out continuously, however. Between trades, the world price is changing without necessarily affecting domestic prices. Stored commodities maintain an intertemporal arbitrage condition. As such, the spot prices respond to new information with respect to expected future world supply. Because arbitrage, either through trade or through storage, is costly, domestic prices, which are not backed by transactions, do not respond instantaneously to changes in world prices. Consequently, as illustrated effectively by Williams and Wright (1991), the dynamic paths of world prices and domestic prices within the year are likely to differ. When intrayear variations in the world price are summarized in equation 2 by a single figure, a discrepancy is built in between the domestic price and the pertinent world price. This is, of course, a short-term phenomenon, but it recurs with every new shock to the system. Because the prices are dated, this dynamic may matter and thus affect the results.

Second, the problem of deciding on the right deflators to convert the world prices from nominal to real is similar to the question of what exchange rate to use, which was discussed above. The deflators and exchange rates may bias the estimates downward. The bias may be substantial and may lead to a rejection of the empirical validity of the law of one price. Also, in some countries (for example, Canada) the estimates of the exchange rate elasticities change very little over the sample period. Therefore the spread is not sufficient to get reliable estimates.

IV. The Data Set for the European Community

A potential problem of any empirical application is that the results emerging from the study reflect the idiosyncrasies of the way in which the data are collected, estimated, or reported rather than the underlying economic effects. This possibility carries a special weight in view of the doubt researchers express with respect to FAO data. Therefore we repeat the analysis on a separate data set for the European Community (EC), which has had an active agricultural policy as well as good data.

The EC agricultural policy is well financed and sophisticated in its execution and reporting mechanisms. Because it is well financed, any wedge between domestic and international prices can be expected to be longer lived than in lower-income countries. The data are taken from Herlihy and others (1989), and cover 25 years of producer prices. The commodity coverage available from the EC data is more limited than in the FAO data set, but it contains the major staple products. Table 6 presents some summary results. For the sample pooled across time and commodities, equation 3, the transmission elasticity varies between 0.91 and 1.01, and the values of R^2 vary between 0.84 and 0.92. The estimated exchange-rate elasticity, not reported in the table, varies between 0.79 and 1.06. The corresponding values for the pool of *all* the EC countries are 0.97, 0.97, and 1.03, respectively. The results for the between-commodities regressions are similar.

The within-commodity estimates of the transmission elasticity (equation 5) are somewhat smaller, with a median value of 0.74, compared with a median value of 0.96 for the between-commodity regression. This pattern is similar to what we observed above for the first sample. It is also similar to the results reported in Mundlak and Larson (1990) for equation 6, with domestic prices measured in dollars. We use this similarity to report in table 7 the results in Mundlak and Larson (1990) for individual commodities, with dollar domestic prices.

The results for the EC confirm the earlier results. Although the commodity coverage is different, the pooled elasticities for countries common to both samples are remarkably close. The estimates for wheat vary between 0.54 and 0.91, with a median at 0.70 and a value of 0.77 for the pool of all the EC countries. Recall that the median for the country estimates in table 4 is 0.66, and the estimates for the pooled country data derived from equation 3 is 0.69. For some of the other commodities, the median elasticities are also somewhat lower than the aggregates. But for milk the estimated transmission elasticity is larger than 1

Table 6. *Estimated Transmission Elasticities, European Community, 1960–85*

			Between				*Within*			
	Pooled		*Commodities*		*Time*		*Commodities*		*Time*	
Country	*Elasticity, b*	R^2	*Elasticity, b(i)*	R^2	*Elasticity, b(t)*	R^2	*Elasticity, w(i)*	R^2	*Elasticity, w(t)*	R^2
Belgium and Luxembourg	0.98	0.84	1.00	1.00	0.76	0.94	0.74	0.99	0.99	1.00
Denmark	0.96	0.88	0.95	1.00	1.09	0.98	1.05	0.98	0.94	1.00
France	1.01	0.88	1.04	1.00	0.82	0.98	0.78	0.99	1.03	0.99
Germany, Fed. Rep. of	0.96	0.85	0.97	0.99	0.54	0.88	0.47	0.99	0.96	0.99
Greece	1.00	0.92	1.02	1.00	0.68	0.99	0.65	0.99	1.02	1.00
Ireland	0.91	0.84	0.91	0.99	0.97	0.98	0.92	0.98	0.90	0.99
Italy	1.00	0.89	1.02	1.00	0.81	0.98	0.74	0.98	1.01	1.00
Netherlands	0.94	0.84	0.94	0.99	0.76	0.92	0.69	0.99	0.94	0.99
United Kingdom	0.95	0.90	0.96	0.99	0.90	0.95	0.86	0.98	0.96	0.99
All countries	0.97	0.97	1.02	1.00	0.89	0.98	0.85	0.99	1.00	1.00

Note: Exchange rate effects were included in estimates.
Source: Authors' calculations, based on data from Herlihy and others (1989).

for several countries, indicating a strong adjustment of domestic prices that was positively correlated with world prices.

V. Conclusions

By way of generalization, the deviation from unitary elasticity is, on the whole, surprisingly small. The deviation from unitary elasticity is in part the result of policy measures and in part the result of domestic inputs that are not necessarily synchronized with world agricultural prices. This does not imply that policies generated with respect to particular products are not important in affecting the prices of these products. They certainly affect the price levels, and, whenever a country taxes agriculture, the domestic prices will differ from world prices. Consequently, there are cross-country variations of prices. Such policies do not, however, prevent domestic prices from moving with world prices. Furthermore, world prices are the major contributor to variations in domestic prices.

In this analysis it was assumed that the world price is independent of the disturbances in the price equation. On the face of it, this assumption might be too strong for the United States, and perhaps some other countries, when dealing with some specific commodities. If this assumption were violated, world price would be endogenous and the estimates would be subject to least-squares bias. However, this is not reflected in the results in any meaningful way.

What, then, is the role for domestic supply and demand? They determine the traded quantities of the traded goods, and the prices of the traded goods affect to a large extent the prices of the specific factors in agriculture and thereby the supply of the nontraded goods. This is basically the mechanism of factor-price equalization. For instance, depressed world prices affect land prices, agricultural wage rates (through their effect on labor supply), and the price of quasi-fixed inputs. This spreads to all commodities.

An important implication for thinking about the dynamics of world agriculture (Mundlak 1989) is that we can think of the world as a closed economy facing a downward-sloping demand function that serves as a constraint to production growth. The trend in world prices is determined by the relative growth in world supply and demand. In this century supply has outpaced demand, and as a result real world agricultural prices have declined. The essence of our analysis is that such a decline should have taken place in all countries, regardless of whether their supply actually increased in relation to demand.

This implies that technical change and other permanent shocks that originate in one country but that are big enough to affect world prices eventually affect prices in all countries. Even though domestic policies affect prices, they cannot prevent the covariations of domestic prices with world prices in the long run, because price distortion is costly, and public resources, like private resources, are finite. Passive countries, which are shock takers, should implement the necessary structural adjustments called for by the shock—including the enhance-

Table 7. *Estimated Transmission Elasticities for Selected Commodities, European Community, 1960–85*

	Belgium and Luxembourg		*Denmark*		*France*		*Germany, Fed. Rep. of*		*Greece*	
Commodity	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2
Barley	0.714	0.873	0.972	0.940	0.691	0.865	0.684	0.858	0.632	0.873
Butter	0.522	0.822	1.101	0.930	0.607	0.915	0.736	0.907	0.716	0.916
Cattle	0.958	0.963	1.193	0.972	0.889	0.960	0.987	0.959	0.829	0.957
Cheese	0.921	0.947	1.287	0.976	0.844	0.972	1.022	0.989	0.773	0.920
Eggs	0.636	0.662	0.919	0.921	1.198	0.917	0.787	0.921	0.739	0.807
Maize	n.a.	n.a.	n.a.	n.a.	0.683	0.877	n.a.	n.a.	n.a.	n.a.
Milk	1.188	0.895	1.731	0.904	1.230	0.895	1.395	0.916	0.669	0.907
Oats	0.778	0.901	0.998	0.944	0.716	0.900	0.753	0.909	0.747	0.861
Pigs	0.722	0.938	0.819	0.956	0.571	0.910	0.754	0.950	n.a.	n.a.
Poultry	0.955	0.953	0.950	0.928	0.604	0.716	0.880	0.927	0.411	0.730
Potatoes	1.079	0.689	1.105	0.769	0.906	0.650	0.901	0.851	0.755	0.814
Rye	0.844	0.911	0.912	0.958	0.697	0.914	0.822	0.914	n.a.	n.a.
Sugar beets	0.741	0.712	0.885	0.825	0.798	0.777	0.718	0.766	0.645	0.649
Wheat	0.661	0.811	0.907	0.910	0.619	0.844	0.723	0.841	0.537	0.727

n.a. Not applicable.
Source: Authors' calculations, based on data from Herlihy and others (1989).

ment of technical change, if this is the source of the shock—rather than delay the process through taxation. This is certainly a very general statement, and it has to be properly interpreted when it comes to a particular policy; however, it is mentioned here in order to place possible implications of the analysis within a broader framework.

Appendix. A Summary of the Formal Relations between the Various Estimators

The analysis in the text differs somewhat from more familiar forms of panel data analysis. It is therefore useful to evaluate the results within a uniform framework. Let W, $B(i)$, $W(i)$, and $W(it)$ be projection (symmetric and idempotent) matrixes that generate residuals. They can be defined in terms of their operation on an arbitrary vector, x, of order IT: $Wx = (x_{it} - x_{..})$, $B(i)x = (x_{i.} - x_{..})$, $B(t)x = (x_{.t} - x_{..})$, $W(i)x = (x_{it} - x_{i.})$, $W(t)x = (x_{it} - x_{.t})$, and $W(it)x = (x_{it} - x_{i.} - x_{.t} + x_{..})$.

The parentheses contain the typical elements of the vectors in question. The following identities can then be derived.

$$W = W(i) + B(i) \tag{A-1}$$

$$= W(t) + B(t) \tag{A-2}$$

$$= W(i) + W(t) - W(it) \tag{A-3}$$

$$= B(i) + B(t) + W(it). \tag{A-4}$$

Table 7. *(continued)*

Ireland		*Italy*		*Netherlands*		*United Kingdom*		*All countries*	
Elasticity, b	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2	*Elasticity, b*	R^2
0.878	0.887	0.718	0.865	0.762	0.916	0.869	0.870	0.769	0.774
n.a.	n.a.	0.654	0.843	0.880	0.804	1.072	0.883	0.786	0.733
1.105	0.949	0.873	0.966	0.911	0.928	1.023	0.943	0.974	0.849
n.a.	n.a.	0.837	0.343	1.040	0.976	1.116	0.900	0.980	0.671
0.785	0.883	0.548	0.793	0.762	0.874	0.634	0.612	0.779	0.633
n.a.	n.a.	0.854	0.866	n.a.	n.a.	n.a.	n.a.	0.769	0.851
1.551	0.974	1.393	0.903	1.312	0.910	1.173	0.972	1.294	0.818
0.845	0.868	0.773	0.878	0.719	0.924	0.819	0.898	0.794	0.801
0.767	0.898	0.642	0.908	0.733	0.933	0.735	0.892	0.718	0.860
0.748	0.669	0.534	0.840	0.937	0.946	0.913	0.727	0.770	0.680
1.018	0.718	0.950	0.733	1.016	0.757	0.923	0.719	0.961	0.641
n.a.	n.a.	0.624	0.807	0.773	0.915	1.052	0.886	0.848	0.790
n.a.	n.a.	0.774	0.703	0.790	0.744	0.795	0.562	0.818	0.785
0.698	0.811	0.637	0.827	0.674	0.833	0.898	0.885	0.768	0.688

If p and p^* are the vectors of the two prices, then the regression coefficients of p or p^* can be presented in terms of $a = p^*Ap/p^*Ap^*$. When $A = W, B(i), B(t)$, the resulting estimators are b (pooled), $b(i)$ (between commodity), and $b(t)$ (between time), respectively. Also, when $A = W(i)$, $W(t)$, and $W(it)$, the coefficients are referred to as within commodity ($w[i]$), within time ($w[t]$), and within time and commodity $w([it])$, respectively.

We can then decompose the pooled regression coefficient:

$$\text{(A-5)} \qquad \begin{aligned} b &= p^*Wp/p^*Wp^* \\ &= \theta w(i) + (1-\theta)b(i) \end{aligned}$$

where $\theta = p^*W(i)p^*/p^*Wp^*$ is the ratio of the within-commodity sum of squares and the total sums of squares, and the complement is a similar ratio for the between-commodity sum of squares. Table 5 presents a decomposition of the sum of squares of p^* by sources. Because p^* is the world price, the sums of squares should be the same for all countries. However, the set of commodities analyzed varies somewhat among countries, and therefore the numbers in the table differ accordingly. It is clear that the variations among commodities are greater by far than the variations over time; therefore, the pooled regression is closer to the between-commodity regression. A similar comparison can be made for the other estimators. Also, the results are easily generalized to multiple regressions, where the weights will be matrix, rather than scalar, weights (Mundlak 1978).

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