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Aggregate Import Demand and Elasticities of The Major Oil-Exporting Countries

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This paper estimates aggregate import demand elasticities for five major oil-exporting countries for the period 1960-1982. The results are consistent across the five countries with regard to the income-elasticty of demand. Real GDP is positively associated with import demand in all five countries, with an average elasticity of approximately 1.5. Somewhat less consistent results are obtained for the importance of relative prices or separately, the import and domestic price indices, in determining import demand. Nevertheless, there is strong statistical evidence that relative prices influence real imports in Saudi Arabia, Mexico, and Venezuala, with price-elastic demand for the first two, and price inelastic demand for the latter.

I. Introduction

The purpose of this paper is to present estimates of import demand and the income and price elasticities of demand for the aggregate imports of some major oil-exporting nations. Much of the recent literature on this topic has been limited to the determination of import elasticities for the United States and the other industrialized countries. To the authors' knowledge, there has been no similar research to date on this topic for the developing oil-exporting nations.

As the world economy has become more interdependent and as the oil revenues and incomes of these oil-exporting countries have increased rapidly, these countries have become major growing markets for the exports of the industrialized world. It is, therefore, both useful and important for analyzing the trade performance of the developed economies to determine how these dynamic import markets respond to unstable prices and large

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changes in income.

The traditional determinants of import demand should be applicable to the oil-exporting countries. These import markets, however, may be affected strongly by structural changes in their economies and their dependency on fluctuating international reserves. Specifically, in this paper, the demand for real imports is expressed as a function of real income, an import price index to the domestic price index ratio as a relative price variable, and the country's international reserve position. In addition to these, dummy and interaction variables are included in the demand functions to examine and adjust for possible structural change due to the effect of the quadrupling of oil prices in 1973.

For the analysis, we examine the aggregate import demand function for five of the largest oil exporters in the developing world : Saudi Arabia, Mexico (the only non-OPEC exporter in the group) , Nigeria, Venezuela, and Indonesia. All these countries have also been among the largest importers in the so-called "Third World." Our import demand function and its variants are estimated for the period 1960-1982, using annual time series data for each country, which is available from international sources.

With the recent slowdown of global inflation and the decline of oil prices and revenues, it is particularly useful at this time to analyze the income and price elasticities of import demand in oil-exporting developing countries. This analysis may not only be valuable in explaining the responsiveness of these import markets to economic changes but also in projecting the effect of these changes on future levels of trade between the industrial countries and the major oil-exporters. It is necessary that trade policy-makers and economists on both sides of the market understand more completely the magnitude of the determinants and elasticities of import demand in the oil-exporting, developing countries. This paper is a first attempt to contribute to that important objective.

II. Methodology and Data

Various import demand functions are constructed which incorporate the independent variables that are traditionally associated with the demand for real imports such as the real GDP and the relative price index. Also, the functions are specified to include, as explanatory variables, international reserves, an intercept-shifting dummy, and a slope adjusting interaction variable for the quadrupling of oil prices by OPEC in 1973. The relative price variable, the import price index divided by the domestic price index, has been questioned in recent studies, for it constrains the influence of the two price variables to be equal in magnitude but opposite in sign (Murray and Ginman, 1976). Following the procedure of Warner and Kreinin (1983), the import demand function

is estimated in a second specification where the import price and domestic price indices are separated and their individual coefficients examined.

All the variables are expressed in logarithms with the exception of the dummy and the interaction variables so that the resulting parameters can be interpreted as elasticities. The demand equations are estimated through standard multiple regression procedures that adjust for autocorrelation of the first order in the disturbance term. Lagged variables of the independent variables are examined where theoretically appropriate. The regression estimates are evaluated and interpreted in the text of the paper.

The principal data analyzed is for the period 1960 to 1982 in annual terms and is essentially based on published data in the IMF *International Financial Statistics* with all values converted to domestic currency units and expressed in real (1975) terms. The exception is the international reserves position variable which is typically measured for all countries in dollars. It is expressed in real terms to measure the purchasing power of a country's reserves, by deflating with the export price index of the OECD countries, available from OECD, *National Accounts Statistics*.

III. The Import Demand Model

The basic import demand model specified and estimated in this paper is as follows:

$$RIMP = C + a_1\, RPI + a_2\, GDP + a_3\, TR_{-1} + a_4\, DUM + a_5\, DGDP + U$$

The variables are expressed in logarithms and real values (base 1975), with the exceptions of the dummy and interaction variables and defined as follows:

- *RIMP* – the annual real imports of each country measured in millions of local currency units
- *RPI* – the relative price index measured as the ratio of the import unit value index (IPI) divided by the domestic price index (DPI) for each country
- *GDP* – annual real gross domestic product of each country in millions of local currency units
- TR_{-1} – lagged annual total reserves of each country deflated by the exprot price index of the OECD countries
- *DUM* – a dummy intercept–shifting variable which represents the immediate, once –and–for–all impact of the quadrupling of oil prices in 1973. DUM is equal to 0 for the period 1960–1972 and equal to 1 for 1973–1982.

DGDP – a slope shifting interaction variable equal to DUM x GDP

U – random term

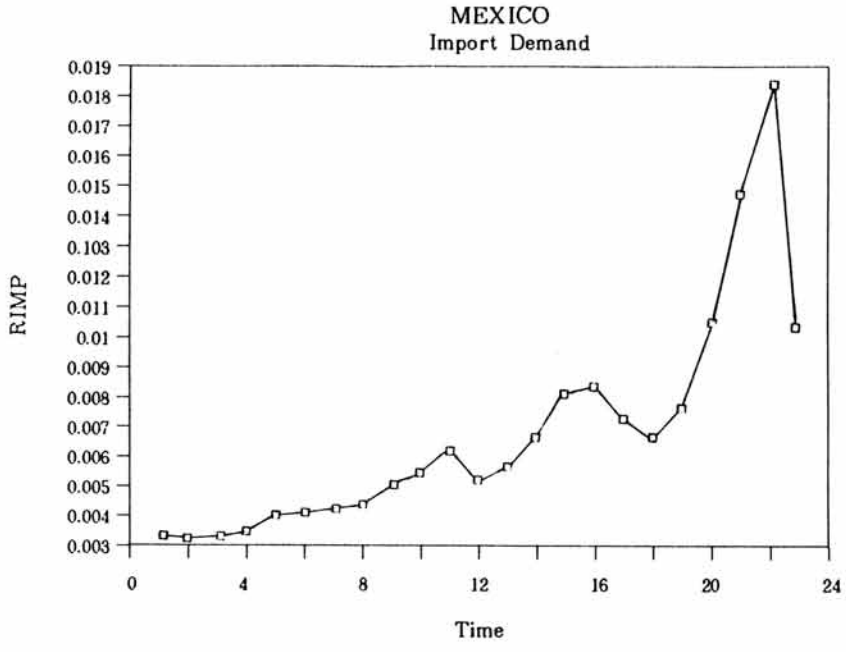
To test more completely the effect of domestic and import prices on demand for real imports, the basic model was respecified to examine separately these price effects. All variables in the model are defined as before with the exception of RPI. RPI is deleted and the import price index (IPI) and domestic price index (DPI) are included separately in the model. Because the import unit value and domestic price indices are constructed differently, with different formulas and similar but not identical composition, and because it is unlikely that their effect on real imports will be of the same order of magnitude, this new specification may be instructive.

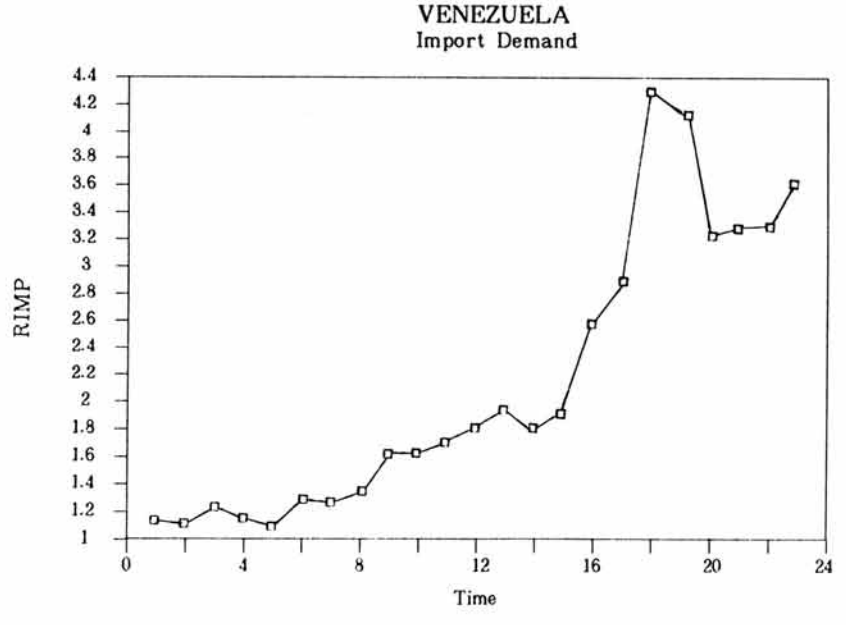
The variables were selected and measured on the basis of theoretical justification and on the availability of a consistent time series for each of the five countries examined. A one year lag structure for the independent variables was also tested, examining the possible responsiveness of current real imports to recent income levels, to prices contracted months prior to delivery data, and to the total reserve position at the end of the previous year. Only in the case of total reserves and only for three of the countries (Venezuela, Saudi Arabia, and Nigeria) did a lagged value appear significant. Therefore, the results presented in Tables I and II report equations for the model specified earlier in which only the total reserve variable is lagged.

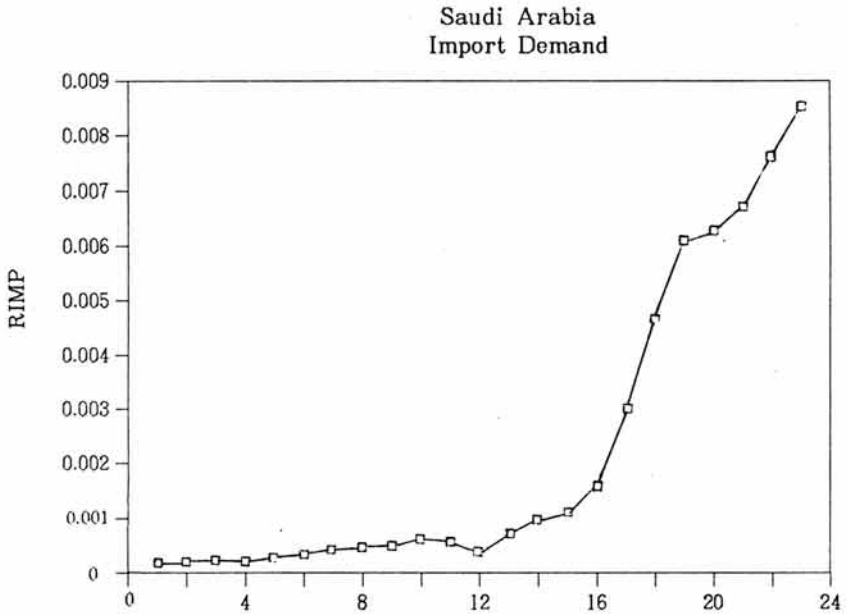
A close examination of the data (see Figure 1) reveals a possible structural break around 1973. Our assumption is that after the oil embargo and quadrupling of oil prices which occurred in 1973, the real imports of these countries were fundamentally altered in magnitude. In order to examine and accommodate for a possible structural change, we introduce into the model an intercept–shifting dummy and a slope–shifting interaction variable. The dummy (DUM) takes the value of 0 for 1960–1972 and the value 1 for the second period 1973–1982. The inclusion of the dummy variable allows the regression to change intercept from one period to the other. The value of its coefficient estimates the change in the intercept. The interaction variable introduced into the equations allows the regression line to change slope from one period to the other. The coefficient of the interaction variable estimates the difference in coefficients of the income variable between the two periods.

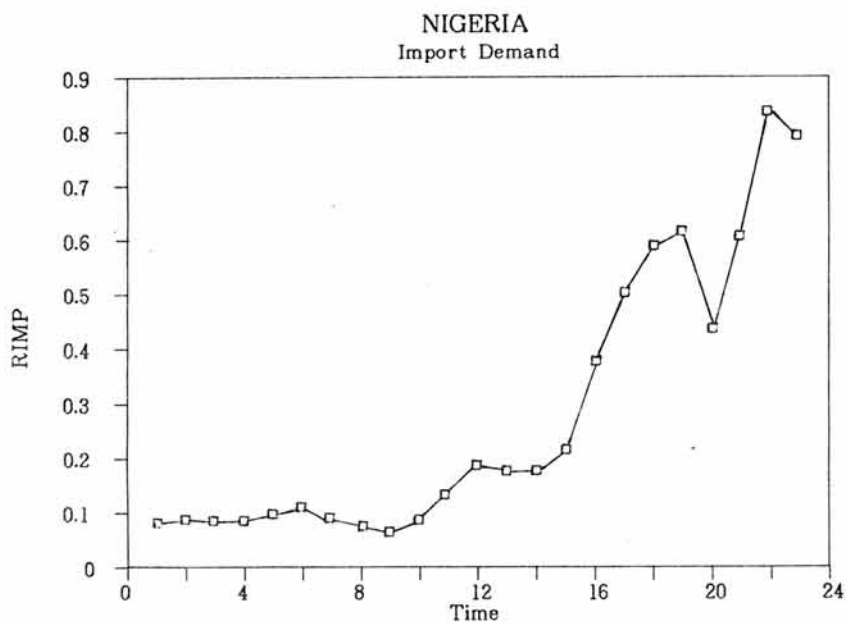
The theoretical expectation is for a positive sign for the coefficients of GDP and TR_{-1}. The coefficient of RPI is expected to be negative, however, when the import price index and domestic price index are entered separately in the respecified model, the expected sign is negative for the former and positive for the latter. The expected joint effect from the inclusion of the intercept shifting dummy and the slope adjusting interaction

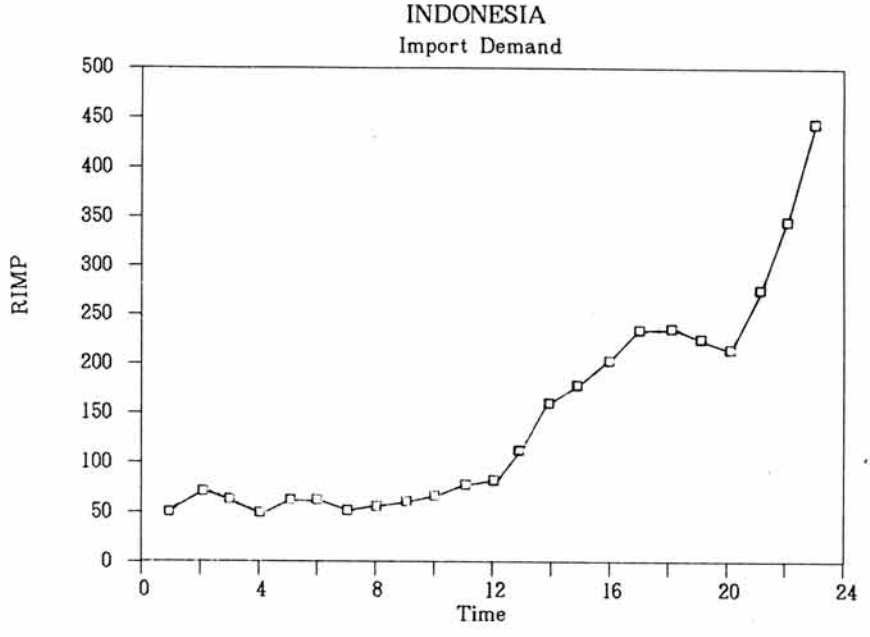
Figure 1


MEXICO
Import Demand
RIMP
0.019
0.018
0.017
0.016
0.015
0.014
0.103
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0
4
8
12
16
20
24
Time


VENEZUELA
Import Demand
RIMP
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0
4
8
12
16
20
24
Time


Saudi Arabia
Import Demand
RIMP
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
4
8
12
16
20
24


NIGERIA
Import Demand
RIMP
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
4
8
12
16
20
24
Time



term is to raise real imports since real import demand should be positively related to the current and expected stream of export earnings and income, which may have been altered fundamentally by the quadrupling of oil prices in 1973 for the five countries in our study.

IV. Empirical Results

The basic model and the respecified model and their variants are estimated using the time series annual data, 1960−82, for the five major oil exporting countries (Saudi Arabia, Mexico, Venezuela, Nigeria and Indonesia). Because the initial ordinary−least squares regressions indicated some serial correlation in the residuals based on Durbin−Watson statistics, we employed the maximum likelihood procedure.[1] Tables I and II, respectively, present the regression results of both the models.

1.These estimation procedures are carried out using TSP (Time Series Processor)

TABLE 1

Import Demand Functions – Major Oil Exporting Countries
1960–1982 – With Relative Price Index

Country	C	RPI	GDP	TR_{-1}	DUM	DGDP	R^2	F–Stat	D.W.
Mexico	−7.70	−1.35	0.62	0.062	−14.77	1.09	0.970	93.7	1.80
	(−3.15)*	(−5.29)*	(3.76)*	(0.344)	(−4.30)*	(4.33)*			
Venezuela	−8.23	−0.404	0.844	0.28	−9.98	0.854	0.965	82.4	1.83
	(−3.84)*	(−1.92)*	(4.24)*	(2.85)*	(−2.32)*	(2.30)*			
Saudi	−12.44	−0.47	0.567	0.292	−25.90	2.21	0.989	267.5	1.86
Arabia	(−4.64)*	(−1.98)*	(2.68)*	(2.38)*	(−7.57)*	(7.47)*			
Nigeria	−3.32	−1.31	0.755	0.165	−0.562	0.733	0.981	155.3	1.73
	(−1.01)	(−4.95)*	(2.80)*	(3.35)*	(−0.081)	(0.11)			
Indonesia	−15.42	−0.026	1.25	0.02	0.127	0.0001	0.956	65.8	1.72
	(−1.54)	(−0.20)	(2.10)*	(0.41)	(0.331)	(0.33)			

The dependent variable in all equations is the log of the annual real imports in local currency.
All the predetermined variables are the logarithmic values except the dummy variable.
t–ratios are in parentheses.
*Significant at the 5% level.

TABLE 2

Import Demand Functions – Major Oil Exporting Countries –
With Separate Domestic and Import Prices

Country	C	IPI	DPI	GDP	TR_{-1}	DUM	DGDP	R^2	F–Stat	D.W.
Mexico	−11.20	−0.912	0.082	0.942	0.276	−44.00	3.21	0.997	601.2	2.52
	(−7.76)*	(−5.32)*	(0.33)	(9.08)*	(2.74)*	(−7.93)*	(7.96)*			
Venezuela	−9.41	−0.826	0.179	1.38	0.145	−23.50	2.04	0.994	345.1	2.62
	(−9.02)*	(−5.61)*	(1.35)	(10.43)*	(2.29)*	(−6.67)	(6.64)*			
Saudi	−2.69	−1.76	−0.079	0.863	0.426	−45.50	3.88	0.992	248.3	2.00
Arabia	(−0.46)	(−2.13)*	(−0.16)	(3.65)*	(3.34)*	(−4.28)	(4.25)*			
Nigeria	−9.65	−0.43	0.978	0.75	0.172	3.04	−0.311	0.980	98.6	1.73
	(−1.34)	(−0.46)	(2.29)*	(2.71)*	(3.43)*	(0.38)	(−0.38)			
Indonesia	−33.40	−0.633	−0.044	2.71	0.027	0.206	0.00005	0.981	104.3	1.85
	(−2.78)*	(−2.07)*	(−0.41)	(3.18)*	(0.62)	(0.68)	(0.15)			

The dependent variable in all equations is the log of the annual real imports in local currency.
All the predetermined variables are the logarithmic values except the dummy variable.
t–ratios are in parentheses.
*Significant at the 5% level.

In the interest of space and brevity, not all results are reported. A criterion in reporting the regression results was that common equations be examined and compared for each of the five countries studied, which include specifications of the price variables as either the relative price ratio or separate import and domestic price indices.

Most variables in our equations have the theoretically expected sign and the explanatory power of the equation is high. The other regression tests are acceptable in most cases. Good results were obtained for three of the countries studied (Mexico, Venezuela, and Saudi Arabia). The results are satisfactory for Nigeria but are inconclusive for Indonesia. The coefficients of the price and income variables are generally significant, and correctly signed for all countries.

If we examine the results across countries for each of the independent variables traditionally associated with import demand, the results are interesting and have important implications for both the importing and exporting countries. Real GDP has a significant and positive coefficient for every country and in all equations estimated. Income elasticity varies from an estimate of 0.57 for Saudi Arabia to about 1.25 for Indonesia. Specifically, import demand appears to be slightly income inelastic overall with an average elasticity of approximately 0.82 for the five countries, when the effect of structural change on the income variable is not inclued. This indicates that a percentage increase in income will increase imports by about 0.82 percentage points. However, in order to include the long-term possible effect of structural change on real import demand, the coefficient estimate of the interaction variable, DGDP, has to be considered in the interpretation of income elasticity. This interaction variable measures the incremental effect of changes in income on real imports after the structural break of 1973. In order to obtain a precise estimate of income elasticity after 1973, the coefficient of the interaction variable, when significant, should be added to the coefficient of the income variable in each equation to capture any adjustment in the slope of the import demand function. This generates a range of import income elasticity from 1.71 for Mexico to 2.78 for Saudi Arabia. In the case of Nigeria and Indonesia, there is no statistical evidence of structural change since the interaction variable coefficient is insignificant. Therefore, for the three largest oil exporters, it appears that real import demand is highly income elastic since 1973.

Our conclusion of income elastic-import demand has serious implications for both the countries of this study and their principal suppliers. The recent slowdown in the economic growth of the oil-exporting countries, due to a combination of declining oil revenues and foreign debt servicing problems, are likely to reduce the growth of import demand significantly. The exporters of the industrial countries may experience substantial

reduction in their exports to the oil-exporting nations if their real income stagnates or declines. Therefore, stability in the global oil markets and workable solutions to the debt-servicing problems of the countries in the study (with the exception of Saudi Arabia) are crucial to the trade and economic recovery prospects of many exporting industries in the industrialized world.

Our results on the relative price elasticity coefficient are mixed. The coefficient of the relative price is significant and correctly signed (negative) for Mexico, Venezuela, and Nigeria. However, for Saudi Arabia and Indonesia, although correctly signed, it is insignificant. For Mexico and Nigeria, price elasticities are −1.35 and −1.31 which are price-elastic. For Venezuela import demand appears price-inelastic with a coefficient of −0.40. Thus, these countries' imports are sensitive to changes in relative prices as trade theory predicts, but for Saudi arabia and Indonesia, this is not supported in our statistical results. These varying results may reflect differences in the composition of aggregate imports and in the definition and construction of the domestic price indices, and unique institutional and market factors in these countries which differentiate them from each other. The respecified model, whose results are presented in Table Ⅱ, provides an analysis of the relationship of real imports to separate indices of import and domestic prices, which may be informative, particularly for Saudi Arabia and Indonesia.

The results of our models estimated were mixed regarding the role of lagged international reserves in import demand. The coefficient of lagged reserves is significant and correctly (positively) signed for Venezuela, Saudi Arabia, and Nigeria. These economies for internal reasons may be particularly dependent upon the availability of international reserves to finance their imports. There is no statistical evidence that this is the case for Mexico and Indonesia.

The intercept-shifting dummy variable does have a significant and nagative coefficient for the three largest oil-exporting countries in our basic model, Mexico, Venezuela and Saudi Arabia, but was insignificant in all regressions for Nigeria and Indonesia. The negative coefficient, at first glance, appears to contradict the conventional, popular argument that the import demand function of oil exporting countries was shifted up in 1973 by the quadrupling of oil prices. However, an intercept-shifting dummy presumes an immediate once-and-for-all autonomous effect. It may be the case that the 1973 oil embargo and the quadrupling of oil prices generated a negative autonomous impact on the level of trade because of the Western political reaction to the 1973 events and the trade disruption and uncertainty created. For Nigeria and Indonesia, the effect of the cartelization of the oil market may have had more gradual, continuing effect on import demand in these two countries and not any significant autonomous effect. An interaction slope-shifting term is more appropriate than an intercept-shifting dummy

to test this hypothesis. We, therefore, include in our model such an interacion variable.

For Mexico, Venezuela, and Saudi Arabia, the coefficient of our interaction variable is significant and positive. It is, however, insignificant for Nigeria and Indonesia. Our conclusions regarding OPEC-induced structural change in real import demand were generally verified by our use of the Chow stability test for sub-period analysis for each country. It appears that the overall effect over time of the 1973 events increased the slope significantly of the real import demand function of the three largest oil-exporters. In economic terms, sine 1973, the incomes of these countries grew substantially, increasing the growth of real imports as expected. However, there is no statistical evidence that this shift has occurred for real import demand in Nigeria and Indonesia. These countries may not have experienced significant structural change in their economies since 1973, given their smaller economic size and oil sector and their unique political environment. Furthermore, it is possible that much of the effect of the 1973 oil price adjustment influenced import demand through its effect on the other variables in our model for these two countries. If the 1973 oil price quadrupling effected real import demand in some oil-exporting countries, it is likely that the subsequent doubling of oil prices in 1979 may also have influenced oil import demand functions of these countries. However, given the limited sample observations beyond 1979 it is not really possible to conduct a satisfactory formal Chow test for stability.[2] In any case, the effects of the 1979 price increase would have, reinforced and maintained the effects of the 1973 price increase on real import demand.

Finally, the results based on our respecified model with separate import and domestic price variables do not alter significantly the conclusions reached earlier regarding the income, total reserves, intercept-shifting dummy and slope-shifting interaction variables. Import demand remains highly income-elastic. With our reformulation of the price variable, the results in Table II indicate that with the exception of Nigeria the domestic price indices are insignificant, although correctly signed. This may be due to the composition of real imports, essentially capital and luxury goods that are not produced domestically, and to the use of an aggregate domestic price index. Regarding the import price index, its coefficient is significant and correctly (negatively) signed for all countries except Nigeria. The estimate of this price elasticity varies from -0.633 to -1.76, with an average of -1.04. In the case of Nigeria, however, the results are perplexing with respect to the two price indices. The domestic price index coefficient is significant while the import price index coefficient is insignificant, although both

2. A close examination of the real import demand graphs indicates some possible shift in the import demand around 1979 may have occurred.

are correctly signed. It appears that Nigeria, in some unspecified way, is structurally unique with regard to the relationship of prices to aggregate real imports. Further research on disaggregated import demand, given sufficient data, may be more conclusive for Nigeria.

V. Summary and Conclusion

This paper estimates aggregate import demand elasticities for five major oil-exporting countries for the period 1960-1982. The regression results are generally good and conclusive. The results are consistent across the five countries with regard to the income-elasticity of demand. Real GDP is positively associated with import demand in all five countries, with an average elasticity of approximately 0.82 before 1973 and about 1.63 since 1973. Obviously, import demand of these oil exporting countries has become highly income elastic since 1973. Similar empirical findings resulted from the model estimated with separate price indices. This suggests that a stagnation or decline in real income of the oil-exporting countries has serious ramifications for their major suppliers in the industrial countries. Therefore, approaches to the debt servicing problems and economic stagnation in Mexico, Venezuela, Nigeria, and Indonesia, and to the slowdown of economic growth in Saudi Arabia, which generate a return to stable growth patterns is in the interests of policy-makers in the industrialized countries as well as the oil-exporting countries.

Somewhat less consistent results are obtained for the importance of relative prices or separately the import and domestic price indices in determining import demand. Nevertheless, there is strong statistical evidence that relative prices negatively influence real imports in Mexico, Venezuela, and Nigeria with price-elastic demand for Mexico and Nigeria, and price-inelastic for Venezuela. It appears import markets in these three countries are responsive to market signals, while for Saudi Arabia and Indonesia, relative prices do not significantly affect import demand. When relative price is separated into its component indices, for Mexico, Venezuela, Saudi Arabia, and Indonesia the results are consistent. The import price index coefficient is significant and correctly signed with an average price elasticity of -1.04, while the domestic price index is insignificant throughout. Surprisingly, the results in the case of Nigeria for the price indices are the opposite for unspecified reasons and merit further analysis.

Despite some uncertainty, our results may have major implications for pricing policy in industrial countries. This study generally suggests that oil-exporting countries are likely to have, on the average, unitary price elasticity of demand for aggregate imports. But elasticity differs greatly from country to country. For Nigeria and Mexico, import

demand appears to be relative price−elastic, relative price−inelastic for Venezuela, and for Saudi Arabia and Indonesia, relative price appears not to matter at all. The results for the separate import price indices indicate import price−elastic demand for Saudi Arabia, and slightly import price−inelastic demand for the others.

The responsiveness of import demand to lagged total reserves is generally verified by this study. Lagged reserves seem positively associated with imports for all countries, with the exception of Indonesia. The intercept−shifting dummy for the quadrupling of oil prices in 1973 has a significant negative coefficient in the estimates, except for Nigeria and Indonesia, suggesting an immediate and autonomous negative impact on import demand. Finally, as discusseed earlier, the slope−shifting interaction variable introduced into the model statistically verifies a possible shift in the growth rate of import demand of Mexico, Saudi Arabia, and Venezuela since 1973. The coefficient of the interaction variable, DGDP, raised the slope of import demand function and increased the income elasticity for these countries.

Obviously, further work must be done on the analysis of import demand functions in developing oil−exporting countries. It may be useful to examine a number of alternatives such as differential lag structures for the independent variables, disaggregating, including multiple slope shifting interaction variables, and respecifying the model to consider simultaneity and other issues. However, this paper does provide strong evidence that aggregate import demand is highly income−elastic in the larger oil−exporting countries while price elasticity for aggregate imports varies from country to country. The finding of a highly income elastic import demand has important implication for the export policies of the industrialized countries. As OPEC oil revenues and incomes decline or stagnate, exports to these countries are likely to diminish more than proportionally. For the industrialized nations, new aggressive export strategies will need to be devised and new product markets developed in the oil exporting countries in order to maintain exports and prevent a possible rapid decline through the remainder of the Eighties.

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