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ARDL Approach to the Demand for Disaggregate Imports: the case of Iran

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Abstract

In this article, demand equations for import of consumer, intermediate and capital goods, for the period ۱۹۷۱(۲) to ۱۹۹۹(۱), is estimated and analyzed, using the ARDL Pesaran & Shin method. The results show that the behavior of the different categories of imported goods in Iran is best explained by the parallel market exchange rate, implying this rate is a closer approximation for the opportunity cost of importers, despite their access to foreign exchange at official or controlled rates.

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۱- Introduction

In this article, model of demand for import of consumer, intermediate and capital goods based on ARDL Pesaran & Shin method will be estimated and analyzed, with the quarterly data for the period ۱۹۷۱:۲-۱۹۹۹:۱. Methodological considerations will be explained in the specification of the import demand functions and the variables which should have been included theoretically and the different ways of their measurement will be discussed. Then with the specification of empirical model of response of import to the determinant factors, long run and short run models will be estimated and analyzed. The conclusions will be useful for the conditional forecasts of fluctuations of those goods groups and the design, implementation and evaluation of macroeconomic policies.

Import goods are classified into three groups of consumer, intermediate and capital goods. Since behavior of demand of import and also supply of exports in the different groups of goods is different, estimations of aggregate import and export can be misguided as a matter of policy making which is known as aggregation bias in econometrics terminology.

The effect of three important relative price indices, constructed by using the parallel market exchange rate, weighted exchange rate and import prices of the different groups of imported and exported goods, will be compared. We will see that the behavior of different groups of imported goods in Iran has been based on the parallel market exchange rate, thus rendering the mentioned rate a closer approximation for the opportunity cost of imported goods.

The second section will handle the econometrics theory of the model and illustrate the ARDL Pesaran & Shin approach for the cointegration analysis. In the third section the trend of the share of different groups of goods during the sample period will be studied. The fourth section will explain the theoretical basis of the model (demand for imports and supply

of exports). The model of long run and short run demand for imports will be estimated and analyzed, using appropriate criteria for each variable in the different groups. Each one of these models has been estimated with three variables, namely the parallel market exchange rate, the weighted market exchange rate, and wholesale price index of imports. The importance of each variable for explaining fluctuations (long run & short run) of trading flows will be evaluated. In the ٦th section conclusions will be drawn from the above noted discussions.

۲- Basic econometrics of the model

We employ the single equation procedure advanced by Pesaran and Shin (۱۹۹۸) and Pesaran et al. (۱۹۹٦), which allows for a mix of I(۱) and I(۰) variables in the same cointegration equation.
In this method each trading equation is specified as follows:

$$\Phi(L,P)y_t = \sum_{i=1}^{k}\beta_i(L,q_i)x_{it} + \delta w_t + u_t$$

$$\Phi(L,P) = 1 - \Phi_1 L - \Phi_2 L^2 - \Phi_p L^p \qquad (۱)$$

$$\beta_i(L,s) = \beta_{i0} + \beta_{i1}L + \ldots + \beta_{is}L^s$$

$$u_t \sim iid(0,^2)$$

in which y_t reflects the trading flow (group of import goods) and x_{it} the determinant factors of trading flow including relative prices and income. w_t is a deterministic variables vector like constant term, time trend and exogenous variables with fixed lags. In the ARDL method the model (۱) is estimated for different values p = ۰،۱،۲, … , m and q_i = ۰, ۱, ۲ , … m , i = ۱،۲,...,k namely a total of $(m+۱)^{k+۱}$ different ARDL models. The maximum lag , m , is chosen by the user , and all the models are estimated on the same sample period, namely t=m+۱ , m+۲ ,… , n.

m is selected four in this study as we use quarterly data. In order to identify the true lag (p,q) for each variable one of the criteria of model selection like adjusted $R^{٢}$,the Akaike information criterion(AIC), Schwarz Bayesian criterion(SBC), or the hannan-quinn criterion (HHQ) can be used. This study has used the SBC criterion, which gives the highest priority to parsimony of the model with respect to the fitness. The long run coefficients or elasticities for the response of Yt to a unit change in Xit are estimated by:

$$\hat{\alpha}_i = \frac{\hat{\beta}_i(1,\hat{q}_i)}{\hat{\Phi}(1,\hat{p})}$$

where $\hat{P}$ and ($\hat{q}_i$ ١, … k) are the selected (estimated) values of p and $q_{i,}$,i=١،٢،٣,…,k. Similarly the long run coefficients associated with the deterministic or exogenous variables w_t are estimated by:

$$\hat{\psi} = \frac{\hat{\delta}(\hat{p},\hat{q}_1,\hat{q}_2,...,,\hat{q}_k}{1-\hat{\Phi}_1-\hat{\Phi}_2-...-\hat{\Phi}_p}$$

the estimates of the asymptotic standard error of $\hat{\alpha}_1,\hat{\Theta}_2,...,\hat{\Theta}_k$ and $\hat{\psi}$ are computed using the Bewley's regression approach.

The error correction model associated with the ARDL model can be obtained through reparametrization of equation (١) in terms of the lagged levels and the first difference of y_t , Xit and w_t as follows:

$$\Delta y_t = -\Phi(1,\hat{p})Ec_{t-1} + \sum_{i=1}^{k}\beta_{10}\,\Delta x_{it} + \delta'\Delta w_t - \sum_{j=1}^{p-1}\Phi_i^{*}\,\Delta y_{t-i} - \sum_{i=1}^{k}\sum_{j=1}^{q_i-1}\beta_{ij}^{*}\,\Delta x_{i,t-j} + u_t \qquad (٢)$$

in which the correction term is defined as follows:

$$EC_t = y_t - -\sum_{i=1}^{k}\Theta_i x_{it} - \psi w_t$$

The term $\Phi(1,\hat{p})$ measures the importance of the coefficient of error correction term. The rest of the coefficients β_{ij}^{*} , Φ_{j}^{*} relate to the short run dynamics and the model convergence to equilibrium.
The short run equation can be simplified as follows:

$$\Delta y_t = \sum_{i=1}^{k} \alpha_i \Delta x_{it} + \alpha_0 \Delta w_t - \Phi_0 EC_{t-1} \qquad (۳)$$

in which:

$$\alpha_i = \frac{\sum_{i=0}^{q_i-1} \beta_{ij}}{1+\sum_{j=1}^{p-1} \Phi_j^{*}}$$

$$\alpha_0 = \frac{\delta}{1+\sum_{j=1}^{p-1} \Phi_j^{*}}$$

$$\Phi_0 = \frac{\Phi(1,p)}{1+\sum_{j=1}^{p-1} \Phi_j^{*}}$$

In fact equation ۳ can be viewed as another illustration of the short run model for all three categories of goods.
In summary, the ARDL procedure involves two stages. At the first stage, cointegeration implying existence of a long run equilibrium relation between the variables of the model is tested. In case such a long run relation exists, the resultant residual term will be stationary even if some of the variables are non-stationary and integrated of degree one. In this

$$\hat{\Theta}_i = \frac{\hat{\beta}_i(1,\hat{q}_i)}{\hat{\Phi}(1,\hat{p})}$$

case consistent and efficient estimations can be calculated from import elasticities with respect to price and scale variables. The existence of the long-run relation between the variables under investigation is tested by computing the F-statistic for testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. However, the (asymptotic) distribution of this F-statistics is non-standard, irrespective of whether the regressors are I(۱) or I(۰). Pesaran et al. (۱۹۹٦) have tabulated the appropriate critical values for different numbers of regressors (k), and whether the ARDL model contains an intercept and/or trend. They give two sets of critical values. One set assuming that all the variables are I(۱). For each application, this provides a band covering all the possible classifications of variables into I(۱) and I(۱), or even fractionally integrated ones. If the computed F-statistic falls outside this band, a conclusive decision can be made without needing to know whether the underlying variables are I(۰) or I(۱), or fractionally integrated. If the computed statistic falls within the critical value band, the result of the inference is inconclusive and depends on whether the underlying variables are I(۱) or I(۰). It is at this stage in the analysis that the investigator may have to carry out uniy root tests on the variables. Once the existence of one cointegerating vector is established, consistent estimations of long run elasticities will be obtained in the same framework. As it was described before, such estimates can be obtained from auto-regressive distributed lag (ARDL) regression based on levels of variables. Once orthogonalization between the residual term and the right-hand side variables is achieved (by including a sufficient number of auto-regressives), and residuals appear to be serially uncorrelated, one can use standard tests to establish the statistical significance of coefficients.

After estimating a set of long run elasticities or coefficients, the second step of analysis of cointegeration consists of modeling underlying short

run dynamics leading to the long run level equilibrium equation. As shown by Engel and Granger (۱۹۸۷), existence of a long run equilibrium relationship among a set of variables implies at least one error correction equation, which shows how endogenous variables adjust to return to long run equilibrium. The statistical inferences on coefficients in the second step are valid and have asymptotic efficiency.

۳- Trends of share of consumer, intermediate and capital imports during the sample period

In this study, imports are classified into ۳ groups: consumer, intermediate and capital goods. The share of each group in total imports during the sample period (۱۹۶۳-۹۸) is demonstrated in the graph (۱). As can be seen, the share of intermediate goods is more than the share of capital and consumer goods in all of the periods because of import substitution industrialization policy. This share fluctuates from a low of ٤٤٪ in ۱۹۹۸ to a high of ٦۹٪ in ۱۹۹٥. Following the development of basic industry in the first and second plans, the share of intermediate imports has started to decrease from ۱۹۹٦ and at the end of the period reaches ٤٤٪ (to the profit of capital goods) which reflects the country's changing industrial structure.

After intermediate goods, capita goods with an average share of ۲٥٪ in the sample period account for the second highest share of total imports. The share of capital imports after the revolution decreased substantially up to ۱۹۸۱ when it reached ۱٦٪, mostly due to decrease of capital imports in the mining and industrial sectors. But after that the mentioned share gradually increased and in ۱۹۸٤ reached ۲۷٪ and stabilized around ۲۳٪ for the period ۱۹۸٥-۹۰. Share of capital imports in the year ۱۹۹۱ increased to maximum ۳۳٪, due to entry of foreign capital and the start of the reconstruction period. This share declined to ۱٥٪ in ۱۹۹٥ because of critical foreign exchange conditions and debt repayments. Then from the

year ١٩٩٦ an upward trend started reaching ٤٢٪ by the end of the period (١٩٩٨). The increase of this share simultaneously with a decrease of the intermediate goods share due to foreign exchange constraints of ١٩٩٨ indicate a basic revolution in the productive structure of the country in the direction of decreased dependency on imports of intermediate goods.

Graph ١ relative share of different group of import goods

Consumer goods have the least share with the average of ٢٥٪ of imports, which shows that the productive structure of the country is based on importing capital and intermediate goods in order to produce consumer

goods. Until the year ۱۹۸۰ we see a growing trend of the share of consumer goods due to introduction of new consumer goods to Iran's market, specifically after the oil shock of ۱۹۷٤. But the share of consumer goods in imports has had a decreasing trend since ۱۹۸۰, which results from continuing import substitution policies during the sample period.

The composition of imports reflects a growth trend in the country's productive structure, based on a high degree of dependence on intermediate and capital goods over an extended period. The main reason for the high share of intermediate and capital good imports is an import substitution industrialization policy. But this policy was weakened during the period (۱۹۷٤-۷۸) because of a sudden increase in foreign exchange earnings and a resultant surge in imports of consumer goods. Since the start of the first post-revolution development plan in ۱۹۸۹, two opposing tendencies have been at work. On the one hand, increased local production of intermediate goods and raw materials reduced the need of existing industries for imported inputs. On the other hand, the development and expansion of industrial activities and new investment, created new import needs. Thus on balance there was increased demand for import of capital and intermediate goods.

٤- model of import demand under conditions of constrained foreign exchange availability

Traditionally, the model of demand of imports under conditions of imperfect substitution, where imports and domestic productions are not perfect substitutes for each other, with the assumption of homogeneity of zero degree in prices, is specified as follows:

$$M_t = f(Y_t, PR_t) \qquad (٤)$$

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