Cereal Import Demand in Developing Countries

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ABSTRACT

The major determinants of cereal import demand in seventy-four less developed countries (LDCs) were analyzed through the use of an econometric cross-sectional model. Key explanators included the level of income and degree of urbanization, financial capacity proxies, and domestic grain supply variables. A major innovation involved the analysis of the impact of income distribution on LDC cereal import demand in 1986 and 1987 for a more restricted sample of twenty-three nations. These developing countries exhibit a greater than proportional increase in cereal imports due to an increase in the income share of the poorest 40 percent of their populations. The inclusion of regional slope and intercept dummies in the cereal import demand model also provided improved results. High levels of government debt appear to have inhibited cereal importation in nations in South America, but not in Asia and Africa. In all three continental regions, particularly in Africa, there is a positive relationship between food aid and cereal imports. The model predicts cereal imports for nations in Asia and South America more satisfactorily than for those in Africa. Finally, the results support the view that improvements in income distribution in developing nations would considerably stimulate cereal imports.

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Introduction

There have been dramatic changes in the structure of the international grain trade in recent decades. Not only has the volume of grain trade increased, particularly in the 1970s, but also the import shares of the different socio-economic regions have changed. Less developed countries (LDCs) became the fastest growing import market segment, while developed country import markets declined significantly. Cereal imports into the LDCs increased by 5.6 percent per year between the early 1960s and the early 1980s, the LDC share of world cereal imports increasing from 36 to 46 percent in the process (Mellor, 1988). In the 1980s, however, there have been concerns that slower economic growth and high levels of debt, which constrain the financial capacity of many LDCs, may have been limiting LDC grain imports. The relative importance of various import demand factors is assessed in this analysis through the development and testing of a cross-sectional model of import demand for cereals. This analysis includes two notable improvements over previous research (Morrison, 1984): the incorporation of dummy variables and an investigation into the effects of income distribution on cereal import demand.

The Model and Data

The factors affecting cereal import demand can be broadly categorized into four groups: development variables, which attempt to quantify the level, growth, and distribution of income and the degree of urbanization in a country; financial capacity variables, which measure a country's ability to afford imports; potential and actual domestic cereal supply, which measure the gap between demand and supply; and socio-economic dummy variables, which quantify structural differences in import demand across countries. These four categories are included in the following single equation import demand model:

(1) \[ CM = f(X_1, X_2, X_3, X_4), \]

where: \( CM = \) cereal imports
\( X_1 = \) vector of development variables (GNP, rGDP, URB)
\( X_2 = \) vector of financial capacity variables (LRES, AID, LDBT, TDS, X86, EXP, LACN)
\( X_3 = \) vector of domestic grain supply variables (CP, FLUC, DENS)
\( X_4 = \) vector of intercept and slope dummy variables.

Price variables are omitted because the analysis is cross-sectional and prices are assumed to be fixed for the year (Christiansen, 1987, p. 5 and Morrison, 1984, p. 21).
Table 1 contains a summary of the definitions and data sources of the various alternative proxy variables. The data are for the year 1986, with all lagged variables being from 1985. Per capita values are used in order to eliminate the influence of different country sizes from the data set. For the initial analysis, seventy-four LDCs are chosen from three continents (South America, Asia and Africa), and from all income levels (low, medium and high). All net cereal importers are included in the sample with the exception of high-income oil exporters (Saudi Arabia, Kuwait and United Arab Emirates), which are excluded as being atypical developing nations.

Table 1
Variable Definitions and Data Sources, LDCs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>POP</td>
<td>1986 population</td>
<td>A (1988)</td>
</tr>
<tr>
<td>URB</td>
<td>1985 percent urban population of total population</td>
<td>A (1988)</td>
</tr>
<tr>
<td>AID</td>
<td>quantity of cereal food aid, kg/capita</td>
<td>A (1988)</td>
</tr>
<tr>
<td>CP</td>
<td>1985 quantity of cereal production, kg/capita</td>
<td>C (1987)</td>
</tr>
<tr>
<td>FLUC</td>
<td>difference between 1985 and 1986 cereal production, kg/capita</td>
<td>C (1987)</td>
</tr>
<tr>
<td>DENS</td>
<td>1986 population density on arable land, 1000 persons/ha</td>
<td>C (1987)</td>
</tr>
<tr>
<td>DSA</td>
<td>dummy variable for 20 South American countries</td>
<td></td>
</tr>
<tr>
<td>DAS</td>
<td>dummy variable for 18 Asian and Mid-Eastern countries</td>
<td></td>
</tr>
<tr>
<td>DAF</td>
<td>dummy variable for 36 African countries</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> A: World Bank, *World Development Report*  
B: FAO, *Trade Yearbook*  
C: FAO, *Production Yearbook*  

It should be noted that data for the dependent variable, cereal imports, include concessional food aid imports as well as commercial cereal imports (Huddleston, 1984, pp. 13-14). Since food aid enters the regression as an independent variable, the preferred procedure would be to express cereal imports net of food aid.
aid. Unfortunately, cereal imports are measured on a calendar year basis, while the food aid data are measured on a crop year basis (July to June). Therefore, the dependent variable, cereal imports, cannot be expressed net of food aid, which limits the explanatory power of the food aid variable (AID).

The intercept dummy variables DSA, DAS and DAF divide the sample set on the basis of geography to account for factors such as general weather patterns, resource endowments and cultural differences that may influence tastes and preferences across nations. In addition to these intercept dummies, slope dummy variables were also included in the analysis once the preliminary set of significant variables was identified.

**Results of the Cereal Import Demand Model**

Equation 2 presents the final results of the preliminary model, which was estimated with a linear functional form using the statistical package SHAZAM, version 6.1. T-statistics appear in brackets; t-critical (2-tailed, $\alpha = 0.05$, 60 d.f.) = 2.000 and t-critical (2-tailed, $\alpha = 0.01$, 60 d.f.) = 2.660.

\[
(2) \quad CM = -31 - 24 \text{DAF} - 86 \text{DS A} + 0.03 \text{GNP} + 0.89 \text{URB} + 1.11 \text{AID} - 0.15 \text{CP} + \\
0.03 \text{LDBT} - 0.24 \text{FLUC} . \quad \text{adj.} \ R^2 = 0.83.
\]

Of the two alternative income variables, GNP was a significant explanator of cereal imports but average annual growth in income was not and is, therefore, omitted from the regression. Two of the financial capacity variables were significant, AID (food aid) and LDBT (lagged government debt). Contrary to expectations, the coefficient on the lagged debt variable is positive, i.e. countries with heavier loads of debt per capita tend to import more cereals. This factor is further explored in the next section of the paper. The alternative debt variable, total debt service (TDS), was also significant in separate regressions, but LDBT explains more variation in cereal imports than does TDS.

It was initially surprising that LRES, the foreign exchange variable, is insignificant in the regression. Further investigation revealed that LRES is significant, but only when the variable GNP is omitted. When both GNP and LRES appear in the same regression, the coefficients on LRES is insignificantly different than zero and has a counter-intuitive sign. This result is the consequence of strong, destructive collinearity between these two variables (discovered through testing using the procedure outlined by Belsley, Kuh and Welsh, 1980). Since the variable LRES is more adversely affected by the collinearity than is GNP, LRES was dropped from the regression. The same destructive collinearity with GNP also applies to X86, the value of merchandise exports; like LRES, X86 was dropped from the regression due to this. The other two finance
variables, LACN and EXP, are simply insignificant and were also dropped. The cereal production variables, lagged cereal production and production fluctuations, were significant explanators of cereal imports; population density on arable land was not.

The geographical intercept dummies indicated that there are significant differences in the level of cereal imports by Asian, African and South American countries. (An alternative set of dummy variables based on income level are not significant in this regression). Slope dummy variables were then introduced to test for significant regional differences in import response as measured by the independent variables. These included:

- FLUC.AF: cereal production fluctuations in Africa
- FLUC.SA: production fluctuations in South America
- CP.AF: cereal production in Africa
- CP.SA: cereal production in South America
- AID.AF: food aid in Africa
- LDBT.AF: lagged debt in Africa
- LDBT.SA: lagged debt in South America.

Slope dummies for the cereal production variables (FLUC and CP) are tested because there may be regional production and, therefore, import differences in different regions due to factors such as resource endowments and continental weather patterns. The slope dummy for food aid in Africa is included because African countries rely more on food aid as a source of cereal imports than do Asian or South American countries (Huddleston, 1984, p. 25), and aid may therefore have a differential impact on African cereal import demand. Finally, the dummy variables for government debt are included to test whether differences in cereal imports are associated with regional differences in different levels of debt or different reactions to external debt. While most LDCs face major debt problems, these have been particularly severe in South America (Holley, 1987, p. 9 and Kuczynski, 1988, p. 1). A government debt slope dummy variable is also included for Africa.

The seven slope dummy variables were entered into the regression in various combinations and F-tests were applied to assess which combination of variables was significant. The results are presented in Equation 3, which represents the best set of tested explanatory variables for cereal import demand in LDCs. Testing the model indicates that there is no significant heteroskedasticity in the regression at the 5% level ($\chi^2 = 15.61, 10 d.f.$ with $\chi^2$ critical = 18.302).

$$CM = 42 - 41 DSA - 55 DAF + 0.023 GNP + 0.689 URB + 0.729 AID - 0.190 CP + 0.040 LDBT + 0.134 CP.AF + 1.353 AID.AF - 0.051 LDBT.SA, \quad adj. R^2 = 0.867.$$
The significant negative slope dummy variable for government debt in South America indicates that cereal imports in that region are adversely affected by the level of government debt. For South America, the value of the coefficient on LDBT is -0.011 (derived by adding the coefficients for LDBT and LDBT.SA). In contrast, the implication from the positive coefficient on LDBT, that government debt did not act as a dampening agent on cereal imports in 1986, reflects the lower levels of debt per capita in Asia and Africa relative to South America and the possibility that cereals are given a very high import priority in these two regions.

The slope dummy variable for food aid in Africa has a coefficient value of +2.082 as opposed to +0.729 for South America and Asia (2.082 is derived from the sum of the coefficients for AID and the African AID slope dummy). The higher value for Africa suggests that, as expected, African countries do indeed have a higher dependence on food aid as a form of cereal imports than the other two regions. For all three regions, the positive sign on the AID variable coefficient suggests that cereal food aid and cereal imports are complementary, rather than competitive, goods.

The only cereal production slope dummy that is significant is that for Africa. For the entire sample, the coefficient on CP is -0.190 while for Africa this value is -0.056. In all regions, domestic cereal production acts as a substitute for cereal imports, but more so in Asia and South America than in Africa. Addition of the slope dummy variables caused the variable FLUC (cereal production fluctuations) to become insignificant in Equation 3 (FLUC was a significant variable in the preliminary regression results given in Equation 2). It appears that the level of cereal production is a more important determinant of cereal imports than production fluctuations. The variables GNP and URB (percent urbanization) both have the same effect on cereal imports across all countries: cereal imports increase as GNP levels increase and as urbanization increases.

Graphs of the actual versus predicted cereal imports are plotted for each of the three regions as a visual indication of how well the model performs for each region. These illustrate one finding of this analysis: while cereal imports of countries in Asia (and South America) are predicted quite well by the model, cereal imports for certain African countries are not predicted so well. There is no evident unifying geographic or income characteristic among the African countries to suggest a reason for the relatively poorer predictive ability of the model for this continent.

Table 2 contains the estimated cereal import elasticities of demand from the results in Equation 3. All are relatively inelastic. For example, a one percent increase in per capita national income, GNP, causes only a 0.5 percent increase in cereal imports. The elasticities of import demand with respect to the variables AID (food aid), LDBT (government debt), and CP (domestic cereal production) differ between regions.
Cereal imports are slightly more elastic with respect to food aid (AID) for Africa than for Asia or South America. This may reflect Africa's high level of cereal food aid in cereal imports relative to the other two regions. The responses in cereal imports to changes in government debt for both Africa and Asia show positive elasticities, while South American countries exhibit a negative and very inelastic response in cereal
imports to government debt. The cereal import elasticities with respect to cereal production (CP) reveal that Africa reduces cereal imports less for each unit of domestic production increase than do either Asia or South America. This may result from Africa's relatively high cereal deficit compared to Asia and South America.

**Income Distribution and Cereal Imports**

It has long been argued that income inequality is one of the principal causes of the food problems in LDCs. According to Yotopoulos (1985), income distribution influences both the quantity and composition of cereal import demand and the total supply of cereal available for consumption through direct and indirect (i.e. animal product) means. However, the issue of income distribution is often overlooked in the study of cereal import demand in LDCs, despite cereals being a major component of the human diet and LDCs being the fastest growing market segment for cereal imports. Since income distribution influences both the quantity and composition (food or feed grains) of cereal import demand, an empirical investigation of the impact of income distribution on the demand for cereal imports will improve our understanding of the world food economy. The purpose of this section is to conduct such an investigation.

The cereal import demand in Equation 3 is re-estimated with the addition of two kinds of income variables. One variable is SH, the share of income of the poorest 40% of the population. This variable is a measure of the income distribution within a single country, with the data coming from the World Bank World Development Report. An alternative measure of relative inequality in the distribution of income, the Gini Coefficient, was also used but proved to be a weaker explanator or cereal imports than the income share of the poorest 40 percent. The second kind of additional income variable is a set of slope dummy variables which divides the sample between countries on the basis of low, middle and high GNP. These GNP dummies are initialized using the World Bank definitions of low, middle and high income:

- DL = 1 for 7 countries with GNP < U.S. $350; otherwise = 0
- DM = 1 for 9 countries with U.S. $450 < GNP < U.S. $1800; otherwise = 0
- DH = 1 for 7 countries with GNP > U.S. $1800.

These variables enter the regression as slope dummies for low and middle income countries on the GNP variable (GNP.DL and GNP.DM) and for low and middle income countries on the income distribution variable (SH.DL and SH.DM). The divisions are based on the 1987 data and then imposed on the 1986 data.

The results of the regressions appear in Table 3. The model is estimated for data from 1986 and 1987 to determine the stability of the results over time. The sample sizes are limited to twenty-three countries due to the availability of data for the variable SH. A complete list of the twenty-three countries including the low, middle and high income designations can be found in Appendix A.
Two tests are run on each model, the Breusch-Pagan test for heteroskedasticity and the Ramsey RESET test for mis-specification. The BP test indicates that there is no significant heteroskedasticity in any regression. The RESET tests (not presented here) indicate that the linear functional form is appropriate and that there is probably no mis-specification error.

Table 3
Results of the Cereal Import Demand Regressions Involving Income Distribution

<table>
<thead>
<tr>
<th>Year</th>
<th>Const</th>
<th>DSA</th>
<th>GNP</th>
<th>GNP.DM</th>
<th>AID</th>
<th>AID.AF</th>
<th>CP</th>
<th>SH</th>
<th>SH.DL</th>
<th>SH.DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>29</td>
<td>-64</td>
<td>0.03</td>
<td>0.08</td>
<td>1.37</td>
<td>0.04</td>
<td>-0.17</td>
<td>7.35</td>
<td>-7.17</td>
<td>-10.226</td>
</tr>
<tr>
<td></td>
<td>(1.45)</td>
<td>(5.03)</td>
<td>(3.25)</td>
<td>(4.19)</td>
<td>(2.49)</td>
<td>(3.24)</td>
<td>(3.92)</td>
<td>(3.40)</td>
<td>(4.52)</td>
<td>(4.49)</td>
</tr>
<tr>
<td></td>
<td>adj. $R^2 = 0.91$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>-27</td>
<td>-57</td>
<td>0.04</td>
<td>0.06</td>
<td>0.59</td>
<td>2.56</td>
<td>-0.19</td>
<td>10.19</td>
<td>-6.66</td>
<td>-8.09</td>
</tr>
<tr>
<td></td>
<td>(1.15)</td>
<td>(3.90)</td>
<td>(3.40)</td>
<td>(3.88)</td>
<td>(1.04)</td>
<td>(4.05)</td>
<td>(4.49)</td>
<td>(3.80)</td>
<td>(3.07)</td>
<td>(3.10)</td>
</tr>
<tr>
<td></td>
<td>adj. $R^2 = 0.93$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the t-statistics: $t$-critical (2-tailed, $\alpha = 0.05$, 14 d.f.) = 2.145 and $t$-critical (2-tailed, $\alpha = 0.01$, 14 d.f.) = 2.977.

The results, given in Table 3, reveal that the coefficient estimates for most of the variables were fairly stable in the two years considered. With the exception of government debt, the explanatory variables from Equation 3 are still significant when income distribution variables are added to the basic cereal import demand model. The remainder of the income distribution discussion centers on the 1987 equation since the 1986 equation is only presented to assess the stability of the regression results.

The 1987 regression results reveal that all of the variables, with the exception of the constant and food aid, are significant at the 95% confidence level. The insignificant food aid variable, AID, can be interpreted to mean that cereal food aid in Asia and South America did not influence cereal imports very much. The significant food aid dummy variable for Africa, AID.AF, means that, as found previously in Equation 3, Africa is relatively more reliant on cereal food aid than are the other two regions.

In contrast to the results noted earlier from the larger sample, there is a significant slope dummy variable on income for countries in the middle income category, GNP.DM, which suggests that these middle income countries display a different import demand behavior than do either low or high income developing countries. It appears that among the twenty-three countries in the smaller cross-section, middle income
countries tend to import more cereals for a given increase in per capita income than do either the low or high income countries. The dummy variable on income for low income countries, GNP.DL, was dropped from the regression as it was insignificant.

The income distribution variables reveal some interesting within-country and between-countries import demand behavior. First, the significant share variables indicate that the income distribution within a country does have an impact on cereal import demand. Improving the equity of income distribution within a country, increasing the share of income of the poorest 40% and thereby reducing the income share of the richer 60%, has a large, positive impact on the demand for cereal imports. This result conforms with evidence that income elasticities of demand for food by the poor in developing countries are relatively high (Mellor, 1988). Secondly, the significant share slope dummy variables for low and middle income countries reveal that between countries, improvement in the equity of income distribution can be expected to have different impacts on cereal imports that depend on the level of per capita income that the countries have attained. Specifically, an increase in the income distribution equity of the seven countries with a national per capita income greater than U.S. $1800 has a relatively larger impact on cereal imports than the same increase in equity of the seven countries with national per capita income less than $450 or the nine countries with national per capita income between $450 and $1800. It may be that this differential impact on cereal import demand is a result of the poorest 40% of the population in high income developing countries having a relatively higher level of income and therefore different cereal demand pattern than the poorest 40% in middle and low income countries. Admittedly, our sample of seven high income LDCs is relatively small, contains several nations with high degrees of inequality, and thus may not be fully representative.

Table 4 contains the income and income distribution elasticities for the 1987 regression. The income elasticities reveal that a one percent increase in GNP in middle income countries causes a greater than proportional increase in cereal import demand, probably due to an increase in feed grain and meat consumption. This impact on cereal import demand of an increase in income is less than proportional in low and high income LDCs.

Table 4
Cereal Import Elasticities with Respect to Income and Income Distribution Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low GNP Countries</th>
<th>Middle GNP Countries</th>
<th>High GNP Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNP</td>
<td>0.76</td>
<td>1.12</td>
<td>0.76</td>
</tr>
<tr>
<td>SH</td>
<td>1.39</td>
<td>1.25</td>
<td>1.80</td>
</tr>
</tbody>
</table>
The elasticities of cereal import with respect to the income distribution variable, SH, reveal that at all three income levels, developing countries exhibit a greater than proportional increase in cereal imports due to an increase in the income share of the poorest 40% of their populations. This increase is greatest for the high income developing countries and smallest for the middle income LDCs in our sample.

Conclusions

The results of the estimation of the import demand for cereals in LDCs reveal that cereal imports are determined by such factors as the geographic location of an individual country, the level of development as measured by income and the degree of urbanization, and domestic cereal production. Cereal food aid appears to be a complementary rather than competitive goal to cereal imports (though this is clouded by the data on cereal imports which are not net of food aid). The relationship between cereal imports and variables postulated to reflect financial capacity was tested. Lagged foreign exchange reserve levels and value of exports were expected to be significantly positively associated with cereal imports. This was the case, although the destructive collinearity that exists between these variables and GNP led to deletion of both financial capacity variables from the model. Lagged levels of government debt were expected to be significantly negatively associated with cereal imports. This was the case for South American countries but not for Asian and African countries. Indeed, the final results, for the sample of 74 countries, suggest that for African and Asian countries, lagged government debt levels have not been a deterrent to cereal imports, at least in cross section.

The investigation into the impact of income distribution on cereal import demand for a sample of 23 countries reveals that income distribution is an important determinant of the demand for cereal imports in developing countries and that improving distributive equity has a positive effect on cereal imports. The results of incorporating slope dummy variables for GNP and the income distribution proxy, SH, on the basis of different development levels indicate that cereal import response differs across nations with different levels of income. More extensive work on the impact of income distribution needs to be undertaken when data on income distribution in more LDCs are available.

In this study, the importance of including income distribution as an important determinant of cereal import demand in developing nations, the difficulties of analyzing financial capacity constraints on LDC import demand, and the importance of considering regional and socio-economic differences in cereal import demand are all illustrated. The analysis lends strong support to Mellor's contention (1988) that the fortunes of the developed and developing nations are closely intertwined in the world food economy. The pace at which poor nations can develop, both through increasing income levels and improving income distribution, significantly influences their cereal imports and, concomitantly, cereal exports, largely from rich nations.
Appendix A


Middle income countries: Philippines, Egypt, Ivory Coast, El Salvador, Turkey, Chile, Peru, Mauritius, Costa Rica.

High income countries: Malaysia, Mexico, Brazil, Panama, Korea, Venezuela, Trinidad and Tobago.

References


