Cereal Import Demand in Developing Countries

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Abstract: The major determinants of cereal import demand in 74 less-developed countries (LDCs) were analysed using an econometric cross-sectional model. Key explanatory factors 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 23 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 provides improved results. High levels of government debt appear to have inhibited cereal imports in nations in South America but not in Asia and Africa. In all three continental regions, particularly Africa, there is a positive relationship between food aid and cereal imports. The model predicts cereal imports more satisfactorily for nations in Asia and South America than for those in Africa. Finally, the results support the view that improvements in income distribution in developing nations would considerably stimulate cereal imports.

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 socioeconomic 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 were concerns that slower economic growth and high levels of debt, which constrain the financial capacity of many LDCs, may have limited 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.

Model and Data

The factors affecting cereal import demand can be broadly categorized into four groups: development variables, that attempt to quantify the level, growth, and distribution of income and the degree of urbanization in a country; financial capacity variables, that measure a country's ability to afford imports; potential and actual domestic cereal supply, that measure the gap between demand and supply; and socioeconomic dummy variables, that 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*, and *URB*)
X_2 = vector of financial capacity variables (*LRES*, *AID*, *LDBT*, *TDS*, *X86*, *EXP*, and *LACN*)
X_3 = vector of domestic grain supply variables (*CP*, *FLUC*, and *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, 74 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

Variable	Definition	Source[1]
POP	1986 population	A (1988)
GNP	1986 GNP per capita, $US/capita	A (1988)
rGDP	Average annual growth rate of GDP, 1980–86	A (1988)
URB	1985 percent urban population of total population	A (1988)
AID	Quantity of cereal food aid, kg/capita	A (1988)
LRES	1985 gross international reserves, $US/capita	A (1987)
LACN	1985 current account balance, $US/capita	A (1987)
LDBT	1985 external public debt, outstanding and disbursed, $US/capita	A (1987)
TDS	1986 total debt service on government debt, $US/capita	D (1987)
EXP	Average annual growth rate of merchandise exports, 1980–86	A (1988)
X86	1986 value of merchandise exports, $US/capita	A (1988)
CM	1986 gross quantity of cereal imports, kg/capita (SITC 041–046)	B (1987)
CP	1985 quantity of cereal production, kg/capita	C (1987)
FLUC	Difference between 1985 and 1986 cereal production, kg/capita	C (1987)
DENS	1986 population density on arable land, 1,000 persons/ha	C (1987)
DSA	Dummy variable for 20 South American countries	
DAS	Dummy variable for 18 Asian and Mid-Eastern countries	
DAF	Dummy variable for 36 African countries	

[1]A: World Bank, *World Development Report*; B: FAO, *Trade Yearbook*; C: FAO, *Production Yearbook*; and D: World Bank, *World Debt Tables*, Vol. 2.

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. Unfortunately, cereal imports are measured on a calendar year basis, while food aid data are measured on a crop year basis (July–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.

$$
\begin{aligned}
CM = &- 31 - 24DAF - 86DSA + 0.03GNP + 0.89URB + 1.11AID - 0.15CP + \\
&\ \ (2.04)\quad (2.29)\quad (7.26)\quad (6.84)\quad (3.65)\quad (5.27)\quad (3.76) \\
&0.03LDBT - 0.24FLUC \qquad \text{adj. } R^2 = 0.83 \\
&\ \ (2.58)\qquad (2.15)
\end{aligned}
\tag{2}
$$

Of the two alternative income variables, *GNP* was a significant explanatory factor in 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 coefficient on *LRES* is insignificantly different from 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 Welsch, 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 explanatory factors in 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.[2] 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), and *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 heteroscedasticity in the regression at the 5-percent level (χ^2 = 15.61, 10 d.f., with χ^2 critical = 18.302).

$$(3)\quad CM = \underset{(2.72)}{42} - \underset{(2.56)}{41}DSA - \underset{(3.67)}{55}DAF + \underset{(7.31)}{0.023}GNP + \underset{(3.09)}{0.689}URB + \underset{(3.19)}{0.729}AID - \underset{(4.39)}{0.190}CP$$

$$+ \underset{(4.17)}{0.040}LDBT + \underset{(1.98)}{0.134}CP.AF + \underset{(3.20)}{1.353}AID.AF - \underset{(2.97)}{0.051}LDBT.SA \qquad \text{adj. } R^2 = 0.867$$

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 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* (percentage of urbanization) both have the same effect on cereal imports across all countries: cereal imports increase as GNP levels increase and as urbanization increases. 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 as well. There is no evident unifying geographical or income characteristic among the African countries to suggest a reason for the relatively poorer predictive ability of the model for that continent.

Table 2—Elasticities of Import Demand for Cereals in LDCs

Variable	Elasticity
GNP	0.477
URB	0.407
AID	
Africa	0.232
Asia	0.123
South America	0.123
LDBT	
Africa	0.306
Asia	0.306
South America	−0.037
CP	
Africa	−0.314
Asia	−0.449
South America	−0.449

Table 2 contains the estimated cereal import elasticities of demand from the results in Equation (3). All are relatively inelastic. For example, a 1-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 among 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 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 percent of the population. This variable is a measure of the income distribution within a single country. An alternative measure of relative inequality in the distribution of income, the Gini coefficient, was also used but proved to be a weaker explainer of 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 that 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 per capita GNP < US$350, otherwise = 0; *DM* = 1 for 9 countries with US$450 < per capita GNP < US$1,800, otherwise = 0; and *DH* = 1 for 7 countries with per capita GNP > US$1,800.

These variables enter the regression as slope dummies for low- and middle-income countries on the GNP variables (*GNP.DL* and *GNP.DM*) and for low- and middle-income countries on the income distribution variables (*SH.DL* and *SH.DM*). The divisions are based on 1987 data and then imposed on 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 23 countries due to the availability of data for the variable *SH*.[3]

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

Year	Constant	*DSA*	*GNP*	*GNP.DM*	*AID*	*AID.AF*	*CP*	*SH*	*SH.DL*	*SH.DM*
1986	29	−64	0.03	0.08	1.37	0.04	−0.17	7.35	−7.17	−10.226
	(1.45)	(5.03)	(3.25)	(4.19)	(2.49)	(3.24)	(3.92)	(3.40)	(4.52)	(4.49)
1987	−27	−57	0.04	0.06	0.59	2.56	−0.19	10.19	−6.66	−8.09
	(1.15)	(3.90)	(3.40)	(3.88)	(1.04)	(4.05)	(4.49)	(3.80)	(3.07)	(3.10)

Notes: 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. Adjusted R^2s are 0.91 and 0.93 for 1986 and 1987, respectively.

Two tests are run on each model, the Breusch-Pagan (BP) test for heteroscedasticity and the Ramsey RESET test for misspecification. The BP test indicates that there is no significant heteroscedasticity in any regression. The RESET tests (not presented here) indicate that the linear functional form is appropriate and that there is probably no misspecification error.

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 centres 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-percent 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 behaviour than do either low- or high-income developing countries. It appears that among the 23 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 behaviour. 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 percent and thereby reducing the income share of the richer 60 percent, 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). Second, 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 the countries have attained. Specifically, an increase in the income distribution equity of the 7 countries with a national per capita income greater than US$1,800 has a relatively larger impact on cereal imports than the same increase in equity of the 7 countries with national per capita income less than US$450 or the 9 countries with national per capita income between $450 and $1,800. It may be that this differential impact on cereal import demand is a result of the poorest 40 percent 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 percent in middle- and low-income countries. Admittedly, the sample of 7 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 1-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

Variable	Low GNP Countries	Middle GNP Countries	High GNP Countries
GNP	0.76	1.12	0.76
SH	1.39	1.25	1.80

The elasticities of cereal imports 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 percent of their populations. This increase is greatest for the high-income developing countries and smallest for the middle-income LDCs in the 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 geographical 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 (although 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 become available.

In this study, the importance of including income distribution as an important determinant of cereal import demand in developing nations, the difficulties of analysing financial capacity constraints on LDC import demand, and the importance of considering regional and socioeconomic differences in cereal import demand are all illustrated. The analysis lends strong support to Mellor's (1988) contention 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.

Notes

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[2]An alternative set of dummy variables based on income level are not significant in this regression.

[3]Low-income countries: Bangladesh, Tanzania, India, Kenya, Zambia, Sri Lanka, and Indonesia. Middle-income countries: Philippines, Egypt, Côte d'Ivoire, El Salvador, Turkey, Chile, Peru, Mauritius, and Costa Rica. High-income countries: Malaysia, Mexico, Brazil, Panama, South Korea, Venezuela, and Trinidad and Tobago.

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Discussion Opening—*John Dyck* (US Department of Agriculture)

This paper raises important issues about trade flows and global interdependence. It provides some interesting empirical results. The paper reports that each equation was estimated several times, with different specifications, in order to see which variables' coefficients were significant. Such respecification means that the final estimated equation is tailor made for the particular data set and the coefficients may not be as robust as the *t*-test suggests. The estimations do suggest that GNP/person is positively correlated with cereal import demand, as is a lessening of income inequality. However, the study regresses import demand for all kinds of cereals on explanatory variables. Cereal imports behave quite differently if they are for food or for feed. Cereal imports for food are expected to rise at very low levels of income. But at some point, cereal food consumption/person needs are satisfied, and that may happen at relatively low income levels. At higher levels, as in East Asia, such consumption may even decline.

However, the demand for livestock products grows throughout the development process, and it is hard to see where it will stop. Livestock-derived foods require more grain than do cereal foods. Thus there are two distinct demands for cereals, and mixing the two can be misleading. The income elasticity of cereal import demand calculated in the paper is unlikely to hold in other situations because the relative importance of food and feed imports will have changed. It would be preferable to use data that allow calculation of cereal imports for food and feed and estimate the effect of income on each type of import. Feed imports should measure both direct feed grain imports and the feed equivalent of imported livestock products.

Cereal imports by LDCs are important to developed country agriculture, and a correlation of those imports with income growth in the past seems clear, although not well quantified in the current study. It is true that rising incomes in the Third World may lead to continued rising cereal imports, which could alleviate the problem of excess cereal production in the developed countries. However, surpluses in the developed countries have been created by policies that can be changed. Also, food supply growth in a developing country can initially lag behind food demand growth, but, given favourable policies and technological progress, can catch up. Thus, rising, income-led cereal consumption by LDCs in the 1990s and beyond may not translate into rising cereal import demand as it has in the past if supply curves in LDCs shift out because of technical change and in developed countries shift in because of policy reforms. An interesting question to discuss is whether the current fit between excess cereal demand in developing countries and excess supply in developed countries will continue, especially in light of policy reforms in agriculture and evidence of how much technology can boost supplies.

[Other discussion of this paper and the authors' reply appear on page 282.]