Why Don't Developing Countries Import More Food?

Douglas Gollin

Williams College

David Lagakos

Arizona State University

Michael E. Waugh

New York University

This Version: November 2010

ABSTRACT

Most developing countries are far less productive in agriculture than in the non-agriculture sector compared to the rest of the world. Standard Ricardian trade theory predicts that developing countries should be large importers of food and should have few workers in agriculture. The data is in stark contrast to this predction. In this paper, we explore deviations from from standard trade theory — with economic and empirical content — to quantitatively explain this apparent deviation from comparative advantage. In particular, we focus on the role of internal trade costs and curvature in the production possibility frontier, both of which increase the incentives for workers in developing countries to produce their own food.

Email: douglas.gollin@williams.edu, lagakos@asu.edu, mwaugh@stern.nyu.edu. Preliminary and incomplete – comments welcome.

1. Introduction

Most developing countries are far less productive in agriculture than in the non-agricultural sector compared to the rest of the world (Caselli (2005); Restuccia, Yang, and Zhu (2008)). Yet few developing countries are large importers of food, as would be expected from standard Ricardian trade theory. In fact, the typical developing country is a net *exporter* of food, and conducts very little food trade overall. What explains this apparent deviation from comparative advantage?

We argue that large internal trade costs are at the heart of why developing countries do not import more food. In contrast to frictionless internal trade, as posited by most trade models, the cost of shipping goods within the typical developing nation is enormous. According to the World Bank, roughly 79 percent of African households live at least 2 hours from the nearest market center using available transport networks, while 34 percent live at least 5 hours from a market center (Sebastian, 2007). Internal trade costs can be even larger than international trade costs. For example, the cost of shipping a bushel of wheat the 9,000 miles from St. Paul, Minnesota to Dar es Salaam, on the coast of Tanzania, is lower than the cost of shipping the same bushel from Dar es Salaam to the interior of Tanzania – a distance of less than 1,000 miles.

To understand the role of internal trade costs on the lack of food imports by developing countries we build and explore several variants of a standard two-sector, two-region model in which internal trade is subject to "iceberg" trade costs. We show how one common theme of these models is that internal trade costs provide incentives for workers to produce their own food rather than import it. The reasoning is two-fold. First, internal trade costs increase the relative price of agriculture goods consumed in the non-agriculture region. Second, because of non-homothetic preferences, agents derive (on the margin) more utility from agriculture goods than non-agriculture goods and hence agents locate in the agriculture region where these goods are cheaper. We also show how this effect is even more pronounced when the production possibility is concave, as opposed to linear as is commonly assumed.

To discipline the internal trade costs we use a new data set of regional prices collected in a sample of developing countries as part of the World Bank's Living Standards Measurement Surveys (LSMS). In each of our countries, we observe prices for a sample of commonly-purchased goods in a large number of geographic locations. communities. We measure trade costs in three ways. First, using an arbitrage argument, we back out trade costs from regional price differences in a way similar to Eaton and Kortum (2002) and Simonovska and Waugh (2011). Second, using arguments similar to those in Donaldson (2010), we find goods whose production location is known for certain, such as goods denoted "domestically produced." Third, we use direct estimates of transportation costs from "marketing studies" which measure the prices of agricultural products from the farm gate up through the supply chain until sold in retail markets.

The paper most closely related to ours is that of Tombe (2010), who also attempts to understand the lack of food imports by developing countries. He argues that the culprit is a combination of barriers to international trade in general and internal barriers to labor mobility that keep workers in the agriculture sector and hence keep domestic food prices artificially low. Our work differs in our focus on the frictions to internal movement of goods, rather than the frictions in the labor market, and in our direct measurements of the frictions. We both find large potential gains of removing barriers to the imports of food by developing countries.

Our work also builds on a literature trying to understand why productivity is so much lower in agriculture in developing countries than rich countries. Recent explanations include barriers to the adoption of intermediates and to sectoral labor mobility (Restuccia, Yang, and Zhu (2008)), policies that result in farms being too small Adamopoulos and Restuccia (2011), and low average ability among agriculture workers, resulting from having most workers in agriculture (Lagakos and Waugh (2010)). All of these studies abstract from international trade, however, which is at the core of the current paper.

2. Motivating Evidence

In this section, we show that cross-country labor productivity differences are large in agriculture and smaller in non-agriculture, relative to aggregate differences. These productivity differences suggest a particular pattern of trade. We then show that this pattern of trade is not seen in the data.

Table 1 reproduces data from Caselli (2005), who constructs Purchasing Power Parity (PPP) adjusted measures of output per worker in agriculture and non-agriculture sectors for 79 countries in 1985. His calculations combine PPP GDP per worker data from the Penn World Tables with PPP agriculture value added per worker data from the Food and Agriculture Organization (FAO)(Rao (1993)).[1] Panel A reports that the ratio of agricultural output per worker in the 90th and 10th percentiles of the income distribution is 45, compared to just four in non-agriculture. As a frame of reference, the ratio for aggregate output per worker is 22. Thus, across countries, labor productivity in agriculture is roughly twice as variable relative to labor productivity in the aggregate, and non-agriculture is roughly one-fifth as variable as the aggregate.[2]

[1] In independent work, Restuccia, Yang, and Zhu (2008) arrive at findings similar to those in Table 1.

[2] These findings relate to a long history of research in macroeconomic development, dating back to Schultz (1953), which has found that value added per worker is much higher in non-agriculture than in agriculture. Recently, Gollin, Parente, and Rogerson (2004) examine data from a sample of countries in 2000 and find that non-agriculture value added per worker is far higher than agricultural value added per worker, often by a factor of 10.

Table 1: Labor-Productivity and Labor Allocations

Panel A: Labor Productivity Differences	
Sector	Ratio of 90th-10th Percentile
Agriculture	45
Aggregate	22
Non-Agriculture	4
Panel B: Percent of Labor in Agriculture	
Country Income Percentile	Percent
90th	2.8
10th	78.3

Source: Caselli (2005)

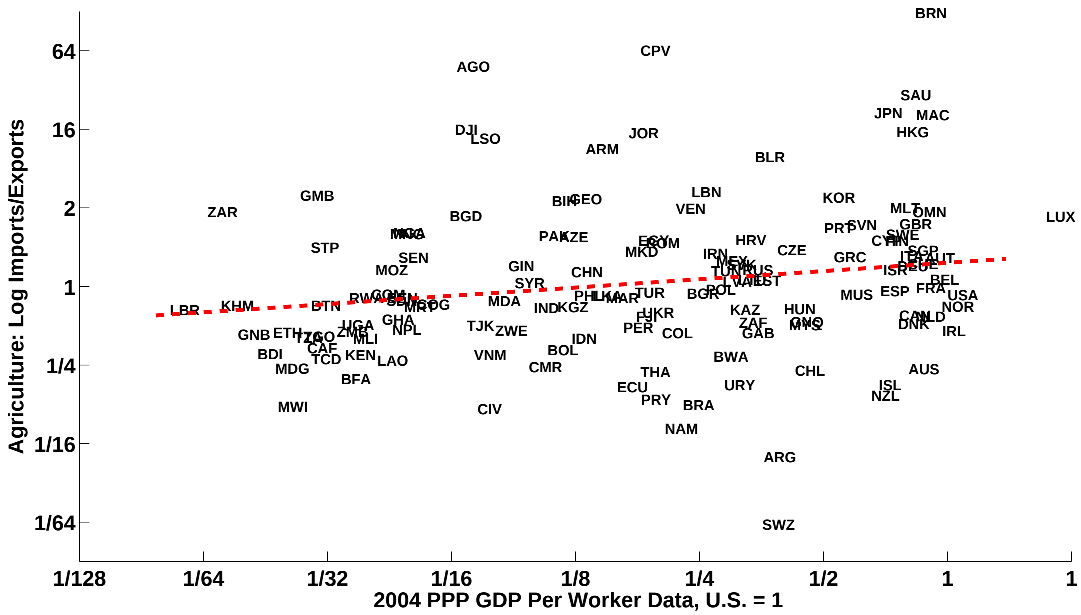
Standard Ricardian trade theory suggests that the following trade should occur. Workers in developing countries should import and move out of agriculture and they should export non-agriculture goods. The potential gains from this trade are enormous. Assuming that after this trade agriculture's share of labor in all countries is equal to 2.8 percent of workers in agriculture, as in the 90th percentile country (Panel B of Table 1). The hypothetical ratio of aggregate output per worker is a factor 4.2, which is far lower than the actual 22 in the data.

In the data, its hard to find developing countries systematically importing agriculture goods and exporting non-agriculture goods. Figure 1(a) and 1(b) illustrates this. It plots the log ratio of imports relative to exports versus real GDP per worker data in 2004.

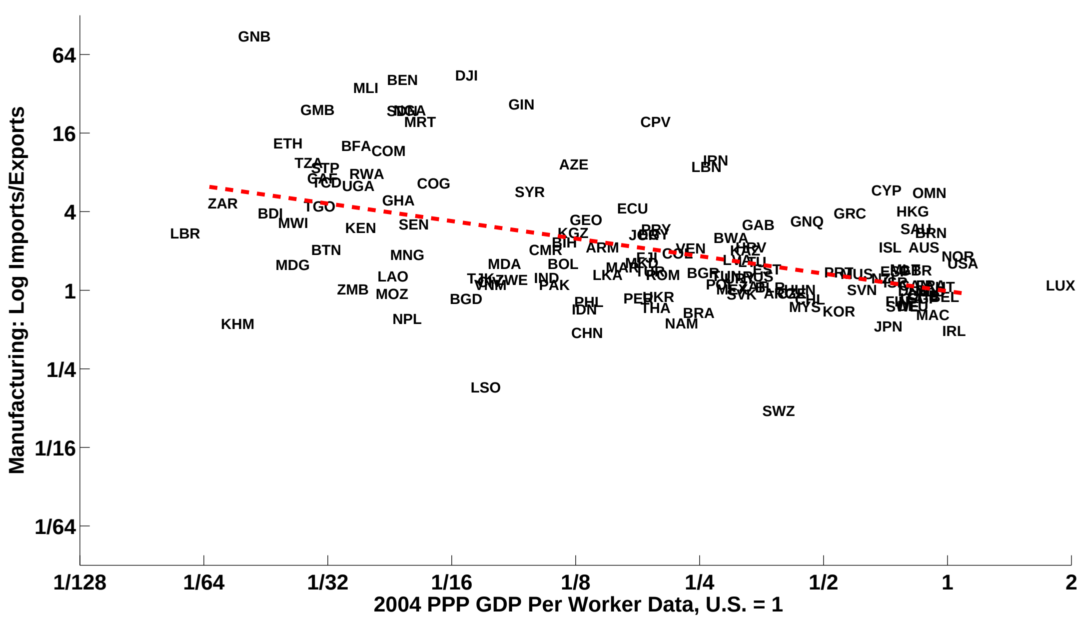
Figure 1(a) plots this relationship for agricultural goods. Agriculture is defined as goods that correspond with ISIC Rev. 3 categories 01,02,05.[3] Figure 1(a) illustrates that there is a slight upward sloping relationship between net-imports and income. That is rich countries appear to import relatively more agricultural goods than they export.

Figure 1(b) plots this relationship for manufacturing trade. Here the relationship with level of development is negative and the opposite of figure 1(a). Poor countries clearly appear to be net-importers of non-agriculture goods.

[3]Including processed food stuffs typically categorized as manufacturing did not affect this relationship.



(a) Agriculture Imports / Exports and Real GDP Per Worker Data



(b) Manufacturing Imports / Exports and Real GDP Per Worker Data

Figure 1: Agriculture and Non-Agriculture Trade and Development

3. Closed-Economy Model

In this section we develop a simple two-sector model with two regions. Agricultural goods are produced in a ”rural” agricultural region which can be thought of as the interior of the country, and non-agriculture goods are produced in the non-agricultural ”urban” region, which represents a coastal city. Trade between the two regions are subject to internal trade costs of the iceberg form. While we ultimately consider an open-economy version of the model, where the urban region has access to trade on international markets, we first build intuition about the role of internal trade costs in a closed-economy version.

A. Households

There are measure one of agents. Agents are indexed by i which indexes the location choice of that agent, which is described in more detail below. Preferences are given by

$$U = \phi \log(c_a - \bar{a}) + (1 - \phi) \log(c_n), \tag{1}$$

where c_a is agricultural good (food) consumption, c_n is non-agricultural good consumption, $\bar{a}$ is a parameter representing a subsistence agriculture requirement, and ϕ governs the long-run share of expenditure on agriculture. These ”Stone-Geary” preferences ensure that food is a necessity, and consumed in higher amounts relative to the non-agricultural good when overall expenditure is lower.

Each agent is endowed with one unit of time, which she supplies inelastically to the labor market. Agents earn labor income y^i, which is described in more detail below. The budget constraint is

$$p_a^i c_a + p_n^i c_n \leq y^i \tag{2}$$

where p_a^i is the price of agriculture in region i, and p_n^i is the price of the non-agricultural good in region i.

B. Geography and Production

In the economy there are two regions, indexed by i, where $i = \{a, n\}$. Regions are defined by the type of good they can produce and thus correspond exactly with a sector. The agriculture (”rural”) region produces agriculture goods and the non-agriculture (”urban”) region produces non-agriculture goods. The production technologies in the regions are

$$Y_a = A_a L_a \quad \text{and} \quad Y_n = A_n L_n \tag{3}$$

where L_a and L_n represent the total number of labor units employed in the two regions.

Flows of goods between the two regions are subject to internal "iceberg" trade costs, represented by $\tau > 1$. This implies that for every τ units of a good that are shipped, only one unit arrives at a destination.

C. Optimization and Equilibrium

I. Producers

Perfect competition in production markets drives profits to zero and prices are set equal to marginal costs. The prices faced in each region are:

$$p_a^a = \frac{w^a}{A_a}, \quad p_n^a = \frac{\tau w^n}{A_n} \quad \text{and} \quad p_a^n = \frac{\tau w^a}{A_a}, \quad p_n^n = \frac{w^n}{A_n}$$

II. Consumers

Agents take prices and sector wages as given when they optimize. The problem for an agent is to pick which region to work in to maximize utility (1) subject to its budget constraint (2). Define $V(p_a^i, p_n^i, w^i)$ to be the indirect utility function for an agent choosing to locate in region i.

III. Equilibrium

An indifference condition is at the heart of the equilibrium of this economy. Because all agents are identical, they must be made indifferent between locating in the urban and rural regions. Mathematically this is

$$V(p_a^a, p_n^a, w^a) = V(p_a^n, p_n^n, w^n) \tag{4}$$

which implicitly defines an equilibrium relative wage $\frac{w^a}{w^n}$. Given an equilibrium relative wage $\frac{w^a}{w^n}$, the aggregate budget constraints for each region must hold:

$$L_a p_a^a c_a^a + L_n p_a^n c_a^n = L_a(p_a^a c_a^a + p_n^a c_n^a)$$

$$L_n p_n^n c_n^n + L_a p_n^a c_n^a = L_n(p_a^n c_a^n + p_n^n c_n^n).$$

These equations assure that income earned in each region equals total expenditure on the two types of goods. These equations pin down the relative sectoral employment shares

$$\frac{L_n}{L_a} = \frac{p_n^a c_n^a}{p_a^n c_a^n}. \tag{5}$$

Relative to trade models, equation (5) is reminiscent of a balanced trade condition. The key distinction here is that equation (4) pins down the relative wage necessary to make workers indifferent. Equation (5) determines the shares of workers needed in each sector to make payments balance.

4. Qualitative Features

In this section we characterize qualitative features of the model

A. Internal Trade Costs $\Rightarrow$ Wedge In Wages

In equilibrium, the relative wage between non-agriculture and agriculture is characterized by the following relationship:

$$\frac{w^n}{w^a} = \tau^{2\phi-1}\left\{1 - \frac{\bar{a}}{A_a}\right\} + \tau\left(\frac{\bar{a}}{A_a}\right) \geq 1 \tag{6}$$

Equation (6) says that the equilibrium relative wage in non-agriculture is larger than agriculture and the wedge between the two sectors characterized by the trade friction, the long-run expenditure share on agriculture (ϕ), the productivity of agriculture, and the subsistence consumption parameter.

To understand why this wedge arises, consider first the special case of homothetic preferences $(\bar{a} = 0)$. When preferences are homothetic, the wedge in wages equals $\tau^{2\phi-1}$ with ϕ being the expenditure share on agriculture goods. So when agriculture is relatively important $\phi > 0.50$ the non-agriculture wage is relatively higher. This is because agents care relatively more about agriculture and those those agents in non-agriculture must be compensated for facing trade costs for the good they care the most about. Note if $\phi = .5$, then there is no wedge in wages in spite of internal trade costs.

With non-homothetic wages, the intuition for the wedge is very similar to the $\phi > 0.50$ case with homothetic preferences. Agents derive (on the margin) more utility from agriculture goods than non-agriculture goods and hence those that locate in non-agriculture region need to be compensated for this.

B. Increasing Internal Trade Costs Shifts Labor Allocations To Agriculture

Proposition 1 summarizes that an increase in an internal trade costs shifts labor out of the non-agriculture sector and into the agriculture sector.

Proposition 1 *Let $\ell_a = L_a/L_n$. Then in the closed-economy model, increasing internal trade costs increases the share of workers in agriculture:*

$$\frac{\partial \ell_a}{\partial \tau} > 0.$$

This result is a straightforward implication of equation (6) and has the similar intuition. On the margin agents derive more utility from agriculture goods than non-agriculture goods and the more costly it becomes to consume agriculture goods in non-agriculture regions, more agents will want to locate in the agriculture region.

5. Extension to Open Economy

6. Internal Price Data

To estimate the size of internal trade costs in the developing world, we employ a set of regional price data from a sample of low-income countries. Our data comes from the World Bank's Living Standards Measurement Studies (LSMS), which include, for each country under study, observations on prices of commonly-purchased consumer goods from a large number of randomly-sampled locations. In urban areas these locations are typically a ”neighborhood” defined in a way similar to U.S. census tracts. In rural areas the locations are villages, or in some cases, village groups.

Table 2 lists the countries for which we have regional price data, the number of goods for which prices are collected, and number of locations in which they are collected. For most countries we observe prices of between 30 and 70 goods, and for several hundred of locations. While variation exists from survey to survey, the typical survey records three observations on each good in each locations, and reports the prices in local currency units per kilogram.[4]

To measure internal trade costs in each country, we first classify all surveyed locations into two aggregated areas: the ”urban” and ”rural” areas. The urban area is set to be the city with the largest international sea port or airport. The rural area is defined to be all other regions. This choice is made to capture the relatively low access to international markets that come with having a large port. While this classification is somewhat subjective, in practice the urban area in most countries is the capital city, which is often far larger than any other city, and in most cases has both the largest airport and seaport in the country.[5]

We measure trade costs using these regional price data in two basic ways. The first, which we call the ”no arbitrage” approach, computes the maximum price difference between the urban and rural regions over all goods in the sample. This method, which has been used by Eaton and Kortum (2002) and many other papers which use similar models, works through an arbitrage argument. The argument in short is that If trade costs were lower than the largest price difference, there would be an arbitrage opportunity for middlemen to ship the good from the cheap region to the expensive one. Thus, the maximum price difference puts a lower bound on the size of the internal trade costs. See Simonovska and Waugh (2011) for a method (which we plan to follow in the current paper) to estimate trade costs using this basic argument when the number of goods for which prices are available is small.

The second way to estimate trade costs we call the ”known source” approach, and looks for price differences in goods for which the source of production is known with certainty. This is the methodology used by Donaldson (2010) for example, who uses salt prices and knowledge

[4] For certain goods, such as eggs or one-liter bottles of cooking oil, prices are reported as a number of local currency units per good.

[5] For example Abidjan in Cote D'Ivoire, Accra in Ghana, and Dar es Salaam in Tanzania.

Table 2: Internal Price Data

Country	Year	Number of Goods	Number of Locations
Albania	2005	66	450
Azerbaijan	1995	33	91
Cote d'Ivoire	1987	54	160
Ghana	1999	164	300
Guatemala	2000	66	745
Ecuador	1998	64	570
Kazakhstan	1996	30	200
Kyrgyz Republic	1998	88	255
Malawi	2005	46	564
Morocco	1991	74	420
Nicaragua	2005	84	587
Pakistan	1991	15	300
Panama	2008	69	800
Peru	1985	7	362
South Africa	1993	55	360
Tanzania	1993	49	222
Vietnam	1998	38	3000

of the few sources of salt that existed in India during the period he studies. One challenge with this method in the present study is that few such goods are available in most countries. However, some do exist, and typically they are food goods explicitly recorded as ”local.” For example, prices of ”local rice” and ”local maize” are report in several of the studies. Since these goods are grown in the rural area, one can look at the difference between prices of these goods in the rural and urban areas for direct estimates of trade costs.

We also supplement our trade-cost estimates where possible with direct estimates of ”marketing costs” for agricultural goods. For example Gollin and Rogerson (2009) construct a measure of internal trade costs in Uganda using studies that measure prices of maize from the farm gate, through primary and secondary wholesale markets, to final retail destinations in urban centers. These studies, where available, provide an opportunity to cross-check the estimates that we compute using the no-arbitrage and known-source approaches and our regional price data.

7. Example: Cote D'Ivoire

As an example, we describe in more detail what we estimate for Cote D'Ivoire, which had an LSMS survey conducted with rich price data in 1987.[6] We set the urban region in Cote D'Ivoire to be Abidjan, which is the capital and largest city in the country, with a large port and international airport nearby. Abidjan is unambiguously the center of international trade, with all major internal trade routes directed in and out of it.

By the no-arbitrage method we estimate that $\tau = 2.5$, which corresponds to cassava, a staple starch for west Africans. The known-origin method yields a $\tau = 2.1$, for the good "local maize." While some maize consumed in Cote D'Ivoire is imported, local maize is, by definition, grown in the rural areas and then either consumed locally or shipped to the city. The average price being 2.1 times as high in Abidjan as the rural areas gives us the estimate of the trade cost using this method. Thus, we conclude that the internal trade costs in Cote D'Ivoire correspond to a τ of at least two.[7]

[6] Note that all other countries in our sample have more recent data than this one.

[7] These calculations use the mean price for each good for each area. Alternative calculations using the median price in each area yield similar results. The max price difference is still for cassava, and the implied τ is 2.4. The median price for local maize is 1.9 times higher in the urban than the rural area, implying a τ of 1.9.

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