The Dynamics and Differentiation of
Latin American Agricultural Exports[*]

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Abstract

In recent years, Latin American and Caribbean (LAC) agricultural exports have steadily gained global market share without much deepening in overall agricultural specialization. This paper documents the composition of LAC's specialization patterns among products with different degrees of processing. Using various methods to classify products as either "upstream" or "downstream," we show that both types of products have contributed meaningfully to LAC's recent increases in market share. We also show that, controlling for global trends in specialization among upstream and downstream products, LAC exporters have been deepening specialization in downstream products. We discuss these patterns in the context of a structural model of multi-stage production with international trade.

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Over the past several years, the share of world agricultural exports supplied by Latin American and Caribbean (LAC) countries has increased by roughly one half, from 8 percent of total agricultural exports in 1994 to almost 12 percent in 2008 (see Figure 1).[1] At the same time, the contribution of agricultural products to overall LAC exports fell by one third, or about 10 percentage points, in line with the shrinking global share of agricultural trade (see Figure 2). Another interpretation of Figure 2 is that LAC has not substantially deepened its specialization in agricultural production and exports. Dividing the agriculture share for LAC by that of the rest of the world yields a measure very close to the revealed comparative advantage (RCA) index by Balassa (1965); the flatness of the ratio of the two series (i.e., LAC's agriculture share is always about 2 times that of the rest of the world) indicates that LAC's overall RCA in agricultural goods has remained fairly stable. Thus, overall LAC agricultural exports are characterized by a consolidation of global market share without a corresponding deepening in specialization.

The above configuration of share changes, discussed in further detail in the next section, is not straightforward to elucidate using standard explanations of international trade patterns. For example, a change in LAC's agricultural comparative advantage, say, through productivity improvements in agricultural methods or alternatively through the increase in arable land endowment, would increase *both* the region's market share and sector specialization. Likewise, in a model with 'home market' effects and where increasing returns to scale are particularly large in agriculture, the growth of the home economy relative to other countries will give rise to a higher global export share in all products *and* a greater degree of agricultural specialization.[2] Possible narratives that would give rise to increasing market share and stable specialization in agricultural products include when *all* of a country's export industries undergo productivity improvements or, analogously, if home market effects are similar across industries and the

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[1] This statistic was tabulated using the aggregates of a bilateral product level trade dataset described below, and includes trade between countries within LAC.
[2] For intuition, consider sector-specific gravity equations where the home country income elasticity of exports is larger for the agricultural sector than the manufacturing sector. Growth in home income would, all else equal, increase LAC's market share and degree of specialization.

country is growing relatively fast.[3] In these instances, a country will sell more relative to other source countries in all industries; market share would rise across the board, but specialization measures would appear flat. LAC's experience over the past two decades suggests that innovations in income and overall productivity have contributed significantly to its export success.

This observation, in turn, is linked to the growing empirical literature on product upgrading, which is the manufacture of higher quality varieties within a given product group. Recent papers on the quality differentiation of traded goods draw explicit links between the productivity or income levels of a producer and the corresponding quality level of their output. For example, Manova and Zhang (forthcoming) illustrates with Chinese firm-level data that firms selling higher priced varieties of a given product tend to have higher revenues and a greater number of export destinations. Similar patterns for the unit values of U.S. exports are demonstrated in Baldwin and Harrigan (2011); export unit values are positively related to destination distance and negatively related to destination market size. These patterns suggest that an important channel by which exporters garner sales is by offering higher priced, higher quality varieties and, further, that relatively productive firms are the ones that furnish high quality varieties to the export market. Factor endowments and income are also closely related to the quality of exports. Schott (2004) estimates that U.S. import unit values are higher for varieties originating in capital- and skill-abundant countries than they are for varieties sourced from labor-abundant countries.

Could quality upgrading be behind the rapid rise in LAC market share for agricultural products? The second section of the paper briefly addresses this question by measuring the level of differentiation of agricultural exports at the level of detailed products. We find that, on average, there is limited evidence of differentiated varieties within agriculture product groups. In

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[3] In the case of ubiquitous productivity improvements, lower marginal costs give rise to higher export sales, while in the case of home market effects, scale economies allow firms to move down their average cost curve.

other words, consistent with conventional wisdom, agricultural exports are relatively homogeneous products. This finding preempts much of the discussion of upgrading *within* product groups since some degree of differentiation is necessary for a new variety to acquire a non-trivial market share (conditional on its price).

Subsequent sections of the paper investigate a second type of product upgrading, the manufacture of product groups with relatively high degrees of processing and value added. The theory behind why this type of *inter*-product upgrading would occur is a natural extension of the above literature on *intra*-product quality differentiation. Whereas within a product group, high productivity firms have a cost advantage in producing high quality varieties, two product groups related through input-output links may exhibit a similar pattern if an exporter has relatively high productivity in an upstream product. For instance, suppose that there are two broad agricultural sectors: grains and meats. Grains are important inputs for the production of meats (i.e., as feed for livestock), but meats are not used as inputs to producing grains. Given this structure of production, the existence of high average productivity in grains would lead to relatively high grain exports, as well as a corresponding input cost advantage, and relative export success, in downstream meat industries. Therefore, one might expect that the export successes of grains and meats are linked.

The notion of downstream linkages across products is related to yet another strand of the international trade literature focused on the international outsourcing of intermediate inputs and the associated concept of vertical specialization (i.e., the use of imported inputs in producing goods which are then exported). Trade in intermediates provides an amplification mechanism for trade, as component goods cross borders multiple times for a given amount of final demand. The implications of this type of trade for the volume of trade, the value added content of trade and relative wages are illustrated, respectively, in contributions by Hummels, Ishii and Yi (2001), Johnson and Noguera (2011) and Feenstra and Hanson (1996). The relevance of intermediates to

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the present study is that the location of production matters when analyzing trade performance using the market share of gross trade flows. In the above example, if both grains and meats are tradable, then it will not necessarily be the case that a country with comparative advantage in grains exports meats, or even supplies its own domestic demand for meat. Therefore, one would expect that high productivity in an upstream sector bestows an advantage on the exports of downstream products *conditional* on the level of domestic vertical specialization in the industry. We explore the input-output relationship between industries further in the third section, in a model of multistage production with international trade.

In the fourth section, we document whether *inter*-product upgrading can account for part of LAC's recent market share increases. That is, could LAC's increasing market share reflect the changing composition of its exports, from low value upstream product groups to high value downstream products? Answering this question involves the complicated task of sorting industries into stages of production, which is not nearly as simple at the level of granularity of industry trade data as it for the broad groups of grains and meats above. We suggest two categorization schemes of bilateral trade data by stage of production. First, the textual descriptions of agricultural export products are used to infer their level of processing according to a set of keywords. For example, categories containing the words, "prepared" or "processed" are assumed to be farther downstream in the value chain of production than those containing the words, "raw" or "fresh". Using these categories, we find that LAC agriculture exports are more specialized in less-processed, upstream stages of production and that there have not been any consequential changes in specialization across stages over the course of the sample.

The second categorization scheme takes a more holistic approach of the input-output structure of production by assigning stages to the entire set of industries in the input-output table, both agricultural and non-agricultural. We utilize the concept of forward flow, which is the amount of output from upstream stages used as inputs to downstream stages *minus* the reverse

flows of outputs from upstream stages used as inputs to downstream stages. Industries are assigned to stages in order to maximize the overall forward flow across all industries in the economy, and we characterize a unique maximum to the 2-stage system for 203 industries in the U.S. input-output table. We then apply these categories to LAC export products. Interestingly, and in contrast to the keywords classification, the net forward flow classification scheme indicates that LAC is already specialized more in downstream products than upstream products, though the extent of downstream specialization has been declining over the past 15 years. Unfortunately, input-output information is not available for the LAC countries themselves at the level of granularity necessary for the net forward flow calculation. Repeating the procedure using the Thai I-O table applied to LAC exports, the level of specialization in upstream and downstream products is in between that of the keywords and U.S.-based net forward flow classifications, though specialization trends over time are quite similar to the U.S.-based measure.

Finally, we compare the dynamics in LAC agricultural specialization to those of the rest of the world by documenting the trend growth in RCA for each country by stage of production. We find, according to either classification scheme, that changes in LAC specialization have been more downstream-oriented relative to the rest of the world. We also find that downstream specialization is decreasing more slowly in LAC than in the rest of the world. The fact that changes in LAC specialization have been less tilted towards upstream products compared to other countries is consistent with the prediction of the multi-stage production model in which upstream productivity increases the size and market share of downstream product exports.

The paper is organized as follows. Section 1 describes recent trends in LAC's market share of world agricultural exports as well as the corresponding share of agriculture in total LAC exports. Section 2 documents the degree of differentiation within narrowly defined product groups. Sections 3 and 4 lay out the theory and empirics of inter-product specialization. Section 5 concludes.

1. Trade in agriculture and LAC, 1994-2008

As further motivation for analyzing the differentiation of LAC agricultural exports, it is informative to decompose LAC's increasing market share and the decreasing agricultural share of LAC exports into contributions from more disaggregate products as well as individual countries. The shaded areas in Figure 1 show the contributions of specific industries, classified at the SITC 2-digit level of aggregation, to LAC's aggregate share of global agricultural exports.[4] Each shaded area is the LAC market share within a 2-digit category, scaled by the size of that category in global agricultural exports. The largest four contributors in 1994 (Fish, Feeding Stuff, Coffee, and Fruits/Vegetables) accounted for roughly half of LAC's 8 percent market share. The next five largest (Oil Seeds, Textile Yarn, Meat, Vegetable Fats and Sugar) accounted for an additional 2 percentage points.

Interestingly, these two sets of products exhibited very different growth patterns over the subsequent 15 year period. The contribution of the former group of large incumbent export products was virtually flat through 2008, accounting for only 5 percent of the 3½ percentage point increase in market share. Meanwhile, the latter group of smaller contributors grew robustly, accounting for almost three quarters of the increase in the share. This growth pattern implies that LAC's export share was much more evenly distributed across products by 2008 than it was in 1994. Moreover, the fact that the bulk of share growth took place in smaller, less-established product categories as opposed to larger, incumbent product groups suggests an important role for newly added varieties and/or growth in relatively new product groups for LAC's rapid share increases. The exercises in the following sections will search for evidence of this type of dynamism within and across products.

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[4] Bilateral industry-level trade flows for merchandise are based on National Bureau of Economic Research-United Nations (NBER-UN) Trade Data compiled by Feenstra, Lipsey, Deng, Ma, and Mo (2005). Robert Feenstra kindly furnished a preliminary version of an updated dataset running through 2008. For lists of included SITC industries and LAC countries, see the Appendix.

Taking an alternative cut of the data shows the extent to which LAC countries depend on agricultural products for export sales. While Figure 2 illustrates the downward trends in the fraction of exports accounted for by agricultural products in LAC and the rest of the world, Figure 3 decomposes the LAC statistics into relative contributions from individual countries. Specifically, each shaded region is the fraction of a country's exports accounted for by agricultural products, scaled by the country's size in total LAC exports. Figure 3 illustrates the heterogeneity in how LAC countries' dependence on agriculture has evolved over time. Through the year 2000, virtually all exporters contributed less to the overall dependence of LAC on agriculture. In contrast, while most countries continued shrinking their fraction of agricultural exports, Brazil and Argentina combined contributed positive 3 percentage points to the region's agricultural share. This pattern implies that, for the majority of LAC countries, the degree of specialization in agricultural products has remained fairly stable even at the level of individual countries, and does not point to country-specific factors as predominantly accountable for the growth in LAC's agricultural export sales. For two notably large exceptions, Brazil and Argentina, specialization appears to have increased in recent years.

2. <u>Intra-product upgrading</u>

Intra-product upgrading refers to the process of producing and marketing new varieties within a given industry. In principle, new varieties can play an important role with regard to development goals and outcomes, as argued in the seminal works of Aghion and Howitt (1992) and Grossman and Helpman (1991) as well as many subsequent contributions. In those two theoretical models, new varieties of a product are ordered in a sequential quality ladder, with monopolistic rents accruing to the producer of a new variety. A logical empirical starting point in our exploration of new agricultural varieties is to document whether or not agricultural products are in fact differentiated. The conventional notion that most agricultural products are composed of fairly homogeneous varieties should not necessarily be a foregone conclusion. It was

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demonstrated in Mandel (2009) that some primary commodities, such as metals, have as much product differentiation as certain manufactured products.

We begin by revisiting two measures of product differentiation from Mandel (2009) to evaluate the degree of differentiation in agricultural commodity exports. The first measure looks at the dispersion of U.S. import transaction prices within narrowly defined (i.e., Harmonized System 10-digit) product categories; the idea is that relatively differentiated products should have lower elasticities of substitution, and hence larger price differences across varieties within a product, than more homogeneous products. Figure 4 shows the standard deviation of import transaction prices (within an HS10 and in logs) averaging across products within major sectors.[5] It is evident that most agricultural goods have relatively small price deviations within narrowly defined categories, with vegetable, wood, animal and foodstuff products having standard deviations of price of less than 50 log points, compared with transportation, electrical machinery and mechanical products which have standard deviations of over 100 log points, on average. If anything, agricultural products have a price distribution profile much closer to that of textiles, footwear and headgear, than to mineral products, transportation and machinery. Moreover, in addition to prices being less diffuse within a given HS10, the variance of prices across products is also markedly lower for most agricultural products. This is illustrated by the vertical lines in Figure 4, which represent the interquartile range of price variance across HS10 within each sector.

A potential problem that would confound the interpretation of price dispersion as a measure of product heterogeneity is that the size of the standard deviation of prices depends on how the HS10 codes are defined. That is, if the specificity of HS10 codes varies across sectors (say, if

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[5] The transaction price data for U.S. imports is from the International Price Program (IPP) at the U.S. Bureau of Labor Statistics. The IPP is a survey that collects the prices of approximately 15,000 imported items per month. To calculate the price dispersion within Harmonized System 10-digit products, attention is restricted to the IPP HS10 products with greater than 5 item observations per product, per month, and within a given unit of measure (e.g., kilo, unit, container). The standard deviation for items within each of these cells is computed and then averaged across products, months and units of measure within a sector using import sales weights from the IPP database.

agricultural products are on average more narrowly defined than manufactures), then more

narrowly defined sectors will have, by construction, lower price dispersion. Moreover, since the

price data in Figure 4 are U.S.-specific, it would be preferable to have a more global statistic.

The second measure of product differentiation mitigates both of these potential measurement

errors by using an alternative classification scheme for products and bilateral trade data covering

the majority of global trade flows.[6] It is an index of intra-industry trade, the incidence of which

should be greater for product varieties that are less similar, ceteris paribus.[7] As shown in Figure 4

for SITC 1-digit sectors, mineral and agricultural products tend to have a relatively low incidence

of intra-industry trade (low levels of product differentiation) while manufactured goods,

machinery, transportation goods and chemicals all tend to have a relatively high incidence of

intra-industry trade (high levels of product differentiation). This hierarchy has tended to be fairly

stable over time, as shown by the similar index values in 1994 and 2008.

Taken together, Figures 4 and 5 document a relatively high degree of homogeneity of

varieties within agricultural products, which suggests a relatively limited role for the production

of new differentiated varieties as a means of gaining market share.

3. <u>A model of multi-stage production</u>

The following sections explore the theory and evidence of export dynamics in the presence of

multiple stages of production and traded intermediate goods. As distinct from intra-product

upgrading, in which a new imperfectly substitutable variety is created, inter-product upgrading

involves increasing specialization in downstream or more highly processed products. For

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[6] The trade data used to compute this measure of differentiation, and for all subsequent international trade flow analysis
in this paper, is due to Feenstra et al. (2005). For the years 1994-2008, the data consist of import and export dollar
values for roughly 1,000 SITC 4-digit product categories and 240 countries. SITC 4-digit categories are more
aggregate than HS10 product categories and do not change as frequently over time. The fact that the SITC codes are
more stable implies that they are less linked to trade volume and so they likely offer a different degree of specificity
relative to HS10.
[7] The simultaneous import and export of varieties in the same product would also be increasing in the size of trading
partners.

example, a fruit producer moving into the concentrate and juice business would constitute an upgrade in this sense.

Yi (2010) provides a parsimonious Ricardian model of trade with multiple stages of production. In the Heckscher-Ohlin framework with monopolistic competition suggested by Amiti (2005), there are multiple sectors with input-output linkages. Both of these models are informative for our purposes since they make an explicit connection between the quantities of exports in upstream and downstream industries. Specifically, both of these models weigh the relative importance of two opposing forces: comparative advantage and input-output linkages. In the absence of input-output linkages, specialization patterns are driven exclusively by comparative advantage. Multistage production introduces the possibility that the comparative advantage in upstream industries has a bearing on the location of downstream industries, an effect operating through the input-output table.

In the special case studied in Yi (2010), there are two countries, and two stages of production for each good in a continuum of goods. The set of products whose second stage occurs in the Home country (versus the Foreign country) depends on relative Home productivity, which is specific to each stage and product. The equilibrium of the model is a cutoff in the continuum of products, below which both the first and second stage of production take place at Home and above which the first stage of production takes place at Home and second stage takes place in Foreign. Since both countries consume all varieties along the continuum, this cutoff determines the extent of trade between the two countries. Of note, this model implies an amplified amount of trade relative to one without intermediates because for a range of goods, the export of the final output involves the import of intermediate inputs.

The objective of the model as applied to LAC agricultural exports will be to derive a structural expression for changes in output resulting from increases in the relative productivity of

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an upstream (i.e., stage 1) product. This model provides clues for how to discern between these two modes of production in the data. For instance, in the absence of domestic vertical specialization, increased productivity in stage 1 at Home would lead to more exports of stage 1 products and more imports of stage 2 products. Home's stage 1 market share would increase and its stage 2 market share would decrease. Alternatively, in the presence of input-output linkages, market share in both stages would increase due to higher productivity in the upstream sector, an effect that we show is increasing in the extent to which stage 1 and stage 2 are integrated in the domestic economy.

The benefit of taking a structural approach is to not have to make the assumption that production of downstream products is inherently better. Rather, downstream specialization arises quite naturally as a result of input-output linkages and comparative advantage in upstream products. That said, the model abstracts from several important reasons why downstream production *would be* inherently more attractive to producers. For instance, manufactured byproducts of agricultural goods may have higher levels of complexity and sophistication than the raw agricultural inputs. Alternatively, if downstream products are relatively differentiated, firms could charge higher average markups and earn a higher surplus compared to the firms producing upstream inputs.

The following section describes a two-country world in which both countries trade in final goods as well as intermediate inputs. In doing so we illustrate how a productivity innovation affecting the factor specific to the input sector in the Home country also affects the broader structure of production and trade. Specifically, we gear our setup to evaluate the extent to which increased productivity in input production in a low-skill, labor-abundant country both deepens its comparative advantage in low-skill intensive inputs and also improves the productivity of its production of downstream final goods. When there is trade in both intermediate inputs and final goods, and when there are specific trade costs, we show that an increase in intermediate input

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productivity leads to increases in the output, and global market share, of both intermediate and final goods, though the magnitude of these effects is conditional on the size of trade costs, the relative prices of other inputs, and the factor abundance of each country.

3.1 Structural Framework

The model is defined by the following assumptions. First, there is a single final good sector, *Y*. To produce output workers costlessly assemble intermediate inputs to produce a composite good, *m*, and combine the composite with high-skill labor, *h*, in the following Cobb-Douglas production function:

(1) $$Y = Am^\theta h^{1-\theta}$$

where A is a technological parameter and θ is the cost share of the intermediate composite.

Workers face a perfectly competitive labor market and are endowed with one unit of labor that is expended producing the individual intermediate inputs that are then combined to produce the intermediate composite good. High-skill workers, *h*, and low-skill workers, *l*, are required to produce each intermediate input. The range of inputs required to produce the composite is normalized to a 0 to 1 continuum, $i \in [0,1]$. Intermediate input production is defined by the relative amount of high- and low-skill labor required in production so that a unit of intermediate input *i* can be produced at the cost *c(w,q,i)*, where *w* is the low-skill wage and *q* is the high-skill wage.

Not all of the intermediate inputs need be produced in the Home country. Specifically, we assume a second Foreign location, denoted by asterisks, in which final output is given by *Y** and inputs can be produced at a unit cost of *c*(w*,q*,i).* It also assumed that the Home country is relatively abundant in low-skill labor, and therefore pays a lower relative price for low-skill workers—i.e., *(w/q) < (w*/q*).* With perfect competition in the market for intermediate inputs, it

follows that there exists a marginal input, denoted *I*, such that inputs $i < I$ are produced at Home, while $i > I$ are produced in Foreign. Figure 6 illustrates this equilibrium[8].

We can now consider what happens when there is a productivity shock to the intermediate input sector in the Home country (a reduction in the unit cost of producing inputs, *c(w,q,i))*. Specifically, we consider the case where the productivity shock affects the production efficiency of low-skill labor, which is specific to intermediate production. From Figure 6 it is evident that the cost curve *CC* will shift downward, as unit production costs will now be lower for all intermediate goods at Home, leading to a rightward shift in the marginal input, *I*. The result is a "deepening" of the country's specialization in the production of inputs. In other words, a wider range of inputs will subsequently be produced in Home[9].

We will also refer to this deepening as an increase in the extent of *domestic vertical integration*, a key idea in the empirical analysis below. As more intermediates are produced at Home the domestic supply chain is further integrated and the output of intermediates is more closely linked with the output of final goods in that country. With the Home country now more deeply specialized in the production of inputs, and the domestic economy more vertically integrated, we can also analyse the impact of this same productivity shock on the production of final goods in the Home country. Setting total (global) sales equal to total aggregate expenditure, we have that

$$P_Y[Y^* + Y] = E$$

where E is aggregate expenditure on both goods. To simplify, we assume that world expenditure on all goods, E, is the numeraire and set it equal to 1.

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[8] See Feenstra (2004) for a more full discussion of this simple model. In addition, Feenstra and Hanson (1996) prove that the cost curves will cross once, and only once.

[9] Note that the fact that the shock is neutral implies that there is no rotation of the cost curve—i.e., all intermediate goods benefit equally from the productivity shock.

We now assume that trade between the countries incurs specific trade costs, which we denote T. Perfect competition in the final goods market means that prices are equal to marginal costs, and so we can re-write the equilibrium condition above as:

(2)
$$Y = \frac{1}{Ic(w,q,i)+(1-I)[c^*(w,q,i)+T]+qa_h}$$

(3)
$$Y^* = \frac{1}{(1-I)c^*(w,q,i)+[Ic(w,q,i)+T]+q^*a_h^*}$$

where the denominator in each of these conditions reflects unit (marginal) costs paid by the final good industry.

First, note that the productivity shock to the cost of intermediate input production at Home, discussed previously, will also affect final goods production. Furthermore, since there is trade in intermediate inputs, *both* countries reap the benefits of this productivity gain in their production of final goods (through a reduction in *c*, affecting both (2) and (3)). However, with specific trade costs these productivity gains will be diluted for the Foreign country and the Home country will reap *relatively* larger productivity gains.

To see this, we can first simplify conditions (2) and (3) by assuming that all inputs are produced in Home, thus setting the marginal input, *I*, equal to 1. Then, differentiating (2) and (3) with respect to the Home unit cost of inputs and taking the ratio of the two, we have

$$\frac{\partial Y}{\partial c} \Big/ \frac{\partial Y^*}{\partial c} = \frac{[c(w,q,i)+T]^2}{[c(w,q,i)]^2}$$

Thus, higher specific trade costs (T) increase the relative output gains for Home when there is a fall in the unit cost of producing inputs. As a result, the Home country produces relatively more final output due to the productivity shock, even though both countries final output goes up[10].

It is important to note that in the situation described—a productivity shock under vertical integration—the intermediate input sector will also increase output due to the shock. In fact, the input sector and the final good sector are inextricably linked given our assumption that all production in the input sector is used by the final good sector. From equation (2) we know that any increase in low-skill labor productivity in the input sector must lead to an increase in final good output (via a reduction in $c(w, q, i)$). And from equation (1) it is clear that any increase in final good output must be accompanied by an increase in the supply of intermediate inputs. Thus, both sectors must expand output in the wake of the productivity shock.

The following propositions summarize our main results in the case of a shock to intermediate input production at Home.

Proposition 1: A productivity shock to Home *intermediate input* production will lead to an increase in Home market share in *inputs*.

Proposition 2: When there is vertical specialization and countries face specific trade costs, a productivity shock to Home intermediate input production will cause both Home and Foreign exports of final goods to increase—however, the increase will be relatively larger for both in Home, and thus Home will gain market share in final good output. Furthermore, the magnitude of the effect on final good output is increasing in the extent of domestic vertical integration (the share of inputs produced at Home, *I*) as well as specific trade costs.

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[10] Note that this is possible due to the fact that world demand has gone up as the result of the fall in output prices that accompanies the reduction in unit costs. So both countries are able to produce more output, though market share for Home output also increases at the expense of Foreign.

Proposition 3: *When there is no vertical specialization*, a productivity shock to Home intermediate input production will lead to a decrease in final output, and global market share of the final good, in Home and will lead to increase final output and market share in Foreign.

The first proposition follows directly from the model presented above in which a reduction in unit costs at Home leads to increased specialization in input production, as depicted in Figure 6. The second proposition also follows from the discussion above. Note that the magnitude of the effect for final good output increases with domestic vertical integration because, from equation (2), the effect on final output in Home from a reduction in $c(w, q, i)$ is weighted by the share of inputs acquired from Home suppliers, denoted by I.

The third proposition presents the limiting case of no vertical integration. Since it is not a case easily nested in the framework above, we provide only a sketch of the proof. That intermediate input production rises and final goods production falls is an illustration of specialization due to comparative advantage. Technically, it follows from an application of the Rybczynski Theorem: if we consider the productivity shock to low-skill labor at Home as an increase in the effective endowment of low-skill labor, then the Rybczynski Theorem dictates an increase in the output of the intermediate input sector *at the expense of* the final goods sector.

In summary, Propositions 2 and 3 provide clear predictions regarding the response of intermediate input and final good exports to a productivity shock in the input sector under differing degrees of domestic vertical integration. Generally, the model illustrates that a productivity shock to upstream production leads to an expansion of both the upstream and downstream (input and final good) sectors under domestic vertical integration, and an increase in the input sector market share at the expense of the final good sector market share when there is no vertical integration. In the first case, global market shares increase in both sectors, though the

magnitude of this effect depends on several parameters, such as the extent of domestic vertical integration and the size of specific trade costs between the countries.

4.   Inter-product upgrading

Our empirical exploration of inter-product upgrading patterns involves measuring LAC specialization patterns at various stages along agricultural product value chains. Unlike in the stylized model environment from the previous section, we do not actually identify an upstream productivity innovation in the data. Rather, we start from the premise that LAC, as a large land-abundant producer, has comparative advantage in upstream sectors of raw materials. The empirical question to be examined is whether this upstream comparative advantage translates into success in downstream products and, further, whether downstream market share and specialization have been evolving over time.

Specialization *within* the agricultural sector at the level of upstream and downstream products requires identifying sequences of agricultural products ordered by their stage of production, between raw input and final output. In the following sections, we will define two value chain classification schemes in which we identify each SITC product in the agricultural international trade data as either stage 1, denoting an upstream industry, or stage 2, denoting a downstream industry.

4.1 Ad hoc classification by keywords

The first classification uses the textual descriptions of SITC 4-digit categories to discern their position along the value chain. This strategy is made possible by the use of certain keywords in the product descriptions that describe the extent of processing of that product. As an illustration, Figure 7 shows the descriptions for all of the 4-digit categories within SITC 34 through 37: fish and crustaceans. It is clear by visual inspection that certain words denote relatively low amounts of processing, while other words denote relatively high amounts of processing. 'Live' and 'fresh'

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in the top panel of Figure 7 are indicators of minimal amounts of processing beyond the catching

and/or raising and of the fish. For the products in the bottom panel, words like 'preserved' or

'preparations' are indicative of the transformation of the raw input into a manufactured fish

product. Conveniently, in the case of fish and crustaceans, as well as in many other product

groups, the disaggregate product classifications are already sorted from low to high processing; as

such, keywords are used merely to identify a logical 'cutoff' product, below which products are

counted as stage 1 and above which products are counted as stage 2. In this manner, we

categorize the vast majority of the 347 4-digit categories included in the analysis of agricultural

products.

A few general patterns emerge from this sorting. First, a large number of food products

divide neatly into raw foods and food products, along the lines of the fish industries above.

Another example of the upstream-downstream distinction is the relatively clean divide in

vegetable-based products groups between raw seeds, nuts and oleaginous fruits, and downstream

cakes, oils and waxes. Similarly intuitive cutoffs emerge between: (i) types of animal hides and

leather products downstream, (ii) wood products and pulp/paper byproducts, and (iii) types of

cotton and wool and the yarn, fabric or textiles made thereof. Admittedly, the share of stage 1

versus stage 2 goods is somewhat ad hoc and will depend on the number and type of products

which are included in the definition of agricultural products. In this paper, we apply a relatively

broad definition of agricultural products, which not only includes agricultural raw materials, but

the closest manufactured goods downstream to those raw materials. Were we to narrow the

definition of what is an agricultural product, it would have a bearing on the share of stage 1 and 2

products. Below, in the second classification scheme, the allocation of products to stages will be

based on *all* of the products in the input-output table and therefore will not depend on the

definition of the subset of agricultural goods.

Applying this classification by keywords, Figure 8a illustrates that both stage 1 and stage 2 categories contributed meaningfully to LAC market share and LAC market share growth between 1994 and 2008. Stage 1 products accounted for 4.8 percent, or roughly 60 percent, of LAC's agricultural market share in 1994, growing 2.3 percentage points thereafter. Stage 2 products accounted for 3.2 percent of LAC's market share in 1994, growing 1.2 percentage points thereafter. The relative growth contribution of products in the two stages maintained the 60/40 split between upstream and downstream export sales throughout the sample.

We can also examine the extent to which LAC exporters are specialized in upstream or downstream products by computing a Balassa RCA index of the following form for the nominal exports (X) for each country (k) and each stage:

$$RCA_k^{stage} = \frac{\left(\frac{X_k^{stage}}{X^{stage}}\right)}{\left(\frac{X_k}{X}\right)}$$

This index is simply the country's market share in a stage divided by that country's share of total agricultural exports.[11] Since LAC's market share of stage 1 exports is greater that its market share of stage 2 products, as shown in Figure 8a, LAC's stage 1 RCA will be greater than one and its stage 2 RCA will be less than one; this is illustrated by the hatched lines in Figure 9. As alluded to above, the market share of stage 1 products grew in line with their proportion, which made the LAC RCA in each stage fairly stable over the sample period. The estimated degree of specialization is consistent with a standard (if stereotypical) narrative about resource-abundant developing countries: that their level of output depends heavily on primary goods with a lower degree of value-added and sophistication. Moreover, unlike the upstream-downstream spillovers described in the model, there is no indication from this classification that specialization in stage 1

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[11] Note that the expression for RCA can be arranged so that the numerator is the share of a country's exports in a given stage and the denominator is the share of world exports in that stage. This exposition is the one used in the introduction to argue that LAC has not been deepening its overall export specialization in agricultural products.

products has given rise to an increasing proportion of exports of stage 2 products. Such a trend would be reflected in the increasing RCA of stage 2 products and the decreasing RCA of stage 1 products.

There are several potential measurement issues that may be influencing the way that industries are assigned to stages by keywords. First, for many products the classification is not as cut and dry as in the grains-meats example above. That is because when there are more than two stages, the placement of intermediate stages is arbitrary. For instance, if a certain value chain can be sliced into three intuitive stages, there is no clear rule dictating the placement of the middle stage. Consider the animal-hide-leather complex. It is not obvious whether hides should be stage 1 or stage 2; they are downstream to animals and upstream to leather.

A second source of possible error in the classification scheme is that it does not account for the many other inputs of production outside the set of agricultural products. The share of non-agricultural inputs to production would likely alter the relative input intensity of a given industry, given that the distribution of those inputs is not uniform across agricultural industries. To illustrate this point, Table 1 shows the composition of input source sectors for four agricultural sectors in the Brazilian I-O table (IBGE, 2012): Agriculture and Forestry, Animal/Fish Products, Foods and Beverages and Tobacco Products. Each column shows the distribution of inputs for a sector.

From Table 1 it is evident that the non-agricultural inputs, Chemicals and Other, are used unevenly across agricultural sectors. For example, 77 percent of inputs in Agriculture and Forestry are non-agricultural (primarily chemicals used for fertilizer), compared with only 24 percent for Foods and Beverages. While the majority of inputs in Animal/Fish, Food/Beverage and Tobacco come from other agricultural industries, the non-agricultural share ranges from 24 percent to 37 percent of total input value. These observations suggest that using only agricultural

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sectors to allocate industries to stages could potentially understate the input-intensity of
Agriculture and Forestry, as well as the other sectors intensive in non-agricultural inputs.

	Intermediate Usage by Sector			
Input Sector	Agriculture and Forestry	Animal and Fish Prods.	Foods and Beverages	Tobacco Products
Agriculture and Forestry	20%	16%	27%	55%
Animal and Fish Products	0%	10%	23%	0%
Foods and Beverages	3%	42%	26%	0%
Tobacco Products	0%	0%	0%	8%
Chemicals (incl. Fertilizers)	50%	13%	1%	1%
Other	27%	19%	23%	36%
	100%	100%	100%	100%

Table 1: Composition of input usage by sector (Brazil I-O table, 2005)

Another compositional issue that could taint the keyword stage classification in an analogous
way is the unevenness of input usage across non-agricultural input sectors. For example,
Chemicals are used intensively in Agriculture/Forestry and Animal/Fish, but barely at all in
Foods/Beverages and Tobacco. The true input-intensity of the former two sectors will depend on
the relative size of Chemicals versus Other inputs. In the next section, we attempt to address
these shortcomings by using the entire list of industries in the U.S. input-output table to construct
a measure of agricultural input intensity.

4.2 Maximizing net forward flow

The second characterization of industries exploits the concept of "net forward flow", an idea
used recently by the Bureau of Labor Statistics (BLS) to expand the scope of the Producer Price
Index (PPI).[12] The goal in this approach is to maximize the aggregate, net forward flow of goods
in the economy, defined as the net value of services flowing to downstream stages from upstream

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[12] This concept is closely related to the definition of stages of processing in the BLS experimental aggregation indexes
of PPI's. See: http://www.bls.gov/ppi/experimentalaggregation.htm. Also, the procedure used to maximize net
forward flow is described in: http://www.gpo.gov/fdsys/pkg/FR-2011-05-17/html/2011-12042.htm.

ones. The result of the procedure described below is an allocation of industries to stages, such that industries in the most downstream stage sell goods predominantly to final demand while using inputs that come predominantly from industries in previous stages. In contrast, industries in the earlier stages should themselves use few inputs and should sell their output predominantly to downstream (forward) stages. More formally, net forward flow for a given stage of production is defined as:

(forward shipments of the stage + inputs received from previous stages) -

(backward shipments of the stage + inputs received from forward stages)

In order to implement this formula, forward and backward shipments for each industry within a stage of production are gleaned from entries in the input-output (I-O) table of a given producer.

The ideal choice of I-O data to measure the net forward flow of LAC exports would be a set of industry-level matrices for each LAC country. Unfortunately, I-O matrices at a level of detail close to the SITC 4-digit products used in the keywords classification are not publicly available for any LAC country. The Brazilian matrix for 2005 used to compute the values in Table 1 is among the more detailed of LAC I-O tables, though the highest level of industry detail it describes is for 55 broad sectors (such as Agriculture and Forestry, Animal and Fish Products, etc.). Below, we will use two other input-output tables, for the United States and Thailand, to approximate the structure of production in Latin America. For each country, we use the input-output table to define stages of production, with industries allocated to stages so as to maximize the economy-wide value of the net forward flow expression above. The key data used to define the production stages are: (i) the 2002 Benchmark Input-Output tables from the Bureau of Economic Analysis (BEA), and (ii) the 2005 Input-Output table for Thailand.[13] [14]

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[13] Specifically, we combine the "Use of Commodities by Industry" tables with the "Make of Commodities by Industry" tables to obtain the U.S. table.

For the purposes of computing the PPI by stage of production, the BLS breaks down the value of goods flows between six-digit North American Industrial Classification System (NAICS) industries into four stages. Using the input-output table, industries are assigned into stages according to the following rules: industries that sell more than X percent of their output to final demand are defined as Stage 4 industries; industries that sell less than X percent to final demand but more than or equal to Y percent to either final demand or to Stage 4 industries (where $Y < X$) are defined as Stage 3; industries that sell less than X percent to stage 4 or final demand but greater than or equal to Z percent to final demand, Stage 4 and Stage 3 industries are defined as Stage 2; finally, all other industries are denoted as Stage 1. Net forward flow is then computed for the system conditional on X, Y and Z.

Maximizing net forward flows entails systematically cycling through values for X, Y and Z, seeking the combination of thresholds between stages that maximizes net forward flow in the system. A subtlety of this approach is that the impact of any particular industry's location on the net forward flow of the system depends on the location of *all* other industries. As a result, the categorization of industries emerging from the procedure is sensitive to the values initially chosen for X, Y, and Z. A first-best solution would be to simply cycle through *every* possible combination of industries and stages to determine the ordering that maximizes net forward flow. However, the number of such combinations for 425 industries and 4 stages is much too large (a staggering 4^{425}). The BLS chooses a second-best solution by picking "reasonable" initial values for X, Y and Z, and then systematically shifting each industry up a stage or down a stage, each time determining new values for X, Y and Z and each time asking whether the new system has higher net forward flow.

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[14] The Thai I-O table was obtained from the Office of the National Economic and Social Development Board of Thailand: http://www.nesdb.go.th/Default.aspx?tabid=97

It turns out that by reducing the dimensionality of the problem from four stages to two, it is possible to find an exact solution for the stage allocations that maximize economy-wide net forward flow. The intuition for this result is that with only two stages, the computation of the optimal placement of each industry no longer requires keeping all other industry categorizations fixed. Consider a second stage industry in the two-stage system. The net forward flow expression for this industry reduces to:

(inputs received from previous stages) - (backward shipments of the stage)

which is simply the sum of a column in the input-output table minus the sum of a row. It is easy to show that if this expression is positive, it will add to the economy-wide net forward flow. Conversely, if it is negative, it will detract from the economy-wide net forward flow. The optimal categorization scheme is therefore one which assigns any industry with a positive expression for second stage forward flow as stage 2 and any industry with a negative value of that expression as stage 1.

Using the U.S. I-O table, we implement this technique for 203 4-digit NAICS industries and then build a concordance of the NAICS industries to a roughly similar number of 4-digit SITC industries in the trade data. The resulting market share contributions by stage are shown in Figure 8b. Strikingly, the forward flow classification has a significant bearing on the level of the share contribution, with stage 1 industries accounting for only about a third of the share contribution, and stage 2 industries accounting for two-thirds. Stated differently, when taking into account the broader range of inputs from outside of agriculture, agricultural products (at least as measured using the U.S. input-output table) are relatively input-intensive.

Over the course of the sample, stage 1 goods classified by net forward flow added 1.7 percentage points to LAC's share of world agricultural exports, compared to 1.8 percentage points contributed by stage 1 products. The slow growth of stage 2 products relative to the level

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of their share meant that stage 2 RCA fell from over 1.45 in 1994 to 1.2 in 2008. Thus, LAC specialization in downstream products according to this classification was high and decreasing. In Figure 9, this high level of stage 2 market share is almost exactly the opposite of LAC RCA as measured by the keyword classification.

Cognizant of the fact that the net forward flow classification is dependent on the particular input-output table used as an input, and that the technology embodied in the U.S. I-O table might not be applicable to certain Latin American countries, we sought to replicate the analysis of specialization patterns using an input-output matrix from a developing country. As mentioned above, the unavailability of detailed LAC input-output tables precluded their use. Albeit an imperfect match in terms of its export composition, we were able to find a fairly detailed matrix for Thailand, to which we applied the net forward flow calculation. We followed a similar procedure as for the U.S. I-O table except that in this case the concordance to SITC industries was at a slightly coarser level of aggregation. The concordance process was complicated by the fact that many industries in the Thai I-O table are not very clean matches with the SITC industries. In the end, a manual concordance of Thai industries to SITC 3-digit level was successful in approximately three-quarters of the industries. In some instances, however, industries without a decent match were simply dropped.[15] The final list of industries consisted of slightly fewer than 150 3-digit SITC industries.

Similar to Figures 9a and 9b, the Thai-based net forward flow calculation implied positive contributions from both stage 1 and stage 2 products to increasing aggregate LAC market share. However, due to the more limited scope of the Thai I-O table, there was also a third category of products in the trade data without a corresponding stage classification. It is therefore difficult to interpret the level of share contribution or specialization based on this incomplete concordance.

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[15] An example of a "less successful" match is the Thai industry "silk worm" matched to the SITC industry "silk textile fibers". An example of a Thai industry that was simply dropped is "Agricultural services" for which there is no SITC category.

Notwithstanding this limitation, the trends in LAC specialization over time based on the Thai input-output table are consistent with those found assuming U.S. technology; as shown in Figure 9, LAC is decreasing its specialization in downstream industries and increasing specialization in upstream industries.

4.3 Revealed comparative advantage by stage of production: LAC vs. the rest of the world

We conclude by examining trends in LAC RCA in each stage of production relative to comparable trends in the rest of the world. We do so by uniformly applying a common keywords classification and common (U.S.- and Thai-based) forward flow classification to export products from all countries. An important reason to compare LAC trends to other exporters is to control for global trends in demand that may vary by stage. For example, if China increases its imports of raw materials from all sources, then all exporters would appear more specialized in stage 1 products; this would not be very informative about the value chain (production) dynamics that we seek to describe. We measure the changes in RCA over time for each stage and each classification scheme with the following panel regression:

$$RCA_{kt}^{stage} = \alpha_0 + \alpha_1 year_t + \alpha_2 year_t * LAC + \sum_{k=1}^{K} \delta_k + \varepsilon_{kt}^{stage}$$

where LAC is a dummy for LAC countries and is δ_k is an exporter fixed effect. α_1 can be interpreted as the rate of specialization deepening in a given stage, while α_2 can be interpreted as the relative rate of specialization deepening of exporters conditional on being a LAC country.

The estimated RCA trends for agricultural export products over the period 1994-2008 are shown in Table 2. For stage 1, the estimates for α_2 are negative and significant regardless of which classification scheme is used. This means that LAC RCA in stage 1 grew more slowly than RCA for stage 1 industries in the rest of the world. Similarly, the point estimates for LAC's specialization deepening in stage 2 are positive, though only statistically significant for two of the

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three classifications. This indicates a faster rate of specialization in stage 2 industries than the rest of the world. Together, these results suggest that in spite of trends in LAC specialization toward upstream products, the composition of LAC exports *relative to other exporters* has tilted towards downstream products. In contrast to α_2, the estimates for α_1 are sensitive to the classification scheme used. While the keywords classification indicates that overall specialization in stage 2 is increasing over time, both net forward flow classifications indicate the opposite.

| | Dependent variable: RCA by exporter-stage-year | | | | | |
| | Keywords | | Net Forward Flow (U.S.) | | Net Forward Flow (Thai) | |
	Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
Year	-0.008 **	0.005 **	0.008 **	-0.011 **	0.008 **	-0.007 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Year*LAC	-0.010 *	0.008 **	-0.007 *	0.001	-0.009 **\	0.010 **
	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,559	3,565	3,567	3,558	3,564	3,566
R-squared	0.79	0.77	0.75	0.77	0.73	0.73

Notes: * denotes significant at 5 percent; ** denotes significant at 1 percent.

Table 2: Trends in RCA by stage in LAC and the rest of the world

5. Conclusions

This paper searches for evidence that LAC's recent increase in agricultural export market share was due to either: (a) offering higher quality varieties of products, or (b) expanding output in higher-value downstream product categories. We dismiss the first alternative after finding little evidence for high product differentiation in agricultural exports; after fuel products, the categories of crude materials, animal products and foods have among the lowest levels of product differentiation. This implies that varieties within agricultural products are relatively substitutable, which limits the degree to which an upgraded variety can set itself apart and capture market share.

We quantify upstream and downstream specialization by defining which industries are relatively input-intensive. Two methods are suggested to allocate industries to stages of production, each with different assumptions about the input-output structure of agricultural industries. We find that, conditional on the definitions of upstream and downstream industries as well as on global trends in specialization, LAC exporters have been tilting their specialization from upstream to downstream industries. Specifically, LAC's specialization in early stage products is growing slower than in the rest of the world, and LAC's specialization in stage 2 products is growing faster than in the rest of the world. This is consistent with the prediction of our model of multistage production in which relatively high productivity in an upstream industry can lead to expanded output and export share in a downstream industry.

A few qualifying remarks are in order. First, there are several empirical observations that hinge critically on how upstream and downstream industries are defined. For one, the level of LAC revealed comparative advantage is much higher in upstream industries when only agricultural products are used to define stages of production. Applying a more holistic definition which takes into account the input-output linkages of agriculture industries with the rest of the economy, LAC is much more specialized in downstream products. The dynamics of specialization also vary with the way that the stages are defined, with LAC either having static specialization or increasing specialization in upstream products. We also note that we do not find stark differences in the economic importance of upstream versus downstream products in explaining LAC's export performance. According to either classification of production stages, both stages contributed meaningfully to LAC's market share and the growth of that share over the past 15 years.

Another potential issue is that in the forward flow production stage classification, the U.S. or Thai input-output tables are assumed to be representative of the structure of production and technology in LAC agricultural industries. Clearly, this assumption will not always hold. In fact,

we show that the level of specialization in upstream and downstream products tends to vary with the technology assumed. If the data were available, the net forward flow technique would be more appropriately applied to detailed LAC country-level input-output tables.

Finally, our model indicates that a productivity innovation in an upstream industry will have positive effects on the exports of a downstream industry, but this result is conditional on industry characteristics which are not observed with a high degree of precision (such as the levels of vertical production linkages and specific trade costs). In the absence of inter-industry input-output linkages, higher productivity in an industry leads to increasing output and export market share in that industry and decreasing output and market share in other industries. In contrast, when there are input linkages across industries, a productivity innovation in an upstream industry increases output for downstream industries in all countries. Due to trade costs, the downstream industry in the same country as the high productivity upstream industry benefits more, increasing the export share of downstream industries in that country. These cases make it clear that the export performance of downstream industries depends crucially on the extent of upstream-downstream links within a country; in the former case downstream share decreases while in the latter it increases. The fact that LAC specialization in downstream products is increasing over time relative to other countries (shown in Table 2) is suggestive that these links are non-trivial in LAC agricultural production.

References

1. Aghion, Philippe and Peter Howitt (1992). "A Model of Growth Through Creative Destruction" *Econometrica*, 60:2, pp. 323-351.

2. Amiti, Mary (2005). "Location of vertically linked industries: agglomeration versus comparative advantage." *European Economic Review*, 49: 809-832.

3. Balassa, Bela (1965). "Trade Liberalization and Revealed Comparative Advantage," *Manchester School of Economic and Social Studies*, 33, pp. 99-123.

4. Feenstra, Robert and Gordon H. Hanson (1996). "Globalization, Outsourcing, and Wage Inequality," *American Economic Review*, 86(2), pp. 240-45.

5. Feenstra, Robert C., Robert E. Lipsey, Haiyan Deng, Alyson C. Ma, and Hengyong Mo (2005). "World Trade Flows: 1962-2000," NBER Working Paper No. 11040.

6. Grossman, Gene and Elhanan Helpman (1991). "Quality Ladders in the Theory of Growth," *Review of Economic Studies*, 58:1, pp. 43-61.

7. Hummels, David, Jun Ishii and Kei-Mu Yi (2001), "The nature and growth of vertical specialization in world trade," *Journal of International Economics*, 54:1, pp. 75-96.

8. Harrigan, James and Richard Baldwin (2011). "Zeros, Quality, and Space: Trade Theory and Trade Evidence." *American Economic Journal: Microeconomics*. 3, pp. 60–88.

9. Instituto Brasileiro de Geografia e Estatística (IBGE). 2012. "Matriz de Insumo-Produto do Brasil – 2005," Sao Paulo, Brazil: IBGE. http://www.ibge.com.br/english/estatistica/ economia/matrizinsumo_produto/default.shtm.

10. Johnson, Robert and Guillermo Noguera (2011). "Accounting for Intermediates: Production Sharing and Trade in Value Added." Working paper.

11. Mandel, Benjamin (2009): "The Dynamics and Differentiation of Latin American Metal Exports," F.R.E.I.T. Working Paper 141.

12. Manova, Kalina and Zhiwei Zhang (forthcoming). "Export Prices across Firms and Destinations," *Quarterly Journal of Economics*. Also see: NBER Working Paper 15342.

13. Schott, Peter (2004). "Across-Product versus Within-Product Specialization in International Trade." *Quarterly Journal of Economics*. 119(2), pp. 647-678.

14. Yi, Kei-Mu (2010). "Can Multistage Production Explain the Home Bias in Trade?" *American Economic Review*, 100(1), pp. 364-93.
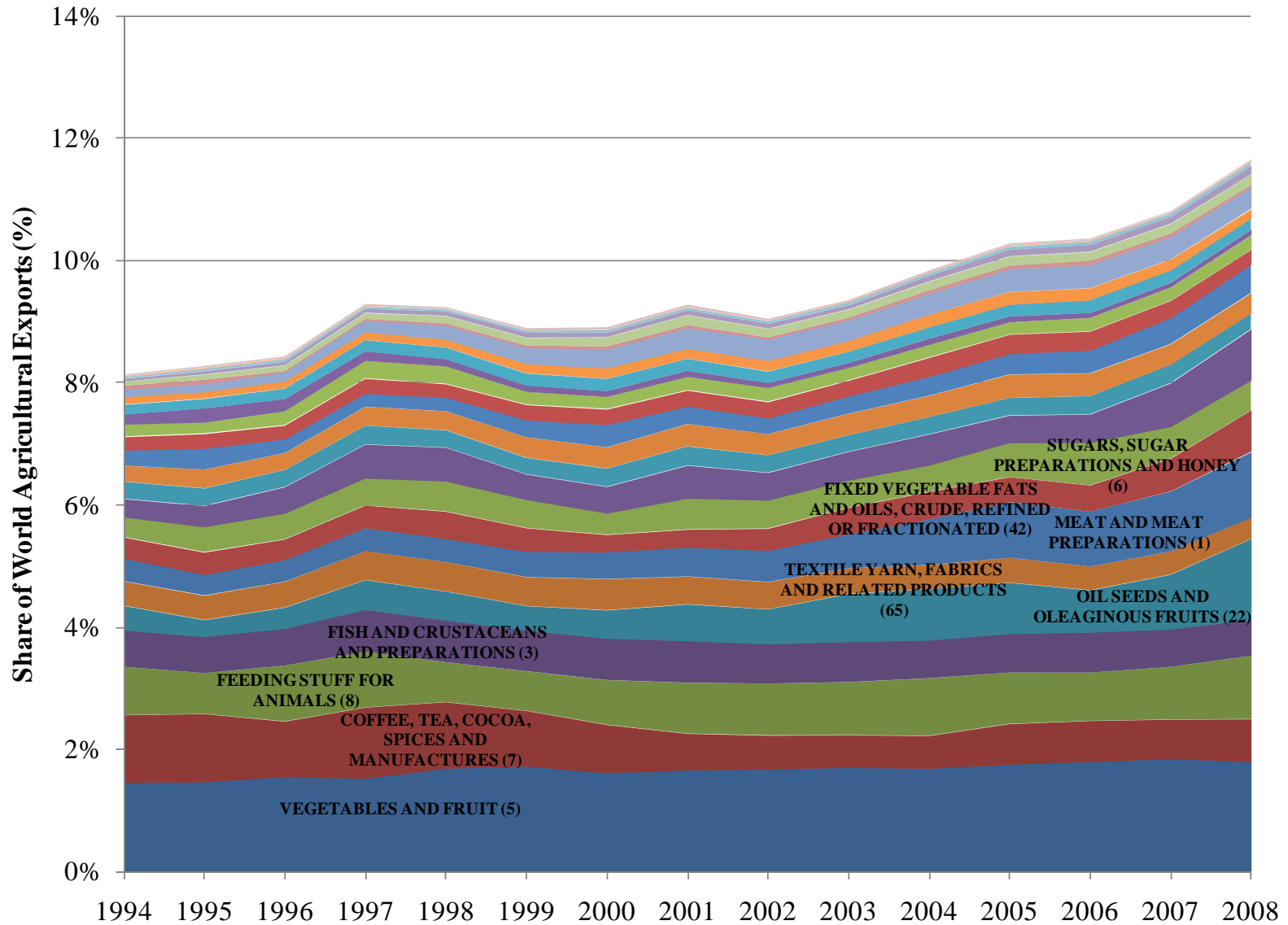
Figure 1: LAC's market share of world agricultural exports
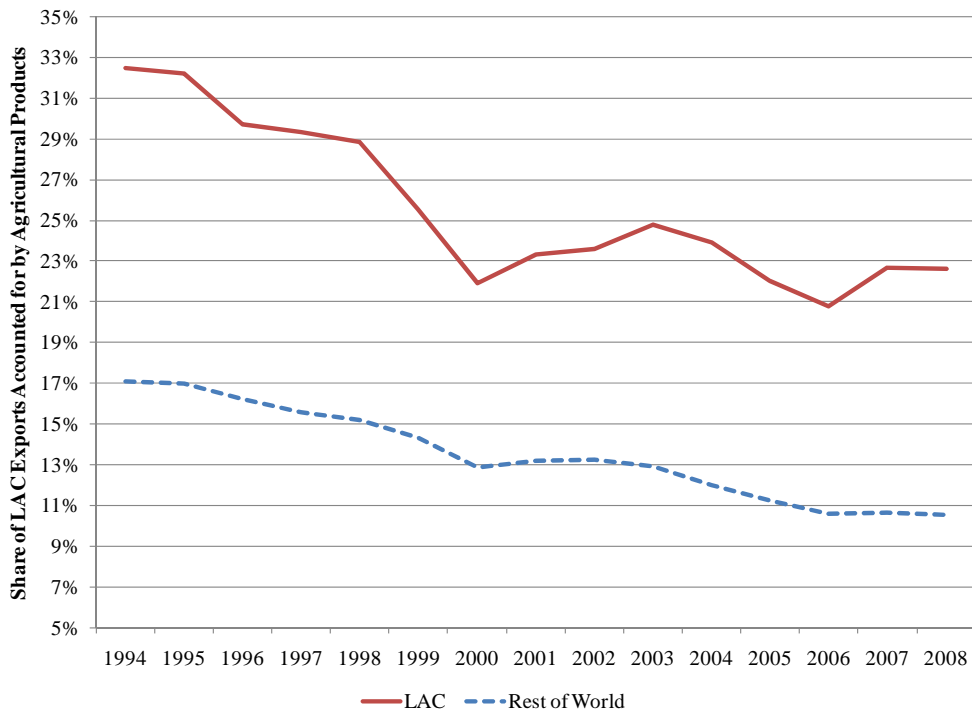
Figure 2: Agricultural exports as a share of total exports (1994-2008)[16]
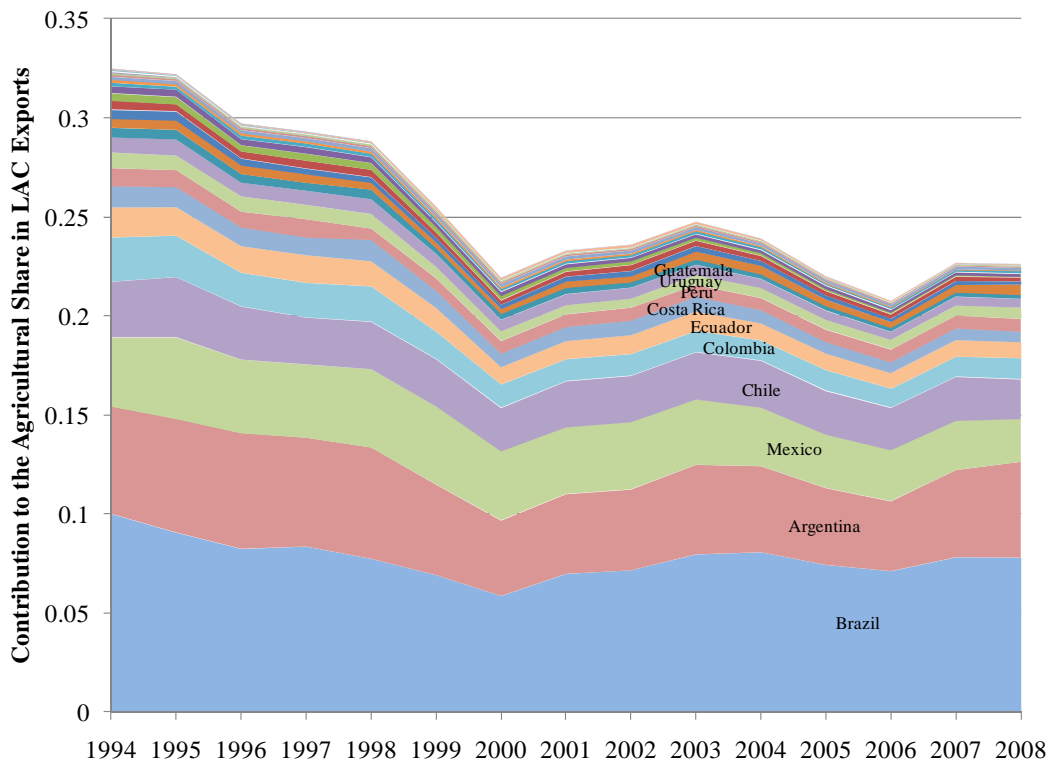
Figure 3: The contribution of individual countries to the agricultural share of LAC exports[17]

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[16] The solid line shows the fraction of LAC exports accounted for by agricultural products. The dashed line shows the same statistic for non-LAC exporters.

[17] Each shaded region represents the relative contribution of each country to the aggregate fraction of LAC exports accounted for by agricultural products. Specifically, it is each country's agriculture share, scaled by the country's size in total LAC exports.
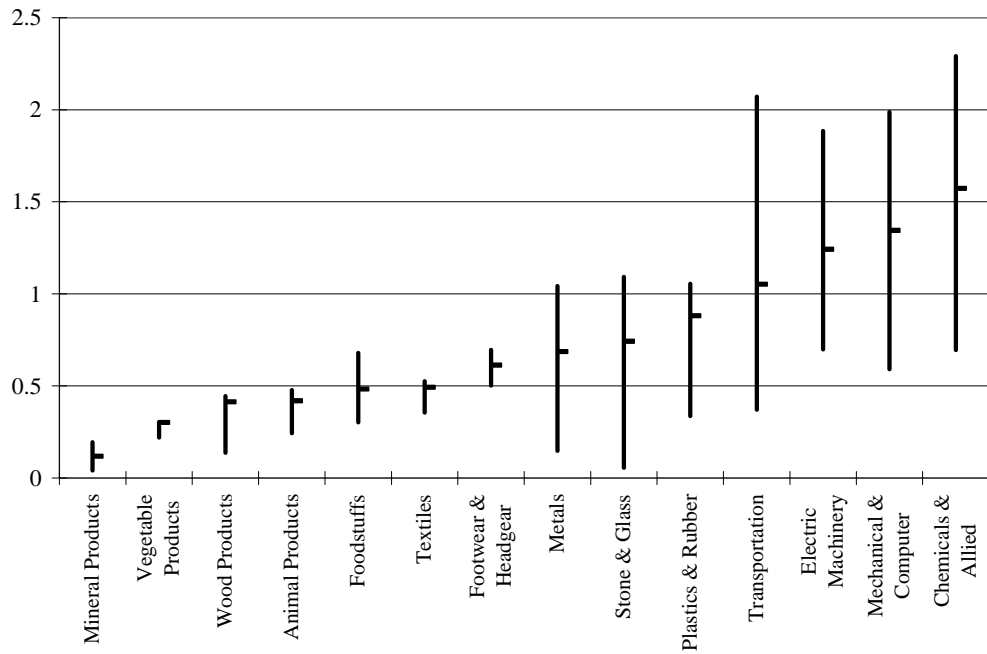
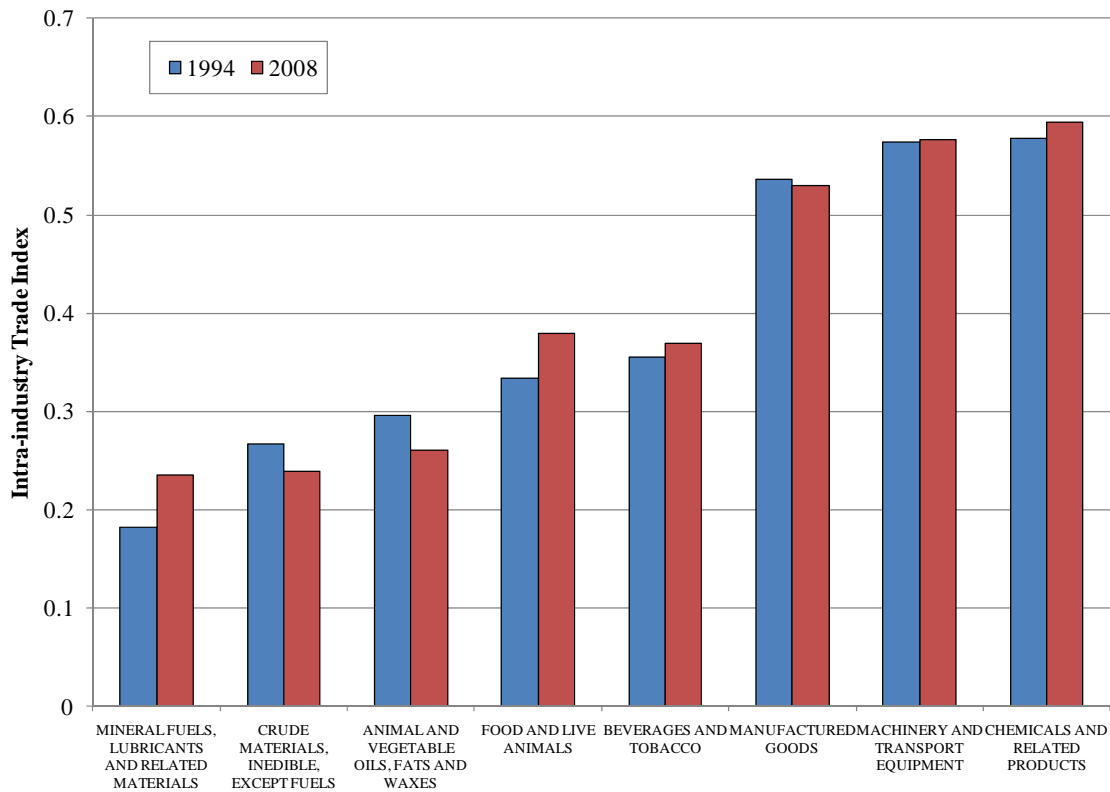**Figure 4: Intra-product price dispersion in U.S. imports**[18]

Figure 5: An index of intra-industry trade by sector[19]

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[18] Shown by sector are the sales-weighted mean (hatch) and interquartile range (line) of the standard deviation of log price levels within Harmonized System 10-digit U.S. import products.

[19] Shown is the value of IIT at the SITC 4-digit industry level, aggregated across SITC codes and source countries using trade weights ((X+M)/2).
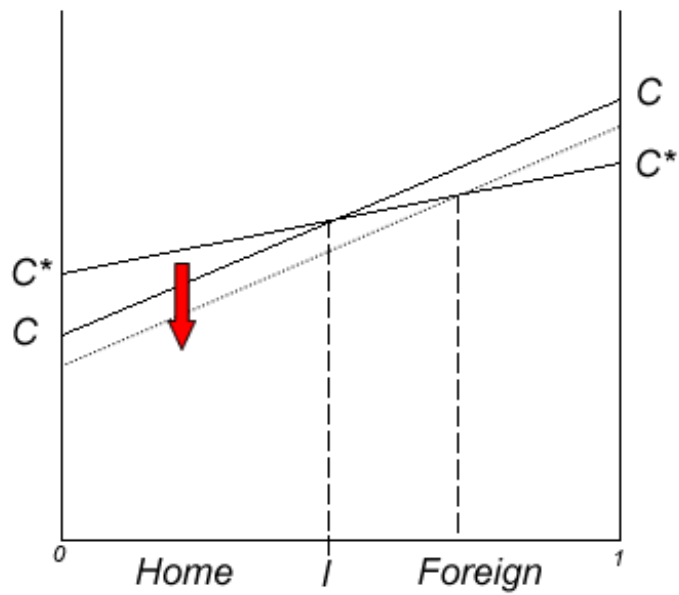
Figure 6: Production of intermediates in Home and Foreign

Stage 1:

| SITC	Description
0341	FISH, FRESH(LIVE/DEAD)OR CHILLED, EXCLUDING FILLETS
0342	FISH, FROZEN (EXCLUDING FILLETS)
0343	FISH FILLETS, FRESH OR CHILLED
0344	FISH FILLETS, FROZEN
0350	FISH,DRIED, SALTED OR IN BRINE; SMOKED FISH
0360	CRUSTACEANS AND MOLLUSCS, FRESH,CHILLED,FROZEN

Stage 1 keywords:

-Fresh

-Live

-Chilled

-Frozen

-Smoked

Stage 2:

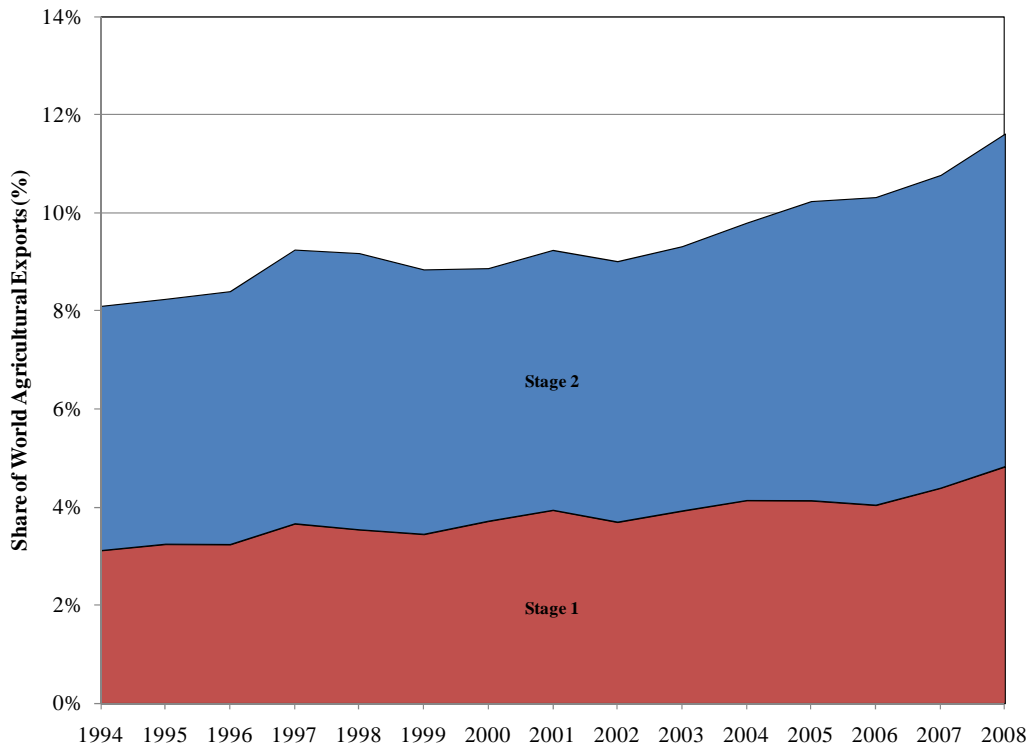| SITC	Description
0371	FISH, PREPARED OR PRESERVED, N.E.S., INCLUDING CAVIAR
0372	CRUSTACEANS AND MOLLUSCS, PREPARED OR PRESERVED

Stage 2 keywords:

-Prepared

-Preserved

Figure 7: Classification of value chain stages by keywords, SITC 34-37

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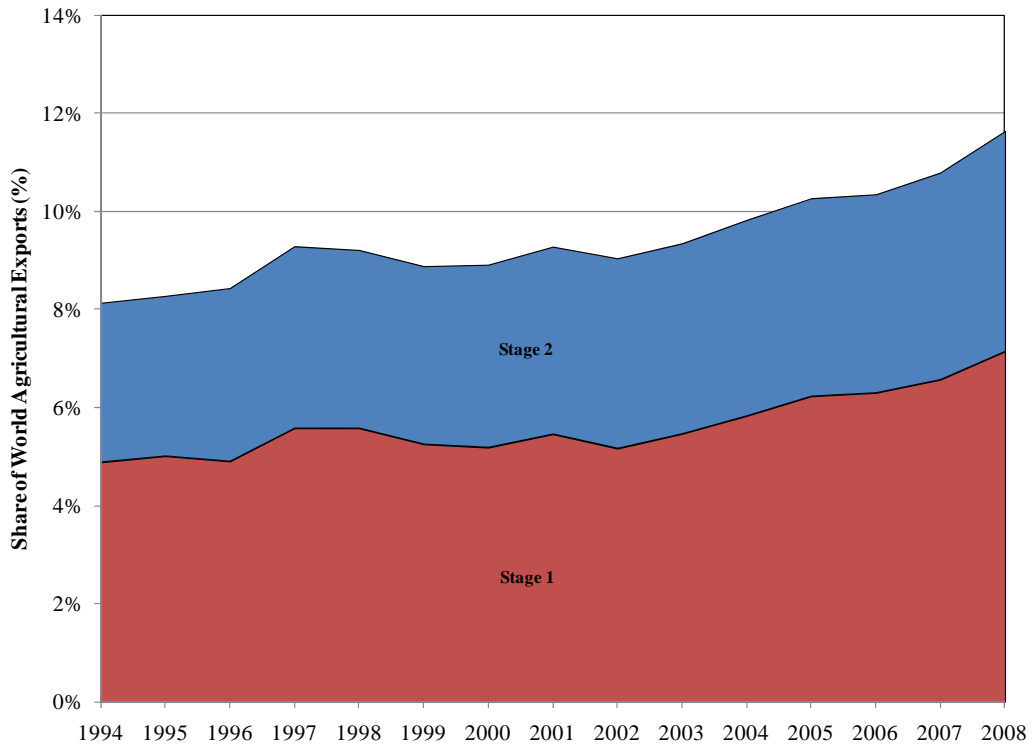
(a) Keywords classification

(b) Forward flow classification (using U.S. I-O table)

Figure 8: LAC's share of world agricultural exports by stage of production
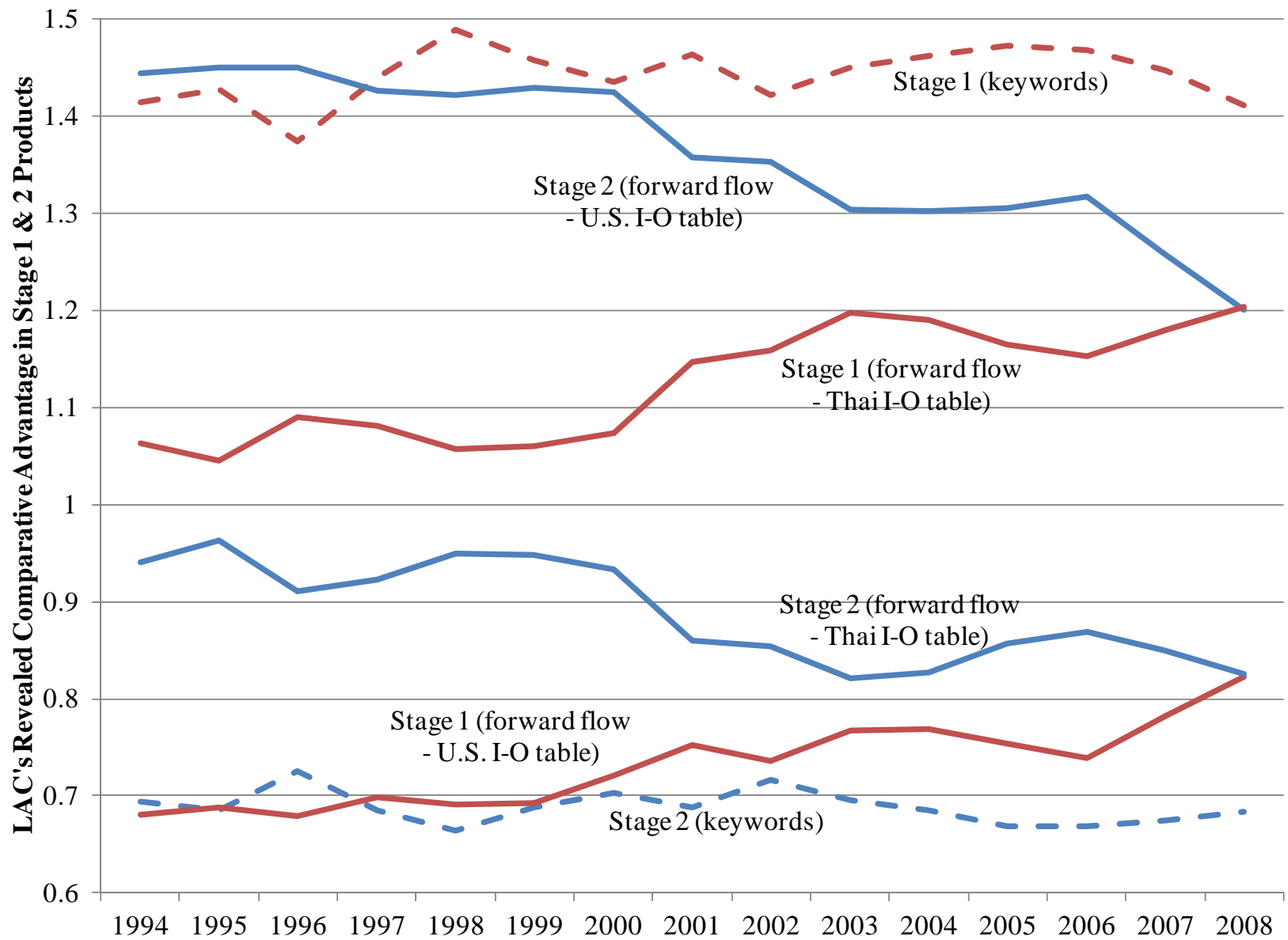
Figure 9: LAC's agricultural revealed comparative advantage by stage of production

Appendix A: List of included agricultural product codes

SITC 2-digit

Code	Description
00	LIVE ANIMALS OTHER THAN FISH
01	MEAT AND MEAT PREPARATIONS
02	DAIRY PRODUCTS AND BIRDS' EGGS
03	FISH AND CRUSTACEANS AND PREPARATIONS
04	CEREALS AND CEREAL PREPARATIONS
05	VEGETABLES AND FRUIT
06	SUGARS, SUGAR PREPARATIONS AND HONEY
07	COFFEE, TEA, COCOA, SPICES AND MANUFACTURES
08	FEEDING STUFF FOR ANIMALS
09	MISCELLANEOUS EDIBLE PRODUCTS AND PREPARATIONS
11	BEVERAGES
12	TOBACCO AND TOBACCO MANUFACTURES
21	HIDES, SKINS AND FURSKINS, RAW
22	OIL SEEDS AND OLEAGINOUS FRUITS
23	CRUDE RUBBER
24	CORK AND WOOD
25	PULP AND WASTE PAPER
26	TEXTILE FIBERS OTHER THAN COMBED WOOL
29	CRUDE ANIMAL AND VEGETABLE MATERIALS, N.E.S.
41	ANIMAL OILS AND FATS
42	FIXED VEGETABLE FATS AND OILS, CRUDE, REFINED OR FRACTIONATED
43	ANIMAL OR VEGETABLE FATS AND OILS PROCESSED
61	LEATHER, LEATHER MANUFACTURES AND DRESSED FURSKINS
63	CORK AND WOOD MANUFACTURES OTHER THAN FURNITURE
64	PAPER, PAPERBOARD, AND ARTICLES OF PAPER PULP
65	TEXTILE YARN, FABRICS AND RELATED PRODUCTS

Appendix B: List of included LAC countries

Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Rep., Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela.