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The Micro-D Classification: A New Approach to Identifying Differentiated Exports

ABSTRACT It is common to assess the evolution of a country's export structure as a manifestation of the extent of progress or stagnation in its development process. Performing this exercise requires determining which features of exported products denote higher stages in that process. We argue that exports of differentiated products, especially when sold to developed countries, signal the acquisition of valuable knowledge that reflects development progress. We propose a new classification, denoted Micro-D, that works at the finest aggregation level in customs nomenclatures to provide a more precise identification of differentiated products. Specifically, the classification uses package size as a proxy for product differentiation to identify differentiated food and beverage exports. Thus, it is especially—though not exclusively—suited to capturing export upgrading in land-abundant developing countries. We apply the Micro-D classification to Argentina in 1998–2011 to deliver a new picture of the country's sources of export upgrading in this period.

JEL Codes: F10, F14, O14

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The evolution of a country's export structure is usually monitored to infer progress or stagnation in its development process. The inference is based on the notion that some products are more desirable than others, in the sense that they can be linked to higher development stages. This exercise requires taking a stand on which products are desirable. Desirable products, for example, may require more sophisticated knowledge, generate knowledge externalities, and support higher wages. In this paper, we argue for product

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differentiation as the defining desirability criterion for a country's exports, and we propose a new, more accurate classification of differentiated products. We apply this new classification to assess the evolution of Argentina's exports from 1998 to 2011.

Numerous efforts have been made to construct product classifications that capture a vertical dimension across products, in terms of technological complexity, the order in which they start being exported, and the development level of countries that export them.[1] A similar but coarser exercise, which is often used in country-specific academic papers and policy reports, focuses on rough indicators of export desirability such as whether exported products are industrial or nontraditional.[2] Differentiated products need not be technologically complex or even industrial. However, the singular attributes that make their physical characteristics, design, brand image, or service reliability unique in the market also allow them to fetch a higher price and reward higher wages. Thus, a country's ability to export differentiated products requires the acquisition of valuable capabilities (many anchored in market-based knowledge) that manifest development progress.

A renowned classification developed by Rauch distinguishes exports by the degree of differentiation.[3] However, this classification is defined at an aggregation level (namely, the four-digit level of the Standard International Trade Classification, or SITC) that is too coarse to identify differentiated products because it lumps these products together with undifferentiated goods in broader categories. While these aggregation issues permeate the entire classification, they are particularly prevalent in food and beverages, which are precisely the categories where product differentiation presents widely recognized export-upgrading opportunities for land-abundant developing countries, such as many Latin American economies.

To address this shortcoming, we propose a new classification of differentiated products, which we call the Micro-Differentiated (or Micro-D) classification. This classification is defined at the maximum level of disaggregation using information on product attributes described in the Argentine export nomenclature. Operating at the finest disaggregation level across all the nomenclature, the Micro-D classification achieves higher accuracy than the Rauch classification in the identification of differentiated products.

1. Hartzichronoglou (1997); Hidalgo and Hausmann (2009); Lall (2000); Feenstra and Rose (2000).
2. Gabriele (1997); Kouzmine (2000); Von Hesse (1994).
3. Rauch (1999).

In particular, it improves on this classification in food and beverages by taking advantage of the fact that product positions at the maximum disaggregation level in those sectors are distinguished by package size, which can be used as a proxy for product differentiation.

Before applying the Micro-D classification to the analysis of Argentine exports, we compare it with the Rauch classification. While discrepancies between the two involve only 16 percent of total export value, the differences are stark in some sectors. For example, while 18 percent of food and beverage exports are differentiated under the Micro-D classification, only 6 percent are differentiated under Rauch. By contrast, 35 percent of metal exports are differentiated under Rauch, versus only 11 percent under the Micro-D. A deeper look at which products generate the discrepancies supports the better accuracy of our classification. In particular, products classified as differentiated by Rauch but not by the Micro-D tend to be standardized intermediate inputs, whereas products classified as differentiated by the Micro-D but not by Rauch are food and beverage products sold in small packages. To further assess the relative performance of these two classifications, we perform various tests. These include comparing export prices, the relationship between price and destination per capita income, and price volatility between differentiated and undifferentiated products under each classification. Overall, these tests also support the better accuracy of the Micro-D classification.

Finally, we apply the Micro-D to the analysis of Argentine export growth in differentiated products between 1998 and 2011. We compare the results with those obtained using alternate classifications of "desirable" exports: (a) manufactures of industrial origin (MOI) as classified by Argentina's National Institute of Statistics and Censuses (INDEC); (b) medium-high and high technology-intensive products as classified by Hartzichronoglou; and (c) differentiated products as classified by Rauch.[4] We focus on exports of desirable products to member countries of the Organization for Economic Cooperation and Development (OECD), which we call upgraded exports, as the metric for assessing virtue in export performance. Exports to developed countries signal the acquisition of diffusible knowledge, which is critical for export development and future export growth.[5]

The four classifications deliver very different results. First, under the INDEC classification, upgraded export growth in Argentina in 1998–2011 was primarily driven by the institute's inclusion of precious metals (mainly

4. Hartzichronoglou (1997); Rauch (1996).
5. Artopoulos, Friel, and Hallak (2013).

unwrought gold) as MOI despite being commodities that only underwent basic industrial processing. Second, under the Hartzichronoglou and Rauch classifications, upgraded export growth was primarily driven by biodiesel, which is neither technologically complex nor differentiated but was tagged as such by these two classifications owing to aggregation with other products. By contrast, under the Micro-D classification, the main contributors to growth in upgraded exports were differentiated food and beverage products, which are widely acknowledged to offer export-upgrading opportunities in land-abundant countries. A country's ability to grab those opportunities manifests the acquisition of technological and market-based knowledge that can percolate through a broad range of other industries and generate future export growth. Thus, our proposed classification more accurately captures the relevant sources of export progress and provides a better guide for export promotion and productive development efforts.

The rest of the paper proceeds as follows. The next section justifies our methodological approach. We then describe the main classification criteria used in the Micro-D scheme. Subsequent sections compare the Micro-D and Rauch classifications and apply the Micro-D scheme to assess the recent evolution of Argentine exports. The final section concludes.

Differentiated versus Industrial Exports

Studying the dynamics of a country's export structure over a given period is a common approach for gaining insight into its productive performance. In particular, increases in industrial exports have been prominently interpreted as a sign of productive development. This practice is supported by the traditional view of economic development as an industrialization process and is facilitated by the fact that national statistical institutes customarily report exports distinguishing industrial from primary products. However, increasing the weight of industry in total exports does not necessarily signal development progress. Some industrial activities (such as basic food processing) do not possess the desirable properties traditionally attributed to industry (for example, they do not support higher wages, require sophisticated knowledge, or generate knowledge externalities), while some nonindustrial sectors (such as biotechnology, information technology, and audiovisual services) do possess those properties.

A finer approach focuses on the technological intensity of a country's export basket. Underlying this approach is the widespread notion that economic

development is associated with a country's ability to produce and export technologically complex products. To capture these exports, Hartzichronoglou and Lall develop two alternative export classifications based on products' technological intensity.[6] These systems have been widely used in empirical studies and country reports to assess export performance.[7]

Although technologically complex products are often differentiated, differentiated products may have the desirable properties attributed to industrial or complex products without necessarily being technologically complex. In fact, widely recognized export upgrading opportunities for land-abundant developing countries (such as many Latin American economies) involve differentiated products that use standard technology. These countries cannot compete in costs with other low-income countries in most undifferentiated low-technology products, yet they do not possess the technological capabilities to compete with high-income countries in differentiated high-technology products. However, their abundant natural resources provide them a competitive potential in differentiated products, which, despite not being technologically complex, can command high prices and reward high wages owing to their quality, design, traceability, brand reputation, and customization.

Artopoulos, Friel, and Hallak point to foreign market knowledge as a key constraint that prevents developing-country firms from exporting differentiated products to developed countries.[8] This type of knowledge is crucial for firms to adopt a set of business practices that will reach these foreign markets, which can differ drastically from the prevailing practices in their domestic market. They need to adapt product designs to foreign demand idiosyncrasies, upgrade quality, conform to foreign distributors' way of doing business, and engage them as a source of information about the evolution of foreign demand.[9] Thus, growth in differentiated exports to developed countries manifests the acquisition of this knowledge and the adoption of this new set of business practices.

6. Hartzichronoglou (1997); Lall (2000).

7. Aggarwal (2002); Bahar, Hausmann, and Hidalgo (2014); Jarreau and Poncet (2012); Mesquita Moreira (2007); Poncet and Starosta de Waldemar (2013); Srholec (2007); Stehrer and Woerz (2009).

8. Artopoulos, Friel, and Hallak (2011, 2013).

9. This evidence is consistent with Molina and Muendler (2013) and Mion and Opromolla (2014), who show that firms are more likely to export if they hire workers and managers with previous work experience at exporting firms. González and Hallak (2013, 2016) argue that insertion in global value chains oriented to nonmass segments of developed-country markets imposes less stringent, but qualitatively similar, requirements on the foreign market knowledge firms need to acquire.

A country's export composition not only reveals its productive capability at a given point in time, but it may also predict future export growth, as suggested by Lall for technology-intensive export structures: "Technology-intensive structures offer better prospects for future growth because their products tend to grow faster in trade: they tend to be highly income elastic, create new demand, and substitute faster for older products."[10] Since differentiated products are also highly income elastic, create new demand, and substitute faster for older products, we argue that export structures intensive in differentiated products may also predict future export growth. Moreover, growth in differentiated exports to developed countries can be viewed as a predictor of further export growth since the knowledge and practices required to export them, once acquired by some firms, may diffuse throughout the economy.

The Micro-D Classification of Differentiated Products

To assess a country's export growth in differentiated products, we need to be able to identify those products in export statistics. Currently the Rauch classification is the only available option to perform this task.[11] This classification divides goods into three categories: (a) homogeneous goods, commercialized in international organized markets; (b) reference-priced goods, with reference prices displayed in specialized publications; and (c) differentiated goods, which encompass all remaining products. This categorization is performed at the four-digit SITC aggregation level, which is sometimes too broad. This problem is particularly prevalent in categories that include agricultural-based products. For example, Rauch classifies the four-digit SITC category 1121 (wine of fresh grapes) as reference-priced goods, and thus lumps together grape must—a scantily differentiated good that has historically accounted for most Argentine wine exports—with cases of bottled fine wine—a differentiated product that currently makes up the bulk of those exports. Since achieving higher value added through differentiation in agricultural-based products has long been recognized as a promising avenue for export upgrading in developing countries, this shortcoming in the classification can obscure key facts in the evolution of these countries'

10. Lall (2000).

11. Rauch (1999). See Bastos and Silva (2010); Castro (2014); Manova and Zhang (2012); Hummels and Klenow (2005); Nunn (2007).

exports. At a much finer aggregation level, customs nomenclatures specify product attributes that can serve as good proxies for differentiation. To exploit this information, our proposed classification resorts to Argentina's twelve-digit Sistema Informático María (SIM), which is based on the Harmonized Commodity Description and Coding System (HS).

To construct our proposed classification, we use products' stage of elaboration as a broad guide to infer differentiation. We take advantage of the HS structure, which organizes the universe of products mostly by their main raw material input, usually starting with codes for the raw material in primary form, continuing with codes for transformations of the raw material into intermediate inputs, and finishing with codes for final products obtained from further processing. For example, codes 3901 to 3914 in HS Chapter 39 (plastics and articles thereof) include different primary forms of polymers and other plastics (for example, HS 3903, "polymers of styrene, in primary forms"); codes 3915 to 3921 include plastic intermediates (for example, HS 3919, "self-adhesive plates, sheets, film, foil, tape, strip and other flat shapes, of plastics, whether or not in rolls"); and codes 3922 to 3926 include plastic final products (for example, HS 3924, "tableware, kitchenware, other household articles and hygienic or toilet articles, of plastics").

At one end of the production chain, we classify products in primary forms as undifferentiated (U) because their essential attributes are homogeneous conditional on standard specifications. At the other end, we classify final products and capital goods as differentiated (D) because they are typically distinguished by their design, quality, brand, customization, technical performance, reliability, after-sale service, or packaging. Thus, primary forms of agricultural products, minerals, chemicals, metals, plastics, rubber, leather, textiles, glass, stone, wood, and paper are U, while manufactures made from these materials are D if they are final or capital goods.[12]

Relative to primary, final, and capital goods, products at intermediate stages of elaboration pose harder classification challenges. In the case of products

12. Although we follow our own criteria to determine whether goods are primary, final, or capital, we check consistency with the U.N. Broad Economic Classification (BEC). Since we work at a finer level than this classification, which maps six-digit HS codes into broad economic categories, we can sometimes classify products more accurately. The main differences are concentrated in food and beverages (for example, we consider yogurt sold in small packages as a final product whereas it is classified as primary by BEC). Differences are almost nil in the remaining products. For example, the Micro-D classifies 98 percent of BEC's primary fuels and primary industrial supplies as U, while it classifies 99 percent of BEC's consumption goods and 100 percent of BEC's capital goods and transport equipment as D. Rauch (1999) also classifies most primary products as U and most final and capital products as D.

other than food and beverages, we rely on the technical advice of sectoral experts, who pointed us to product attributes described in the nomenclature that can serve as indicators of product differentiation.[13] Specifically, we first asked the sectoral experts to describe the sector's value chain and then asked them to determine the degree of standardization and codification of products in the chain. In particular, experts were asked to identify relevant attributes that would determine whether products could be distinguished among the various suppliers. Following this conceptual exercise, we invited the technical experts to mark differentiated products in the export nomenclature.

Identifying differentiated products in the case of agricultural, food, and beverage goods (HS1 to HS24) is largely facilitated by the fact that Argentina's export nomenclature distinguishes these products by package size.[14] Products in small packages tend to be in their last processing stage before final consumption and thus possess a variety of differentiated attributes. Products exported in bulk or in larger packages are likely to be undifferentiated goods in primary forms or at intermediate stages of elaboration. Thus, following the general criterion, we classify products in small packages as D, while those exported in bulk or in larger packages are U.[15] A special distinction arises in the case of final products sold in small packages, such as some unprocessed produce, that are ready for retail sale even though they do not present a high degree of processing. That these products are sold in small packages ready for retail sale indicates the presence of attributes like brand identification or quality that differentiate the product and ultimately translate into additional value added. Here, the high degree of elaboration stems not from various processing stages, but from the care and control of the production process required to obtain the desired product features.[16] Because of the central role of

13. Most of the consulted experts are sectoral analysts at the Argentine Ministry of Production.

14. Starting in 1998, the Argentine government identifies food and beverages by package size in the export nomenclature in an effort to promote higher value added through higher tax rebates to exports shipped in small packages.

15. The package size used as a threshold varies across products depending on the product characteristics and on the level of detail provided by the SIM nomenclature. For example, fruit exports are counted as D if they are traded in packages of less than 20 kilograms, while meat exports are D if they are traded in packages of less than 5 kilograms.

16. Although the package-size criterion is mainly applicable to food and beverages, we also apply it to other products when information is available. Examples of nonagricultural products classified as D when sold in small packages are fertilizers (HS 310510) and paper and paperboard used as a base for photo-sensitive, heat-sensitive, or electrosensitive paper or paperboard (HS 480220).

highly disaggregated information in our classification, we call it the Micro-Differentiated (or Micro-D) classification.[17]

Although the Argentine SIM is based on the HS, which is harmonized across countries up to the six-digit level, it distinguishes food products by package size only at the twelve-digit level. This implies that the Micro-D classification is not directly applicable to other countries' exports. For this reason, our proposed classification follows transparent guiding criteria to ensure easy adaptation to other customs nomenclatures. In this regard, we hope this paper will influence future efforts in customs data collection oriented toward capturing product differentiation.

In addition, we have constructed a six-digit version of our classification by classifying as D six-digit HS categories in which more than 50 percent of the category's export value in Argentina in 2007–11 is differentiated under the twelve-digit classification.[18] Although the six-digit version of the Micro-D classification is based on the specific composition of Argentina's differentiated exports, it may be a useful tool for researchers in other countries studying export upgrading through differentiation.[19]

Comparing Differentiated-Product Classifications: Rauch versus Micro-D

In this section, we compare the Micro-D and Rauch classifications and assess their relative performance in the identification of differentiated goods. We use Argentine export data from INDEC, by product (at the HS twelve-digit level), destination, and year.

Table 1 divides all twelve-digit SIM positions according to what we call their differentiation condition, that is, whether they are classified as D only by Rauch (liberal classification), only by Micro-D, by neither of the two, or by both classifications.[20] It then calculates, for twelve product groups, the

17. The appendix provides a detailed description of the classification criteria, while the full classification database in Stata and in pdf formats are available as an online appendix at the journal's and authors' websites.

18. We thank a referee for this suggestion. A Stata file with the six-digit Micro-D classification is available on the authors' and journal's websites, together with the share of differentiated exports in each six-digit code.

19. When food and beverages are excluded, the correlation between the twelve- and six-digit Micro-D classifications is 0.97. The relevant differences take place in those two sectors, where the correlation is 0.45. Overall, the correlation between the twelve- and six-digit schemes is 0.93.

20. In the Rauch classification, we compute homogeneous and reference-priced products as U.

TABLE 1. Differences between Rauch and Micro-D Classifications, by Product Group: 2007–11
Percent

Group of products	*Rauch: U Micro-D: U*	*Rauch: D Micro-D: U*	*Rauch: U Micro-D: D*	*Rauch: D Micro-D: D*	*Exports (US$ billions)*
Food and beverages	78	4	16	2	24.8
Other agricultural products	94	2	4	0	10.0
Vehicles	0	0	0	100	7.0
Fuels	99	1	0	0	5.7
Chemicals	23	32	2	43	4.3
Metals	62	28	4	7	4.2
Machinery	0	0	1	99	2.9
Textiles, leather, and hides	22	60	3	15	1.7
Plastics and rubber	51	21	0	28	1.7
Precious metals	89	0	2	9	1.7
Paper and paperboard	35	0	25	40	0.7
Other industrial products	9	0	1	90	0.4
Total	64	8	8	20	65.3

percentage value of Argentine exports between 2007 and 2011 under each differentiation condition.[21]

The two classifications coincide in 84 percent of exports (of which 64 percent are U and 20 percent are D). They coincide in classifying as U agricultural commodities such as wheat, maize, and soybean oil and mineral products such as precious metals and fuels, while they coincide in classifying as D transport vehicles and machines. For the remaining 16 percent of exports, 8 percent are classified as D only in Rauch and 8 percent only in Micro-D. Substantial differences arise in specific sectors. On the one hand, a large fraction of only Rauch D exports are present in textile, leather, and hides, where only Rauch classifies tanned and prepared leather as D, as well as in chemicals, plastics and rubber, and metals. On the other hand, 16 percent of food and beverages exports are classified as D only by the Micro-D classification, versus 4 percent under Rauch. This demonstrates the main advantage of the Micro-D classification: by identifying items sold in small packages, it captures differentiation upgrade in goods traditionally derided as primary or commodities.[22]

21. The twelve product groups are food and beverages, other agricultural products, textiles, chemicals, plastics and rubber, paper, precious metals, metals, machinery, vehicles, other industrial products, and fuels. See the online appendix for details.

22. A large percentage of paper product exports that are identified as D under Micro-D only is explained by exports of impregnated paper and paper boxes, which are products that generally include customized features.

TABLE 2. Main Differences between Rauch and Micro-D: 2007–11

Rauch: D and Micro-D: U		*Rauch: U and Micro-D: D*	
Product	*Exports (US$ millions)*	*Product*	*Exports (US$ millions)*
Seamless steel tubes	1,131	Meat of bovine animals, fresh or chilled (under 5.0 kg)	648
Biodiesel	1,077	Wine of fresh grapes (under 2.0 liters)	633
Tanned or crust hides and skins of bovine	638	Apples, pears, and quinces (under 20.0 kg)	495
Leather further prepared after tanning or crusting, of bovine	239	Citrus fruits (under 20.0 kg)	364
Frozen fish, excluding fish fillets (over 1.0 kg)	202	Meat of bovine animals, frozen (under 5.0 kg)	273
Malt, toasted or untoasted (in bulk)	201	Cheese and curd (less than 5.0 kg)	154
Polymers of ethylene, primary forms	170	Meat of poultry (less than 15.0 kg)	147
Essential oils	135	Other prepared or preserved meat (under 5.0 kg)	135
Other vegetables prepared or preserved (over 2.5 kg)	94	Grapes (under 20.0 kg)	118
Petroleum coke	72	Potatoes (under 2.5 kg)	118

Table 2 takes a deeper look at the discrepancies between Rauch and the Micro-D. Within only-Rauch D exports (left-hand side), the most important items are seamless tubes (metals), biodiesel (chemicals), hides, and leather (textiles, leather, and hides). Although seamless steel tubes and biodiesel are capital-intensive products, their main features are standard, and their prices are easily found in specialized sites and publications. Hides and leather exported by Argentina display little scope for differentiation since they have only gone through basic processing.

The right-hand side of table 2 details products classified as D by the Micro-D but not by Rauch. All ten of the largest items in this list are either food or beverages. While these export items are often sold primarily in bulk, a significant volume is sold in small packages as a differentiated product. Additionally, the list shows that differentiation upgrade is not confined to a single product, but is achieved across a large number of food and beverage categories.

We perform three exercises to assess the relative ability of the Rauch and Micro-D classifications to identify differentiated exports.[23] First, a product that has achieved a higher degree of differentiation is expected to face a lower demand elasticity. Thus, conditional on costs, the firm will charge a higher price. To check this prediction, we compare products' unit values according to

23. We thank a referee for suggesting these exercises.

TABLE 3. Price-Level Estimations[a]

Explanatory variable	*(1)*	*(2)*
Differentiated under both systems	0.8376***	0.4554***
	(0.1388)	(0.0747)
Only Micro-D	0.6045***	0.2772***
	(0.1360)	(0.0351)
Only Rauch	0.4212***	0.2096***
	(0.1035)	(0.0662)
2-digit HS–unit–year fixed effects	Yes	No
4-digit HS–unit–year fixed effects	No	Yes
No. observations	67,801	67,801
R^2	0.5314	0.7213

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the (log) unit value of each product (twelve-digit SIM). Clustered standard errors by two-digit HS-year are in parentheses.

their differentiation condition (that is, only Rauch, only Micro-D, both, none). Specifically, we regress the (log) unit value of each product (twelve-digit SIM) on a set of dummy variables for each condition (where the constant corresponds to none), together with fixed effects at the two-digit level (column 1) and the four-digit level (column 2), both interacted with fixed effects for year and unit of measurement (for example, kilos, liters, units, and so on).[24,25]

The results are shown in table 3. Not surprisingly, all products classified as D by at least one classification display higher prices than U products. In all three cases, the average unit value is substantially higher than the benchmark case captured by the constant (not reported). Also, products classified as D by both classifications have the highest prices. Moreover, products classified as D only by the Micro-D display statistically significant higher prices than products classified as D only by Rauch—and the difference is stronger when we include two-digit fixed effects. This finding suggests that the Micro-D can identify differentiated products more accurately than the Rauch classification.

There is a strong caveat to this result. Since the stage of production is a key classification criterion in the Micro-D scheme, and since differentiated products tend to be in their final processing stages, they would mechanically have higher production costs and hence prices. To avoid this potential problem,

24. In the particular case of food and beverages, export quantities are generally expressed in kilos and liters, respectively, rather than in units.

25. We cannot include fixed effects at finer aggregation levels. The six-digit HS coincides with the four-digit SITC, which is the aggregation level used by Rauch to classify products. Thus, including fixed effects at this aggregation level would remove all useful variation for this exercise.

TABLE 4. Export Price and Destination-Country Income[a]

Explanatory variable	*(1)*
Destination GDP per capita (ln)	0.0232***
	(0.0042)
Rauch*GDP per capita (ln)	0.0205**
	(0.0087)
Micro-D*GDP per capita (ln)	0.0446***
	(0.0071)
Both*GDP per capita (ln)	0.0248***
	(0.0051)
12-digit SIM–unit–year fixed effects	Yes
No. observations	436,907
R^2	0.8326

Source: Authors' estimations, based on data from INDEC and World Bank.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the product's (log) price. Clustered standard errors by twelve-digit SIM-year are in parentheses.

we look at price variation across destinations for the same product. We expect that a differentiated product's price (that is, the twelve-digit SIM unit value) will increase systematically with destination per capita income. Differentiated products have a broader scope of variation in quality, brand recognition, and consumer loyalty, which should be reflected in systematic price variation with income via the impact on costs and markups.[26] Undifferentiated products, in contrast, have standardized attributes and higher demand elasticities.

In table 4, we regress the product's (log) price on the destination per capita income and on the interaction of this variable with differentiation-condition dummy variables, controlling for year-unit-product (twelve-digit SIM) fixed effects. As expected, prices are higher, on average, for products exported to higher-income countries. Also, as expected, the positive relationship between destination income and price is stronger for products classified as D by at least one classification. Among those, D products only under the Micro-D are those that display the strongest relationship with income even compared to D products under both classifications. We view this result as evidence that the Micro-D classification can identify differentiated products more accurately than the Rauch system.[27]

26. See, for example, Berry, Levinsohn, and Pakes (1995); Goldberg (1995); Hausmann, Leonard, and Zona (1994); and Petrin (2002).

27. Rauch (1999). We find similar results for these two exercises when we use the six-digit Micro-D classification instead of the twelve-digit Micro-D (see the online appendix). These results suggest that the coarser classification still identifies differentiated goods more accurately.

TABLE 5. Price Volatility

Explanatory variable	*All products (1)*	*Continuous products (2)*	*All products (3)*	*Continuous products (4)*
Only Rauch	0.0692***	0.0634***	0.0339**	0.0597
	(0.0083)	(0.0216)	(0.0156)	(0.0710)
Only Micro-D	0.0401***	0.0380*	–0.0049	–0.0122
	(0.0077)	(0.0208)	(0.0079)	(0.0398)
Both	0.0980***	0.0649***	–0.0208	–0.0378
	(0.0075)	(0.0183)	(0.0175)	(0.0803)
2-digit HS–unit–destination fixed effects	Yes	Yes	No	No
4-digit HS–unit–destination fixed effects	No	No	Yes	Yes
No. observations	157,328	16,404	157,328	16,404
R^2	0.2033	0.2940	0.3893	0.5606

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the price variation coefficient. Clustered standard errors by two-digit HS-year are in parentheses.

Finally, we analyze export price volatility by differentiation condition. Since differentiated products command higher markups, their price in foreign markets can absorb more variation in costs—for example, due to exchange rate movements—than commodities. Thus, we would expect that differentiated product prices are more stable over time. To assess export price volatility, we compute the coefficient of variation of each twelve-digit-SIM export unit value in each destination over the period 2002–11 and regress it on a set of dummy variables for each differentiation condition, alternatively including destination combined with unit of measurement and two-digit and four-digit fixed effects (columns 1 and 3). Since some products are not exported every year, we perform an alternate regression using products exported every year (columns 2 and 4).[28]

Table 5 displays the results. When we control for two-digit fixed effects, the price of D products (as classified by Rauch, Micro-D, or both) is significantly more volatile than the price of U products. A potential reason for this finding is that differentiated products have shorter product cycles, leading to innovation and variation in product characteristics over time, which increase price variability. In addition, even a twelve-digit position consists of a variety

28. Since identification here relies on time-series variation, we exploit a longer time period available in our data set (using previous years would involve dealing with heavy concordance issues). The results of tables 3 and 4 are almost unchanged if we use the sample period 2002–11.

of items with different features, quality, and prices. Hence, its unit value is determined by the particular composition of these varieties, which changes every year. The composition of undifferentiated positions, by contrast, is more homogeneous, which helps stabilize these products' prices. When we control for four-digit fixed effects (the highest possible disaggregation level for product fixed effects), the results are more in line with our conjecture: differentiated goods by both classifications and only by the Micro-D present lower price volatility over time than undifferentiated goods, although the difference is not statistically significant.

Assessing the Evolution of Argentine Exports

In this section, we apply the Micro-D classification to analyze the evolution of Argentine exports in 1998–2011. Those years mark the peaks of two macroeconomic cycles. The first peak is at the height of the convertibility regime that was in place between 1991 and 2001, when the peso was pegged at parity with the U.S. dollar. The second is at the height of the post-convertibility regime. After 2011, the Argentine government embarked on an unabated turn toward a commercial policy of generalized protection that imposed discretionary authorization requirements on all import shipments. Analyzing the consequences of this policy shift for Argentina's exports is left for future research.

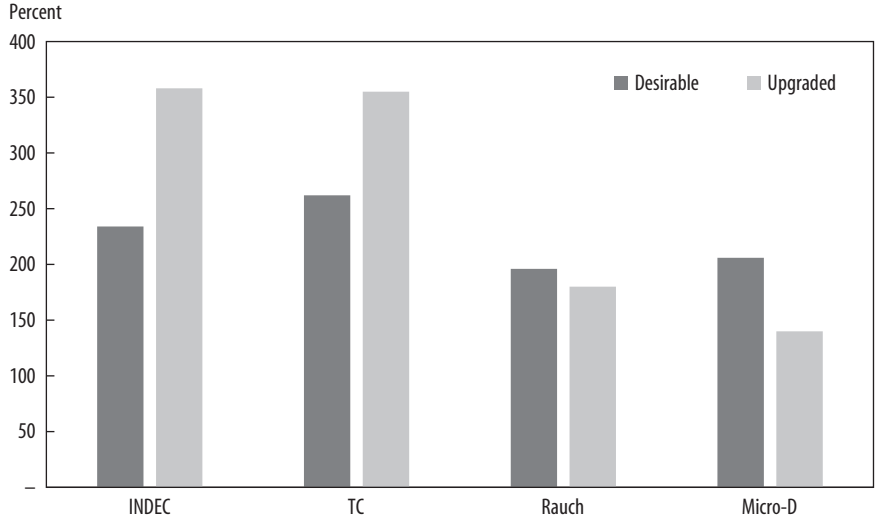
We also compare the results from applying the Micro-D to Argentina's exports with those obtained using alternative classifications. Specifically, we assess the evolution of so-called desirable export products under four alternative definitions. First, following the classification used by Argentina's official statistical institute (INDEC), we consider as desirable those products included in the category manufactures of industrial origin (MOI).[29] Second, the most widely used product classification is by technological content (TC), where high-intensity and medium-high-intensity products are considered desirable exports.[30] Third, desirable products are those classified as differentiated (D) under Rauch and, fourth, under Micro-D.[31]

29. INDEC classifies products in four categories: primary products, manufactures of agricultural origin (MOA), manufactures of industrial origin (MOI), and fuels and energy. It is customary to regard MOI as the virtuous category both in the press and in the academic literature.

30. This classification is from Hartzichronoglou (1997).

31. We exclude used products from the analysis. Used exports are particularly relevant in airplanes, where used items account for 99 percent of airplane exports from Argentina.

FIGURE 1. Growth Rate of Desirable and Upgraded Exports, September 1998 to January 2010



Source: Authors' elaboration, based on INDEC data.

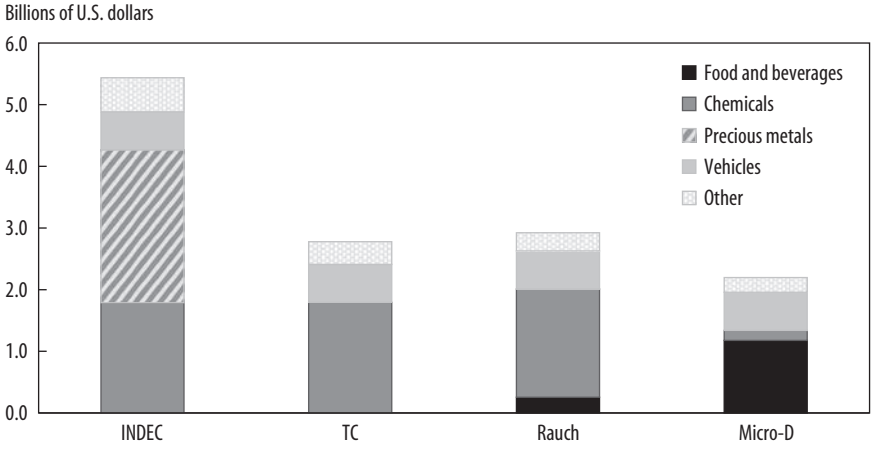
As argued earlier, differentiated exports to high-income countries are more likely to manifest the acquisition of diffusible knowledge than differentiated exports to other destinations. In particular, differentiated exports to neighboring countries and to low-income countries do not necessarily require the capability to adapt products and business practices to foreign market needs. We refer to desirable exports to developed countries as upgraded exports to distinguish them from desirable exports to all destinations. More specifically, upgraded exports are desirable exports shipped to any of the twenty-three OECD members in 1990 (this set excludes more recent members such as Mexico, Korea, and Chile).[32]

Figure 1 displays the growth rate of desirable and upgraded exports under each of the four definitions between the 1998–99 average and the 2010–11 average.[33] All four classifications deliver similar growth rates for desirable exports. The growth rate is highest when desirable exports are computed using

32. In all four classifications, upgraded exports account for a small share of desirable exports, namely 27 percent, 19 percent, 20 percent, and 19 percent of the 2010–11 desirable export average under INDEC, TC, Rauch, and Micro-D, respectively.

33. We use two-year averages to smooth out idiosyncratic variation in the extreme years.

FIGURE 2. Contribution to Absolute Upgraded Export Growth, September 1998 to January 2010



Source: Authors' elaboration, based on INDEC data.

the TC classification (262 percent), while it is lowest when they are computed using Rauch (196 percent). However, when we focus on upgraded exports, differences in growth rates become larger. In particular, upgraded exports identified by differentiation (Rauch and the Micro-D) deliver substantially lower growth rates than upgraded exports singled out by the other two classifications (INDEC and TC).

To uncover why the classifications yield such different results, we divide products in the same twelve groups used earlier and identify which are responsible for the main differences. For this exercise, we use absolute growth rather than growth rates. Figure 2 decomposes absolute growth in upgraded exports by product group according to each classification. Under the INDEC classification, the main growth contributor is precious metals, which is mainly unwrought gold.[34] The other three classifications rightly leave precious metals out of the desirable set; the TC classification does not consider these products desirable because they are not technologically intensive, while the other two classifications do not consider them desirable because of their low degree of differentiation.

34. INDEC classifies unwrought gold as a manufacture because after extraction and before export, the crude mineral goes through basic chemical and casting processes to obtain the gold ingot.

Second, the TC and Rauch classifications surprisingly deliver similar results in terms of the sectoral composition of export growth. In both cases, the most important contributor is chemicals, driven almost exclusively by biodiesel exports. This product is basically a commodity obtained from further processing of soybean oil.

Under the Micro-D classification, growth in upgraded exports is more modest. Upgraded exports grew by US$2.2 billion under the Micro-D scheme, versus US$2.8 billion and US$2.9 billion under the TC and Rauch classifications, respectively. Most important, substantial differences arise in growth composition. Two elements stand out. First, chemicals is the most important growth component under the TC and Rauch classifications, accounting for 65 and 60 percent of total growth, respectively. In contrast, this sector's contribution to upgraded growth under the Micro-D is only 7 percent, since this classification rightly considers biodiesel to be an undifferentiated product. Second, food and beverages is the most important contributor to upgraded growth under the Micro-D scheme. This category accounts for 54 percent of total growth in upgraded exports, whereas it accounts for 9 and 0 percent of upgraded growth under the Rauch and TC classifications, respectively. While the Micro-D classification can single out differentiated food and beverage items in small packages, the Rauch classification can only identify specific food categories as differentiated (for example, frozen fish, malt, and malt extract). In the case of the TC classification, the neglect is more dramatic, as this classification does not include any food or beverage item in its two upper technological-content categories.[35]

To delve deeper into the differences in upgraded export growth under the Rauch and Micro-D classifications, we list the largest divergences in table 6. In the left panel, the table shows that vehicles and vehicle parts are the most important export growth items among those considered upgraded under both classifications. Other important items are hormones, pumps for liquids, and inlet valves. In the center panel, the products with the highest export growth that are classified as upgraded by Rauch but not by the Micro-D are biodiesel, seamless steel tubes, peanuts, essential oils, and petroleum coke. These are

35. The remaining large upgraded growth component is vehicles, whose exports are unanimously classified as desirable. Qualitatively, similar differences across classifications arise when we perform this exercise considering exports to all destinations. Although vehicle exports become the main desirable export item under all four classifications—due to the large amount of Argentine vehicle exports to Brazil—the sectoral composition of export growth is qualitatively unchanged.

TABLE 6. Upgraded Exports with the Highest Absolute Export Growth, September 1998 to January 2010
Millions of U.S. dollars

Rauch: D Micro-D: D		*Rauch: D Micro-D: U*		*Rauch: U Micro-D: D*	
Description	*Growth*	*Description*	*Growth*	*Description*	*Growth*
Motor vehicles (for transport of goods)	555	Biodiesel	1,503	Wine of fresh grapes (under 2.0 liters)	472
Parts of vehicles	85	Seamless steel tubes	277	Meat of bovine animals, fresh or chilled (under 5.0 kg)	243
Hormones	56	Peanuts (over 2.5 kg)	226	Other fruits (under 2.5 kg)	105
Pumps for liquids	33	Essential oils	88	Citrus fruit (under 16.0 kg)	91
Inlet valves	33	Petroleum coke	34	Apples (under 2.5 kg)	45

products that have standard features and thus are not differentiated. In the right panel, top growth items that are classified as upgraded by the Micro-D but not by Rauch are all either food or beverages. This list includes wine, bovine meat, citrus fruits, apples, and other fruits exported in small packages. These products are correctly classified as D since their shipment in small packages manifests the possession of differentiated attributes.

Adding value through differentiation in food and beverage items sold to high-income countries is a relevant manifestation of productive transformation in land-abundant developing countries. However, the TC classification neglects this type of transformation by focusing on technological content, while the Rauch classification does not capture it due to insufficient disaggregation. By looking at package size in disaggregated export statistics as an indicator of product differentiation in food and beverage products, the Micro-D classification is better suited to identify export upgrading in land-abundant countries.

Improving on the seminal contribution of Rauch is crucial for reaching a more accurate assessment of the evolution of Argentine differentiated exports to developed countries.[36] Based on an inaccurate classification of biodiesel as a differentiated product, under the Rauch classification we would conclude that chemical products were the main contributor to upgraded exports in the period 1998–2011. In contrast, under the Micro-D classification, we conclude that the major contributor to this type of export was food and beverages

36. Rauch (1999).

sold in small packages. This result supports an assessment of the sources of recent export upgrading in Argentina, which might point to very different policy recommendations.

Conclusions

This paper argues that product differentiation is the best criterion for identifying desirable exports and proposes a new classification of differentiated products that builds upon the seminal work of Rauch.[37] By working at a very fine aggregation level, the Micro-D classification allows for a more accurate identification of differentiated products. Applied to Argentina's exports in 1998–2011, the Micro-D classification delivers a very different view about the sources of Argentine export upgrading. Whereas the Rauch classification identifies chemicals (basically biodiesel) as the main driver of export upgrading, the Micro-D classification highlights the role of differentiated food and beverages. This new result induces a different interpretation of the recent Argentine export performance that has implications for the optimal choice of international insertion policies.

Appendix: A Detailed Description of the Micro-D Classification

The HS classification was modified twice during our sample period (HS 1996 to HS 2002, then to HS 2007). Since some product codes were changed, we had to work on the correspondence between these nomenclatures and the trade flows assigned to each code to guarantee consistency over time. At the authors' websites, in addition to providing a Stata file and a PDF file with the full 2007 SIM classification database (Micro-D.dta) and description (Micro-D full description.pdf), we also provide a Stata file (Combined SIM for Micro-D.dta) with the classification applied to all SIM codes in the 1998–2011 period.[38]

Some trade flows in 1998 and 1999, which should have been registered under HS 1996 nomenclature, were instead registered using the earlier HS 1988/1992 nomenclature. Since the newer HS 1996 had finer codes than

37. Rauch (1999).
38. See the website https://sites.google.com/view/jhallak/.

the HS 1988/1992, several differentiated and undifferentiated products were bundled together under the older nomenclature. This problem was particularly important for meat and fruit products, because the HS 1988/1992 did not yet distinguish products by package size. To deal with this issue, we assigned the same D/U shares observed in 2000 at the eight-digit level and destination-group level to exports reported under these troublesome codes in 1998 and 1999.

The main criteria for classifying goods under the Micro-D classification are discussed in the body of the paper. Essentially, primary products are undifferentiated (U), final products and capital goods are differentiated (D), and intermediate products are classified case by case as U or D based on their specific attributes. Here, we discuss the application of these broad criteria to sets of goods.

—Agricultural products, food, and beverages (HS 01–24): Products in this category are classified for the most part according to their package size. Food and beverages exported in small packages are considered D, whereas those exported in bulk are classified as U. This follows the general rule of classification according to degree of elaboration. Processed consumer goods (for example, dulce de leche, candy, champagne, pasta, and so on) are classified as D. For unprocessed or partially processed animal and vegetable products such as meat, fish, dairy, produce, fruit, cereals, and their derivatives, which constitute the vast majority of products in these chapters, we identify whether they have reached their last stage of elaboration by looking at the size of the package in which they are exported. They are classified as U if they are exported in bulk and as D if they are exported in packages ready for retail sale.

—Minerals products (HS 25–27): All products in these three chapters are classified as U because all are primary products.

—Products of the chemical or allied industries (HS 28–38): Following the general rule, products in these chapters are classified according to their degree of elaboration. In the case of intermediate products, they are D when the production process (purification protocols and synthesis process) and form of distribution (for example, refrigeration package) determine their effectiveness. All remaining intermediate products are U. Subgroups are categorized as follows:

(a) Inorganic and organic chemicals (HS 28–29): Primary products (for example, fluorine, carbon, and hydrocarbons) are U. Among intermediate items, there is a group of D products (for example, hormones, vitamins, and antibiotics) for which the purification protocols and form of distribution are important for subsequent performance and a group of U products

(for example, inorganic acids and oxides, alcohols, and phenols) with standard characteristics and less relevant purification protocols.

(b) Pharmaceutical products (HS 30): All intermediate and final products are classified as D. Intermediate items are D because the specific synthesis process used to produce them determines their effectiveness.

(c) Fertilizers (HS 31): They are classified according to their package size.

(d) Tanning, dyeing extracts, pigments, and other coloring matter (HS 32): Primary products (for example, tanning substances and dyeing extracts) are U. Among intermediate products, there are both D products (prepared pigments, paints, varnishes, and driers), which are customized to market niches, and U products (coloring matters) with standardized features.

(e) Essential oils, perfumery, cosmetic, and toilet preparations (HS 33): Intermediate products (essential oils and odoriferous substances) are U because they have standardized features. Final goods are D (for example, perfumes, makeup, and preparations for hair use).

(f) Soap, organic surface-active agents, washing preparations, and prepared waxes (HS 34): All products are classified as D because they are final products.

(g) Albuminoidal substances, modified starches, glues, and enzymes (HS 35): All intermediate and final products are classified as D because the specific purification protocols and production processes followed to obtain them determine their performance.

(h) Explosives, pyrotechnic products, matches, and pyrophoric alloys (HS 36): Intermediate products (for example, propellant powders and prepared explosives) are U because they contain standardized features. Final goods (such as safety fuses, fireworks, and matches) are D.

(i) Photographic or cinematographic goods (HS 37): All products are D because they are final products.

(j) Miscellaneous chemical products (HS 38): Primary forms (for example, artificial graphite, activated carbon, and tall oil) are U. A group of intermediate commodity chemicals (for example, rosin and resin acids, turpentine, mixed alkylbenzenes, fatty acids, and biodiesel) are classified as U because there is little scope for differentiation given the chemical composition. Another group of intermediate specialty chemicals (for example, agrochemicals, finishing agents, prepared rubber accelerators, and diagnostic or laboratory reagents) are D because their synthesis process and purification protocols determine their performance.

—Plastics and rubber products (HS 39–40): Primary forms, such as polymers, cellulose, silicone, and natural or synthetic rubber, and some semi-manufactures, such as monofilaments, tubes, and floor coverings, are classified as U. Manufactures made from these primary inputs are D (pneumatic tires are a prominent example).

—Hides, skin, and leather (HS 41–43): Primary forms, such as raw and tanned hides, skins, and furskins, are U. Most intermediate products (for example, dressed furskins and leather) are U because they present standard features. The exceptions are chamois and patent leather, which contain differentiated attributes. Articles of leather, apparel, and artificial fur are D because they are final products.

—Wood and wood articles (HS 44): Primary forms of wood (such as fuel wood, wood wool, sawn wood, fiberboard of wood, and densified wood) are U. Wooden frames for paintings, packing boxes, tools, and other articles of wood are D.

—Cork and articles of cork (HS 45): Natural and agglomerated cork (primary forms) are U. Their articles (final products) are D.

—Manufactures of straw (HS 46): All products are D because they are final products.

—Pulp of wood (HS 47): All products are U because they are primary products.

—Paper and paperboard (HS 48): Intermediate products are divided between those with standardized features (for example, newsprint in rolls, toilet or facial tissue stock, uncoated kraft paper and paperboard, corrugated paper and paperboard, and filter paper and paperboards), which are U, and those with customized features (paper and paperboard coated, impregnated, covered, or printed; envelopes and letter cards, toilet paper, cartons, boxes, cases, bags, and paper and paperboard labels), which are D. Uncoated or coated paper and paperboard and cigarette paper with kaolin are D only when they are conditioned for retail sale.

—Printed books, newspaper, and pictures (HS 49): All products are D because they are final products.

—Textiles (HS 50–56): Primary forms of each material (for example, silk, wool, and cotton) are U. Among intermediate products, woven fabrics of cotton and synthetic fibers are in general U because they contain standardized characteristics, except for printed woven fabrics (classified as D) which are differentiated by their designs. Woven fabrics of other textile fibers (for example, silk, wool, and flax) are D because they are typically customized to

market needs. Yarns are U because they contain standardized characteristics (within a textile fiber).

—Textile articles (HS 57–63): Intermediate products (for example, special woven fabrics, impregnated, coated or laminated textile fabrics, and knitted fabrics) are in general D because they tend to be differentiated by their brand or design. The exceptions are unbleached and dyed knitted fabrics of cotton and synthetic fibers, which are U because their features are standard. Final products (carpets and articles of apparel and clothing) are D.

—Footwear, umbrellas, and prepared feathers (HS 64–67): All products are D because they are final products.

—Articles of stone, ceramic, and glass (HS 68–70): All products are D because they are final products.

—Base and precious metals products (HS 71–83): Products in these chapters are classified according to their degree of elaboration and their differentiated attributes:

(a) Natural or cultured pearls, precious or semi-precious stones, and precious metals (HS 71): Primary forms (unwrought metals and unworked pearls, diamonds, and precious stones) are U. Final products (articles of jewelry and articles of goldsmiths' or silversmiths' ware) are D.

(b) Iron and steel (HS 72): Steel and stainless steel products (primary forms and intermediate products) are U because their attributes are standard conditional on observable characteristics (for example, thickness or diameter). Primary forms of alloy steel are U. Other alloy steel products are D because they are differentiated by the specific combination of metals they contain.

(c) Articles of iron and steel (HS 73): Sheet piling, railway construction material, tubes, pipes, and hollow profiles are U because their attributes are standard, conditional on observable characteristics. Other intermediate products (for example, containers, screws, bolts, nuts, and springs) are D because they are customized to market needs. Final products (for example, tables and other household articles, sanitary ware, and stoves) are D.

(d) Copper, aluminum, other metals, and articles thereof (HS 74–81): Primary forms (unwrought base metals and powders) are U. Bars, plates, sheets, and tubes of these metals are also U because they have standardized features. Other intermediate products (such as reservoirs) and final products (such as tables and kitchen articles) are D.

(e) Tools, implements, cutlery, spoons, forks, and miscellaneous articles of base metals (HS 82–83): All intermediate and final products are classified as D because they have customized characteristics.

—Machinery, appliances, vehicles, and transport equipment (HS 84–89): All products are D. They include capital goods (for example, electromechanical domestic appliances, nuclear reactors, and turbines), specialized intermediate products (such as vehicle parts), and final products (for example, vehicles and aircraft).

—Miscellaneous manufactured articles and works of art (HS 94–97): All products are classified as D because they are either final products (for example, furniture, musical instruments, arms, toys, and photographic instruments) or specialized intermediate products (for example, parts of these products). Collections and antiques are the only exceptions because, despite being differentiated, they are not reproducible.

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