Development and Change
Published on behalf of the Institute of Social Studies, The Hague

Classification and Roundabout Production in High-value Agriculture: A Fresh Approach to Industrialization

Christopher Cramer, Jonathan Di John and John Sender

ABSTRACT

Developing countries are balance-of-payments constrained. In this context, high-value agricultural exports can make a greater contribution to structural change than development economists and developing country governments have typically acknowledged. This is thanks to dramatic recent changes in agricultural production, consumption and trade. These transformations are obscured by a simple classification system that has not adapted to changing patterns of global capitalist production. This article examines some recent efforts to rethink the basis of economic classification; it contributes to this emerging literature by proposing a way to think about the distinctions among economic activities that builds directly from the observation of production rather than a method of *ex-post* mapping of trade data. A more accurate classification of economic activities would, the authors suggest, help policy officials design more coherent and growth-enhancing industrial policies in support of accelerated structural change and productivity growth. The article draws on primary fieldwork in Ethiopia in particular, but also on fieldwork in South Africa and on secondary evidence.

INTRODUCTION: THE DOMAIN OF THE INDUSTRIAL

Although there has been a recent flurry of research on industrial policy, involving both neoclassical and less orthodox economists (Cherif and Hasanov, 2019; Oqubay et al., 2020; Storm, 2015), this new and rediscovered policy literature devotes surprisingly little attention to what constitutes 'industrial' and, therefore, to the question of the appropriate extent of the domain of industrial policy. Likewise, there is an important and ongoing debate about premature deindustrialization — how much of it there has been, why, and whether it is unavoidable in low- and middle-income

The authors would like to thank the journal's editors and anonymous reviewers for their constructive criticism, which they hope has led to an improved article. They thank the Agence Française du Développement for funding support and all those in Ethiopia and South Africa who gave their time for interviews.

Development and Change 0(0): 1–30. DOI: 10.1111/dech.12708

countries (Nguimkeu and Zeufack, 2019; Rodrik, 2016, 2018) — but this debate has not questioned what counts as industrial. The broad classification of economic activities has been treated in this literature as largely immutable. Similarly, work on economic sophistication, for example in the *Atlas of Economic Complexity* (Hausmann et al., 2014; Hidalgo and Hausmann, 2009), rests on the interpretation of trade data derived from the standard classification systems which, as we show below, import inappropriate assumptions about the characteristics of particular kinds of economic activity.

Systems of economic classification such as the International Standard Industrial Classification of All Economic Activities (ISIC) do undergo periodic revisions, each revision representing one adjustment in a long evolution of definitions, measurement and classification of economic activities (UNSD, 2008: ix; see also Smith and James, 2017). But this article questions how far these revisions have gone to address fundamental changes in global production, especially changes in technologies and in the organization of production. We argue that the boundaries between 'sectoral' activities have become increasingly blurred as manufacturing, services and agricultural activities overlap, integrate and become imbricated in one another.

A relatively well-known instance of this is 'servicification' (Baldwin et al., 2015; Lodefalk, 2017), whereby a growing share of the final market value of goods is accounted for by service activities (logistics, marketing and branding, research and design, etc.). In this article we focus specifically on a different, less-studied set of activities which breaches the categorical boundaries between agriculture and industry (and in fact services too) that we identify as the 'industrialization of freshness'.

Most non-mainstream economists classify goods produced in the manufacturing sector as particularly important for economic development, because the manufacturing sector is believed to have the production and demand characteristics most likely to fuel growth and structural change. Manufacturing output, in terms of Kaldor's (1967) growth laws, is causally linked to overall GDP growth, to productivity growth within manufacturing, and to productivity growth outside manufacturing. Both static (largely within-firm) and dynamic (more general, between-firm) economies of scale, and the scope for forward and backward investment linkages (Hirschman, 1958), have often been regarded as more concentrated in manufacturing than in any other economic activities. At the heart of much structuralist development economics, in particular, has been the idea that the income elasticity of demand for manufactured goods is significantly higher than that for primary commodities (Ocampo et al., 2009: Ch. 4).

Our argument in this article is that a definition of the special characteristics of manufacturing activities that lend themselves to growth-accelerating interventions (targeted industrial policy) should build on an understanding of the *full* range of activities across which these characteristics apply. We argue that many of the properties and benefits believed to be associated

with 'the manufacturing sector' can also stem from the production of high-value agricultural 'fresh' goods.[1] We claim on the basis of Ethiopian, South African and other evidence that the labour-intensive assembly of ornamental plant cuttings and chilled blueberries, for instance, is no less technologically complex than piecing together T-shirts, jeans and sports shoes in turnkey factories. Some of this complexity relates to the 'narrow margin for failure' (Hirschman, 1967) that is a characteristic of global markets for agricultural goods with a high income elasticity of demand (see below).

If developing countries can expand their exports into markets with a high income elasticity of demand, then revenue from these exports may help ease the balance-of-payments constraint on their economic growth. Thirlwall (2011) argues that a country's growth is determined by its rate of growth of export earnings combined with the income elasticity of demand internationally for the goods it exports, and by the rate of growth of imports and the domestic income elasticity of demand for imports.[2] Thirlwall provides the theoretical framework for our discussion of the need for a policy focus on increasing exports of high-value and fresh agricultural exports in low- and middle-income economies. Our policy conclusions are consistent with the fact that different goods have different production and demand characteristics.[3]

We begin with a discussion of the rationale for our fieldwork methods, before highlighting the theoretical and practical differences between research strategies that rely on officially published international statistics and our own primary research, which builds both on Young's insights into 'roundabout' production (1928) and Hirschman's understanding of linkages (1958).[4] We then suggest that because high-value agricultural exports can be shown to have many properties historically associated with capitalist manufacturing, they ought to be included in the viewfinder and range of industrial policies that aim to accelerate structural change.

After analysing the flaws in the long-established simple sectoral division of activities, we set out a new and different foundation for analysing

1. The ratio of value to volume of exports (the V-V ratio) provides an indication of the extent to which the product can be considered relatively 'high value' (World Bank, 2004: 8). Cut flowers, fish, dairy, and some fresh fruit and (miniature) vegetables have higher export V-V ratios than do commodities such as cereals. The V-V ratio for a product can change because of changes to the product itself that increase its value, such as quality improvements, or the introduction of new varietals as a result of research and development.
2. The evidence supporting this proposition is strong (Pérez Caldentey and Vernengo, 2019). Some of the critics of balance-of-payments-constrained growth models are discussed in Thirlwall (2019: 558).
3. 'This obvious point is missing from the one-good aggregate closed-economy models of mainstream growth theory so prevalent in textbooks' (Thirlwall, 2019: 556).
4. Roundabout, or indirect, production reflects the way that 'an increasingly intricate nexus of specialist undertakings has inserted itself between the producer of raw materials and the consumer of the final product', together with 'an increase in the diversification of intermediate products' (Young, 1928: 537–38).

economic activities, with an emphasis on agricultural exports. We illustrate our discussion by focusing on two specific examples of the way in which ISIC sub-categories set up a 'category error'. We then show how appreciating the 'roundabout' complexity of these export activities leads to a concern with the many barriers that need to be overcome if government policies are to address the significance of the industrialization of freshness, in a context of balance-of-payments-constrained growth.

Our findings lead us to issue a warning to policy makers who promote sectoral shifts to accelerate structural change: they should not ignore the risk that failing systems of sectoral classification result in a relative neglect of agriculture. We stress the dangers in continuing to rely on the familiar, simple sectoral division of activities because it has become an inadequate guide to structural change, to the identification of policy priorities and to export opportunities. The concluding section not only provides a summary of some of our article's main arguments but also stresses the limitations of our methods and the need for further research covering a wider range of developing economies and activities.

FIELDWORK METHODS IN THE UPPER AWASH VALLEY AND THE WESTERN CAPE

We decided to study some of the most rapidly expanding export activities: the production of avocados, macadamia nuts, blueberries, herbs, poinsettia cuttings, passion fruit, citrus and deciduous fruit and more.[5] Do they match their characterization in the Harvard Growth Lab's *Atlas of Economic Complexity*? Are they accurately described and classified in international classification systems? What might be the policy implications of a readjustment in our understanding and classification of these activities? More specifically, what are the organizational and technical requirements of competing in international markets for high-value agricultural commodities, what skills and accumulated learning are involved, and how do these shape the constraints that face the firms (and economies) engaged in these markets?

The evidence we collected to explore these questions came from two separate projects: one in South Africa in 2015 and one in Ethiopia in 2016–18. The first project was designed originally to identify the contribution that high-value agricultural exports could make to employment and the balance of payments in South Africa (Cramer and Sender, 2015). We carried out 33 interviews with farm owners and managers, mainly in the Western Cape but also in Limpopo and Mpumulanga Provinces, as well as with policy officials, investors and exporters based in Gauteng Province (in Johannesburg,

5. Data on export volumes and technological innovation in these activities are regularly reported at: www.freshplaza.com/

Pretoria and the industrial zones in between). Our interviews focused on crops including citrus fruit, deciduous fruit, blueberries, avocados and macadamia nuts. The second project, in collaboration with the Ethiopian Development Research Institute in Addis Ababa and funded by the Agence Française du Développement, had similar objectives and focused chiefly on producers of flowers and plant cuttings, vegetables such as green beans, herbs and passion fruit, although we also interviewed mango, grape and tomato producers supplying the domestic market, and other horticulture firms. Our 30 interviews were concentrated in the Upper Awash Valley, in farms close to Bishoftu (Debre Zeit, some 50 km east of Addis Ababa), and on the road south from Bishoftu to the floriculture centre of Ziway (where we had previously done extensive labour market survey work and producer interviews). Further follow-up field visits were planned, but violent protests and attacks, including on some of the farms in our sample, made it unsafe to travel.

Interviews were semi-structured, and we adopted a purposive and snowballing method for identifying and selecting interviewees, while also drawing on enterprise lists provided by producer associations and research institutes. Our sampling was guided by the simple principle of trying to identify 'the best' producers in each country, in terms of quality, productivity, technological sophistication and recent rates of growth of export volume. Senior figures in producer associations, in government agencies, and in firms importing inputs like irrigation equipment, as well as international investors and the leadership of Ethiopian Airlines, all helped to identify 'the best' producers.

We chose this type of small purposive sample partly because the international evidence (especially from Chile and Colombia and also from Kenya) suggests that successful integration into global horticultural value chains depends on a handful of 'export superstars' (Moran, 2018; see also Cramer and Sender, 2015 on South Africa).[6] There are empirical similarities between successful supply chain creation in manufacturing and horticulture in developing economies: success in both activities requires 'export superstars that are born big, start out as highly productive firms, and grow fast' (Moran, 2018: 3).[7] Indeed, the increasing role of international standards (phytosanitary, quality, voluntary 'ethical', etc.) has only led to a greater concentration within horticultural production. For example, in 2004 smallholders dominated Kenyan horticulture exports, but by 2011 the smallholder share of export revenue had fallen to less than 30 per cent

6. Similarly, Easterly et al. (2009) found that exports tended to be highly concentrated in a handful of 'big hit' exports in successful economies, but they focused exclusively on manufacturing. The international evidence is that the industries that are becoming more concentrated are those with faster growth of productivity and innovation (Autor et al., 2020).
7. Ethiopia's domestic fruit and vegetable market has been dominated by one huge 'Ethiopian' conglomerate owner.

(ibid.: 12). It is no wonder that all the export agribusiness managers we interviewed struggled with their efforts to promote smallholder out-grower schemes, which appeared to be more significant as a political gesture than as a productive strategy.

A Theoretical Case for Investigating Intricate and Roundabout Production in the Field

This research design differs from the work from which, for example, Hausmann et al. (2014) develop their *Atlas of Economic Complexity*. As noted above, the economic complexity research effectively works as a method of '*ex-post* mapping' (Andreoni and Chang, 2019), assessing the degree of sophistication of economic activities from the evidence that is published in standard international trade classification. The type or category of a product (rather than the design, branding, tasks and technologies used in its production) determines its sophistication or 'complexity'. But such a measure cannot explain why certain products (for example, Jamaica Blue Mountain coffee, rubber Havaiana flip flops, a Hermes leather handbag) are differentiated to such an extent that they command vastly higher prices than the average price within a given 'product' space. Below, we show in detail how particular 'fresh' agricultural products are significantly more complex than suggested by their codes in international classification systems. Moreover, while agriculture is typically shown on these product maps to be simple and 'distant' from more 'complex' sectors (and thus less likely to facilitate productivity-enhancing linkages), the extent to which complex tasks are embedded within 'fresh' production suggests that the cartography of complexity in the *Atlas* published by the Harvard Growth Lab is distorted. We hope that our fieldwork complements this widely quoted work on economic complexity and contributes to analytical and policy debates.

Our interviews with Ethiopian, Dutch and Israeli farm managers established that many high-value agricultural export activities are highly sophisticated, to the point that they meet a reasonable definition of what it is to be 'industrial' (Ho, 2016). They entail the insertion of an 'intricate nexus' — as Allyn Young (1928) had it — between the commodity and its form as a final consumption good (and in fact extending to the origin of the commodity itself through genetic plant stock development and adaptation), even if the final product appears on the retail shelf as if it had simply grown on and been picked off a tree, trellis, bush, or row of plants. Young's intricate nexus was a function of what he described as 'capitalistic and roundabout' production (ibid.: 531), effectively an aspect and extension of Smith's discussion of how the division of labour and specialization depend on the extent of the market. The production in Ethiopia of herbs such as basil, for example, involves a string of processes and inputs besides labour and capital. We observed basil producers using computerized fertigation equipment, specialist

packaging that was the result of decades of research and development (R&D) investment, different types of cold storage facility, a mechanized rotating table passing the product of one person's work (for instance, snipping a bunch of basil) to another (binding), along with equipment for testing the phytosanitary condition of the herbs, barcoding technology for precise traceability, extended visits from experienced Israeli, Indian and Ecuadorian technicians, and so on. None of these — or the training packages for skilled labour in managing logistics, cold storage control, plant stock aptitude for local soils and climate, etc. — would be designed or produced for just *one* herb-producing firm in Ethiopia, or even exclusively for herbs anywhere. Rather, they evolve over time as related — *intimately connected*, as Marshall might have put it (1920) — activities further extend market size and open up opportunities for profitable specialization, product differentiation and the division of labour.

Young's roundabout production and intimate nexus, the ongoing interplay of market size and specialization, are the terrain on which Hirschman's (1958) ideas of linkage effects were later developed. For Young himself they were the heart of the increasing returns central to capitalist dynamics: 'the principal economies which manifest themselves in increasing returns are the economies of capitalistic or roundabout methods of production' (1928: 531). What we found, and show in more detail below, is that the scope for linkages and broadly conceived economies of scale and scope, which are often thought to characterize *manufacturing* industry in particular, are increasingly characteristic of high-value agriculture.

This is not the same as what is more conventionally included in 'agro-processing'. Agro-processing may involve the transformation of an agricultural product through combination with other substances, essence extraction, pulping, milling, fermenting and brewing, drying, etc. Rather, what we observed involves the production of goods in pursuit of quality and efficiency and to maximize the gains of 'freshness'.[8] We saw just-in-time production, and farm-to-plate systems, which may involve the manipulation of time (based on research to tweak ripening rates or the 'window of non-perishability'). Thus, we distinguish such production from agro-processing and refer to these activities as the 'industrialization of freshness'. This industrialization of freshness is partly a result of a 'complexification' of agricultural supply chains generally (Muyanga et al., 2019: 24) and the digitalization of farming, which some argue is the 'most significant change to occur in the food system since the Green Revolution of the 1950s and 1960s' (Rotz and Fraser, 2019: 208). Digitalization includes the use of remote satellite data and in-situ sensors to improve the accuracy and reduce the cost of

8. Recent developments in technology and phytosanitary standards represent the latest evolution of what is another far from immutable category; see Freidman (2010).

monitoring crop growth and ensuring traceability.[9] Such complexification of fresh supply chains creates a basis for high value-added product differentiation not commonly generated in agro-processing.

One implication is that classification systems inappropriately render many high-value agricultural products as 'simple' or basic. Once treated this way, these products tend not to appeal to development economists or policy officials as having especially 'developmental' properties. By contrast, we argue that they have many properties historically associated with manufacturing and that, therefore, they ought to be included in the range of industrial policies that aim to accelerate structural change.

THE NEED TO REFRESH DEBATES ON STRUCTURAL CHANGE

Many low- and middle-income countries have recently suffered a deepening of their balance-of-payments constraint on growth and a fall in both international remittances and wage employment opportunities, especially in domestic wage employment opportunities for the least skilled and poorest (Kalantaryan and McMahon, 2020; Wageningen University and Research, 2020). When low-income African economies began to be disrupted by COVID-19, the larger, vertically integrated enterprises in the fresh fruit and vegetables (FFV) export supply chains demonstrated much more resilience and innovation than most of the small producers and traders in the domestic FFV chains (Van Hoyweghen et al., 2021). Designing effective policies on the basis of country-specific constraints on export expansion is becoming increasingly important as, in the wake of COVID-19, the high-value agricultural export products on which we focus may offer a lifeline to large numbers of people seeking seasonal and permanent rural wage employment.

In development economics the sectoral classification of activities has been used to understand and compare patterns of structural change. Ideas about the different properties of discrete categories of economic activity were supposed to lead to insights into the dynamics of long-run growth, structural change and sustainable improvements in welfare. 'Broadly speaking, [structuralist development economists] emphasized that productive sectors are different in their potential to generate growth and development' (Gala et al., 2018: 1). Shifting a rising share of the labour force into higher productivity activities — typically those characterized by increasing specialization, learning by doing, and economies of scale — is at the heart of the process of development discussed by Lewis (1954).

9. It also includes the Weedscout App that automatically recognizes weeds, insects and crop diseases on the basis of a photo taken by a mobile telephone. This is currently being targeted on farms in Africa to reduce agro-chemical applications and minimize the risks of residues that restrict access to important markets (Menne, 2019).

Unfortunately, the 'Lewis model' has been misleadingly read as a shift out of agriculture and into urban manufacturing. This, together with the traditional understanding of Kaldor-Verdoorn insights into the contribution of manufacturing to rapid economic growth, has often led to a relative neglect of agriculture. Meanwhile, the tendency to neglect agriculture as a source of export revenue is sometimes compounded by a fatalistic belief in the Prebisch-Singer hypothesis of a secular decline in the net barter terms of trade faced by primary/agricultural commodities.[10] However, the shift from low to higher productivity activities might just as well take place *within* agriculture as away from agriculture. There is immense scope for dynamic technical change and for raising agricultural productivity in low-income countries (Luan et al., 2019; Mueller et al., 2012), not just by adopting higher yielding cereal varieties, more fertilizer and irrigation, but also through the industrialization of freshness.

Furthermore, the demand characteristics of many agricultural goods are far more favourable (for export potential and employment opportunities) than is often acknowledged. Rising incomes lead to shifts in demand and the income elasticity of demand for 'non-nutritive attributes [of food] — appearance, safety, storability, taste, variety, as well as perceived environmental or social attributes associated with the production process (e.g., Fair Trade, organic) — is much higher than for nutritive attributes' (Barrett et al., 2019: 5). The global rate of growth of demand for 'high-quality' foods and for more nutritious, perishable vegetables, fruits and animal products is much higher than for staple cereals, legumes and tubers, and has been a powerful driver of agricultural supply chain changes. By 2004 the value of horticultural exports of fruit and vegetables from developing countries had already reached US$ 70 billion (Moran, 2018: 1). Since then, multinational investor and retailer-supervised supply chains in the vegetable and fruit business — sorted, graded, washed, and sometimes packaged or processed, shipped ready-to-eat with traceable bar-codes — have become, alongside cut flowers, multi-billion dollar industries.[11]

In wealthier countries, rising incomes may not lead to increasing calorie consumption but do produce additional spending on 'diet diversification, improved quality, convenience, or … food which satisfies consumer values such as organic, fair trade, or animal welfare' (Regmi and Meade, 2013: 167). There has also been a fundamental shift in diets globally — in low-income as well as high-income countries — involving a shift to more purchased food consumption, consumption of more perishable foods, and more foods processed or those prepared away from home (Muyanga et al., 2019: 22). Total demand for some food product categories (in Africa,

10. A critical discussion of the evidence for Prebisch-Singer in sub-Saharan Africa is provided by Cashin and Pattillo (2006); see also Cramer et al. (2020: Ch. 5).
11. For example, horticulture exports from Kenya — both cut flowers and packaged vegetables — amounted to more than US$ 1 billion in 2015 (Moran, 2018: 2).

Asia and Latin America) 'can double in five years and quintuple in ten' (ibid.: 26).

The Failing System of Sectoral Classification

Classification can always be criticized, since it involves the imposition of artificial breaks on what are typically continuous realities, in order to tame 'the wild profusion of existing things' (Foucault, 1973). But if a classification system helps to reveal analytically useful patterns and to suggest economic policy initiatives, then it is more likely to be adopted despite the inevitable difficulties in agreeing coding rules and precise definitions. The current simple classification by broad sector no longer works well to distinguish between economic activities.[12] There are many data sets and classification systems that do break down economic activities and sectors into more refined categories, but our research suggests that these too are often misleading, based on outdated coding rules.

To give a simple example, what is the most appropriate way to classify a punnet of blueberries destined for international trade? The blueberries are not obviously 'processed'; they are not pulped or juiced, nor skinned or de-husked or pasteurized, so they look like a classic, albeit 'non-traditional', primary commodity. But they are knowledge intense: they are the result of costly and highly technical R&D into low-chill genetic plant stock material (in Australia, California, Chile, Florida and Georgia), combined with codified and tacit knowledge about specific local agro-climatic conditions and the licensing of intellectual property; they are the product of sophisticated capabilities in running large-scale agribusiness, sourcing inputs, negotiating government incentive schemes, managing labour relations, designing marketing campaigns, making subtle adjustments to the computer systems managing drip fertigation, lighting and humidity management. And they are complex in their production, cooling and innovative packaging materials, in the logistics of just-in-time exporting, and in their sales. Price and profitability depend in part on popularizing a narrative about health benefits (blueberries being marketed as a 'superfood', high in antioxidants). So it was perhaps not surprising to hear a South African blueberry exporter lifting a blueberry from its punnet, rolling it between two fingers, and declaring 'this is a pill'. He regarded his business as part of 'big pharma' (Cramer and Sender, 2015).

Should blueberry production benefit, as in Chile, from public investment in R&D and infrastructure, and the subsidized allocation of resources to promote blueberries in large and growing international markets? Many

12. The broad three-sector classification owes a lot to Colin Clark, who 'continued to stress and sacralise the three-sector breakdown and structural change in interpreting economic growth' (Maddison, 2004: 24).

policy makers and some development economists would be doubtful, because blueberries are primary commodities grown on farms, not manufactured in factories; they are not described as manufactured goods characterized by a large scope for linkages, for economies of scale, for learning by doing. But this may be wrong. Other economists admit that it would be 'useful to refine the standard three-sector focus' of the literature on growth, production and structural transformation. They note that some services, like healthcare and education, involve massive investment and skill intensity, and are characterized by high scope for productivity increases, while other service activities, such as much of retail trade, are very different (Herrendorf et al., 2014: 929).

An increasing interdependency between manufacturing and services, evident in analyses of the World Input Output Database (Timmer et al., 2014), reflects a process of servicification, defined as the increasing share of the value of final manufactured goods derived from services including logistics, transport, embedded software, branding, design, etc. (Koopman et al., 2010). This process underlies the dramatic increase in the share of world expenditure on services, which rose from about half of global expenditures in 1970 to 80 per cent in 2015 (Lewis et al., 2018: 1). One important implication for development policy is that the 'classic focus on factories can be misleading' (Baldwin et al., 2015: 28).

The new focus on servicification has encouraged discussion of the breakdown of barriers between manufacturing and services, but it is still often assumed that these two 'modern' sectors are distinct from agriculture. For example, Gala et al. (2018: 2) admiringly quote Adam Smith: 'The nature of agriculture, indeed, does not admit of so many subdivisions of labour, nor of so complete a separation of one business from another, as manufactures (Smith, 1994, p.7: Book 1)'. This leads to the astonishing claim that: 'Specializing in agriculture and extractive industries does not enable … technological evolution' (Gala et al., 2018: 2). But agriculture no longer fits Smith's diagnosis, nor in fact that of Hirschman (1958: 109) who also argued that there was far less scope for forward and backward linkages in agriculture than in manufacturing.

In parallel to the rise of agribusiness and 'the industrial organization of food' (Barrett et al., 2019: 4), there has been an industrialization of freshness. The blueberry example is one among many. A fresh orange exported from South Africa to the EU would seem to be a primary commodity and would be classified as such in the ISIC system (under A in ISIC), while a carton of orange juice might be regarded as more high-tech and as a manufactured product (C.103 in ISIC). Yet the carton of orange juice is industrially simple and uses low-quality oranges that fail to meet the stringent quality standards for international trade in fresh oranges (interviews with South African citrus producers, September 2015). Securing a reliable supply of high-quality fresh oranges for the EU or other demanding markets is more complex and more technically difficult than producing a carton

of orange juice. Similarly, producing a bottle of avocado oil involves less complex technology and skills than delivering fresh, blemish-free and ripe-within-three-days avocados to EU supermarkets.[13]

The industrialization of freshness is the complement of servicification, and it helps to show that many efforts to develop economic analysis of exports on the basis of simplistic definitions of 'processing' are barely 'fit for purpose'. One of the most influential of these efforts has been made by Wood (2017: 9), who misleadingly asserts that 'Processed primary exports are … clearly more skill-intensive than unprocessed primary exports'. Wood's generalization is not based on a 'clear' view of the data. In terms of the example above, he ignores the skill intensity required for success in exporting fresh oranges to EU supermarkets, and his analysis suggests that exporting processed orange juice is more skill intensive. Similarly pessimistic conclusions concerning the economic consequences of exporting unprocessed agricultural commodities have been derived from an econometric study based on an equally misleading assertion: 'Agricultural industries are homogenous in the UNCTAD data, and so we treat agriculture as undifferentiated by skill' (Blanchard and Olney, 2017: 169).

The Economic Complexity Index and Other Recent Efforts to Refine Categorical Distinctions

In response to the shortcomings of the standard three-sector classification of economic activity, a number of attempts have been made to refine categories or introduce new ways of distinguishing among outputs. One influential exercise designed to reveal key patterns, dynamics and trends in the global structure of production is the work on economic complexity (Hidalgo and Hausmann, 2009). Complexity is defined in terms of the 'multiplicity of knowledge' embodied in outputs and as expressed in the composition of output. The *Atlas of Economic Complexity* shows that richer countries, apart from a few outliers, produce more complex outputs than lower-income countries. Countries are expected to produce and export most easily a range of goods that are closely related to what they already produce: patterns of production and trade are path dependent, although it is admitted that some middle-income developing countries may begin to shift away from the 'normal' path, growing faster and producing outputs less closely related to what they already produce (Pinheiro et al., 2018: 3).

There is some circularity in the definitions of complexity. Economies are complex if they produce complex goods. Knowledge-intense places are 'those that produce knowledge intense activities, and knowledge intense

13. As argued by the CEO of Granor-Passi Pty Ltd., the leading fruit processor in South Africa, and by the Managing Director of Westfalia SA (part of Hans Merensky Holdings), the leading producer of avocados.

activities are those produced by knowledge intense places' (Pinheiro et al., 2018: 5). When confronted with evidence that some countries have a much higher Economic Complexity Index (ECI) than their income per capita would predict, and appear to have strayed from the path suggested by their historic comparative advantage by shifting into 'unrelated' products *before* becoming classified as high-income economies, the policy recommendations remain cautious and conventional: 'these results do not imply that all countries are able and should [*sic*] invest in unrelated variety growth' (ibid.: 24).

This caution reflects the fact that the bulk of the economic complexity literature implicitly relies on a version of the augmented Hecksher-Ohlin factor endowment approach to comparative advantage. Some of those who stress the dangers of 'defying comparative advantage' are pessimistic about the sustainable results of exporting products that are not as labour intensive as a country's existing endowment of labour suggests they should be. Like the old theorists of technological dependency, they believe that the medium-term results in most low-income developing countries of defying comparative advantage by attracting foreign direct investment into complex processing industries 'could well hinder further transformation of the productive structure by locking the economy into a specialization trap in assembly industries' (Lectard and Rougier, 2018: 105).

The ECI is built in reverse; the starting point is to use recently published international trade data to find 'revealed comparative advantage' to proxy for the sophistication of the structure of production. One commonly acknowledged problem with this is that the data on trade may lead to an under-appreciation of complexity in those economies that have large domestic markets, produce a diverse range of outputs, but are *not* big exporters of diverse goods. Another difficulty is that this approach makes assumptions about the complexity of products, and about their level of embodied technical knowledge (codified and tacit) *without* direct observation of granular production processes. This approach risks failing to pick up some forms of complexity and sophistication. The lack of a sufficient level of disaggregation in international data sets compounds the problem, leading to ad hoc empirical analysis, as acknowledged in some of the literature (Gala et al., 2018: 3). This 'product space' approach also fails to acknowledge that existing maps of product space for advanced industrialized economies are not 'natural' but rather are themselves the product of prior industrial policies (Andreoni and Chang, 2019: 140). Indeed, many countries and individual firms have successfully diversified into 'unrelated' rather than proximate activities and products (ibid.), contrary to the recommendations generated by the product space approach.

An illustration of these difficulties is the treatment of Brazil, which is said to show 'no productive structure improvements … one of the worst dynamics of ECI among emerging countries in recent years' (Gala et al., 2018: 4). But this assessment appears to flow from a prior definition of agricultural

production as lacking complexity. It is difficult to explain the rise of several world-class Brazilian multinational corporations without recognizing that many of the country's most dynamic activities have precisely been in very large-scale, knowledge-intense, technically sophisticated and innovative *agriculture* (OECD/FAO, 2015: 62). Its export success owes a lot to the integration of agriculture with manufacturing (Safdar, 2015), and was also based on the choice to provide generous public funding to R&D and services (often relying on government services, which are arbitrarily deemed by many complexity scholars to be less sophisticated than private services).

Other recent literature makes some progress in overcoming the dismissive analytical assumptions about the sophistication of agriculture and its role in structural change. Divanbeigi et al. (2016) summarize how structural transformation has taken place within agriculture through modernization and technical change, rising productivity and increasing integration with other sectoral activities. Mendez-Ramos and Paustian (2017) distinguish between 'primary' and 'manufactured' agribusiness, on the back of empirical analysis showing the huge and rising significance of agribusiness trade in the growth of developing countries in recent decades. But problems in defining 'primary', 'unsophisticated', 'simple', or 'un-complex' processes and activities remain. For example, in modern agricultural production even the distinction between 'harvesting' and 'processing' is not clear cut; in the USA it has been suggested that harvesting be defined to include extremely sophisticated (quasi-processing) operations, such as: 'cooling, field coring, filtering, gathering, hulling, shelling, sifting, threshing, trimming of outer leaves of, and washing raw agricultural commodities grown on a farm' (US HHS and FDA, 2016: 8).

Young and Hirschman on Shifting Patterns of Capitalist Production

The historical evolution of manufacturing and industrial processes has long been reflected in shifting analytical perspectives. An early example is Adam Smith's analysis and classification of different types of division of labour, including the division of labour in the production of specific goods, such as a woollen coat (Smith 1776/1979: 22–23). Later, Marx was able to describe the transition to large-scale industrial capitalism, emphasizing a tendency towards economies of scale within specific firms and the integration of large-scale production (Ho, 2016). A complementary tendency to industrial differentiation, the splitting of complex processes into sets or chains of simpler processes, was emphasized by Young (1928) who regarded it as obvious that 'over a large part of the field of industry, an increasingly intricate nexus has inserted itself between the producer of raw materials and the consumer of the final product' (ibid.: 538). From Young's perspective, whether or not production takes place in factories matters less than what forms of industrial organization are at play and how roundabout production is. We

consider this perspective a more useful approach to understanding production and to classifying types of exports than the factory focus used by Wood and Mayer (1998: 6), for example.

Hirschman came to accept that there are many more backward and forward linkages — as well as fiscal and consumption linkages — associated with agricultural production than he had initially supposed (Adelman, 2014[14]). But neither Hirschman nor others anticipated the extent to which the sophistication of roundabout production processes and complex forms of industrial organization might move into agriculture. An 'increasingly intricate nexus' is currently inserting itself between African rural producers, of a fresh orange, blueberry, avocado or poinsettia, and the consumers of the final product in the supermarkets of advanced capitalist economies. Moreover, the development of these high-value fresh products appears to depend on technological innovations within the agricultural sector itself. Labour productivity has increased not only because more workers shift out of low-productivity activities, but also because of productivity improvements *within* individual agribusinesses.

DIRECT OBSERVATION OF PRODUCTION AS A BASIS FOR CLASSIFICATION

Drawing on two types of agribusiness export activity in Ethiopia — plant propagation and the manufacturing of juice — we show how a fine-grained observation of productive activities suggests a basis for rethinking the implications of the increasingly roundabout character of agricultural exports.

Plant Propagation (ISIC Rev.4: A.013)

The asexual propagation of plants, by cuttings or division, is misleadingly assumed in the ISIC system to be a *simple* agricultural process. But once a certain scale is introduced and a level of care applied to generate higher productivity while meeting international phytosanitary requirements, propagation becomes an extremely roundabout, intricate process. Among the requirements of production are compliance with EU sanitary and phytosanitary standards (which in turn mean purchase, monitoring and cleaning of workwear, pest control, regulation and sanitary treatment of footwear and passage between sections of a production plant, etc.), traceability technology, temperature and humidity control, water treatment, fertigation, logistics and transport equipment and processes, workforce training, chemicals, plant stock expertise, branding and much more. Processes depend on the specific

14. Adelman's book brings together 16 of Hirschman's essays, each with a short introduction by Adelman.

plant and where it is grown. In Ethiopia, for example, there are perfect natural conditions for propagating pelargoniums but to propagate higher-priced plants such as poinsettias the air is too dry so different techniques and processes must be applied to increase and manage humidity.

Two of the most successful exporting firms that we interviewed in Ethiopia use reverse osmosis (RO) technology to remove unwanted particles (especially bicarbonates) dissolved in water. In 2016, it cost around € 150,000 to buy an RO machine, and € 30,000 to change an RO membrane, which has to be done every 12–24 months.[15] Under plastic greenhouse canopies, elaborate piping along the ground and up into the metal frames enables precise regulation of water and nutrients, of misting to maintain humidity levels required for poinsettia plants, and of light. Plants are 'tortured' (as the owner of one European-owned firm in the Upper Awash Valley agreed in May 2016) by regular spates of (radium bulb) light on and off, a form of sleep deprivation for the cuttings. A 12-hectare propagation farm invested € 50,000 on a single piece of equipment to produce fine misting in one of its many greenhouses. Producing plastic greenhouse coverings has taken years of R&D; each plastic sheet has seven layers, including UV filters.

Adhering to strict phytosanitary rules regulating market entry into the EU involves, among other things, careful management of clothing and of movement between greenhouses or between a greenhouse and other parts of the farm. These rules add to the demands for labour supervision, which comes to form part of the know-how that sets a parameter for judging the optimal size of a cuttings farm. Profitability requires 'guard labour' (Bowles and Jayadev, 2004) and technology. We did a rough count of about 50 computers in the rural administrative offices of the propagation farm which was, in early 2018, in the process of switching from fingerprinting to face recognition technology to control the movement of labour on site.

The nexus of activities, mechanisms and processes inserted between the raw commodity (the origins of the mother stock plant) and the final consumer is an intricate one. The 'assembly' of a poinsettia involves a great deal of machinery (computers, power plants, RO machines, tractors, misting and fertigation equipment, soft plug production, steaming of the soil to disinfect it, laboratory testing facilities, cooling the cuttings to 4 degrees for 24 hours, careful maintenance of refrigerated trucks). Firm managers accumulate and deploy tacit knowledge (knowledge acquired on the job, particular to the insights and experience of those engaged in production in a specific time, place and context) — about localized agro-climatic conditions and

15. Based on interviews (May 2016); according to one commercial estimate, a 30–50 gallon-per-minute (GPM) commercial-quality reverse osmosis membrane system may cost around US$ 200,000, though higher GPM high-end systems can be considerably more expensive (www.samcotech.com/much-reverse-osmosis-nanofiltration-membrane-systems-cost/; accessed 11 November 2019).

variations, about labour relations and supervision requirements, about 'the market', about sources of efficiency in the organization of production, and about the broader policy environment, institutions and ethnic politics in Ethiopia that affect their operations.[16] This combines with a great deal of technical expertise acquired in universities and on the job. For example, articulated and tacit technical knowledge have gone into the '50 years of breeding' (interview with firm manager, February 2018) to produce a mother stock of 10 plants held in Ethiopia by one European-based multinational. Plant propagation embodies a 'multiplicity of knowledge' that runs counter to the assumptions of the *Atlas of Complexity*. There are also multiple, complex linkage effects between on-farm plant propagation and packaging, input production and supplies, capital goods, work clothing production, transport, logistics, and the development of cold storage and freight facilities at Addis Ababa's Bole International Airport (see below).

Adapting Young, we might say that, with increasingly roundabout production, not only representative firms and industries, but whole classes of a sector 'lose their identity'. Agricultural production involves both sophisticated services and complex manufacturing. The difficulty in classifying plant propagation (given the weaving together of manufacturing, agriculture and sophisticated services) was brought home to us in February 2018, near Ziway, Ethiopia, by the manager of one firm which propagates branded ornamentals and whose offices were papered with the expensively produced, glossy branding and advertising posters of the linked multinational firm. 'We used to think we exported flowers', he said. 'Now I realize we are selling emotion'.[17]

Manufacture of Juice (ISIC Rev.4: C.103)

Manufacturing fruit juice (and pulps or purées) might seem a step up in sophistication from simple agriculture. Certainly, the process for juicing passion fruit or mangoes is usually broken down into a series of intricate stages, each requiring specialized equipment. Condensing juice into concentrate requires even more sophisticated and costly evaporator machinery. It is this machine-mediated process that appears to qualify juicing as industrial; but it is managing production *in the fields* to ensure a reliable supply of high enough quality passion fruit (or mango) in the first place that makes this business particularly complex, sophisticated and difficult.

A clear illustration of the difficulty of overcoming production problems outside the factory and in the field is the fact that one large passion fruit firm

16. On tacit knowledge, see Dampney et al. (2002).
17. There is indeed a rising interest in 'sensory branding' and the appeal to the affective in marketing, studied in the relevant literature (see, for example, Duffy and Hooper, 2004; Rossiter and Bellman, 2012).

(financed by the International Finance Corporation) has *never* been able to run its expensively acquired condensing machinery. Moreover, on this farm, as in other related enterprises in Ethiopia, capacity utilization of all the juicing/processing equipment has always been very low, because of inadequate and erratic production and throughput of raw materials (interviews with producers, producer associations and research institutions in Addis Ababa, Ziway and the Upper Awash Valley, May 2016 and February 2018). Of course, problems of inadequate supply of fruits are not confined to Ethiopian high-tech processing factories. Aliko Dangote, who has a successful record of managing sophisticated cement factories, had much less success when he invested in an up-to-date tomato paste factory (costing about US$ 12.5 million). This Nigerian factory has never been able to operate at anything like full capacity and has been idle for most of the past five years; the production record of Sam Jonah's tomato processing factory near Port Elizabeth has been equally dismal (Laessing, 2017; Laing, 2016).

Passion fruit provides an excellent example of a feature common across much high-productivity agribusiness: most farm operations involve exacting just-in-time production processes. In agriculture just-in-time production depends on tacit knowledge as much as on the more readily codified and transferrable knowledge in auto-assembly. Across hundreds of hectares, trellises with the right tautness of wires between poles bear the weight of passion plants. To prevent the drooping tendrils reaching the ground and to maximize fruit bearing, the plants need continuous pruning. Apart from a lull of a couple of months, the fruit must be harvested every day. Key to the process is the *daily* hand cross-pollination, that is, pollinating between flowers on different plants which grow opposite each other on different trellises. This hand pollination must be done within a one-hour slot each afternoon. Supervisors must monitor flowering quickly and precisely across a large area and manage the labourers trained as pollinators. Large-scale hand pollination, daily pruning and harvesting, in variable climate conditions with troubled access to water is what really presents a challenge of complexity to even the most skilled managers and their (in this case global) financiers.

Infrastructure and Government Services at the Heart of High-value Exports

Horticulture exports embody another dimension of complex, cross-sectoral, roundabout economic activity through their reliance on high-tech logistics and transport. With International Trade Centre (ITC) data suggesting that the value of Ethiopia's horticultural exports in 2017 was very much greater than the value of more 'traditional' manufactured exports, it seems likely that the horticulture export sector has created greater demands and pressures for the development of up-to-date transport and logistics in Ethiopia than,

for example, the textile and leather sectors.[18] Delivering freshness requires cold storage and just-in-time air delivery. In Hirschman's (1967) terms there is a 'narrow margin for failure'; a delayed delivery of textiles or leather goods might cause substantial financial loss and reputational damage but is unlikely to be disastrous. A good example of how problems in infrastructure can compromise the delivery of freshness is provided by the enduring difficulties in South African shipping ports. A 'state of absolute chaos' at harbours in Port Elizabeth and Ngqura in 2019 (shortages of cranes and containers, slow turnaround times, labour disputes) was 'inflicting unbelievable damage on the citrus industry' in the country in late 2019.[19]

In Ethiopia, through complex linkage and feedback mechanisms, the demands of horticulture have both contributed to and been supported by the remarkable growth of a state-owned enterprise — Ethiopian Airlines (EAL), which is now the leading passenger and cargo carrier in Africa (Oqubay and Tesfachew, 2019). The initial expansion of the floriculture sector was facilitated by EAL and at the same time it put pressure on EAL to provide and expand airfreight facilities (developing the capabilities in transporting temperature- and time-sensitive products that were necessary for achieving another 'roundabout' leap — towards becoming the largest global vaccine transporting airline).[20] They began by leasing ageing cargo jets, but the expense, as well as the rapid growth in floricultural exports, led the company to purchase its own fleet of new freight jets (Oqubay and Tesfachew, 2019; and interviews with senior management of EAL, February 2018). By early 2018 EAL had eight freight jets and 1.5 million tons of warehouse capacity. EAL has also developed a joint venture with DHL to integrate itself further into the logistics global value chain.[21]

The need for just-in-time delivery has had an indirect political linkage effect. Senior managers of EAL (and policy officials speaking off the record) argued that it has prompted EAL to become the focal point in the long-overdue reform of the Ethiopian Customs and Revenues Authority. EAL has become the main lobby demanding that the customs authority expedites transactions, and it is near completing a series of advanced technology e-customs platforms to facilitate and trace imports and exports. This development may have a further benefit if it facilitates the timely collection and analysis of reliable trade data, the lack of which, we suggest below, is a significant constraint on effective policy making.

---

18. Data from ITC 'Trade Map'. Geneva: International Trade Centre (Trade statistics for international business development): www.trademap.org/Product_SelCountry_TS.aspx?
19. www.freshplaza.com/article/9123535/crisis-at-south-afric/ (accessed 4 January 2022).
20. www.logupdateafrica.com/ethiopian-airlines-carries-35-mn-doses-of-covid19-vaccine-to-brazil-air-cargo (accessed 4 January 2022).
21. www.aircargonews.net/airlines/freighter-operator/dhl-and-ethiopian-airlines-scale-up-their-joint-venture/ (accessed 4 January 2022).

The literature on economic complexity sometimes labels 'government services' as simple and unsophisticated. But the pursuit of profitability in Ethiopian horticulture and floriculture shows how government services, including security services, cannot be treated as categorically distinct from sophisticated agro-industrial exports. Milling about outside the airport cold storage facilities are armed soldiers. It is mandatory for horticulture exporters to have state security provision on every truck from farm to customs point. Farm managers we spoke to were happy with this arrangement, which meets their expectations about how an effective state can provide the conditions of accumulation and profitability.

POLITICS AND POLICIES LIMITING THE EXPANSION OF HIGH-VALUE AGRICULTURAL EXPORTS

We have argued both that existing systems of classification are misleading and that important dynamics of economic development blur the boundaries between sectors and categories of product. A greater understanding of this imbrication of economic activities would help policy officials identify and support areas of promising intersection and linkage. A more accurate way of identifying economic activities would also help policy officials design more coherent and growth-enhancing policies. This is especially true of policy efforts to design industrial policy in support of accelerated structural change and productivity growth. Acknowledging the complexity, the knowledge, the roundaboutness and linkages embedded in much high-value agriculture may lead to a new priority being assigned to efforts to identify and overcome the barriers faced by such activities. Below we highlight key policy priorities which were emphasized during fieldwork.

Inputs, Institutions and Political Economy

It has not been possible to achieve an *accelerating* expansion of high-value agricultural exports from Ethiopia or South Africa. An inadequate growth rate of these exports has threatened the sustainability of Ethiopia's remarkable growth and development in recent years, just as a related series of inconsistent 'industrial' policies in South Africa has in recent decades threatened the political and economic sustainability of development there (Cramer and Sender, 2015). The list of these problems includes under-investment in agricultural R&D capabilities, as well as in irrigation facilities and power supplies and in institutions to promote land tenure security, as well as the neglect of other aspects of social and physical infrastructure. These problems are unlikely to be overcome by a simple technical or economic fix, because the sources of failure to expand new agricultural exports are fundamentally socio-political. Several decades ago, Hirschman

(1968: 24) observed the same thing in trying to understand the dynamics of industrialization in Latin America.

Nothing underscores the political character of barriers to expanding production so much as land tenure policies, which, for reasons of space, can be noted only briefly here. In Ethiopia, investors have become embroiled in deep-running political tensions, which have themselves been framed increasingly in terms of the competition for resources and political power between regions and states (Chinigò, 2015; Lavers, 2012; Moreda and Spoor, 2015), against a longue durée in which, as Clapham (2017) argues, the source of political power has been concentrated in the central and northern highlands but the source of material reproduction chiefly located in the 'peripheral' regions and lowlands. In South Africa land continues to be the object of political contention and — beyond its role in economic debates — has become a symbolic focus for broader post-apartheid political divisions (Hall, 2014; O'Laughlin et al., 2012).

Meanwhile, investing in transport infrastructure is key to expanding investment in, and export earnings from, high-value agriculture. Ethiopia's all-weather roads still cover less than a third of the estimated required road network.[22] The level and quality of investment in road maintenance has been criticized (Foster and Morella, 2011): one estimate is that only about 30 per cent of Ethiopia's rural roads are in 'good condition' (Iimi et al., 2017: 8). A glaring example is the road which heads northeast off the main road south from Adama and runs through the Upper Awash Valley. Along this road is one farm that claims to supply 60 per cent of the entire demand within Ethiopia for fruit, while other farms served by this road produce passion fruit or ornamental plant cuttings for export. All the large agribusinesses along the valley complained (in different visits between May 2016 and February 2018) that the authorities had not delivered on a promise made several years ago to grade the road. Prevarication on grading and resurfacing the road is one example of a policy failure to prioritize an area with very high potential for generating foreign exchange and employment opportunities. 'The road is everything', one production manager at a fruit-processing plant insisted: the poor condition of the road raises maintenance costs substantially for the 57 vehicles and 10 large trucks the firm owns. Another farm packs its main output into aseptic aluminium-lined bags before these are sent by truck for transport to the Netherlands. The bad road shakes up the bags, wears through the lining, and causes fermentation. The firm estimates a regular loss of about 12 per cent of the value of these exports thanks to the condition of the road.

Poor roads have additional economic costs. Producers in the Upper Awash Valley complained to us during our repeat visits how difficult it is to attract

22. UNDP (2014: 83) stated that in the 16 years up to 2013, Ethiopia had spent US$ 7.1 bn on road construction, 77 per cent of which was from internal funds and 23 per cent from external grants and loans.

qualified staff to senior posts — partly because of the time it takes to travel to Adama, let alone Addis Ababa, for better schools, health posts, etc. And, undermining Marshallian 'intimate connections', for one farm the condition of the road meant forgone prospects for productive clustering. The owners had hoped a bottling company would set up in the valley, but the bottlers withdrew from negotiations at least partly due to the poor road.

In South Africa, some large-scale agribusinesses are allocating their own resources to maintain rural roads, because they cannot rely on local state agencies to perform the maintenance required. Since 2005, a backlog in rail investment has resulted in a decline in rail traffic and a switch to road transport (Williams, 2021). Rural rail branch lines have increasingly been abandoned; for example, Westfalia Fruit no longer uses 'the avocado train' for refrigerated transport to the port (interviews with Westfalia Fruit management, September 2015), although a functioning rail link could provide huge cost savings for exporters. The lack of investment in the equipment used in most of the container ports has also reduced efficiency and raised the costs of agro-exporting (Cramer and Sender, 2015: 18).

Policy-relevant Data Needs

We have presented some of the production-focused evidence necessary for a more appropriate understanding and classification of high-value agricultural exports. We have also argued that a more accurate understanding of these activities would help policy officials to prioritize policies designed to overcome constraints on activities that have strong potential to be part of and contribute to structural change, relaxing the balance-of-payments constraint, and generating employment. But policy officials are hamstrung by the lack of reliable evidence.

A classification scheme is only as good as the observations that populate its categories. Designing appropriate policies to support the expansion of 'industrial' horticulture in Ethiopia, South Africa and elsewhere in Africa requires much better data. Policy proposals and economists' debates on agriculture in sub-Saharan Africa would be more useful if they were based on better data. The most basic understanding of patterns of production and employment is made difficult by the unreliability of published data on rural production and employment trends (Cramer et al., 2020; Sender, 2019).

In South Africa, the largest agribusinesses and their associations use their own funds to collect a few unofficial industry statistics in an effort to compensate for the failure of Statistics South Africa to provide reliable time series data on the area cultivated and yields for several high-value crops. There has been no survey in South Africa of the number of farms or the number of hectares cultivated with flowers, berries, macadamia or other nuts, despite the fact that, globally, these are growing, high-value markets

with huge potential for South Africa (and with substantial employment-creation benefits that are not currently being measured).

Different Ethiopian official sources of data on horticulture do not agree with each other, and there are differences between trends and levels reported by Ethiopian agencies and international agencies, despite the latter drawing primarily on Ethiopian official data for their published estimates. Looking closely at specific data sets compounds these difficulties. Take, for example, the category for 'cabbages and lettuces' (HS070511) as defined in the Harmonized Commodity Description and Coding System (HS). In the Ethiopian Horticulture Development Agency data there are more than 20 separate categories labelled either 'cabbage' or 'lettuce' but no reference to HS categories. Using the categories 'cabbage lettuce', and 'cabbage and lettuce', and using data from international data sets as well (from COMTRADE and ITC), we were able to produce sharply contrasting pictures of the level and trend in the volume and in the value of exports of these products (Cramer et al., 2018: Figure 6).

CONCLUSION

We add the 'industrialization of freshness' to the concept of 'servicification' to advance understanding of changes in global economic activity and their implications for classification and analysis of structural change. The idea that there are particular gains to be made from the rapid expansion of the manufacturing sector has been the basis for industrial policy design. Industrial policy is now championed by proponents across a broader range of intellectual and ideological backgrounds than was previously the case. But at the same time there have been rising fears that this is too late, that industrial policy cannot, in the face of 'premature deindustrialization', secure the development gains that it did in the past. We add to this debate the finding that rather more is 'industrial' than most observers acknowledge. That may lead to a readjustment of trends and to less pessimistic expectations — which to some extent has already been underway in the light of new estimates of real manufacturing value added and more recent data on previously unrecorded manufacturing employment (Kruse et al., 2021). If we add the industrialization of freshness, there is *more* structural change underway across a broad swathe of low- and middle-income countries than officially estimated trends in manufacturing value added as a share of GDP have been able to pick up.

Distinctions between sectors as demarcated by official international statistical publications have largely broken down, the interrelationships between sectors have deepened, and the variations within each sector have grown to be much larger than the variations between them. The evidence (internationally and from fieldwork observation) points to the scope for the misallocation of resources based on a form of category error — the mistaken assumption of development gains (or losses) on grounds of categorical distinctions

that may no longer be appropriate. We argue that economic analysis needs to focus more on specific activities and their interconnections than on artificially discrete 'sectors'. For as Young (1928: 538) suggested: 'with the extension of the division of labour among industries the representative firm, like the industry of which it is a part, loses its identity'.

What a country produces and exports matters, because production and demand properties vary and because some economic activities have greater scope for propelling dynamics of structural change (as well as for generating export revenue and jobs) than others. This article has found that high-value agricultural export production in low- and middle-income countries has production requirements and global demand properties that make it increasingly complex, imbued with a 'multiplicity of knowledge', and rich in Allyn Young's 'capitalistic and roundabout' production. The implication is that industrial policy, which aims to stimulate higher-productivity activities and economies of scale within and between firms and 'sectors', should make greater efforts to support these high-value agricultural exports as part of the pursuit of structural change and industrialization. This ought to be a foundation for setting priorities in resource allocation — for example, which infrastructure spending to prioritize, what R&D activities to support, what policies to develop for development finance, what monitoring capacity and data collection needs to focus on, and so forth.

Unfortunately, in both Ethiopia and South Africa, there is little evidence of any concentration of support on those agricultural exports with a proven capacity to generate significant foreign exchange earnings and wage employment opportunities. We suggest that effective support to high-value horticultural/agricultural exports would involve entering a 'race to the top' in international trade; and success in this race would need policy officials to give greater priority to the promotion of champions or star exporters (Moran, 2018). These suggestions may involve some political risk, but they do appear to have had an impact on South Africa's Industrial Policy Action Plan (Department of Trade and Industry, 2016: 96).

Ethiopia provides a good example of the need for the kind of policy (re)design suggested by the findings of this research. Some extremely successful Ethiopian horticulture firms (employing 800–1,200 workers) cannot benefit from state support for soil analysis and fertilizer mixes through the well-funded Agricultural Transformation Agency, because this agency is focused exclusively on *smallholder* farmers. Yet these large-scale horticultural firms also fall outside the domain of industrial policy, which is currently focused on factories producing leather, garments, etc. They have not received the same attention from government in, for example, setting up sector-specific institutes (as for leather and textiles) (Oqubay, 2015).

We argue that international classification bodies like the UN Statistics Division (UNSD, which maintains the ISIC) need to revisit their coding rules. This is only one element of a constantly evolving set of practices by which economic statistics, to support comparative analysis and policy design, have

evolved for centuries, from the political arithmetic of Petty and King in the 17th century through Clark and Kuznets's work on the foundations of national accounts in the 20th (Maddison, 2004), and beyond (Smith and James, 2017). For example, since first issuing the broad economic categories (BEC) data to supplement the Standard International Trade Classification system in 1971, the UNSD has produced five BEC revisions motivated by the need more accurately to reflect economic reality.[23] Many business surveys in Africa not only need to update their sampling frames much more regularly, but also need frequent redesigns to accommodate changes in the classification of economic activities, in the same way that the UK's surveys (for example) have been adapted.[24]

Our findings are limited in that there is far wider scope to probe varying operations of the processes of industrial differentiation and the advance of increasing returns across a large number of types of agricultural output. We carried out interviews in only two countries, collecting evidence relevant to the exports from those countries of a few high-value products. Much might be learned from a broader comparison of these processes and their variation, under different policy and economic conditions, across different low-, middle- and high-income countries, and that could generate new insight and policy thinking. It may be helpful to extend the scope of the research also by examining the dynamics of the 'intricate nexus' not only in high-value agricultural exports but also in what are commonly regarded as (low-skill) manufacturing activities such as textiles and garments.[25]

REFERENCES

Adelman, J. (2014) 'A Generalized Linkage Approach to Development, with Special Reference to Staples' (originally published 1977), in J. Adelman (ed.) *The Essential Hirschman*, pp. 155–94. Princeton, NJ: Princeton University Press.

Andreoni, A. and H.-J. Chang (2019) 'The Political Economy of Industrial Policy: Structural Interdependencies, Policy Alignment, and Conflict Management', *Structural Change and Economic Dynamics* 48: 136–50.

Autor, D., D. Dorn, L.F. Katz, C. Patterson and J. Van Reenen (2020) 'The Fall of the Labor Share and the Rise of Superstar Firms', *The Quarterly Journal of Economics* 135(2): 645–709.

Baldwin, R., R. Forslid and T. Ito (2015) 'Unveiling the Evolving Source of Value Added in Exports'. Chiba: Institute of Developing Economies.

Barrett, C., T. Reardon, J. Swinnen and D. Zilberman (2019) 'Structural Transformation and Economic Development: Insights from the Agri-food Value Chain Evolution'. Ithaca, NY: Cornell University (mimeo).

Blanchard, E.J. and W.W. Olney (2017) 'Globalization and Human Capital Investment: Export Composition Drives Educational Attainment', *Journal of International Economics* 106: 165–83.

23. https://unstats.un.org/unsd/trade/classifications/bec.asp (accessed 4 January 2022).
24. Ibid.
25. In apparel factories, for example, changes in global production and trade (discussed in Whitfield et al., 2020: 1023) have increased the complexity of 'lower node' apparel assembly.

Bowles, S. and A. Jayadev (2004) 'Guard Labor: An Essay in Honor of Pranab Bardhan'. Amherst Economics Working Papers No. 2004–15. Amherst, MA: University of Massachusetts Amherst.

Cashin, P. and C. Pattillo (2006) 'African Terms of Trade and the Commodity Terms of Trade: Close Cousins or Distant Relatives?', *Applied Economics* 38(8): 845–59.

Cherif, R. and F. Hasanov (2019) 'The Return of the Policy that Shall Not Be Named: Principles of Industrial Policy'. IMF Working Paper WP/19/74. Washington, DC: International Monetary Fund.

Chinigò, D. (2015) 'The Politics of Land Registration in Ethiopia: Territorialising State Power in the Rural Milieu', *Review of African Political Economy* 42(144): 174–89.

Clapham, C. (2017) *The Horn of Africa: State Formation and Decay*. Oxford: Oxford University Press.

Cramer, C. and J. Sender (2015) 'Agro-processing, Wage Employment and Export Revenue: Opportunities for Strategic Intervention'. Working Paper for the Department of Trade and Industry. Johannesburg: Trade and Industrial Policy Strategies (TIPS).

Cramer, C., J. Di John and J. Sender (2018) 'Poinsettia Assembly and Selling Emotion: High Value Agricultural Exports in Ethiopia'. AFD Research Paper Series 2018–78. Paris: Agence Française du Développement (AFD).

Cramer, C., J. Sender and A. Oqubay (2020) *African Economic Development: Evidence, Theory, Policy*. Oxford: Oxford University Press.

Dampney, K., P. Busch and D. Richards (2002) 'The Meaning of Tacit Knowledge', *Australasian Journal of Information Systems* 10(1): 3–13.

Department of Trade and Industry (2016) '*Industrial Policy Action Plan: IPAP 2016/17–2018/19*'. Pretoria: Economic Sectors, Employment and Infrastructure Development Cluster.

Divanbeigi, R., N. Paustian and N. Loayza (2016) *Structural Transformation of the Agricultural Sector: A Primer*. Washington, DC: World Bank.

Duffy, N. and J. Hooper (2004) *Passion Branding: Harnessing the Power of Emotion to Build Strong Brands*. Chichester: Wiley and Sons.

Easterly, W., A. Reshef and J. Schwenkenberg (2009) 'The Power of Exports'. Policy Research Working Paper No. 5081. Washington, DC: World Bank.

Foster, V. and E. Morella (2011) 'Ethiopia's Infrastructure: A Continental Perspective'. Policy Research Working Paper No. 5595. Washington, DC: World Bank.

Foucault, M. (1973) *The Order of Things: An Archaeology of the Human Sciences*. New York: Vintage Books.

Freidman, S. (2010) *Fresh: A Perishable History*. Cambridge, MA: Belknap Press.

Gala, P., J. Camargo, G. Magacho and I. Rocha (2018) 'Sophisticated Jobs Matter for Economic Complexity: An Empirical Analysis Based on Input–Output Matrices and Employment Data', *Structural Change and Economic Dynamics* 45(C): 1–8.

Hall, R. (2014) 'Who, What, Where, How, Why? The Many Disagreements about Land Redistribution in South Africa', in C. Walker and B. Cousins (eds) *Land Divided: Land Reform in South Africa for the 21st Century*, pp. 127–44. Johannesburg: Jacana Media.

Hausmann, R., C.A. Hidalgo, S Bustos, M. Coscia and A. Simoes (2014) *The Atlas of Economic Complexity: Mapping Paths to Prosperity*. Cambridge, MA: MIT Press.

Herrendorf, B., B. Rogerson and Á. Valentinyi (2014) 'Growth and Structural Transformation', in S. Durlauf and P. Aghion (eds) *Handbook of Economic Growth*, pp. 855–941. Amsterdam: Elsevier.

Hidalgo, C.A. and R. Hausmann (2009) 'The Building Blocks of Economic Complexity', *Proceedings of the National Academy of Sciences* 106(26): 10570–75.

Hirschman, A.O. (1958) *The Strategy of Economic Development*. New Haven, CT: Yale University Press.

Hirschman, A.O. (1967) *Development Projects Observed*. Washington, DC: Brookings Institution Press.

Hirschman, A.O. (1968) 'The Political Economy of Import-substituting Industrialization in Latin America', *The Quarterly Journal of Economics* 82(1): 1–32.

Ho, P.S. (2016) 'Linking the Insights of Smith, Marx, Young and Hirschman on the Division of Labour: Implications for Economic Integration and Uneven Development', *Cambridge Journal of Economics* 40(3): 913–39.

Iimi, A., H. Adamtei, J. Markland and E. Tsehaye (2017) 'Port Rail Connectivity and Agricultural Production: Evidence from a Large Sample of Farmers in Ethiopia'. World Bank Policy Research Working Paper No. 8088. Washington, DC: World Bank.

Kalantaryan, S. and S. McMahon (2020) *Covid-19 and Remittances in Africa*. European Commission Joint Research Centre. Luxemburg: Publications Office of the European Union.

Kaldor, N. (1967) *Strategic Factors in Economic Development*. Ithaca, NY: Cornell University.

Koopman, R., W. Powers, Z. Wang and S.-J. Wei (2010) 'Give Credit where Credit is Due: Tracing Value Added in Global Production Chains'. NBER Working Paper No. 16426. Cambridge, MA: National Bureau of Economic Research.

Kruse, H., E. Mensah, K. Sen and G. Vries (2021) 'A Manufacturing Renaissance? Industrialization Trends in the Developing World'. Working Paper No. 2021–28. Helsinki: UNU-WIDER.

Laessing, U. (2017) 'Ghost Tomato Factory Showcase for Nigeria's Farming Problems'. Reuters 30 August. www.reuters.com/article/us-nigeria-farming-idUSKCN1BA0IZ

Laing, R (2016) 'Famous Brand Spots Gap, Buys "Practically Unused" Tomato Paste Factory', *Marketing & Media News South Africa* 4 July.

Lavers, T. (2012) '"Land Grab" as Development Strategy? The Political Economy of Agricultural Investment in Ethiopia', *The Journal of Peasant Studies* 39(1): 105–32.

Lectard, P. and E. Rougier (2018) 'Can Developing Countries Gain from Defying Comparative Advantage? Distance to Comparative Advantage, Export Diversification and Sophistication, and the Dynamics of Specialization', *World Development* 102: 90–110.

Lewis, L.T., R. Monarch, M. Sposi and J. Zhang (2018) 'Structural Change and Global Trade'. Working Paper No. 2018(333). Dallas, TX: Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute.

Lewis, W.A. (1954) 'Economic Development with Unlimited Supplies of Labour', *The Manchester School* 22(2): 139–91.

Lodefalk, M. (2017) 'Servicification of Firms and Trade Policy Implications', *World Trade Review* 16(1): 59–83.

Luan, Y. et al. (2019) 'Cropland Yield Divergence over Africa and its Implication for Mitigating Food Insecurity', *Mitigation and Adaptation Strategies for Global Change* 24(5): 707–34.

Maddison, A. (2004) 'Quantifying and Interpreting World Development: Macromeasurement before and after Colin Clark', *Australian Economic History Review* 44(1): 1–34.

Marshall, A. (1920) *Principles of Economics* (8th edn). London: Macmillan.

Mendez-Ramos, F. and N. Paustian (2017) 'Measurement and Patterns of World Agribusiness Trade'. World Bank Research and Policy Briefs No. 112195. Washington, DC: World Bank.

Menne, T. (2019) 'Digital Revolution Takes Farming to Another Level', *Croplife.org News and Views*. https://croplife.org/digital-revolution-takes-farming-to-another-level/

Moran, T. (2018) 'FDI and Supply Chains in Horticulture (Vegetables, Fruits, and Flowers, Raw, Packaged, Cut, and Processed): Diversifying Exports and Reducing Poverty in Africa, Latin America, and Other Developing Economies'. CGD Working Paper No. 475. Washington, DC and London: Center for Global Development.

Moreda, T. and M. Spoor (2015) 'The Politics of Large-scale Land Acquisitions in Ethiopia: State and Corporate Elites and Subaltern Villagers', *Canadian Journal of Development Studies* 36(2): 224–40.

Mueller, N.D., J.S. Gerber, M. Johnston, D.K. Ray, N. Ramankutty and J.A. Foley (2012) 'Closing Yield Gaps through Nutrient and Water Management', *Nature* 490/7419: 254–57.

Muyanga, M. et al. (2019) 'Synthesis Report III: Rural and Agrifood Systems in Transforming Economies in Africa and Asia'. East Lansing, MI: Michigan State University; Washington, DC: International Food Policy Research Institute; Pretoria: University of Pretoria.

Nguimkeu, P. and A.G. Zeufack (2019) 'Manufacturing in Structural Change in Africa'. Policy Research Working Paper No. 8992. Washington, DC: World Bank.

Ocampo, J.A., C. Rada and L. Taylor (2009) *Growth and Policy in Developing Countries: A Structuralist Approach*. New York: Columbia University Press.

OECD/FAO (2015) *OECD-FAO Agricultural Outlook 2015*. Paris: OECD Publishing.

O'Laughlin, B., H. Bernstein, B. Cousins and P.E. Peters (2012) 'Introduction: Agrarian Change, Rural Poverty and Land Reform in South Africa since 1994', *Journal of Agrarian Change* 13(1): 1–15.

Oqubay, A. (2015) *Made in Africa: Industrial Policy in Ethiopia*. Oxford: Oxford University Press.

Oqubay, A. and T. Tesfachew (2019) 'The Journey of Ethiopian Airlines'. Policy Brief: How They Did It Vol. 2 Issue 1. Abidjan: African Development Bank.

Oqubay, A., C. Cramer, H.-J. Chang and R. Kozul-Wright (eds) (2020) *The Oxford Handbook of Industrial Policy*. Oxford: Oxford University Press.

Pérez Caldentey, E. and M. Vernengo (2019) 'Thirlwall's Law at 40', *Review of Keynesian Economics* 7(4): 427–28.

Pinheiro, F.L., A. Alshamsi, D. Hartmann, R. Boschma and C. Hidalgo (2018) 'Shooting Low or High: Do Countries Benefit from Entering Unrelated Activities?'. arXiv preprint arXiv:1801.05352.

Regmi, A. and B. Meade (2013) 'Demand Side Drivers of Global Food Security', *Global Food Security* 2(3): 166–71.

Rodrik, D. (2016) 'Premature Deindustrialization', *Journal of Economic Growth* 21(1): 1–33.

Rodrik, D. (2018) 'New Technologies, Global Value Chains, and the Developing Economies'. Pathways for Prosperity Commission Background Paper Series No. 1. Oxford: Blavatnik School of Government.

Rossiter, J. and S. Bellman (2012) 'Emotional Branding Pays Off: How Brands Meet Share of Requirements through Bonding, Companionship, and Love', *Journal of Advertising Research* 53(2): 291–96.

Rotz, S. and E. Fraser (2019) 'The Politics of Digital Agricultural Technologies: A Preliminary Review', *Sociologia Ruralis* 59(2): 203–27.

Safdar, M.T. (2015) 'Agro-industrial Value Chains in Developing Countries in the Era of Globalization: The Case of Sugarcane in Punjab, Pakistan'. PhD thesis, Cambridge University, Cambridge.

Sender, J. (2019) 'Assessing Poverty Trends in Ethiopia, 1990–2015', in F. Cheru, C. Cramer and A. Oqubay (eds) *Oxford Handbook of the Ethiopian Economy*, pp. 308–25. Oxford: Oxford University Press.

Smith, A. (1776/1979) *An Inquiry into the Nature and Causes of the Wealth of Nations*. Indianapolis, IN: Liberty Classics.

Smith, A. (1994) *The Wealth of Nations*. London: Random House.

Smith, P. and G. James (2017) 'Changing Industrial Classification to SIC (2007) at the UK Office for National Statistics', *Journal of Official Statistics* 33(1): 223–47.

Storm, S. (2015) 'Structural Change', *Development and Change* 46(4): 666–99.

Thirlwall, A.P. (2011) 'Balance of Payments Constrained Growth Models: History and Overview', *PSL Quarterly Review* 64(259): 307–51.

Thirlwall, A.P. (2019) 'Thoughts on Balance of Payments Constrained Growth after 40 Years', *Review of Keynesian Economics* 7(4): 554–67.

Timmer, M.P., A.A. Erumban, B. Los, R. Stehrer and G.J. de Vries (2014) 'Slicing Up Global Value Chains', *Journal of Economic Perspectives* 28(2): 99–118.

UNDP (2014) *National Human Development Report 2014: Ethiopia*. Addis Ababa: UNDP.

UNSD (2008) 'International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4'. United Nations Statistics Division, Statistical Papers Series M No. 4/Rev.4. New York: Department of Economic and Social Affairs.

US HHS and FDA (2016) 'Classification of Activities as Harvesting, Packing, Holding, or Manufacturing/Processing for Farms and Facilities: Guidance for Industry'. Washington, DC: US Department of Health and Human Services; Food and Drug Administration, Center for Food Safety and Applied Nutrition. www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiUk5DhzaT2AhVUhP0HHaDfBcwQFnoECBcQAQ&url=https%3A%2F%2Fwww.fda.gov%2Fmedia%2F99911%2Fdownload&usg=AOvVaw2lfF_PernZfbuXyxt7Ti-A (accessed 3 March 2022).

Van Hoyweghen, K., A. Fabry, H. Feyaerts, I. Wade and M. Maertens (2021) 'Resilience of Global and Local Value Chains to the Covid-19 Pandemic: Survey Evidence from Vegetable Value Chains in Senegal', *Agricultural Economics* 52(3): 423–40.

Wageningen University and Research (2020) 'Labour and Labourers in the Sesame Lowlands: Analysis and Action for Health and Wealth'. Labour Issue Brief. Sesame Business Network 29 July. https://sbnethiopia.org/2020/07/29/labour-and-labourers-in-the-sesame-lowlands-analysis-and-action-for-health-and-wealth/

Whitfield, L., C. Staritz and M. Morris (2020) 'Global Value Chains, Industrial Policy and Economic Upgrading in Ethiopia's Apparel Sector', *Development and Change* 51(4): 1018–43.

Williams, D. (2021) 'Why there are So Many Trucks on the Road and So Few Trains on the Tracks'. Discussion Paper 003/2021. Johannesburg: Brenthurst Foundation.

Wood, A. (2017) 'Variation in Structural Change around the World, 1985–2015. Patterns, Causes and Implications'. WIDER Working Paper 2017/34. Helsinki: UNU-WIDER.

Wood, A. and J. Mayer (1998) 'Africa's Export Structure in a Comparative Perspective'. IDS and UNCTAD Study No. 4. Geneva: United Nations Conference on Trade and Development.

World Bank (2004) 'Opportunities and Challenges for Developing High-value Agricultural Exports in Ethiopia'. Poverty Reduction and Economic Management, Country Department for Ethiopia, Background Report. Washington, DC: World Bank.

Young, A. (1928) 'Increasing Returns and Economic Progress', *The Economic Journal* XXXVIII: 527–42.

Christopher Cramer (corresponding author: cc10@soas.ac.uk) is Professor of the Political Economy of Development, SOAS, University of London, UK, and Distinguished Visiting Professor at the University of Johannesburg, South Africa. Recent publications include *African Economic Development: Evidence, Theory, Policy* (Oxford University Press, 2020, co-authored with John Sender and Arkebe Oqubay) and *The Oxford Handbook of Industrial Policy* (Oxford University Press, 2020, co-edited with Arkebe Oqubay, Richard Kozul-Wright and Ha-Joon Chang).

Jonathan Di John (jd5@soas.ac.uk) is Senior Lecturer in the Political Economy of Development at SOAS, University of London, UK, and Visiting Professor at the University of Johannesburg, South Africa. His recent publications include 'The Political Economy of Development Banking', in *The Oxford Handbook of Industrial Policy* (Oxford University Press, 2020) and *Social Service Delivery in Violent Contexts: Achieving Results against the Odds* (World Bank, 2017, co-authored with Simon O'Meally).

John Sender (john.sender@gmail.com) is Emeritus Professor of Economics at SOAS, University of London, UK. His past appointments have included Director of the African Studies Centre, University of Cambridge, UK, and Visiting Professor of Political Economy, University of the Witwatersrand, South Africa.