

# **Modelling Global Value Chains: Approaches and Insights from Economics<sup>1</sup>**

Davin Chor  
Tuck School of Business, Dartmouth College  
& National University of Singapore

January 2019

## **Abstract**

In recent years, the emergence of global value chains in how firms organize their production strategies has drawn the attention of economists, particularly those in the field of international trade. This has spawned a growing body of applied theoretical work to capture the fragmentation of production and sourcing decisions across country borders. This chapter overviews this literature on economic models that speak to the broad phenomenon of global production. It elucidates the core modelling approaches that have been developed to understand the drivers behind these decisions, as well as their consequences for trade flows, labor markets, and aggregate welfare. The chapter also highlights how this modelling work complements key themes that have been developed in the broader social science literature on global value chains.

Keywords: Global value chains, global production, global sourcing.

## 1. Introduction

Over the past ten years, the term “global value chains” (GVCs) has gradually found its way into the working vocabulary of economists, particularly those in the area of international trade. A simple search on Google Scholar will reveal that up until 2010, the term “global value chain” had not appeared in a single published article in the *Journal of International Economics*, the leading field journal for economics research on globalization issues; between 2011-2017, this count increased to 17 articles.<sup>2</sup> This reflects the growing interest of trade economists in understanding modern-day global production arrangements. Economists have been studying these in earnest since the mid-1990s, when the rise in trade in intermediate inputs – as opposed to trade in finished goods – was documented extensively (e.g., Feenstra 1998). With this research, trade economists have developed a parallel lingo, describing what would otherwise be called GVC activity by such terms as: “fragmentation”; “disintegration of production” (Feenstra 1998); “vertical specialization” (Hummels et al. 2001); “global sourcing” (Antràs and Helpman 2004); “unbundling” (Baldwin 2006); etc. The relative under-use of the GVC terminology is a reflection of the modest and, arguably, insufficient interaction between economists and GVC scholars from other social science disciplines.<sup>3</sup>

This lack of contact is particularly evident on the theory side. This is in spite of the large overlap in the research questions that both sets of scholars have been investigating: What are the forces that shape the formation of cross-border value chains? How do the characteristics of the good, or the relative power of the firm vis-à-vis its supplier, affect the organizational structures that mediate these relationships? What are the implications of these global production arrangements for labor markets and country development?

By contrast, the work of economists on measurement issues related to GVC activity has had more visibility among GVC scholars.<sup>4</sup> A first strand of this empirical work has

developed methodologies for credibly estimating the volume of cross-border production activity, using international trade data and the information on the cross-industry use of inputs contained in Input-Output Tables. This has given rise to the concept of “value-added trade”, that reapportions the conventionally reported gross trade flows to more accurately reflect the country of origin where value was created, and the destination country where that value is ultimately consumed (Johnson and Noguera 2012, Koopman et al. 2014); GVC scholars now regularly refer to sources such as the OECD’s Trade in Value-Added (TiVA) database in their work. Concomitantly, a second class of measures has emerged that help in mapping out where industries and countries are positioned within GVCs. This has enabled researchers to speak with more precision about the “upstreamness” of a country’s activities relative to the end-consumer, or their “downstreamness” relative to primary sources of value-added (Fally 2012; Antràs et al. 2012; Miller and Temurshoev 2017).

These improvements in measurement have generated a bevy of stylized facts on the rise of GVCs, which in turn has driven an initiative among economists to write down better models to capture the rich patterns of global production today. This work is still on the upswing. But it has already yielded a series of models that have delivered predictions on sourcing location and organizational structures – the nature of the “functional integration” (Gereffi 1994, 1999) – in these global production arrangements. With many of these economic models, the predictions that they generate have been tested empirically, using for example data on cross-border trade flows or on production linkages across establishments. In other instances, researchers have taken such models of firm-level sourcing, and embedded them in a general equilibrium setting, as has been the tradition with modelling work in international trade. With a general equilibrium approach, one can take into account the interdependencies across countries and industries, as well as between production units and

factor markets, when evaluating how the rise of trade in intermediate inputs would affect country-level outcomes such as welfare and the income distribution.

This article aims to provide a bridge for GVC scholars to this burgeoning literature on economic models of global production. It is useful here to make the case for what these models can bring to the table for GVC research, particularly since the modelling work of economists can admittedly be perceived as technical due to the use of mathematical tools. The advantage of such models is that they discipline the researcher by means of rigorous, step-by-step derivations. Where explicit mathematical expressions and results can be obtained, this makes precise the link from the primitives of the economic environment – the nature of the production technology; the locational attributes of different countries; the frictions that impinge on firm-supplier interactions – to predictions on firms’ sourcing decisions.<sup>5</sup> That said, one should acknowledge a shortcoming with this approach to theory, namely that economic models of GVCs can come across as stylized. This is because modelling work involves tradeoffs: What features should I as a researcher abstract from, in order to focus on the core forces I wish to elucidate? Without making such modelling choices, one can end up writing down mathematical equations that quickly become intractable and unilluminating. Naturally, this comes at the expense of potentially neglecting the full range of forces that are pertinent to GVC activity in practice. GVC scholars, on the other hand, have not been shy to embrace such nuance and detail, as is evident from the comprehensive taxonomies that they have developed through in-depth case studies, surveys and interviews of GVC actors.

This chapter proceeds as follows. In Section 2, we discuss the firm-level approaches that have been formulated in recent years by trade economists to understand the location and organization of global production. In Section 3, we overview several general equilibrium models that shed light on the aggregate implications of living in a GVC world, in which

production takes place on the back of active trade in intermediate inputs. Section 4 concludes by identifying several key directions for future work, where there remains much scope to fully exploit the synergies between GVC scholarship and economists' modelling tools to enhance our theoretical understanding of the underpinnings and consequences of GVC activity.

## **2. Firm-level models of sourcing decisions**

Economic models of global sourcing typically start from the premise that each firm possesses a technological blueprint for a particular good, and subsequently acts as a decision-making unit whose objective is to maximize its total worldwide profits. Broadly speaking, these models have focused on two main firm decision margins, namely: (i) over *location* (which countries to source inputs from, or to locate production facilities in); and (ii) over *organizational mode* (whether to conduct production in-house or to outsource to an arm's-length supplier). We survey below key papers on each of these decision margins.<sup>6</sup>

### **2.1 Location Decisions**

The earliest models that spoke to location decisions were stylized two-country models. These often featured firms with headquarters in the developed North, that face a decision over whether to offshore their production or the sourcing of a key input to the developing South; this simplified the location problem to a binary choice between North and South. Grossman and Helpman (2005), for example, consider a setting in which firms are confronted with a choice between outsourcing domestically and outsourcing abroad. Their analysis reveals the rich interplay of forces that could ultimately feed into this decision. This involves comparing differences between North and South in the legal enforcement of contracts, the “thickness” (or availability) of suppliers, the degree to which the matching

process with suppliers is affected by search frictions, as well as the extent to which lower production costs in South could compensate for any weaknesses in South's institutional or economic environment along the preceding dimensions.

While such two-country models delivered useful qualitative insights, they were limited in their ability to match the rich patterns of global production observed in a multi-country world. For a time, it was viewed as challenging to extend the models beyond two-country settings, as one would have to keep track of an ever-expanding list of possible location choices and production arrangements. For instance, several models explored adding a third country, often a developed country that firms might consider as an additional production location and/or destination market for their finished goods (Yeaple 2003; Grossman et al. 2006).<sup>7</sup> These exercises often boiled down to an enumeration of cases that describe the conditions under which each particular location configuration was more likely to emerge.

A modelling solution to this problem of large combinatorial possibilities was offered recently in Antràs et al. (2017). In their model, each firm has a large number of intermediate inputs – formally, a continuum of inputs – over which it needs to make source country choices. This converts the firm's problem from one of picking a single source country for all its inputs, to one of deriving predictions on the share or fraction of inputs that would be obtained from each source country. The authors then drew on mathematical tools that had been devised in Eaton and Kortum (2002), and more specifically Tintelnot (2017), to derive compact expressions for these input shares. These expressions take into account the role of factor prices (e.g., wages), shipping costs, and the average productivity levels of suppliers across the set of potential source countries. Furthermore, Antràs et al. (2017) took on board the observation that not all countries are selected as sourcing locations: a U.S. firm might obtain inputs from China, for example, but not from Zimbabwe. To rationalize this, the

authors posit that there are fixed costs that firms need to incur to gain access to suppliers from a source country; in the example above, these fixed costs would presumably be higher for Zimbabwe than for China.<sup>8</sup>

The global firm in Antràs et al. (2017) thus engages in a two-step decision: it first pins down the subset of countries to source from (i.e., for which to incur the fixed costs), and then chooses how much to source from each country (i.e., the input shares). A pertinent theme that emerges from this analysis is that there are cross-country dependencies in a firm's sourcing decisions. Consider a situation where a firm's profits are particularly responsive to reductions in its costs of production, to the extent that a decrease in the cost of inputs that it receives from one particular country would raise the firm's incentives to seek out further input cost reductions; this is the case which Antràs et al. (2017) find to be empirically relevant in the U.S. data. Under this condition, firms that are innately more productive would choose to source from a larger set of countries, as they would be able to bear the higher fixed costs to seek out opportunities in more country locations to lower their sourcing costs.

The toolkit in Antràs et al. (2017) is a powerful one, but their framework features a one-stage production process. This stands in contrast to the multi-stage chains that are often described in real-world case studies of GVCs. When production comprises a sequence of many stages, the location decision becomes more complex. In the absence of shipping costs, firms would want to locate each stage in the respective country where the stage input can be obtained at the lowest cost. But the presence of cross-border transport costs for unfinished goods can significantly complicate that calculus, by creating interdependencies in the locations chosen across adjacent stages in the production sequence. Antràs and de Gortari (2017) provide an insight into this issue: When transport costs are a function of the gross value of the goods that are shipped, a *centrality-downstreamness* nexus emerges wherein each firm would want to place its most downstream stages in countries that are more centrally

located. This is in order to minimize the compounding effect of shipping costs for downstream goods in which a lot of production value has been accumulated. The models in Harms et al. (2012), Baldwin and Venables (2013), and Tyazhelnikov (2016) articulate a closely-related intuition: The presence of transport costs can lead firms to cluster production stages within the same country, even though that country may not be the lowest cost site for each individual stage within a cluster.

## **2.2 Organizational Decisions**

The second key GVC decision margin that economists have studied extensively is the organizational mode under which sourcing is conducted. This is often conceptualized in the models as a choice between “integration” and “outsourcing”, namely whether to produce an input in-house or to purchase it from an independent supplier. Here, trade economists have leveraged on a body of theoretical work on the ownership boundaries of the firm. The models developed have in turn provided guidance on the types of industries in which integrated firm-supplier relationships can be expected to be more prevalent, and vice versa. GVC scholars will see in this parallels with the large literature on governance forms within value chains (c.f., Humphrey and Schmitz 2001, Gereffi et al. 2005), although the overlap is not an exact one.

We focus the discussion on models that spotlight the role of contracting frictions in firm-supplier relationships, this being a focal line of research on the organizational decisions of global firms in the past 15 years.<sup>9</sup> As a starting point, it is presumed that the firm’s sourcing problem requires that it procure a highly customized input: The supplier needs to invest effort to tailor the input to the specifications of the firm – think of a wing part for a particular model of wide-bodied aircraft, rather than a generalized widget – so much so that the customized input has little value outside of the bilateral relationship. At the same time,

the contracting environment is such that neither the quality of the delivered input nor the effort incurred by the supplier can be independently verified. This could be because external parties lack expert knowledge, or because it is not feasible for them to adjudge whether contingencies that have arisen are reasonable mitigating circumstances. This rules out turning to a third-party panel or court to seek recourse in the event of a contractual dispute.

Together, the relationship-specific nature of the input and the incompleteness of the contracting environment imply that the interaction between the firm and its supplier would be exposed to opportunistic behavior. The supplier can threaten to withhold delivery of the input knowing that the firm cannot easily find replacement parts; on the other hand, the firm can stall on payments to the supplier since the input has little resale value. The prospect of such holdup problems in turn discourages these actors from investing what would constitute the first-best level of effort in the bilateral relationship. Since one cannot rely on contracts to directly discipline effort levels, it is instead the organizational mode (i.e., integration versus outsourcing) decided upon by the firm at the outset of the relationship that plays a crucial role in (partially) counteracting the inefficiency in effort levels.

The seminal “transactions costs” approach of Ronald Coase and Oliver Williamson can be considered the first generation of theories of firm boundaries that is predicated on such contracting frictions.<sup>10</sup> This approach derives its name from the “transactions costs” encountered with sourcing on the open market: An arm’s-length supplier would under-invest in customizing the input, in anticipation that the firm (as buyer of the input) would force a renegotiation of payment terms at the delivery stage. Conversely, a fully integrated firm is assumed to avoid these market-based frictions; instead, the integrated entity faces costs of a different nature – bureaucratic or governance costs that come with running a large operation – which limits the ownership boundaries of the firm. This tradeoff between transactions costs

under outsourcing on the one hand, and bureaucratic costs under integration on the other, lies at the heart of the Coase-Williamson approach.

Trade economists have adopted this transactions-cost framework to draw insights on various dimensions of the global sourcing decision. Grossman and Helpman (2002), for instance, incorporated a search and matching process for firms seeking out a suitable arm's-length supplier. Such search frictions are arguably a realistic feature, and they impose an additional cost – on top of market transactions cost – that would be faced by firms under outsourcing. More recently, Fally and Hillberry (2018) developed a model in the spirit of Coase-Williamson that resembles the production setting of a GVC.<sup>11</sup> Specifically, production of the final good requires that a large sequence of stages be executed in a pre-determined order; think, for example, of silicon wafers that have to be purified, before semiconductor chips can be fabricated from them. The firm then decides on how to partition the sequence of stages, to assign them to be performed by distinct suppliers across countries. This delivers a theory of supplier “scope” in the GVC: The span of stages that each supplier performs is determined by comparing the transactions costs of moving semi-finished goods across suppliers against the bureaucratic costs incurred when suppliers are assigned more stages.

The Coase-Williamson approach is deservedly credited for formulating the concept of market transactions costs, and articulating how these would impinge on a firm's efficiency. That said, it has been open to several criticisms. At a basic level, the foundations of what constitute “bureaucratic costs” under integration are often not fully elaborated. The approach also delivers implications that can be counter-intuitive: Consider an industry in which the input to be customized by the supplier is very important to the value of the final good. To fix ideas, think of the labor effort required at the assembly stage in a labor-intensive industry. Under outsourcing, the transactions-cost logic implies that the supplier would under-invest in labor effort, which would be particularly detrimental for a labor-intensive production process.

To avoid this, one might then expect that firms in this industry would instead adopt integration as their organizational mode. This however does not gel well with the observation that GVCs in labor-intensive industries, such as apparel or low-end electronics, are often characterized by arm's-length relationships in practice.

These observations motivate the “property rights” approach to the theory of firm boundaries (Grossman and Hart 1986). Rather than presume that integration eliminates opportunistic behavior, the Grossman-Hart model instead posits that holdup problems would occur too between firm headquarters and a supplier that it owns. What then distinguishes integration from outsourcing as an organizational mode? Under the property rights approach, integration confers on the firm headquarters a better fallback position vis-à-vis its supplier in the face of holdup. This is because the ownership position of firm headquarters yields it residual rights of control over assets such as the semi-finished goods should the bilateral relationship break down. Following this logic, the organizational mode that would then be chosen would seek to assign residual control rights, and hence a better bargaining position and stronger incentives, to the party that contributes the more important input in the production process. In other words, integration would be adopted if headquarter inputs such as proprietary knowhow or capital assets are especially critical, holding all else constant; conversely, outsourcing would be chosen when supplier effort contributes relatively more to the value of the final good.

This foundation for organizational decisions was embedded in an international context in Antràs (2003). In particular, the model in Antràs (2003) mapped the core intuition behind the property-rights approach into testable implications on the nature of trade flows. The latter exploits the fact that U.S. customs data report a breakdown of whether trade flows are taking place between related parties (that share ownership ties) or between unrelated parties. The propensity towards integration as the sourcing mode in an industry can thus be captured by

the share of total imports that is related-party (or “intrafirm”) in nature. Consistent with the model’s predictions, Antràs (2003) found that the U.S. intrafirm import share – and hence the propensity toward integration – is indeed higher in capital-intensive industries such as chemicals and drugs (where headquarter inputs play a large role), relative to labor-intensive industries such as textiles (where supplier effort is more important).

It is useful at this juncture to discuss how the above dichotomy between integration and outsourcing relates to typologies of governance forms in the broader GVC literature. There are clearly strong parallels. The industries in which economists have found a high propensity towards integration tend to coincide with those which Gereffi (1994) would characterize as featuring “producer-driven” chains. These are industries in which the producer, often by virtue of the proprietary technology it holds, becomes the lead actor in making key decisions and thus assumes a high degree of control over various stages of the value chain. Conversely, industries in which the intrafirm trade data point to a greater adoption of arm’s-length sourcing would likely be labelled by GVC scholars as “buyer-driven”. One interpretation therefore of these economic models of firm organization is that they formalize how the characteristics of the good and its production technology – specifically, the relative importance of headquarter versus supplier inputs – would influence whether producer- or buyer-driven governance is more likely to emerge.

It should be stressed however that the two sets of concepts are not isomorphic. The property-rights approach in economics builds a foundation for understanding firm ownership that is grounded in legal concepts related to residual control rights. On the other hand, the notion of power and how it affects governance in the GVC literature is less tied to formal legal concepts, and thus offers more flexibility for exploring the sources of that power and how it is distributed across actors. This flexibility and depth is on display, for example, in how GVC scholars have elucidated through detailed case studies the role of large retailers

and wholesalers in exercising market power in buyer-driven supply chains; this phenomenon has received much less attention in terms of formal modelling by trade economists.<sup>12</sup>

We round off this section by discussing the body of work that has built upon the baseline framework in Antràs (2003). Antràs and Helpman (2004) considers in more detail the global sourcing decision, in an environment where firms differ in their productivity levels following the influential work of Melitz (2003). This delivers a rich pattern in which firms sort according to their productivity levels into four possible sourcing modes: domestic outsourcing, domestic integration, foreign outsourcing, or foreign integration. In particular, if the fixed costs of foreign integration are plausibly assumed to be the highest, then only the most productive firms would choose to become a fully-integrated multinational firm as their global sourcing strategy. In Antràs (2005), the framework is adapted to shed light on the phenomenon of product cycles (Vernon 1966). Suppose the headquarter intensity of a good were to decline over time, for instance, due to the underlying technology becoming more standardized as it ages. This can rationalize why production of a good is often conducted domestically and in-house initially, but may shift over time towards arm's-length sourcing modes with offshore suppliers. This dovetails with the narratives of how governance structures in the global electronics industry have evolved over the past decades, as documented extensively by GVC scholars (e.g., Gereffi et al. 2005).<sup>13</sup>

Elsewhere, the global sourcing framework has been extended to consider the roles of financing and risk, which the broader literature has also identified as critical factors for global production (e.g., Coe and Yeung 2015). Carluccio and Fally (2012) demonstrate how the financing constraints faced by foreign suppliers could tilt firms towards integrating these suppliers, particularly when the inputs are highly complex and non-contractible. On the issue of risk, Carballo (2016) explores how the organizational decisions of global firms would respond to uncertainty in market demand conditions for the final good.

The mechanics of production often requires that upstream inputs (e.g., raw materials) need to be readied and delivered before downstream stages (e.g., assembly) can commence. This sequentiality and how it can shape organizational decisions within a firm – across suppliers in its value chain – are the subject of Antràs and Chor (2013).<sup>14</sup> In a sequential production setting, organizational choices made over upstream stages would have spillovers on downstream suppliers' actions. As a consequence, the degree of complementarity between stage inputs now matters: Suppose that inputs are “sequential complements”, in that high levels of effort by upstream suppliers complements that of downstream suppliers. Then, Antràs and Chor (2013) show that the optimal organizational mode would involve outsourcing a subset of upstream stages, while integrating the remaining stages downstream. This allows the firm to incentivize effort from upstream suppliers, and to then leverage the built-in complementarity in the production process to elicit effort from downstream suppliers. On the other hand, if inputs are “sequential substitutes”, the firm would instead adopt integration over upstream stages to moderate the effort of early-stage suppliers, coupled with outsourcing over downstream stages to avert under-investment by those late-stage suppliers. These rich but subtle predictions on the patterns of organization within GVCs have received empirical validation, both in the data on U.S. intrafirm input shares (Antràs and Chor 2013), and in more detailed data on the activities and ownership structure of establishments around the world (Del Prete and Rungi 2017, Alfaro et al. 2019).

Last but not least, there has been work that considers how repeated interactions between a firm and its supplier can deter the opportunistic behavior that would otherwise surface in a one-time interaction. Specifically, the threat of punishment – to discontinue the bilateral relationship – can sustain “good” behavior if all actors care sufficiently about future payoffs. This logic has been incorporated in the Grossman-Hart framework in the model of “relational contracts” in Baker et al. (2002), and subsequently transplanted to analyze global

sourcing issues in Kukharskyy (2016). This organizational mode is naturally related to the notion of governance in “relational value chains” advanced in Gereffi et al. (2005).<sup>15</sup>

### 3. General equilibrium approaches

We turn now to overview a line of work that has sought to aggregate up the micro-level decisions of firms, in order to understand the macro-level implications of the rise in global production. The models we discuss in this section are *general equilibrium* in nature: These formalize how firm decisions collectively influence country-level outcomes such as factor prices, while also accounting for the feedback effects of these macro-level variables on individual firms. Many such models now feature firms that source for their inputs globally, giving rise to trade in intermediate inputs. With improvements in computing power, it has moreover become feasible to solve numerically for the equilibrium outcomes in these models, and to simulate counterfactual scenarios. This has allowed researchers to trace out the effects of, for example, a reduction in trade frictions on a range of meaningful outcomes such as trade volumes, welfare and inequality. This body of work has grown rapidly in recent years, and so the discussion below is selective by necessity; it is nevertheless intended to showcase the potential of these modelling frameworks for shedding light on the aggregate implications of GVCs.

**On the volume of trade.** The increase in international trade as a share of world income since the 1950s has been well-documented. Yi (2003) highlighted a central puzzle lying amidst this well-known fact, namely that the rise in trade has been quantitatively much larger than can be accounted for by observed decreases in import tariff rates, if one were to adopt a conventional setting in which only final goods are traded. To resolve this, Yi (2003) constructed what was arguably the first general equilibrium model with multiple stages of production that was amenable to calibration. As trade barriers decline, this triggers the

geographic separation of production stages, and hence spurs a rise in trade in intermediate inputs. This would in turn magnify the effect of a decline in import tariffs on aggregate trade volumes. These ideas have been developed further in the work of Johnson and Moxnes (2016) and Antràs and de Gortari (2017), who have constructed and estimated more sophisticated multi-stage general equilibrium trade models that feature in particular a larger set of country locations.

**On the pattern of trade.** What are the economic fundamentals that determine which segments within GVCs a country would specialize in? Which countries have a comparative advantage in producing and exporting upstream inputs, as opposed to downstream finished goods? Costinot et al. (2013) formulate a tractable model that speaks to these issues, in which countries are assumed to differ in their productivity, or more literally, the rate at which costly production mistakes occur that would destroy the value of goods-in-process. In this setting, the equilibrium would see countries that are more productive specializing in relatively more downstream segments of the global supply chain. This is because it would be especially crucial to avoid production errors after a lot of value has been built in from prior stages.<sup>16</sup> Taking a more quantitative approach, Antràs and Chor (2018) develop an extension of the Caliendo and Parro (2015) model, in which firms source inputs from multiple industries and from countries around the world. This model is then used to simulate how forces such as a decline in trade costs would affect the positioning of countries within GVCs.

**On welfare gains.** There has been a resurgence in research in international trade on quantifying the welfare gains that countries stand to reap from trade liberalization. This has been spurred by the influential theory in Arkolakis et al. (2012), who derived a gains-from-trade formula that pervades a broad class of general equilibrium models; they moreover demonstrated how to discipline the key variables in this formula with data, to obtain an estimate of the welfare gains from trade. These “quantitative trade models” have since been

extended to incorporate multiple industries, with the industries further inter-linked in a “roundabout” production structure where each industry uses the output of all other industries as intermediate inputs (Costinot and Rodríguez-Clare 2014; Caliendo and Parro 2015).

An important takeaway message from this work is that *ceteris paribus*, a decline in trade costs delivers larger welfare gains in a setting with trade in intermediates, relative to a baseline model with trade only in final goods. Intuitively, the welfare gains are magnified when there is global sourcing, since a decline in trade frictions lowers not just the price of final goods, but also the input costs faced by firms around the world.<sup>17</sup> Melitz and Redding (2014) have further argued that if one were to consider a multi-stage setting where production is sequential (rather than “roundabout”), and inputs for each stage are globally sourced, then the welfare gains from trade can become unboundedly large as the number of stages increases.

**On labor markets and inequality.** A policy concern that often arises with global production is the potential impact on labor markets. How in particular would offshoring affect skilled versus unskilled workers? Feenstra and Hanson (1996) gave voice to these concerns by developing a model in which the offshoring of production stages from a developed North to a labor-abundant South results in a rise in inequality in both countries. This would be the case as long as the offshored stages are among the least skill-intensive production tasks originally performed in North, but are regarded as highly skill-intensive from the perspective of the developing South. The offshoring activity can therefore lead to a rise in the relative demand for skills, and hence a wider skill premium, in both countries.

However, Grossman and Rossi-Hansberg (2008) caution against the conclusion that offshoring necessarily hurts unskilled workers. They identify how offshoring can simultaneously generate a “productivity effect”, whereby the demand for unskilled labor can rise as a result of the cost-savings that firms realize through offshoring; whether inequality

risers or falls thus depends on how strong this productivity effect is relative to other forces. Accordingly, several quantitative general equilibrium models have been developed that feature multiple worker types and cross-country trade in intermediates, which in principle allows the researcher to consider the interaction between global sourcing and inequality (e.g., Galle et al. 2017). Among these, Lee and Yi (2017) is notable for explicitly adopting a multi-stage sequential production setting, to explore the possible interplay between specialization in upstream versus downstream stages and inequality across worker types within countries.

#### **4. Conclusion**

This chapter has discussed the recent wave of models advanced by trade economists to understand firm-level decisions on global production (Section 2), and the consequences for aggregate outcomes (Section 3). While we have described how these models might speak to the broader social science literature on GVCs, the relationship between these two lines of research to this point can still be described by: “so close, yet so far”. The links are “so close” because of the shared agenda to understand the drivers and socio-economic implications of GVC activity in the modern world economy. At the same time, the lack of engagement (“so far”) represents a lost opportunity. There are several prominent issues in the GVC literature, where modelling work by economists could yet contribute fruitful insights. I highlight three possible areas for such future work below.

First, the issue of power in global production arrangements remains under-studied by economists. GVC scholars have theorized that the imbalance between developed-country firms and developing-country suppliers, the thickness of the local pool of alternative suppliers, as well as institutional or regulatory structures all influence power in firm-supplier ties. By contrast, economic models of firm organization have remained relatively silent on such fundamental forces that could shape the bargaining strength of a firm vis-à-vis its

supplier. There is room for more modelling work to be done, to develop clear testable predictions on how these determinants of the distribution of power would affect firms' global production strategies.<sup>18</sup>

Second, most existing economic models of GVC activity are tailored towards features of global production in the manufacturing sector. But GVCs in their totality encompass service sector activities, ranging from upstream product development and testing, to downstream marketing and logistics. How might the incentives of a firm to internalize the provision of service inputs differ from that for physical components? What about the role of financial services in GVC activity? There is currently a dearth of economic models that speak to the specificities of GVC activity involving services.<sup>19</sup>

Third, we have not yet fully exploited the potential of economic models to inform us on policy issues in a GVC world. How could GVC activity and the rising importance of trade in value-added affect the conduct of trade policy? How should we assess the use of industrial policy, such as fiscal incentives, to promote activities that seek to plug countries into GVCs? What is the relationship between GVCs, industrial upgrading ("moving up the value chain"), and economic growth? On the first question, we are starting to see promising work on optimal tariff policy in a GVC world (Antràs and Staiger 2012; Blanchard et al. 2016). The latter two questions however point to a genuine gap in the economics literature. The importance of these policy issues should be clear, since they impact broader labor market and growth outcomes for countries. GVC scholars have been keenly aware of the need to connect their research with such developmental implications.<sup>20</sup> Moving forward, this topic deserves a similar level of attention from economists.

---

## Notes

<sup>1</sup> I thank Pol Antràs, Gary Gereffi and Stefano Ponte for helpful comments, and colleagues at GPN@NUS for educating me on the scholarly research by non-economists on global production. Han Loong Ng provided editorial assistance.

<sup>2</sup> This counts articles in which either the singular (“chain”) or plural (“chains”) was used. When expanding the search to include the term “global supply chain(s)”, the count is still zero prior to 2011, but increases to a total of 29 articles between 2011-2017. As a rough estimate, the *Journal of International Economics* published about 300 articles in international trade in the latter seven-year period. The related term “global commodity chain(s)” appeared in two articles in this journal, including the highly cited symposium piece by Gereffi (1999).

<sup>3</sup> A notable exception in the initial years when scholarship on global production was gaining momentum was the “Symposium on Business and Social Networks in International Trade” put together by James Rauch and Robert Feenstra. The symposium papers – which appeared in a special issue of the *Journal of International Economics* in 1999 – reflected a balanced mix of contributions from economics and sociology.

<sup>4</sup> See Johnson (2018), as well as Chapters 13-15 in this Handbook (respectively authored by Frederick, Sturgeon, and Low), for survey articles on the measurement of GVC activity.

<sup>5</sup> In this regard, economic models of global production offer much by way of identifying the underlying forces behind the formation of these production arrangements. This is in the same spirit as what Coe and Yeung (2015) set out to do when developing their “GPN2.0” framework.

<sup>6</sup> We discuss the literature on location decisions first, given that this has been a more basic, longstanding decision margin of interest to international trade economists. See Antràs (2015) for a comprehensive resource on issues related to the location and internalization decisions of global firms.

<sup>7</sup> These models were developed within the context of a literature on the global strategies of multinational firms. For such business entities, the decision problem goes beyond selecting which country to source inputs from, as considerations related to proximity to potential markets would also come into play.

<sup>8</sup> This simple example presumes that the variable trade costs of shipping from Zimbabwe to the U.S. are not prohibitively high to the extent that this would suffice to shut down imports from Zimbabwe.

<sup>9</sup> Economic models of ownership boundaries have been built around alternative foundations; these include the idea that firms serve to address moral hazard problems in production or that ownership facilitates the secure transfer of intangible knowledge assets. See Gibbons (2005) for a comprehensive review of economic models of the theory of the firm.

<sup>10</sup> As is clear, for example, from Humphrey and Schmitz (2001) and Gereffi et al. (2005), the concept of transactions costs in market interactions as formulated by Coase (1937) has played a prominent role in GVC scholars’ understanding of governance structures.

<sup>11</sup> This in turn builds upon the closed-economy version of the model in Kikuchi et al. (2018).

<sup>12</sup> See also the review on the state-of-the-art on thinking related to governance in GVCs in Chapters 1 and 4 of this Handbook by Ponte et al.

<sup>13</sup> This is also consistent with the key observation from the GVC literature that the earliest GVCs to emerge (in the 1950s-1960s) tended to be “producer-driven” chains in manufacturing that featured a high degree of vertical integration of the lead firm’s activities. It was only in the 1970s-1990s that “buyer-driven” chains emerged as a phenomenon. I thank Gary Gereffi for highlighting this point.

---

<sup>14</sup> Acemoglu et al. (2007) and Schwarz and Suedekum (2014) develop models where a firm makes sourcing decisions over multiple inputs, but these decisions are made simultaneously rather than sequentially.

<sup>15</sup> There is admittedly less modelling work that corresponds to the “captive” or “modular” forms of governance in the Gereffi et al. (2005) taxonomy.

<sup>16</sup> In Costinot et al. (2012), the authors elaborate upon the implications of their framework for within-country inequality across workers of different skill types.

<sup>17</sup> This echoes the themes of former WTO Secretary General Pascal Lamy’s “Made in the World” and “Aid for Trade” agendas (2009-2013), on why a GVC world with trade in intermediate inputs would magnify the importance of trade liberalization. See Chapter 39 in this Handbook by Mayer and Gereffi for an elaboration of the links between international development organizations and GVCs.

<sup>18</sup> McLaren (2000) is an exception in this regard, in that his model considers the thickness of the market for alternative buyers of a specialized input in a setting with arm’s-length transactions costs. See also Chapter 17 in this Handbook by Sako and Zylberberg on the topic of firm-level strategic behavior.

<sup>19</sup> See Chapter 15 in this Handbook by Low for an update on the state of research on services in GVCs.

<sup>20</sup> For treatments of this issue by GVC scholars elsewhere in this Handbook, see Chapter 3 by Fernandez-Stark and Gereffi on GVC links to economic policy, Chapter 5 by Gereffi on economic upgrading, Chapter 24 by Kaplinsky on inequality and the distribution of rents, as well as the chapters in Part 6 by Sturgeon and Whittaker, Morris and Staritz, and Stolzenburg et al. on the interface between economic development and GVCs.

---

## References

- Acemoglu, Daron, Pol Antràs, and Elhanan Helpman (2007), 'Contracts and Technology Adoption', *American Economic Review*, **97** (3), 916-943.
- Alfaro, Laura, Pol Antràs, Davin Chor, and Paola Conconi (2019), 'Internalizing Global Value Chains: A Firm-Level Analysis', *Journal of Political Economy*, forthcoming.
- Antràs, Pol (2003), 'Firms, Contracts, and Trade Structure', *Quarterly Journal of Economics*, **118** (4), 1375-1418.
- Antràs, Pol (2005), 'Incomplete Contracts and the Product Cycle', *American Economic Review*, **95** (4), 1054-1073.
- Antràs, Pol (2015), *Global Production: Firms, Contracts and Trade Structure*, Princeton University Press.
- Antràs, Pol, and Davin Chor (2013), 'Organizing the Global Value Chain', *Econometrica*, **81** (6), 2127-2204.
- Antràs, Pol, and Davin Chor (2018), 'On the Measurement of Upstreamness and Downstreamness in Global Value Chains', in Lili Yan Ing and Miaojie Yu (eds), *World Trade Evolution: Growth, Productivity and Evolution*, Routledge, pp. 126-194.
- Antràs, Pol, Davin Chor, Thibault Fally, and Russell Hillberry (2012), 'Measuring the Upstreamness of Production and Trade Flows', *American Economic Review Papers & Proceedings*, **102** (3), 412-416.
- Antràs, Pol, Teresa Fort, and Felix Tintelnot (2017), 'The Margins of Global Sourcing: Theory and Evidence from U.S. Firms', *American Economic Review*, **107** (9), 2514-2564.
- Antràs, Pol, and Alonso de Gortari (2017), 'On the Geography of Global Value Chains', NBER Working Paper No. 23456.
- Antràs, Pol, and Elhanan Helpman (2004), 'Global Sourcing', *Journal of Political Economy*, **112** (3), 552-580.
- Antràs, Pol, and Robert Staiger (2012), 'Offshoring and the Role of Trade Agreements', *American Economic Review*, **102** (7), 3140-3183.
- Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare (2012), 'New Trade Models, Same Old Gains?', *American Economic Review*, **102** (1), 94-130.
- Baker, George, Robert Gibbons, and Kevin J. Murphy (2002), 'Relational Contracts and the Theory of the Firm', *Quarterly Journal of Economics*, **117** (1), 39-84.
- Baldwin, Richard (2006), 'Globalisation: The Great Unbundling(s)', mimeo.
- Baldwin, Richard, and Anthony Venables (2013), 'Spiders and Snakes: Offshoring and Agglomeration in the Global Economy', *Journal of International Economics*, **90** (2), 245-254.
- Blanchard, Emily J., Chad P. Bown, and Robert C. Johnson (2016), 'Global Supply Chains and Trade Policy', NBER Working Paper No. 21883.
- Caliendo, Lorenzo, and Fernando Parro (2015), 'Estimates of the Trade and Welfare Effects of NAFTA', *Review of Economic Studies*, **82** (1), 1-44.
- Carballo, Jeronimo (2016), 'Global Sourcing under Uncertainty', mimeo.
- Carluccio, Juan, and Thibault Fally (2012), 'Global Sourcing Under Imperfect Capital Markets', *Review of Economics and Statistics*, **94** (3), 740-763.
- Coase, Ronald (1937), 'The Nature of the Firm', *Economica*, **4** (16), 386-405.
- Coe, Neil M., and Henry Wai-Chung Yeung (2015), *Global Production Networks: Theorizing Economic Development in an Interconnected World*, Oxford University Press.
- Costinot, Arnaud, and Andrés Rodríguez-Clare (2014), 'Trade Theory with Numbers: Quantifying the Consequences of Globalization', in Gita Gopinath, Elhanan Helpman

- 
- and Kenneth Rogoff (eds), *Handbook of International Economics*, Volume 4, North-Holland, pp. 197-261.
- Costinot, Arnaud, Jonathan Vogel, and Su Wang (2012), 'Global Supply Chains and Wage Inequality', *American Economic Review Papers & Proceedings*, **102** (3), 396-401.
- Costinot, Arnaud, Jonathan Vogel, and Su Wang (2013), 'An Elementary Theory of Global Supply Chains', *Review of Economic Studies*, **80** (1), 109-144.
- Del Prete, Davide, and Armando Rungi (2017), 'Organizing the Global Value Chain: A Firm-Level Test', *Journal of International Economics*, **109**, 16-30.
- Eaton, Jonathan, and Samuel Kortum (2002), 'Technology, Geography, and Trade', *Econometrica*, **70** (5), 1741-1780.
- Fally, Thibault (2012), 'Production Staging: Measurement and Facts', mimeo.
- Fally, Thibault, and Russell Hillberry (2018), 'A Coasian Model of International Production Chains', *Journal of International Economics*, **114**, 299-315.
- Feenstra, Robert C. (1998), 'Integration of Trade and Disintegration of Production in the Global Economy', *Journal of Economic Perspectives*, **12** (4), 31-50.
- Feenstra, Robert C., and Gordon H. Hanson (1996), 'Foreign Investment, Outsourcing and Relative Wages', in Robert C. Feenstra, Gene M. Grossman and Douglas A. Irwin (eds), *Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati*, Cambridge: MIT Press, pp. 89-127.
- Galle, Simon, Andrés Rodríguez-Clare, and Moises Yi (2017), 'Slicing the Pie: Quantifying the Aggregate and Distributional Effects of Trade', NBER Working Paper No. 23737.
- Gereffi, Gary (1994), 'The Organization of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks', in Gary Gereffi and Miguel Korzeniewicz (eds), *Commodity Chains and Global Capitalism*, Praeger Publishers, pp. 95-122.
- Gereffi, Gary (1999), 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', *Journal of International Economics*, **48** (1), 37-70.
- Gereffi, Gary, John Humphrey, and Timothy J. Sturgeon (2005), 'The Governance of Global Value Chains', *Review of International Political Economy*, **12** (1), 78-104.
- Gibbons, Robert (2005), 'Four Formal(izable) Theories of the Firm?' *Journal of Economic Behavior and Organization*, **58** (2), 200-245.
- Grossman, Gene M., and Elhanan Helpman (2002), 'Integration versus Outsourcing in Industry Equilibrium', *Quarterly Journal of Economics*, **117** (1), 85-120.
- Grossman, Gene M., and Elhanan Helpman (2005), 'Outsourcing in a Global Economy', *Review of Economic Studies*, **72** (1), 135-159.
- Grossman, Gene, Elhanan Helpman, and Adam Szeidl (2006), 'Optimal Integration Strategies for the Multinational Firm', *Journal of International Economics*, **70** (1), 216-238.
- Grossman, Gene, and Esteban Rossi-Hansberg (2008), 'Trading Tasks: A Simple Theory of Offshoring', *American Economic Review*, **98** (5), 1978-1997.
- Grossman, Sanford J., and Hart, Oliver D. (1986), 'The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration', *Journal of Political Economy*, **94** (4), 691-719.
- Harms, Philipp, Oliver Lorz, and Dieter Urban (2012), 'Offshoring along the Production Chain', *Canadian Journal of Economics*, **45** (1), 93-106.
- Hummels, David, Jun Ishii, and Kei-Mu Yi (2001), 'The Nature and Growth of Vertical Specialization in World Trade', *Journal of International Economics*, **54** (1), 75-96.
- Humphrey, John, and Hubert Schmitz (2001), 'Governance in Global Value Chains', *IDS Bulletin*, **32** (3), 19-29.
- Johnson, Robert C. (2018), 'Measuring Global Value Chains', *Annual Review of Economics*, **10** (1), 207-236.

- 
- Johnson, Robert C., and Andreas Moxnes (2016), 'Technology, Trade Costs, and the Pattern of Trade with Multistage Production', mimeo.
- Johnson, Robert C., and Guillermo Noguera (2012), 'Accounting for Intermediates: Production Sharing and Trade in Value Added', *Journal of International Economics*, **86** (2), 224-236.
- Kikuchi, Tomoo, Kazuo Nishimura, and John Stachurski (2018), 'Span of Control, Transaction Costs and the Structure of Production Chains', *Theoretical Economics*, **13** (2), 729-760.
- Koopman, Robert, Zhi Wang, and Shang-Jin Wei (2014), 'Tracing Value-Added and Double Counting in Gross Exports', *American Economic Review*, **104** (2), 459-494.
- Kukharskyy, Bohdan (2016), 'Relational Contracts and Global Sourcing', *Journal of International Economics*, **101**, 123-147.
- Lee, Eunhee, and Kei-Mu Yi (2017), 'Global Value Chains and Inequality with Endogenous Labor Supply', *Journal of International Economics*, forthcoming.
- McLaren, John (2000), "'Globalization" and Vertical Structure', *American Economic Review*, **90** (5), 1239-1254.
- Melitz, Marc J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica*, **71** (6), 1695-1725.
- Melitz, Marc J., and Stephen J. Redding (2014), 'Missing Gains from Trade?' *American Economic Review Papers & Proceedings*, **104** (5), 317-321.
- Miller, Ronald E., and Umed Temurshoev (2017), 'Output Upstreamness and Input Downstreamness of Industries/Countries in World Production', *International Regional Science Review*, **40** (5), 443-475.
- Schwarz, Christian, and Jens Suedekum (2014), 'Global Sourcing of Complex Production Processes', *Journal of International Economics*, **93** (1), 123-139.
- Tintelnot, Felix (2017), 'Global Production with Export Platforms', *Quarterly Journal of Economics*, **132** (1), 157-209.
- Tyazhelnikov, Vladimir (2016), 'Production Clustering and Offshoring', mimeo.
- Vernon, Raymond (1966), 'International Investment and International Trade in the Product Cycle', *American Economic Review*, **80** (2), 190-207.
- Yeaple, Stephen R. (2003), 'The Complex Integration Strategies of Multinationals and Cross Country Dependencies in the Structure of Foreign Direct Investment', *Journal of International Economics*, **60** (2), 293-314.
- Yi, Kei-Mu (2003), 'Can Vertical Specialization Explain the Growth of World Trade?' *Journal of Political Economy*, **111** (1), 52-102.