

6 **Winners and Losers of Globalization: Sixteen Challenges for Measurement and Theory**

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Abstract

The goal of this chapter is to summarize the state of the art in research in international trade and global production, and discuss issues relevant to European policymakers. Much of recent research on globalization is primarily empirical, owing to the proliferation of available data. We begin by discussing recent advances in measuring the causes and effects of globalization, and discussing the particular data challenges that have emerged. We then turn to theories of trade and global production, first summarizing the conclusions on which there is a broad consensus in the field. We discuss new insights that may be relevant for policy-makers, and open research questions.

6.1 Introduction

The fortune of workers, consumers and firms increasingly depends on other countries. This global interdependence is driven by the flow of goods, capital, ideas and people across countries. This chapter summarizes research about two aspects of globalization: international trade in goods and services, and the international fragmentation of production. We first summarize the overarching themes that are common to both topics. We conclude with a set of open questions, and propose an agenda for better connecting academic research with the needs of policy-making. We also discuss data challenges facing economists and policy-makers alike.

The primary motivation of theories of globalization is to explain how international interactions differ from domestic interactions, and why they occur in the first place. Why do countries trade goods with one another? Why do some companies locate part of their production abroad? Canonical models of trade and globalization explain the magnitude and patterns of cross-country movements, and their welfare implications. An almost tautological conclusion of these models is that if countries choose to interact with one another, they must be better off than being in isolation. Models may differ in the

magnitude of the gains from trade they predict, but these gains are almost uniformly positive.

A central theme is that globalization benefits some more than others. In fact, some may even become worse off as their country becomes more open to the flow of goods, ideas, and people. For example, workers in import-competing industries stand to lose when countries open up to trade. These distributional effects of globalization are widely studied both theoretically and empirically.

Economists find it difficult to give definite answers to trade policy challenges partly because the remaining policy barriers to cross-border transactions are difficult to quantify. The standard economics toolbox works with taxes and quotas. Advances in measurement and unifying theories have made it possible to robustly quantify the effects of such taxes and quotas with minimal theoretical assumptions. Less is known, however, about the role of nontariff and nonquota barriers such as regulations and standards in limiting the side effects of globalization. We need to understand the costs of nontariff barriers in limiting international transactions, but also their potential benefits in solving market failures. For example, most analysis of the Transatlantic Trade and Investment Partnership (TTIP) and similar agreements can say little about the effect of harmonized regulation and the investment dispute settlement mechanism, the key ingredients of the TTIP and other such deep agreements.

Given the scope of the task, this survey is admittedly very selective. We have chosen topics that we think are both important for European policy and are well covered in academic research. We have omitted some basic research that may be very influential in shaping our views and future work, but that are not in the forefront of current policy debate in Europe. We also do not discuss the topic of financial integration and international migration, which are the subject of Chapter 3 and Chapter 11, respectively. Chapters 8 and 9 complement our chapter by studying agglomeration and location choices of firms, as well as intra-EU regional development.

Even among the topics we cover, our discussion can only scratch the surface of the academic debate. We did not intend to (and certainly could not) give a comprehensive survey in all the topics. Instead, we just summarized the consensus if there is one, and judiciously discussed the open questions. We have relied on several excellent recent surveys of the literature (O'Rourke and Williamson, 1999, Rauch, 2001, Anderson and Van Wincoop, 2004, Hoekman and Javorcik, 2006, Bernard et al., 2007, Goldberg and Pavcnik, 2007a, Harrison, 2007, Helpman et al., 2008b, Antràs and Rossi-Hansberg, 2009, Bernard et al., 2012c, Melitz and Trefler, 2012, Yeaple, 2013, Johnson, 2014, Gopinath et al., 2014). When necessary, we tried to highlight the key papers, but often just refer to the conclusions of these surveys. Readers who want to follow up on any of the academic topics should turn to these surveys.

6.2 Advances in Measurement and Data Challenges

Data on international transactions is collected differently from domestic data, which both helps and hurts empirical analysis. On the one hand, international transactions are often more likely to leave a paper trail than domestic ones. Historically, many countries relied on tariffs as an easy-to-collect source of government revenue, and built and maintained customs administrations to collect information about shipments and levy the appropriate taxes. This put unparalleled richness of data in the hands of governments, which then became available for economic research. On the other hand, the fact that customs administrations and statistical bureaus have no jurisdiction outside their sovereign borders limits their ability to collect good quality data on international flows.

6.2.1 *Recent Advances in Measuring the Causes and Effects of Globalization*

Firm-level Measurement of Trade Flows and Competitiveness

Firm-level data from balance sheets, earnings statements, customs records or surveys have become increasingly available in a number of countries throughout the past two decades. This led to a rich empirical literature, starting with the papers of Bernard et al. (1995); Bernard and Jensen (1999), on the performance distribution of firms within countries and industries and on how the performance of firms relate to international involvement through trade or FDI.

Most related research on European firms, a recent assessment of which is provided by Wagner (2012), feature data on individual countries. A more systematic approach is made by Mayer and Ottaviano (2007), who look at firm-level data from seven European countries. More recently, two EU-wide research projects (EFIGE, CompNet) generated internationally comparable data. Findings from the EFIGE firm-level survey in seven – mostly major – EU countries are assessed, for example, by Navaretti et al. (2011), while Berthou et al. (2015) discuss evidence from the CompNet firm-level panel of 15 EU countries.

The major findings prove to be remarkably robust across countries, industries and databases. First, firms are very heterogeneous in their performance measures even within narrowly defined industries. Second, this heterogeneity is to a significant extent explained by the international activity. Internationalized firms are larger both in terms of number of employees and sales, they are more productive and more capital and skill intensive than firms operating only on the domestic market. Third, the bulk of exports in any given country is usually generated by a handful of very big exporters, which at the same time also heavily import intermediate inputs.

Firm-level data is also increasingly used for policy analysis (Cernat, 2016). This is helpful not only to identify the heterogeneous effects of trade policy on

individual firms, but also to better quantify the aggregate effects of policy. To understand aggregate effects, we need to rely on industry and macroeconomic models (discussed in Section 6.3).

Challenge 1 *Harmonize firm-level trade and balance sheet data across countries.*

Multidimensional Trade Data

Recent empirical work has used customs transactions data to analyse the patterns of trade. The availability of such data has opened up the possibility to ask questions beyond the volume of trade and its broad sectoral composition. A typical customs declaration (which serves as the primary unit of observation for most trade statistics) records the exporting and the importing firm, the precise classification of the product being shipped, the precise date of shipments, the mode of transport and many other logistical details about shipment. This has made it possible, for example, to study the distribution of trade across products, destination markets and firms.

Bernard et al. (2007) survey the empirical evidence on multi-product and multi-country traders. They find that although most exporters (40% of the total) sell only one product to one destination, most exports are done by large multi-product, multi-destination exporters. The number of products and firms shipping to a particular market increases with market size and decreases with distance. Similar patterns emerge for imports.

Armenter and Koren (2014) caution that patterns in multidimensional trade data may be difficult to interpret because such data is sparse. That is, there are few observations relative to the number of product, firm and country categories.

What is the quantitative relevance of the sparsity of trade data? Armenter and Koren (2014) build a statistical benchmark (which can be thought of as a special case of a wide class of economic models), in which trade shipments are 'randomly' assigned to trade categories. The randomness is conditional on the size distribution of firms, countries, and products, so it does not imply that exporters behave erratically. Such a 'balls-and-bins' model can quantitatively fit many of the statistics reported about the number of exported products, exporting firms, and export destinations. Given that many models are consistent with the balls-and-bins framework, we cannot distinguish among them on the basis of such simple statistics.

We hence need new statistical methods to deal with large multidimensional trade datasets. Armenter and Koren (2014) do not offer a universal tool, but their reliance on the statistical properties of the multinomial distribution may be a useful starting point for further analysis. A more structural approach is followed by Eaton et al. (2012) and Armenter and Koren (2013), who build trade models with infrequent purchases.

The multidimensionality of most databases on international transactions (trade, investment, etc.) also poses a computational challenge in empirical applications. Panels of bilateral trade flows have at least three dimensions, while more detailed (micro) databases potentially more. Most empirical applications of the gravity equation on panel data, for example, include multiple sets of fixed effects to control for country, time, or country-pair unobservables. With large data, estimating out lots of fixed effects can become difficult or even practically impossible. To help overcome this problem Balázsi et al. (2015) derive, both for balanced and unbalanced data, the within transformations for several fixed effects models, while Mátyás et al. (2012) and Mátyás et al. (2013) propose random effects estimation and derive the appropriate estimators.

Challenge 2 *Develop statistical methods and computational tools to work with multidimensional data.*

Using Linked Employer-employee Data

The emergence of linked employer-employee datasets (LEEDs) (see Abowd and Kramarz, 1999) has spurred a fast-growing research on the effect of trade, FDI and other modes of globalization on worker-level outcomes, such as wages and employment probabilities. This is useful because it helps us understand the distributional effects of globalization more deeply.

The value added of LEEDs relative to firm-level studies is twofold. First, they help measure the heterogeneity of responses by different worker types. In a typical research design, some firms are exposed to globalization, some firms are not, and the researchers study the evolution of wages for different classes of workers within the firm. For example, Frias et al. (2012) estimate the effect of increased exports by Mexican firms after the 1994 peso devaluation on the wages of workers at these firms. They find that workers at the bottom of the wage distribution are not affected, but higher ranked workers see wage increases. That is, exports contribute to an increase in within-firm wage inequality. This would be impossible to measure with just firm-level data. See Schank et al. (2007), Krishna et al. (2011), Baumgarten (2013) and Hummels et al. (2014) for studies with similar designs.

A second contribution of LEEDs is that we can measure the exposure to globalization directly at the worker level. Koren and Csillag (2011) use a Hungarian LEED to estimate the effect of machine imports on the wages of machine operators. Crucially, knowing the precise product classification of machines and the precise occupation classification of workers, they can identify which workers are directly exposed to machine imports. For example, importing a new printing machine should affect the printing machine operator, but not the forklift driver. Koren and Csillag (2011) find that this is indeed the case and operators exposed to imported machines receive higher wages.

We expect that proprietary datasets within the firm will help us paint an even richer picture of the microeconomic effects of globalization.

Challenge 3 *Develop new datasets on workers within firms, while ensuring privacy and consistency across studies.*

Trade in Services

Services were earlier treated by economists as nontradables, as they typically require the physical proximity of the consumer and the service provider. Recent advances in information and communication technologies, however, have made several services ‘disembodied’ and enabled their cross-border trade. Where proximity is still important, international trade can take the form of sales through foreign affiliates or the (temporary) movement of persons.

Services are traded not only directly but also indirectly as components of traded manufactured products in the form of, for example, transport, telecommunication, banking or retail services. According to an OECD estimate, the services value added content of exported manufactured goods is 20–30 per cent. Hence, the liberalization of services trade, as long as it leads to cheaper, better quality services, can also improve the competitiveness of the manufacturing sector (see empirical evidence from Arnold et al., 2011 on the Czech Republic and Arnold et al., 2016 on India).

No distinct theory has been developed for understanding trade in services. Some argue that the existing theories of trade in goods and FDI can be applied to services trade as well, once we reinterpret transport costs as costs associated with the need for geographical proximity (Francois and Hoekman, 2010). The cost of this proximity burden in services is likely to be larger than the cost of distance in goods trade. Anderson et al. (2014) find that geographical barriers alone reduce international services trade seven times more than goods trade.

Recent firm-level studies on several large EU economies reveal important similarities between goods and services trade on the micro level (Breinlich and Criscuolo, 2011, Federico and Tosti, 2012, Kelle et al., 2013 and Temouri et al., 2013). Similar to trade in goods, trade in services is also concentrated among a small group of traders. These firms are typically larger, more productive and pay higher wages than other firms. The most productive service exporters tend to be parts of multinational enterprises and export via foreign affiliates. All this suggests that self-selection through productivity into trading and FDI is also present in trade in services.

An important difference between goods and services trade is that most barriers to services trade are of a regulatory nature. Service sectors are typically heavily regulated by national authorities (e.g., due to natural monopolies, asymmetric information or equity concerns). To the extent that these regulations are different across countries or discriminatory to foreign providers, they can act

as barriers to all forms of services trade (cross-border, FDI or movement of people). Drawing on policy experience with the WTO's General Agreement on Trade in Services (GATS) and other bilateral liberalization efforts, Hoekman and Mattoo (2013) emphasize that services trade liberalization cannot be separated from regulatory reform and international regulatory harmonization.

During recent years much has been done to overcome the serious data limitations in the field of trade in services. Bilateral service flow data from several different sources have been consolidated in a global database (Francois et al., 2009). Firm-level data on services trade are available for more and more countries. Information on barriers to services trade are summarized in two large-scale projects, the World Bank's Services Trade Restrictions Database (World Bank, 2015, Borchert et al., 2012a,b) and the OECD's Services Trade Restrictiveness Index (OECD, 2015). Nevertheless, there is still a lot to be done in the future to build and maintain comprehensive and reliable databases in this field.

Challenge 4 *Build harmonized firm-level data on services trade.*

Matched Buyer-seller Data

Most theoretical frameworks, even when they deal with business-to-business transactions, treat one side of the market as anonymous. In these models, exporters sell to many anonymous buyers, and importers buy from many anonymous sellers. In reality, however, most firms are only linked to a few buyers and few suppliers.

Understanding the nature of buyer-supplier linkages is crucial for two reasons. First, firms differ in their set of buyers and set of suppliers, and this heterogeneity may contribute to heterogeneity in performance (Eaton et al., 2013). We want to understand how firms with few and many links behave differently. Second, the structure of the network may affect the behavior of the entire economic system (Acemoglu et al., 2012).

Bernard et al. (2014b) analyse a novel two-sided dataset on trade. Using transaction-level trade data from Norway, they identify buying and selling firms, and document a number of facts about the distribution of trade flows across buyers and sellers. First, there is substantial variation in the number of buyers per seller. Most firms sell to a single buyer, but large firms sell to many buyers. Second, the distribution of sales across buyers does not vary systematically with firm size. Third, larger sellers sell to, on average, smaller buyers.

Carballo et al. (2013) study a similar buyer-seller dataset for Costa Rica, Ecuador and Uruguay. They show how the number of buyers varies across destination markets. Firms have more buyers in large and close markets. In markets with tougher competition, the distribution of sales is more skewed towards the largest buyer. Carballo et al. (2013) also build a model to show that increased

international openness to competition leads to selection and reallocation across buyer–supplier relationships, increasing productivity and welfare.

Data on buyer–supplier links is also (if not more) difficult to obtain for domestic transactions. Bernard et al. (2014a) work with a unique Japanese dataset, showing that the average firm has 4.9 suppliers and 5.6 (business) customers. They also study the geographic distribution of suppliers.

We discuss the theoretical questions raised by this new empirical work on buyer–supplier links in Section 6.3.3.

Challenge 5 *Collect data on buyer–supplier links within the EU.*

6.2.2 Data Challenges

Data Collection is Fragmented Across Countries

To study globalization, it is important to have internationally comparable data, and to follow transactions outside country borders. The European Union is closer to this ideal than other free trade areas would be, as Eurostat coordinates the development, production and dissemination of European statistics (Eurostat, 2011). However, most data wealth is still held by national statistical agencies.

There are several recent advances to improve data harmonization and data matching across countries. Lopez-Garcia et al. (2014) and Berthou et al. (2015) describe the CompNet project, which collects firm-level indicators of competitiveness across European countries in a harmonized manner. Researchers have also matched various datasets necessary for analysis. Bernard et al. (2012a,b) matched trade and production data for Belgium. Bernard et al. (2014b) identify individual buyers of all exporters and sellers of all importers in Norway, which could serve as a first step to match this data with statistics outside Norway. Carballo et al. (2013) similarly identify buyers of exporters in Costa Rica, Ecuador and Uruguay. However, such matched data is not widely available for research.

Challenge 6 *Link national administrative data, harmonize data collection and reporting.*

Collecting Data Within the Firm is Difficult

A large fraction of global transactions are carried out by multinationals (Yeaple, 2013). Correspondingly, economists have started to study the motivation of multinationals to keep production in house, rather than sourcing inputs at arm's length. (See Antràs and Rossi-Hansberg, 2009 for a review.) Understanding the behavior of multinationals demands access to within-firm data: where foreign affiliates are located, how much they sell in various markets, what their transactions are with the parents. We only know of a few such datasets.

First, confidential microdata collected by the US Bureau of Economic Analysis on Direct Investment and Multinational Enterprises is used by many researchers surveyed in Yeaple (2013). Second, the Deutsche Bundesbank collects and maintains the Microdatabase on Direct Investment of German parent companies (Lipponer, 2006). Third, proprietary datasets published by private-sector vendors have also been used in research: WorldBase published by Dun and Bradstreet (Alfaro and Chen, 2014), or Orbis, published by Bureau van Dijk (see Alfaro and Chen, 2012).

We expect more reliance on private-sector data and within-firm case studies to inform the theories of multinationals.

Challenge 7 *Synthesize research based on ad-hoc proprietary data.*

Measuring Trade and Competitiveness in Value Added Terms

The fragmentation of data collection across countries also makes it difficult to identify the real contribution of countries to global value added. The key challenge is that international trade is recorded in gross output terms, which do not necessarily reflect accurately the local contribution of a country. For example, a car assembly plant in Hungary might export to Germany. Exports are recorded as the total value of the car exported, whereas the Hungarian value added might be just a fraction of that value.

National statistical offices compile input–output tables to track how value is added along the supply chain within the country. Johnson (2014) summarizes recent efforts by researchers to estimate a similar global input–output table that also takes account of global trade flows. One such database is the GTAP (Global Trade Analysis Project) Database, which Koopman et al. (2014) used to break up country gross exports into value added components. A more recently compiled and publicly available database is the World Input Output Database (Stehrer et al., 2014), which also has a full time series dimension.

The basic fact is that trade in value added is about 25 per cent less than trade in gross output. Patterns of value added trade also differ in subtle ways from patterns of gross output trade. For example, in terms of value added, services are about as traded as products. In fact, the final price of many high end manufacturing products includes a substantial portion of services, such as design and marketing. Second, some countries add relatively more value to their exports than others. Taiwan's value added exports are about half of its gross exports, whereas for Brazil this ratio is 86 per cent (Johnson, 2014).

Timmer et al. (2013) discuss how measurement of value added trade affects our view on European competitiveness. They develop a measure of global value chain (GVC) income and GVC employment, as the value added that comes directly or indirectly from exporting manufactured goods, and the jobs that are directly or indirectly contributing to these goods. They show that GVC income grew slower in Europe than gross exports, that GVC income is biased towards

services, increasingly over time, and that GVC jobs are increasingly higher and higher skilled.

Challenge 8 *Construct international input-output accounts from the ground up.*

6.3 Insights from Theories of Globalization

This section discusses the insights from theories of international trade and the international fragmentation of production. We first report broad lessons about the causes and effects of globalization, lessons in which there is a consensus among scientists, then discuss open questions.

6.3.1 *Broad Lessons about the Causes and Effects of Globalization*

Gains from Trade

Classical and neoclassical economics states that countries gain from trade because they can specialize according to their comparative advantage. If the country can produce more of what it produces cheaply, and consume more of what it produces expensively, its residents have to be better off.

This basic result in trade theory can be derived with minimal assumptions about the structure of the economy other than what is usual in neoclassical economics: perfect competition and constant returns to scale (see, for example, Dixit and Norman, 1980). Notably, it does not matter whether countries trade because they have access to different technologies, because they have different factor endowments, or because they differ in taste. Simply the fact that an open country finds prices different from its own in the world market establishes the gains from trade: it can sell whatever is more expensive abroad and buy whatever is cheaper.

New trade theory has provided new explanations for why countries trade. Krugman (1979, 1980) argues that even identical countries may gain from trade if firms exploit internal economies of scale. Such economies of scale may arise in high tech sectors, where costs of product development and marketing are large relative to actual production costs. Cars, computers and pharmaceuticals are prime examples.

In an open economy, each firm has an incentive to produce at bigger scale and economize on fixed costs. As a result, more firms will enter and consumers will have more variety at their disposal. To the extent that consumers value variety of choice, they will gain even by integrating with an identical economy. Such models are capable of explaining the large volume of trade between similar economies such as the EU and the US. They are also consistent with large volumes of simultaneous exports and imports of similar products (*intraindustry*

trade'). An additional prediction of the theory is that whenever trade is costly, producers will want to locate and bear the fixed cost close to their final consumers.

Davis and Weinstein (1999) and Head and Ries (2001) provide evidence for the qualitative conclusions of new trade theory. They find that industries subject to product differentiation are overrepresented in countries and regions with high local demand. Hanson and Xiang (2004) also find that industries with more product differentiation and with higher transport costs are overrepresented in large countries.

Broda and Weinstein (2006) quantify the gains from increased variety, which is at the heart of the gains from trade in models with economies of scale. They compute a variety-corrected import price index to account for the fact that consumers value goods from different countries differently. They estimate that US consumers gained 2.6 per cent of GDP from increased import variety between 1972 and 2001.

Old trade theory has been concerned mainly with aggregate trade patterns. New trade theory has focused instead on the export decision: Which firms export, how many products and destinations they serve. We have now finely disaggregated data to answer these questions. New trade theory offers the promise of building aggregate models from the bottom up. Melitz (2003) is the workhorse model in the new trade literature. The theory is built on two key blocks: Firm heterogeneity in productivity and economies of scale (fixed costs) in exporting. The model's tractability makes it possible to bring together micro facts and macro analysis.

The key mechanism of the model is selection: Fixed costs prevent many firms from exporting, and only the more productive firms can recover the fixed cost. In the model as in the data, exporters are few and larger than nonexporters. Selection is also at work on the key implication of Melitz (2003) in the event of a trade liberalization: Existing exporters will sell more (the intensive margin), new firms will start exporting (the extensive margin). Resources are reallocated from nonexporters to exporters and thus to the more productive firms, and the least productive nonexporters are driven out of business. This reallocation leads to gains in aggregate productivity.

Firms can also gain from engaging in other forms of international production. They can substitute export sales and economize on trade costs by setting up production affiliates abroad. The incentive to do such horizontal FDI is characterized by the '*proximity-concentration tradeoff*' (Brainard, 1997). Firms want to produce close to their consumers (proximity) to economize on trade costs, but also want to concentrate production to exploit economies of scale. A special case of horizontal FDI aims to serve other countries from the foreign production plant: export platform FDI. While there is empirical evidence that firms locate their production plants in response to export-platform, not just host country

demand (Feinberg and Keane, 2001, Head and Mayer, 2004), a quantitative modelling of this channel has been lacking due to computational complexities. The question of where to optimally locate a number of production facilities given a distribution of consumers is a computationally difficult problem to solve. New approaches have been proposed by Arkolakis et al. (2013) and Tintelnot (2016).

Much of the trade literature focuses on gains accruing to final consumers. However, firms also source some of their inputs from abroad, so they also stand to gain with lower trade barriers (Hummels et al., 2001).

Grossman and Rossi-Hansberg (2008) build a theory of offshoring based on the idea that firms decide on the set of tasks they want to source from abroad. These tasks differ in their costs of offshoring. In the model, firms that offshore a wider range of tasks become more productive and will expand. Surprisingly, they may even increase their demand for local labour, if the productivity effect is large enough. Halpern et al. (2015) build a model of firms using imported inputs and quantify the productivity gains from the access to foreign inputs. Antràs et al. (2014) combine these theories in a general equilibrium setting, and characterize the complex sourcing strategy of firms.

Some of this input trade may take place within the firm. When a firm opens an affiliate abroad (typically in a low wage country, Yeaple (2013)) to produce some of its intermediate inputs, it engages in vertical FDI. Hanson et al. (2005) find that such vertical FDI is higher in low-wage countries that can be reached by lower trade costs. The growth of vertical production networks has spurred further research, and we return to it in Section 6.3.3.

Several recent studies have contributed to policy analysis with quantifiable models of the gains from trade. They simulate counterfactual scenarios by setting trade costs to prohibitively large (so that countries are in autarky), or setting them to zero (so that countries engage in free trade). These losses from autarky and gains from further trade liberalization are the easiest to compute, but concrete tariff scenarios have also been worked out.

Eaton and Kortum (2002) build a model with Ricardian motives for trade. That is, countries face different productivities. Trade is also subject to trade costs, which can vary across pairs of countries. They derive that the pattern of trade follows a gravity equation: large and close countries trade more with one another. They also highlight subtle trade diversion effects of trade costs, as in Anderson and van Wincoop (2003). There is a multi-country general equilibrium model suitable for analysing the effects of bilateral and multilateral trade agreements, for example.

Alvarez et al. (2007) quantify the gains from trade in a calibrated general equilibrium Eaton-Kortum model. They estimate that eliminating all tariffs among the 60 largest economies would increase their GDP by 0.50 per cent, on average (Table 2, weighted average). This estimate is much smaller than

those of the historical case studies and the reduced-form estimates discussed below.

In an important recent contribution, Arkolakis et al. (2012) show how to quantify the gains from trade in a wide class of models, which includes the Eaton-Kortum model of technology differences, the Krugman model of scale economies and increased varieties, and a variant of the Melitz model due to Chaney (2008). In these models, the gains from trade of a country can be summarized by two important statistics: the share of income it spends on domestic goods and services, and the elasticity of trade volumes to trade costs. Intuitively, spending much on imported goods (and correspondingly little on domestic goods) signals a high willingness to pay for imports, whether because of lower prices, increased variety or selection based on productivity.

This unifying framework is promising for policy analysis, because these statistics are easy to measure or estimate. For example, the US spent 7 per cent of its income on imports in 2000. Using the domestic share of 93 per cent and elasticities of trade between 5 and 10, Arkolakis et al. (2012) estimate that American consumers were 0.7 to 1.4 per cent better off in 2000 than in complete autarky. Relative to the likely disruptions that a complete cessation of American exports and imports would entail, this estimate seems incredibly low.

Existing quantifiable models estimate the gains from trade to be implausibly small. They find that the typical country of the global economy is only about 1 to 2 per cent richer due to trade than it would be in complete isolation. (For other calibrations with different treatments of heterogeneity, multiple sectors, and intermediates, see Ossa, 2015, Melitz and Trefler, 2012, Melitz and Redding, 2014, Costinot and Rodriguez-Clare, 2014.) This is at odds with global efforts to reduce trade barriers and increase trade among countries, such as the creation and expansion of the World Trade Organization and the recent agreement on trade facilitation in the Bali Package. It is also inconsistent with credible reduced-form estimates of the GDP-enhancing effects of openness to trade.

Feyrer (2009a,b) exploits natural experiments in the variation in trade costs between countries to estimate how trade affects income per capita. Feyrer (2009a) uses the closure of the Suez Canal between 1969 and 1975 to generate quasi-random variation in trade costs between countries that were not part of the Suez conflict. He finds that the most affected countries, for which the closure of the canal made sea shipping most expensive, witnessed declines in their volume of trade and smaller-than-average income growth. He estimates the elasticity of income to trade around 0.16, that is, a 10 per cent increase in trade volumes increases income per capita by 1.6 per cent. Feyrer (2009b) exploits variation in the relative cost of air and sea freight over time. Landlocked countries are now more accessible than they were before a dramatic fall in air transport costs. This made them (exogenously) more open to trade and have higher income. Feyrer estimates the elasticity of income to trade to be about twice as high in this study.

One potential reason is that airplanes made it easy to not only transport goods, but also people across countries.

We believe that the quantitative fit between model-based and reduced-form estimates of the gains from trade could be further improved.

Challenge 9 *Reconcile model-based and reduced-form estimates of gains from trade.*

Distributional Effects of Globalization

Almost any change in openness to global competition is going to create winners and losers. A reduction in import tariffs makes consumers better off, while import competing producers worse off. Eli Heckscher and Bertil Ohlin, the founders of a theory of trade based on factor endowment differences already highlighted the distributional effects of trade opening:

Australia has a small population and an abundant supply of land, much of it not very fertile. Land is consequently cheap and wages high, in relation to most other countries. [...] Australian land is thus exchanged for European labour. [...] Thus trade increases the price of land in Australia and lowers it in Europe, while tending to keep wages down in Australia and up in Europe. (Ohlin, 1924, quoted in O'Rourke and Williamson, 1999, pp. 57–58)

The result that trade leads to a convergence of factor prices, and thus benefits the abundant (and hence previously cheap) factor, is known as the Stolper-Samuelson theorem (Stolper and Samuelson, 1941). It identifies the winners of globalization as the factor in abundance in the country (land for Australia), and the losers as the scarce factor (labour for Australia, land for Europe), which previously commanded high prices.

O'Rourke and Williamson (1999) find evidence for this pattern of factor price convergence in the late nineteenth-century Atlantic economy. The ratio of wages to land rents has steadily increased for open European countries such as England, Denmark, Sweden and Ireland. Hence in these countries, landed interests lost at the expense of workers. The wage–rent ratio has fallen for new land abundant countries such as Australia, Argentina and the US. This confirms the original predictions by Heckscher, Ohlin, Stolper and Samuelson.

In the more recent wave of globalization, it is not as easy to identify the losers. Goldberg and Pavcnik (2007a) review the evidence on the distributional effects of globalization in several developing countries (Argentina, Brazil, Chile, Colombia, India, Hong Kong and Mexico) for the time period between the 1970s and the 1990s. All of these countries liberalized international trade some time in this period and saw a surge of both imports and exports. The countries also hosted increasing amounts of FDI. Goldberg and Pavcnik (2007a) study various measures of inequality, but the broad pattern is that inequality

increased everywhere. It seems that the losers are the workers who already had lower wages. This is surprising given that such workers had supposedly been in abundance in developing countries. Goldberg and Pavcnik (2007a) investigate several explanations for this pattern, and we also discuss it in Section 6.3.3.

Focusing on the low end of income distribution, Harrison (2007) reviews both cross-country and within-country studies of how poverty is affected by globalization. They also find that '[t]he poor in countries with an abundance of unskilled labour do not always gain from trade reform' (Harrison, 2007). In fact, even among the poor, there are generally winners and losers. Topalova (2007) finds that rural districts in India with higher-than-average concentration of sectors exposed to import competition witnessed an increase in poverty. Among urban households in Colombia, there is weak evidence that working in an import-competing sector and lower tariffs are associated with higher poverty (Goldberg and Pavcnik, 2007b). In Mexico (Hanson, 2007) and Poland (Goh and Javorcik, 2007), however, higher exposure to trade was associated with lower poverty.

Models with increasing returns and firm heterogeneity also produce losers, not only winners. In Melitz (2003), a reduction in trade costs increases profit opportunities abroad. When exporting entails a fixed cost, only a subset of firms will be exporters who can capitalize on these profit opportunities. Their increased demand for local resources (such as labour needed for production and R&D) will hurt the smaller firms that only sell in the domestic market. They will either shrink or exit the market. Bernard et al. (2003) and Melitz and Ottaviano (2008) arrive at similar conclusions in different models of industry competition and trade. Such reallocation effects across firms have been empirically documented by Pavcnik (2002) and many authors since.

It is important to note that the redistribution effects of globalization are not secondary to the aggregate gain from trade. Often it is exactly the redistribution that brings about the overall gain. Given the amount of resources in the economy, an export sector cannot expand without an import sector shrinking. Similarly, large productive firms cannot grow without the small unproductive firms shrinking or exiting. For too long we have assumed these reallocations to be frictionless: workers fired in shrinking sectors and firms will instantaneously get rehired in expanding sectors and firms. We now have the theoretical tools and measurements to show that this is not the case.

One paper measuring reallocation costs is Artuç et al. (2010), who estimate a structural model of industry choice of workers with switching costs in US data. They build a model where workers pick an industry in order to maximize lifetime discounted income. If they switch to a different industry, however, they have to pay a fixed cost. Artuç et al. (2010) estimate the mean and variance of these fixed costs in a panel of workers from the Current Population Survey by matching both the number of workers that switch sectors

and the sensitivity of cross-sector worker flows to wage gains. The estimates reveal very large switching costs, equivalent to between 4 and 13 years of wage income.

More recently, Dix-Carneiro (2014) refines the above model by, among others, incorporating worker heterogeneity and estimates the switching cost on Brazilian data. He finds that the median switching cost is 1.4–2.7 times the annual wage, but with a high dispersion across the population. He argues that in certain segments of the labour market the adjustment process after a trade liberalization can take a long time, which can significantly offset the gains from trade. On the same Brazilian data, Dix-Carneiro and Kovak (2015) show that the labour market outcomes of the most affected regions deteriorated compared to other regions for more than a decade before beginning to level off.

Antras et al. (2015) study the welfare implications of trade in an economy where redistribution is subject to information constraints. Their conclusion is that even though progressive taxation might mitigate the effects of trade on inequality, in general inequality will go up after opening up to trade.

In a sequence of papers, Helpman and Itskhoki (2010) and Helpman et al. (2010, 2016) develop a new framework to think about trade, unemployment and wage inequality.¹ The key result of Helpman et al. (2010) is that opening a closed economy to trade increases inequality as better-paying exporting firms expand. However, this effect turns around when almost all firms export, and their expansion also pulls up the bottom of the wage distribution. The response of unemployment to trade is ambiguous. Helpman et al. (2016) find that the model describes well the evolution of wage inequality in Brazil, and that trade can contribute to large increases in inequality.

Challenge 10 *Identify losers from globalization and quantify their losses.*

Cross-border Frictions are Large

The third broad lesson from research on international trade is that frictions that impede the flow of goods and other interactions are large. Some of these frictions are related to geography, but many of them are associated with crossing borders.

Anderson and Van Wincoop (2004) provide a survey of the estimated trade costs (see Table 6.1). They report three sets of estimates. The first includes direct measures of transaction costs, such as charges for freight, insurance, tariffs, as well as costs of distribution and local taxes. For the average country, these amount to 170 per cent of the value of international trade. Distribution costs also arise in domestic trade, so the cross-border component of costs is 'only' 74 per cent.

The second method to estimate trade costs exploits the cross-country disparity in prices. If the price of a good in the destination market is 4 per cent higher than in the source market, trade costs between these countries are at least 4 per

Table 6.1 *Percentage equivalents of trade costs. Source: Anderson and Van Wincoop (2004), p. 692*

Cost component	Percentage
Transportation	21
Policy barrier	8
Language barrier	7
Currency barrier	14
Information barrier	6
Security barrier	3
Total border costs	44
Distribution	55

cent.² Estimates of the dispersion of log prices across locations vary between 20 and 40 per cent (Anderson and Van Wincoop, 2004).

The third method infers trade costs from the volume of trade relative to a frictionless benchmark. This method has been immensely popular, relying mostly on the gravity equation as the benchmark trade model.³

Theories of the past decades have incorporated these frictions mostly as taxes or wedges on import prices. These are often modelled as an ad-valorem cost, following Samuelson (1954). Recently, other forms of trade costs have also been modelled and estimated: fixed entry costs of operating in a market, time costs associated with shipping, fixed costs accruing per shipment, and additive rather than proportional shipping charges. We will briefly discuss estimates of each.

Fixed Entry Costs

Entry costs are useful in explaining why many firms do not export. If a firm is too small, it would not find it profitable to bear the fixed costs associated with distribution in a given market. Das et al. (2007) estimate a structural model of exporters with sunk market entry costs, and find that these costs are substantial, of the order of \$400,000. The primary fact identifying such large sunk costs is that many large firms seem to forego large profit opportunities in foreign markets and do not enter.

Helpman et al. (2008a) estimate a model of heterogeneous firms with fixed costs of market entry from macro data: the volume of trade between pairs of countries. Their estimation is based on the idea that only fixed costs can generate zero trade flows in the data, variable costs cannot. They show how fixed costs vary across countries, and that FTAs, a common language, and a common religion predominantly reduce the fixed costs of trade, not the variable cost.

Armenter and Koren (2015) emphasize that there is large heterogeneity in the market entry costs across firms. By matching the size distribution of firms and the number and average size of exporters, they estimate that the 75th percentile of fixed costs is 32 thousand times as much as the 25th percentile. This huge variation suggests that a simple fixed entry cost is not a suitable structural model of export entry.

Arkolakis (2010) develops a theory with convex market access cost. This model is consistent with the fact that some firms do not enter export markets (because the marginal market access cost is strictly positive), but fits the pattern of small exporters better than models with fixed costs.

Time Costs

Trading time, that is, the time it takes to send a shipment from the origin to the destination, represents another form of trade costs. Firms are willing to pay significantly above the interest cost to get faster deliveries. Hummels and Schaur (2013) estimate that US importers pay 0.6–2.3 per cent of the traded value to reduce trading time by one day. Other empirical studies that use different data and methodology also confirm the importance of time costs in trade (Djankov et al., 2010 and Hornok, 2012). Internationally fragmented production processes, which involve the multiple shipping of intermediate inputs, are especially sensitive to the length and variation of shipping time (Harrigan and Venables, 2006).

Per-unit Costs

Recent research emphasizes that part of international trade costs are additive costs, that is, fixed cost per unit traded (Hummels and Skiba, 2004 and Irarrazabal et al., 2015). These may include per-unit tariffs, quotas, or transport costs proportional to the physical quantity of the cargo. The magnitude of these costs is likely substantial. Irarrazabal et al. (2015) estimate it to be 14 per cent of the median product price, which is a lower bound estimate. The presence of additive costs can have important welfare implications. Compared to ad valorem trade costs, per unit costs may create additional welfare losses, as they distort the within-market relative prices and consumption of different product varieties (*'Alchian-Allen hypothesis'*).

Per-shipment Costs

Other trade costs are fixed per shipment. They include the costs of the bureaucratic procedures of sending a shipment and the shipping time. According to direct cost measures from the World Bank's Doing Business database, these costs exceed 10 per cent of the value of a typical shipment (Hornok and Koren, 2015b). Alternatively, Kropf and Sauré (2014) infer per shipment costs from trade flows and find them to be broadly 1 to 5 per cent of the traded value.

Empirical evidence shows that trading firms facing these costs respond by sending fewer and larger shipments. This creates losses in the form of higher inventory expenses (Alessandria et al., 2010) or less consumer satisfaction (Hornok and Koren, 2015a).

Challenge 11 *Understand and quantify nontax, nonquota frictions in trade.*

6.3.2 *Insights for Policy*

Imports Are Important

Earlier empirical studies in trade discussed patterns of exports disproportionately more than patterns of imports. With the emergence of new firm-level data, it has become clear that imports are as important as exports, especially when we think of imports used by firms in their production. Bernard et al. (2007, 2009) show that importers are just as special as exporters: they tend to be larger and more productive than nontrading firms.

The bigger size and better performance of importers is not only due to self-selection into importing. Studies show that improved access to foreign inputs has increased firm productivity in several countries, including Indonesia (Amiti and Konings, 2007), Chile (Kasahara and Rodrigue, 2008), India (Topalova and Khandelwal, 2011) and Hungary (Halpern et al., 2015). Results are conflicting for Brazil: Schor (2004) estimates a positive effect, while Muendler (2004) finds no effect of imported inputs on productivity. And for Argentina, Gopinath and Neiman (2014) show that variation in imported inputs may have contributed to fluctuations in aggregate productivity.

To understand why importers are better, Halpern et al. (2015) formulate a model of firms who use differentiated inputs to produce a final good. Firms must pay a fixed cost each period for each variety they choose to import. Imported inputs affect firm productivity through two distinct channels: as in quality-ladder models they may have a higher price-adjusted quality, and as in product-variety models they imperfectly substitute domestic inputs. Because of these forces, firm productivity increases in the number of varieties imported. They estimate that importing all tradable inputs raises firm-level productivity by 22 per cent relative to not importing at all, about half of which is due to imperfect substitution between foreign and domestic inputs.

Multilateral Agreements Prevent Trade Wars

The canonical view of free trade agreements is that they provide reciprocal market access to countries participating in them (see Maggi, 2014 for a survey of theories of trade agreements). Theory provides three reasons why countries sign trade agreements. First, they want to internalize ‘terms of trade externality’.

Binding trade agreements may stop trade partners from manipulating their terms of trade by restricting trade. Second, with imperfectly competitive industries, trade agreements also help stop a 'profit stealing externality'. Third, trade agreements may serve as a form of commitment guarding against lobbying of special interests.

Empirical work on trade agreements falls into two categories. There is reduced-form evidence on the effect of trade agreements on trade volumes and other economic outcomes (Subramanian and Wei, 2007, Liu, 2007, Dutt et al., 2013). The majority of papers (with the exception of Rose, 2004) finds positive association between trade agreements and trade flows, that is, trade flows increase after a trade agreement is signed.

A key challenge of these reduced-form studies is identification of causal effect. Countries signing trade agreements are also likely better integrated in other, unobserved ways. One way to get around this omitted variable bias is to use only the timing of trade agreements, and see how trade increases in the years following its implementation (Eicher and Henn, 2011).

A second group of studies try to identify the particular theoretical motivations behind why countries sign trade agreements. There is some supporting evidence for all three theories: terms-of-trade externalities (Broda et al., 2008, Ludema and Mayda, 2013, Bagwell and Staiger, 2011), profit-stealing externalities (Ossa, 2014) and domestic commitments (Handley and Limão, 2015, Handley, 2014).

While there are competing interpretations of how and why trade agreements work, one broad lesson is that without binding trade agreements, countries would be prone to occasional escalating trade wars. Ossa (2014) conducts counterfactual analysis with two scenarios. In the trade talks scenario, WTO members (modelled as seven countries and regions: Brazil, China, EU, India, Japan, US, and the rest of the world) come to an efficient agreement about further tariff reductions relative to the status quo in 2007. This would increase global welfare by \$26 bn per year. In the trade wars scenario, members engage in escalated tariff wars. This would reduce global welfare by \$340bn a year. Hence Ossa (2014) argues that the primary success of the WTO is preventing trade wars.

6.3.3 *Open Questions*

In this section we discuss the open questions of recent research in trade. These are questions in which the theories and the data are in apparent disconnect, in which competing theories disagree, or for which we lack compelling theories altogether.

How Big are the Redistributive Effects of Globalization?

Most models of the redistributive effects of globalization are way too stylized to be used for quantitative analysis. The usual approach posits two types of workers, skilled and unskilled and finds some empirical counterpart for these worker groups. In reality, there is a much larger heterogeneity of worker skills that needs to be captured in the model.

Capturing the large heterogeneity across firms has become quite standard after Melitz (2003) and Bernard et al. (2003) and many quantitative studies calibrate firm heterogeneity to the data when studying trade liberalization (Balistreri et al., 2011, Corcos et al., 2012, Breinlich and Cuñat, 2015). A similar approach at the worker level has been lacking.

Costinot and Vogel (2010) build a matching model of heterogeneous workers and sectors to study the evolution of inequality in various globalization scenarios. They work with a continuous distribution of worker skills, so they can study the changes along the entire wage distribution. Antras et al. (2015) also permit rich heterogeneity across economic agents.

Challenge 12 *Develop a toolbox for quantitative analysis of redistribution.*

What are the Side Effects of Globalization?

We have so far mostly discussed the pecuniary effects of globalization: how prices and incomes change, and who wins and who loses in terms of real income. The policy stance towards globalization, however, is often motivated by the presence of nonpecuniary externalities (Harrison and Rodríguez-Clare (2010)), what we colloquially term the ‘*side effects of globalization*’. Exposure to foreign trade and investment may bring about both positive and negative side effects. Below we discuss one example for each, namely productivity enhancements from knowledge spillovers, and environmental pollution. We note that, given the intense policy interest, this is a very active field which we anticipate will flourish in the future.

A body of literature documents the empirical connection between imported technology and productivity. For example, Coe and Helpman (1995) find that countries importing from R&D abundant trade partners are more productive (also see Coe et al., 1997 and Bayoumi et al., 1999), while Keller (2002), Keller and Yeaple (2009), and Acharya and Keller (2009) obtain similar findings at the industry level. Less is known, however, about the effects of technology imports on firm productivity. Firm-level evidence is useful because it can help isolate the effect of imported technology from other confounding factors such as investment or FDI, thus allowing us to identify the mechanism more directly.

Knowledge spillovers from multinationals to local suppliers are thought to be important for foreign knowledge to take hold in the host country (see Pack and Saggi, 2006 for a review of the case-study literature). There is, however, no

consensus if and how these spillovers take place. Görg and Greenaway (2004) survey the evidence to date on spillovers from foreign investment, finding a mix of results with both positive and negative effects.

Arnold and Javorcik (2009) document that Indonesian firms taken over by multinationals improve their productivity after acquisition, which is suggestive of technology transfer from the parent company. Blalock and Gertler (2009) utilize the same dataset to show that firms, which do R&D themselves and employ skilled workers benefit more from FDI. Javorcik (2004) finds that multinationals entering Lithuania have a positive productivity effect on local firms in upstream sectors. In this study, buyer-supplier links are inferred from input-output tables (also see Bloom et al., 2013). Javorcik and Spatareanu (2009) use a survey in the Czech Republic to measure buyer-supplier links at the firm level, and also find positive effects. Guadalupe et al. (2012) show that Spanish subsidiaries innovate more after foreign acquisition.

Knowledge may also spill over to the host country via worker mobility. If the technological and organizational knowledge is not too specific to the firm, then a worker moving from a foreign-owned, foreign-managed, or import-intensive firm will also have a higher marginal product at the new firm. This can serve as an indirect channel through which domestic firms acquire foreign knowledge. Stoyanov and Zubanov (2012) find evidence in Danish data that workers moving from more productive firms tend to enhance the productivity of the host firm. Mion and Opromolla (2014) show that, in Portugal, managers leaving exporting firms take their exporting knowledge with them: the new host companies become more likely to export; they also reward the new managers for their export experience.

This body of literature, and further studies in this area, help both distinguish the particular channels of technology spillovers and identify the barriers of such spillovers.

Trade may also have negative side effects, for example via environmental pollution. It is a firmly established empirical relationship that environmental pollution depends on economic development in an inverted U-shape pattern ('*Environmental Kuznets Curve*' Grossman and Krueger, 1993). In the development process, pollution rises as the scale of activity increases, but above a certain income level the relationship reverses because the economy moves to more environmentally friendly technologies and sectors. Hence, to the extent that trade promotes economic growth, trade openness should eventually also contribute to better environmental quality.

International trade can also have direct effects on the environment, which may be negative or positive. A negative effect may occur if the global competitive pressure makes countries adopt looser environmental policies. In contrast, if globalization helps spread environmentally friendly technologies, rules and standards across the world, trade can lead to less pollution. An excellent review

of the literature on trade, growth and the environment is provided in Ekins et al. in Chapter 7 of this volume.

An issue that received most attention recently is the distributional impact of globalization on pollution. Polluting activity is increasingly concentrated in some developing countries ('*pollution havens*'), and it is fleeing developed countries with stringent environmental regulation. An example is the so-called carbon leakage, when CO₂ emission targets lead firms to relocate from Kyoto countries. The consequence is the rise of pollution-embodied imports in the developed world, which has recently been documented in several empirical studies (Babiker, 2005, Kellenberg, 2009, Grether et al., 2010, Aichele and Felbermayr, 2015).

Challenge 13 *Understand and quantify the external effects of globalization.*

What are the Deep Causes of Cross-border Frictions?

The large estimates of cross-border frictions surveyed in Section 6.3.1 suggest that international transactions are hampered by more than transport costs. In fact, even after controlling for transport costs, crossing a country border is associated with a 44 per cent ad-valorem trade cost. Only 8 per cent of this is related to policy barriers (tariffs and quotas), the rest remain unexplained.

We need better theories and measurement of frictions that are neither a tax, nor a quota. One candidate is the limited access to information across border (Rauch (1999)).

Information Frictions

Allen (2014) builds a model of information frictions and trade, in which producers sequentially search for the best place to sell their product. Estimating the model on agricultural trade in the Philippines, he finds that about half of the price dispersion can be attributed to information frictions.

Chaney (2014) proposes a theory in which firms find new buyers via the network of their existing buyers. This assumption is motivated by the patterns of export market entry of French firms. The model predicts a relationship between international trade and distance, close to what we observe in the data.

There are also several empirical studies finding evidence for the qualitative conclusion that better access to information increases trade. The maintained assumption in many studies is that immigrants facilitate trade between their source and their host country. Rauch and Trindade (2002) exploit spatial variation in the number of Chinese immigrants, Cohen et al. (2012) use the placement of Japanese internment camps as a natural experiment, Felbermayr et al. (2010) extend the analysis to other ethnicities such as Polish and Mexican. The broad conclusion is that regions with a large share of immigrants trade more

with their source country. More work is needed, however, on identifying the specific channels through which immigrant networks facilitate trade.

Local Infrastructure

Another recent strand of literature suggests that local transportation also matters for international trade and development. This has been documented for railroads in India (Donaldson, 2016) and the US (Donaldson and Hornbeck, 2016), roads in Peru (Volpe Martincus et al., 2017), Turkey (Cosar and Demir, 2016) and the US (Duranton et al., 2013), and bridges for Argentina and Uruguay (Volpe Martincus et al., 2014) and the US (Armenter et al., 2014). Felbermayr and Tarasov (2015) also show that there is underinvestment in transport infrastructure in the border regions of France.

Challenge 14 *Develop theories to better understand the deep causes of cross-border frictions.*

How Does Supply-chain Trade Differ from Traditional Trade?

An increasing share of international trade is in intermediates (see Hummels et al., 2001), owing to the increased international fragmentation of production. Companies break up their production process in smaller stages, and source from a larger number of suppliers both at home and abroad. The international trade associated with such production processes is termed ‘*supply-chain trade*’.

Baldwin (2006) and Baldwin and Lopez-Gonzalez (2014) describe the patterns of supply-chain trade across countries and over time. They use several measures of supply-chain trade, such as imported intermediate inputs, re-exports and re-imports and value added trade. They argue that supply-chain trade between technologically advanced and low-wage countries is a relatively recent phenomenon, taking off in the early 1990s. This is the ‘*second unbundling of globalization*’, in which the technological and management expertise of developed countries is matched with cheap labour in developing ones (Baldwin, 2006).

Supply-chain trade tends to be very regional, potentially because the costs of coordinating production increase sharply with distance. There are regional production clusters around the US, within Europe, and, to a lesser extent, Japan. Data on re-exports and re-imports helps identify headquarter and production countries. Within Europe, Germany is clearly a headquarter economy, tightly linked with several low-wage EU members, but also with high-wage neighboring countries. Britain and France also act mostly as headquarters, the role of Italy is less clear.

Bernard et al. (2014a) study buyer–supplier links in data with a broad network coverage. Using data from a Japanese credit report agency, they show links are distributed across firms and over space. They build a model where

firms choose the number of suppliers. More suppliers make the firm more productive, because they can use cheaper inputs (also see Eaton et al., 2013 for a similar model). Exploiting the spatial variation caused by a new high-speed rail line, they find that firms that could expand their supplier base have increased productivity and sales.

Understanding supply-chain trade better is important, because it has distinct implications for trade policy. Baldwin (2011) and Blanchard (2015) summarize the key policy challenges associated with supply-chain trade. First, there is a complementarity between liberalizing trade and liberalizing global production (foreign direct investment). When a multinational company invests in a host country, this raises the incentives of the source country to give preferential market access to the host country. Second, countries may opportunistically manipulate policies behind the border to shift rent from foreign investors. Some form of investor protection may be beneficial, but the current wave of bilateral and regional investment agreements may give excess powers to current technology leaders. Third, long supply chains magnify the effect of trade barriers, especially if regulations concerning international transactions are complex and not harmonized across countries.

Challenge 15 *Build a quantitative theory of supply-chain trade.*

What Do Multinational Firms Do?

Production can be shared internationally not only by shipping the final product, but also by carrying out (parts of) the production process abroad. The research on global production revolves around several key questions (Yeaple, 2013). Why do some firms open production facilities abroad? Where do these multinationals go? What determines whether firms source their inputs from independent suppliers, or whether they vertically integrate with their supplier?

A surprising fact is that most economic activity of multinationals is concentrated at their headquarters and regions close to the headquarter (Keller and Yeaple, 2013). Alfaro and Chen (2014) also find strong agglomeration of multinational plants. This is at odds with models of horizontal FDI, which would predict that multinational production is a way of getting around trade barriers, geographical or other. It is therefore important to understand what frictions multinationals are subject to.

Ramondo et al. (2013) study the trade flows between US multinationals and their foreign affiliates. Surprisingly, they find that the median affiliate does not sell to its parent. Across all affiliates, the average share of sales to the parent company is 7 per cent. This does not vary substantially with the degree of input–output linkages between the parent and the affiliate.

One limitation of the analysis is that the US is geographically isolated from most countries except Canada and Mexico, and supply-chain trade tends to

be very regionalized (Baldwin and Lopez-Gonzalez, 2014). In this respect, it is not surprising that most US affiliates sell primarily to their host countries. However, the finding of Ramondo et al. (2013) is consistent with those of Atalay et al. (2014), who study domestic shipments of vertically integrated firms. They estimate an upper bound for the shipments from upstream plants to downstream plants within the same firm, and find this to be less than 0.1 per cent of all upstream sales for the median firm. They argue that firms share intangible assets among establishments.

Irrazabal et al. (2013) estimate a model of multinational production in which the affiliates use an input provided by the parent company. Because of the above patterns in the movement of goods, it is best to think of these inputs as intangible inputs, yet they are subject to the same trade costs. Irrazabal et al. (2013) estimate the share of these parental inputs in the production by matching the rate at which affiliate sales falls off with distance. They find that about 90 per cent of an affiliate's cost is spent on this parental input. The welfare implication of this is that multinational companies cannot jump trade barriers very effectively, since parental inputs are also subject to these barriers. That is, multinational production adds little welfare relative to trade.

Keller and Yeaple (2013) build a similar model of knowledge transfer within the multinational firm. Their model has the additional implication that affiliate sales should fall off with distance faster for knowledge-intensive goods. They confirm this and related predictions in the data.

We hence need a better understanding of what vertically integrated firms do, what supply chains are used for, and the potential interaction of these two questions.

Challenge 16 *Build a quantitative theory of multinationals.*

6.4 Conclusion

We surveyed the recent economics literature on international trade and global production. We identified four areas where further research would help policy-makers: gains from global production sharing, more quantitative analysis of the redistributive effects of globalization, a better understanding of cross-border frictions, and estimates of the side effects of trade. With the goal of providing a research agenda, we identified 16 specific challenges for measurement and theory, and look forward to future research on trade and globalization.

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Notes

1. Also see Egger and Kreickemeier (2009), Felbermayr et al. (2011), Amiti and Davis (2012) on trade, unemployment and wages.
2. In imperfectly competitive markets, the producer may be willing to swallow some of the trade costs by reducing its markup abroad. They would not charge higher markups abroad for fear of parallel imports.
3. See Anderson and van Wincoop (2003), Anderson and Van Wincoop (2004), Head and Mayer (2014), as well as Proost and Thisse (Chapters 8 and 9 of this volume).

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