The US Gains From Trade:
Valuation Using the Demand for Foreign
Factor Services[*]

Arnaud Costinot   Andrés Rodríguez-Clare

MIT   UC Berkeley

March 2018

About 8 cents out of every dollar spent in the United States is spent on imports. What if, because of a wall or some other extreme policy intervention, imports were to remain on the other side of the US border? How much would US consumers be willing to pay to prevent this hypothetical policy change from taking place? The answer to this question represents the welfare cost from autarky or, equivalently, the welfare gains from trade. In this article, we discuss how to evaluate these gains using the demand for foreign factor services. The estimates of gains from trade for the US economy that we review range from 2 to 8 percent of GDP.

1   Introduction

About 8 cents out of every dollar spent in the United States is spent on imports.[1]

What if, because of a wall or some other extreme policy intervention, these goods were to remain on the other side of the US border? How much would US consumers be willing to pay to prevent this hypothetical policy change from taking place? The answer to this question represents the welfare cost from autarky or, equivalently, the welfare gains from trade.

Unfortunately (or not!), there is little direct empirical evidence about the impact of autarky on prices and quantities. The Jeffersonian trade embargo at the beginning of the nineteenth century is one rare exception. It is not clear, however, what such historical evidence can tell us about the magnitude of US gains from trade today. In order to make progress on this important issue, we therefore propose an alternative strategy combining both theory and empirics.

Our strategy is based on two observations. First, when countries exchange goods, it is as if they were indirectly exchanging the factor services embodied in the production of these goods: unskilled labor, skilled labor, physical capital, land etc. Second, when a country is under autarky, it is as if the prices of all foreign factor services were at least as high as their reservation values.

These observations suggest a parallel between the valuation of the welfare gains from trade and the "new good" problem in the field of industrial organization. When industrial organization economists want to evaluate the welfare gains from the introduction of a new product, from Apple Cinnamon Cheerios to the minivan, they estimate the demand for such products, determine the reservation price at which demand would be zero, and then measure consumer surplus by looking at the area under the (compensated) demand curve between the price at which these new products are currently being sold and their reservation price

---

[1]According to the World Input Output Database, the ratio of imports over total US spending is 7.6 percent in 2014. Since total US spending includes both spending by consumers on final goods and spending by firms on intermediate goods, this number differs from the ratio of imports over GDP, which is 14 percent in 2014 according to the same database. We come back to this distinction in Section 3.

(for example, Hausman, 1996; Petrin, 2002; Nevo, 2003). Trade economists can follow a similar strategy to measure the welfare gains from trade. In this approach, foreign factor services are just like new products that appear when trade is free, but disappear under autarky.

This theoretical connection, in turn, points towards two key empirical considerations for the valuation of the US gains from trade: 1) How large are the US imports of factor services? 2) How elastic is the demand for these imported factor services? If consumers do not spend much on a new product or if this product is a close substitute to other existing products, the welfare gains to consumers from its introduction are likely to be small. Likewise, if the United States does not import much from the rest of the world or if the factor services that it imports are close substitutes to those that it would have access to under autarky, the US gains from trade are unlikely to be large.

The rest of this article is organized as follows. In the next section, we start from the textbook treatment of the welfare gains from trade, as described in Bhagwati, Panagariya and Srinivasan (1998). Following the work of Adao, Costinot and Donaldson (2017), we explain the advantages of measuring the gains from trade by focusing on the international exchange of factor services, rather than on the specific goods and services that are imported and exported. This approach also provides an intuitive perspective on the welfare formula for the gains from trade derived in Arkolakis, Costinot and Rodríguez-Clare (2012a). Throughout this section, we restrict ourselves to a static economy, with a representative agent, and without distortions. This reflects both the emphasis in the existing literature and our view that this benchmark environment has worthwhile lessons to teach.

We then turn to measurement, with a focus on the US economy. We describe the level of the US demand for foreign factor services and discuss the estimation of the elasticity of the US demand for foreign factor services. For a large and fairly closed economy like the United States, our analysis points towards welfare gains from trade ranging from 2 to 8 percent of GDP.

We conclude by discussing three issues set aside in our benchmark analysis: growth, distortions, and redistribution. In theory, their introduction may either

2

increase or decrease the magnitude of the gains from trade. In practice, existing estimates incorporating such considerations do not suggest a significant and systematic bias of our benchmark estimates.

2 Gains From Trade in Theory

2.1 The Textbook Approach

As a warm up, suppose that the United States only exports apples—the fruit, not the computer—in exchange for bananas. Since realism is clearly not the main objective at the moment, suppose further that we know everything that there is to know about the US technology and the tastes of US consumers. We have summarized this information into a production possibility frontier and a series of indifference curves in Figure 1.

In this economy, measuring the gains from trade is a fairly pedestrian affair. In the autarky equilibrium consumption, C_A, is equal to output, Q_A. In the trade equilibrium, production of apples for export increases, and US firms produce at Q_T. After exporting apples and importing bananas, US households consume C_T. To measure the gains from trade, compare the level of income needed to achieve the post-trade utility on the higher indifference curve with the level of income (at the same relative prices) needed to achieve the utility from the autarky equilibrium. Graphically, the US gains from trade are therefore given by $GT = 1 - OA/OT$.[2]

The actual US pattern of trade is a tad more complex. In 2005, for instance,

---

[2]In formal terms, the US gains from trade corresponds to the absolute value of the equivalent variation between the two equilibria. Expressed as a percentage of US initial GDP, we get

$$GT = 1 - \frac{e(p_T, U_A)}{e(p_T, U_T)}, \tag{1}$$

where $e(p_T, U_T)$ represents the income required to achieve the utility level in the trade equilibrium, which is also equal to US initial GDP, and $e(p_T, U_A)$ represents the income required to achieve the autarky utility level, U_A, at the trade equilibrium prices, p_T.
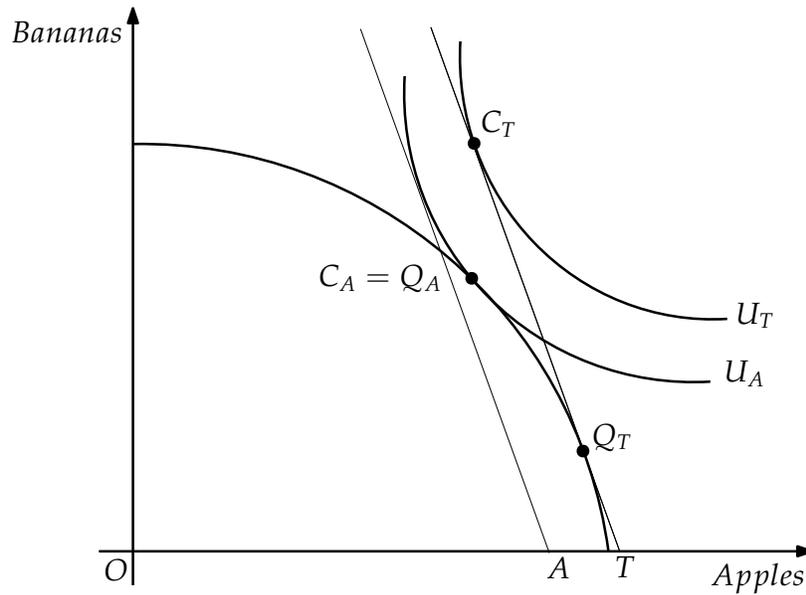
Figure 1: A First Look at the Welfare Gains from Trade.

Baldwin and Harrigan (2011) report that the United States had positive exports in about 8,500 of the product categories in the Harmonized System 10-digit classifications, ranging from "new motor vehicle engine between 1500–3000 cc, more than 6 cylinders" to "bicycles with wheels greater than 63.25 cm diameter." Product differentiation, of course, does not stop there. Within each product category, a large number of firms may themselves be exporting differentiated varieties of these products. For such an economy, how can we measure $1 - OA/OT$?

One potential strategy would be to scale up the textbook approach. Namely, one could start by estimating production sets and indifference curves for all these differentiated products around the world. With those in hand, one could then compute any counterfactual equilibrium, including the one where we send the US economy back to autarky, as well as the welfare cost associated with moving to such an equilibrium. However, the amount of actual information required to implement the textbook approach is, to put it mildly, non-trivial. On the demand-side, for instance, the goal is not merely to obtain information about own-price and cross-price elasticities within any given industry. For this approach, we would

4

need to estimate all own-price and cross-price elasticities for all goods around the world. This means estimating the cross-price elasticity between US smart phones and French red wine, Japanese hybrid cars and Costa-Rican coffee, and all other possible combinations.

## 2.2 From Trade in Goods to Trade in Factor Services

In recent work, Adao, Costinot and Donaldson (2017) have proposed an approach to reduce the dimensionality of what is required for counterfactual analysis, in general, and the measurement of the gains from trade, in particular.

The starting point of their analysis is the equivalence between neoclassical economies and what are called "reduced exchange economies" in which countries simply trade factor services. They show that for any competitive equilibrium of a general neoclassical economy, with arbitrary preferences, technologies and sets of goods and factors, there exists an equilibrium in a reduced exchange economy that is equivalent in terms of welfare, factor prices, and the factor content of trade. Preference and technological considerations in the original neoclassical economy simply map into preferences over factor services in the reduced exchange economy. For the purposes of measuring the gains from trade, this approach implies that instead of estimating production and demand functions around the world, we only need to estimate the reduced demand for factors, that is, the demand for factor services embodied in the goods purchased from countries around the world.[3]

Figure 2 describes this basic strategy. While the United States is endowed with domestic factors, it has, by definition, no foreign factors. In the trade equilibrium, the former can be exchanged for the latter, leading to consumption C_T.

---

[3]From an empirical standpoint, the fewer factors there are, the easier the estimation of the reduced demand for factors is. It should be clear, however, that the approach of Adao, Costinot and Donaldson (2017) does not hinge on the assumption, common in the trade literature, that there are more goods than factors. The critical observation to reduce the dimensionality of what needs to be estimated is that knowledge of the reduced demand for factors is sufficient to measure the gains from trade; separate knowledge of demand for goods, by consumers and firms, and demand for factors, by firms, is not required.
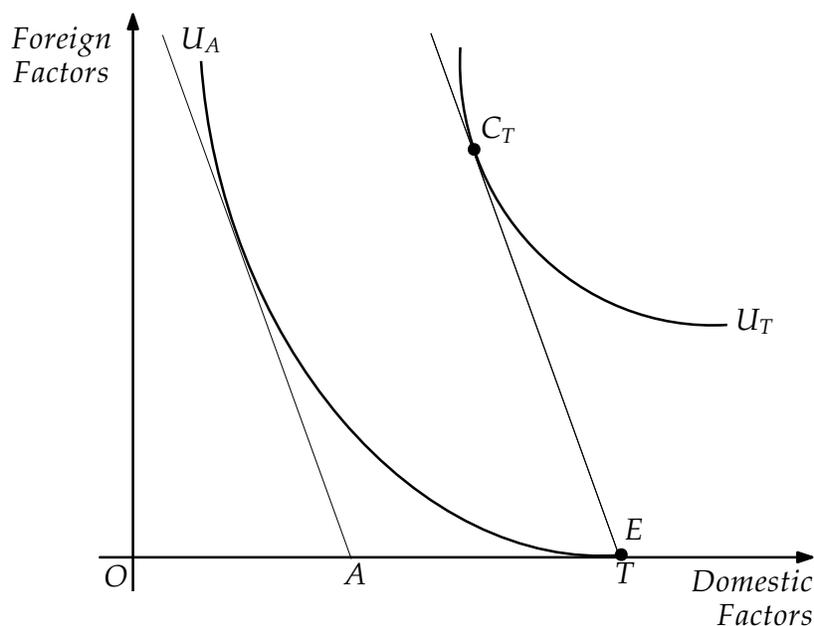
Figure 2: Another Look at the Welfare Gains from Trade.

But under autarky, consumption would have to be equal to the US endowment of domestic factors, as described by point E. Like in the textbook case, we can measure the gains from trade as $GT = 1 - OA/OT$. But here, we no longer need to worry about estimating production and demand functions for goods. The gains from trade only depend on the shape of the indifference curve over domestic and foreign factor services.

In this situation, we can compute the gains from trade in the same way as one would compute the welfare gains from the introduction of new products. Figure 3 illustrates the approach. Under autarky, the expenditure share on foreign factors would be zero and the relative price of foreign factors would be equal to their reservation value, p_A. With trade, the expenditure share on foreign factors, λ_F, would be strictly positive and the relative price of foreign factors, p_T, would be strictly below its reservation value. Using Shepard's Lemma, we can compute (the log of) the difference between the income level required to achieve the autarky utility level, U_A, at the autarky and trade prices by integrating below the
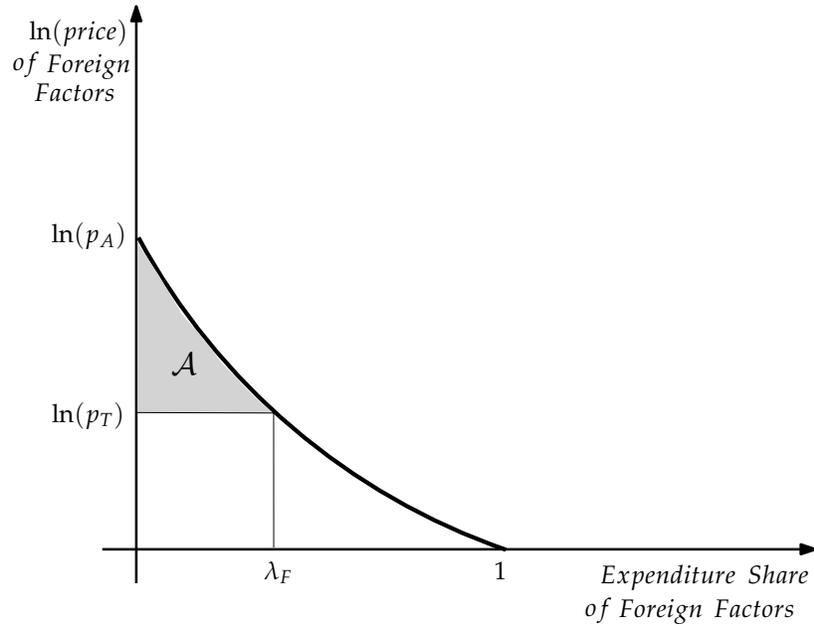
Figure 3: Integrating Below the Factor Demand Curve.

(compensated) expenditure share on foreign services between (the log of) p_A and p_T. After simple manipulations, this leads to the following general formula for the welfare gains from trade,

$$GT = 1 - \exp(-\mathcal{A}), \tag{2}$$

where $\mathcal{A}$ denotes the gray area in Figure 3.[4]

2.3 The ACR Formula in Perspective

The previous discussion offers an intuitive way to understand the welfare formula derived by Arkolakis, Costinot and Rodríguez-Clare (2012a), which we will refer

---

[4]For a small change in the log of the price of foreign factor services, $d \ln p$, Shepard's Lemma implies $d \ln e = \lambda_F d \ln p$. Using US factor services as our numeraire and integrating, we therefore obtain $\ln e(p_A, U_A) - \ln e(p_T, U_A) = \mathcal{A}$. Under this choice of numeraire, US factor income and US expenditure must also be unchanged between the autarky and trade equilibria: $e(p_A, U_A) = e(p_T, U_T)$. Starting from equation (1), the two previous observations lead to equation (2).

to as the ACR formula.

In a class of commonly used trade models, including the models developed by Anderson (1979), Krugman (1980), Eaton and Kortum (2002) and various versions of Melitz (2003), welfare gains from trade can be expressed as a function of two sufficient statistics,

$$GT = 1 - \lambda_D^{1/\varepsilon}, \tag{3}$$

where $\lambda_D = 1 - \lambda_F$ denotes the share of expenditure on domestic goods in the trade equilibrium and $\varepsilon \geq 0$ denotes the trade elasticity.

The economics is straightforward. In spite of their different micro-theoretical foundations, the previous models all generate a similar demand for foreign factor services. Namely, in all these models, the share of expenditure on foreign factors, both compensated and uncompensated, takes a Constant Elasticity of Substitution (CES) form. Depending on the specifics of the model, the trade elasticity may have a different structural interpretation. In Anderson (1979) and Krugman (1980), ε corresponds to the elasticity of substitution between domestic and foreign goods. In Eaton and Kortum (2002) and Melitz (2003), ε instead measures the dispersion of productivity across goods within a country.[5] In all models, however, domestic and foreign factor services remain imperfect substitutes, with ε being the elasticity of substitution between them. Together with how much we trade, this is all we need to know to compute the gains from trade.[6]

To be clear, this approach is related to, but distinct from, the work of Feenstra (1994) and Broda and Weinstein (2006) on the gains from trade as a result of

---

[5]Both Krugman (1980) and Melitz (2003) feature monopolistic rather than perfect competition. In general, this may lead to inefficiencies not captured in the analysis of Adao, Costinot and Donaldson (2017). The assumption of constant elasticity of substitution preferences over goods in Krugman (1980) and Melitz (2003) rules that out.

[6]In the constant elasticity of substitution case, integrating below the demand for foreign factor services between $\ln p_T$ and infinity, which is the price of foreign factors under autarky, one can check that $\mathcal{A} = \ln(1 + p_T^{-\varepsilon})/\varepsilon$. To go from this expression to the ACR formula, one can then use the fact that the CES demand system is invertible. Thus, one can infer the relative price of foreign factors in the trade equilibrium, p_T, from the share of expenditure on those, λ_F. Specifically, given $\lambda_F = \frac{p_T^{-\varepsilon}}{1+p_T^{-\varepsilon}}$, we get $1 + p_T^{-\varepsilon} = 1/(1 - \lambda_F) = 1/\lambda_D$ and, in turn, $\mathcal{A} = -(\ln \lambda_D)/\varepsilon$. Combining the previous expression with equation (2), we get the ACR formula in the text.

new varieties becoming available, under the assumption of CES preferences for varieties from different countries. Here, we emphasize that by estimating the *total* demand for foreign factor services and examining the area below that demand curve, we can measure the *overall* gains from trade.[7]

2.4   Can It Be That Simple?

Although the formula for welfare gains from trade derived in Section 2.2 is fairly general, the overwhelming number of applications of these concepts by trade economists involve a CES factor demand system, as illustrated by the ACR formula in Section 2.3. Clearly, CES is a very strong functional-form restriction. There is a priori no reason to believe that the same assumption that has become popular in the trade literature to date – where popularity is often determined by tractability – should be the best guide to estimate the gains from trade in the United States in practice. In general, we do not expect "the" trade elasticity to be unique: for example, import demand may be much less elastic around autarky than around free trade, or much different in Costa Rica and France than in the United States, a scenario that CES necessarily rules out.

Rather than focus on the specific formula for the welfare gains from trade displayed in equation (3), the basic insight from the work of Arkolakis, Costinot and Rodríguez-Clare (2012a) is that measuring the gains from trade requires addressing two questions: (*i*) How large are imports of factor services in the current trade equilibrium? and (*ii*) How elastic is the demand for these imported services along the path from trade to autarky? The two sufficient statistics in the ACR formula are just specific answers to these two questions. If we do not trade much or if the factor services that we import are close substitutes to those that we would have access to under autarky, then the grey area in Figure 3 must be small, and so must

---

[7]It should also be clear that our approach simultaneously captures the benefits of importing and exporting. In general equilibrium, what matters is the relative price of US imports in terms of US exports, which is here summarized by the price of foreign factor services relative to US factor services. The reason why producer surplus does not appear in our computations is because firms' revenues are fully rebated to factors of production.

be the gains from trade. In the next section, we will organize our discussion of the US gains from trade around these two questions.

Before delving into numbers, however, we want to highlight that aggregation issues will make addressing these questions more complex than the discussion so far might have suggested. By going from trade in goods to trade in factor services, we have argued that we can reduce the dimensionality of what needs to be estimated. The idea is that instead of estimating both production and demand functions for goods, one could just estimate the demand for factors from different countries. It does not follow, however, that factors from different countries can be aggregated into a single domestic factor and a single foreign factor. This aggregation holds true in the CES case, but not necessarily otherwise.

In general, the factor demand system that one needs to estimate may remain high-dimensional. Think of each country implicitly buying skilled workers, unskilled workers, and physical capital from around the world. For foreign factor services, there can be an empirical strategy for getting back to the one- factor case by treating all foreign factor services as a Hicks-composite good.[8] For domestic factor services, however, one cannot escape the fact that as the prices of all foreign factors are taken to their reservation values, one still needs to compute the relative prices of domestic factors under autarky. Again, this problem is similar to the one arising in the context of a single differentiated sector in the industrial organization literature. If Apple Cinnamon Cheerios (and a range of other brands) were no longer available, the prices of other ready-to-eat cereals may respond. Thus, when computing the equivalent variation associated with the removal of Apple Cinnamon Cheerios, such price responses should be included. Here, similar economic considerations are at play economy-wide. If foreign factor services complement certain domestic factor services (say, skilled labor), but substitute for others (say, unskilled labor), then moving to autarky will affect the relative price of these domestic factors, which will affect the utility that is possible under a situation of autarky—that is U_A in Figure 2—as well as the income required to achieve

---

[8]For empirical purposes, this approach requires the existence of a price shifter that uniformly moves the price of all foreign factor services relative to domestic ones.

that utility level—that is $e(p_A, U_A)$.

Finally, it is worth emphasizing that the previous considerations arise under the maintained assumption that there exists a representative agent owning all domestic factors. We discuss the specific issues associated with the distributional consequences of trade in Section 4.

3 Gains from Trade in Practice

3.1 How Large Are the US Imports of Factor Services?

The simplest way to measure the US imports of foreign factor services is to look at the total value of all goods imported by the United States and assume that this is equal to the total payments to foreign factors used to produce these goods. Figure 4 shows the US import share, λ_F, computed as the share of total spending devoted to imports for each year from 1995 to 2014, using data from the World Input-Output Database (WIOD).[9] Despite a decrease during the Great Recession and a slight downtick in the subsequent years, the figure reveals a gradual increase in the importance of trade in the United States over the last two decades, with an increase in the US import share from about 6 to around 8 percent.

The low US import share partly reflects the fact that, as in most rich countries, US spending disproportionately falls on services, which are less likely to be traded. Although the US import share within manufacturing is much higher at 24.5 percent, manufacturing accounts for only 22 percent of total US spending. Another reason behind the low US import share is the size of the US economy, which mechanically raises the importance of intra-national relative to international trade. Thus, in spite of fairly low barriers to international trade, the US import share is one of the lowest in the world. In contrast, a small open economy like Belgium has an import share above 30 percent.

---

[9]Specifically, we use WIOD releases in 2013 and 2016; see Timmer and de Vries (2015). The WIOD release 2013 has 35 sectors and 41 countries (including a synthetic Rest of the World); the WIOD release 2016 has 56 sectors and 44 countries (including a synthetic Rest of the World).
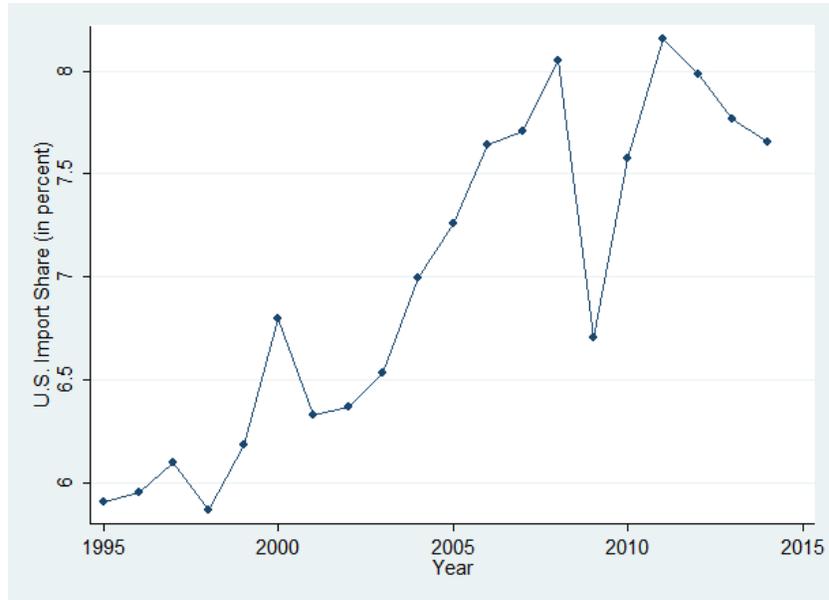
Figure 4: US Import Share

Notes: The figure contains the import share λ_F for the United States between the years 1995 and 2014. Data for the years from 1995 to 2000 come from the 2013 release of the WIOD tables, while data for the years 2000 to 2014 come from the 2016 release of the WIOD tables. The time series coming from the two different releases of the WIOD were spliced so that they take the same value in the year 2000 (this adjustment is very small since the two series match very closely). The import share is calculated as gross total imports (adding across imports for intermediate input use and imports for final use) over total expenditure.

The previous import shares implicitly abstract from global input-output linkages. In their absence, the US share of expenditure on imports, which we have plotted in Figure 4, must be equal to the share of spending by US consumers on foreign factor services, which is what our welfare formula emphasizes. In the presence of such linkages, it may not be.[10]

To assess the quantitative importance of these linkages, we again turn to the World Input-Output Database, which not only has the (gross) trade flows that we have used above, but also country-level input-output flows as well as final consumption and the value-added share in each sector-country. Under a proportionality assumption, this database provides a world input-output matrix that gives the share of output in each sector-country that comes from value added and from intermediate goods from each other sector-country.[11] As in Johnson and Noguera (2012), this matrix can be used to compute the factor services that every country i exports to every other country j both directly – that is, as value added embodied in exports for final consumption – and indirectly as part of worldwide input-output trade flows. This exercise reveals that import shares λ_F computed from gross trade flows (as in Figure 4) systematically understate the extent to which countries are open to international trade. When computed with value added trade flows, the US import share becomes 11.4 percent rather than 8 percent. The same upward adjustment extends to all countries in the World Input-Output Database. The GDP-weighted average import share is 28 percent, whereas measured in gross flows this is 20 percent. In value added terms, the United States and the world appear more open.

---

[10]Because of intermediate goods, both measures also tend to be lower than the ratio of imports over GDP. Note, however, that even in the absence of intermediate goods, imports over GDP may differ from the expenditure share on imports because of trade imbalances. In the case of the United States, a country with a large trade deficit, this consideration further lowers the share of expenditure on imports relative to imports over GDP. Trade imbalances, of course, are related to the gains from intertemporal trade, which static models in the trade literature abstract from. We refer the reader interested in this issue to Costinot and Rodriguez-Clare (2014) and Heathcote and Perri (2014) for further discussions.

[11]Antras and de Gortari (2017) propose a model of global value chains potentially leading to deviations from such proportionality assumptions. de Gortari (2017) further explores the issue empirically using Mexican firm-level data.

The key channel behind this adjustment is the fact that US domestic production also uses foreign factor services, through imports of intermediate goods. This raises the share of spending by US consumers on foreign value added above the share of spending by US consumers on foreign goods. This is what happens, for instance, when some cars made and sold in the US include imports of German factor services used to produce the transmissions in those cars.

To add one more level of complexity, the import share computed with Johnson and Noguera's (2012) value added flows excludes domestic factor services used to produce intermediate goods that were first exported and then imported back in the form of final goods – such services are counted as domestic, though they are traded in practice. Think of US imports of cars assembled in Mexico with US engines. Under autarky, however, all factor services that are currently traded would no longer be available. To compute the gains from trade, one should therefore expand the measure of spending on imports to include all traded factor services, not just the foreign ones.[12]

Using again the World Input-Output Database, this adjustment turns out to be small: for example, in the year 2014, the import ratio for the US increases from 11.4 to 12.1 percent, and similar results hold for the rest of the countries. Intuitively, the presence of trade costs tends to make this second adjustment—involving US factor services exported back and forth—small relative to the first adjustment—involving foreign factor services exported once.

3.2 How Elastic Is the Demand for Imported Factor Services?

The standard approach in the literature is to assume that the demand for factor services exhibits a constant elasticity of substitution, as in the models covered by the ACR formula. Letting λ_{ij} denote the share of expenditure by destination country j on factor services from origin country i and letting t_{ij} be an observable shifter

---

[12]In models with input-output loops, such as Alvarez and Lucas (2007), this means that the relevant price of foreign factor services is not the price of foreign value added, but the price of the bundle of inputs required for production abroad, a bundle that combines foreign value added with domestic value added, through imports of intermediate goods abroad.

of the costs associated with trading those factor services, then we can estimate this elasticity ε from the regression equation,

$$\ln \lambda_{ij} = \delta_i^o + \delta_j^d - \varepsilon \ln t_{ij} + \nu_{ij}.$$

The term δ_i^o is an origin-specific fixed effect that captures the role of the price of factor services in country i as well as anything that makes it costly for that country to export those services anywhere else. The term δ_j^d is a destination-specific fixed effect that captures how costly it is on average for country j to buy factor services. Finally, ν_{ij} is an error term that captures trade costs not included in t_{ij}.[13]

In practice, trade cost shifters may be tariffs, which vary across country pairs thanks to preferential trade agreements (see for example Caliendo and Parro 2015) or freight costs (see for example Shapiro, 2016 and Adao, Costinot and Donaldson, 2017). The identifying assumption is that there is no correlation between the observable shifter t_{ij} and the unobservable term ν_{ij}, so that one can estimate ε using a simple OLS regression. In their review of the literature using this general approach, Head and Mayer (2013) report a median estimate of $\varepsilon = 5$.

The standard approach raises some obvious concerns. One unfortunate feature of the empirical estimates of ε is that they come mostly from variation in trade costs and trade flows across foreign countries. Indeed, the previous regressions are often ran excluding domestic flows. Yet, the relevant elasticity from a welfare standpoint is the elasticity of substitution between domestic and all foreign factors

---

[13]For historical reasons due to the pioneering work of Tinbergen (1962), such an equation is commonly referred to as a "gravity" equation; see Anderson (2011). Given the assumption that the demand for factor services exhibits a constant elasticity of substitution, the share of expenditure on factors from any origin country i in any destination j can be expressed as

$$\lambda_{ij} = \frac{(\tau_{ij} p_i)^{-\varepsilon}}{\sum_l (\tau_{lj} p_l)^{-\varepsilon}},$$

where p_i denotes the price of factor services from country i; τ_{ij} is a a summary measure of all trading frictions between i and j; and ε is the trade elasticity that we want to estimate. Assuming that $\tau_{ij} = \tau_i^o \tau_j^d t_{ij} \exp \nu_{ij}$, where t_{ij} is some observable trade cost shifter, and then taking the log of this equation leads to the regression equation in the main text, where the first two terms of that equation in the text become $\delta_i^o \equiv -\varepsilon \ln(\tau_i^o p_i)$ and $\delta_j^d \equiv -\ln(\sum_l (\tau_{lj} p_l)^{-\varepsilon})$, respectively.

combined.[14]

Another concern is the assumption of a constant elasticity of demand for factor services. Adao, Costinot and Donaldson (2017) have proposed a strict generalization of the constant elasticity of substitution assumption inspired by the work of Berry, Levinsohn and Pakes (1995) in the field of industrial organization. Their "mixed CES" demand system allows the degree of substitutability across factor services from different countries to vary systematically with observable characteristics of those countries. While the average trade elasticity estimated by Adao, Costinot and Donaldson (2017) is close to the estimates reviewed by Head and Mayer (2013), they find that poor countries, like China, are closer substitutes to other poor countries, like Bangladesh and Vietnam, than rich countries, like France and Germany. For the purposes of measuring the gains from trade, this suggests combining their estimates of factor demand with information about the entire vector of expenditure shares – that is, looking at factor demand for foreign shares on a country-by-country basis, not just overall.[15]

Although the demand system estimated in Adao, Costinot and Donaldson (2017) relaxes the CES assumption, it is still very far from a nonparametric procedure that would flexibly trace out the response of the demand for foreign factors as we raise their prices to their reservation values. Given the limits on the number of observations and the amount of exogenous variation typically available in real world datasets, it is not surprising that few papers actually try to estimate the demand for foreign factors directly.

By far the most common alternative approach is to write down a Computable General Equilibrium (CGE) model in which the values of all structural parameters indirectly pin down the demand for foreign factors. Such models typically involve a variety of nested relationships that each use their own constant elastic-

---

[14]Feenstra, Luck, Obstfeld and Russ (2018) is a notable exception. Their estimates point towards less substitutability between domestic and foreign sources than between different foreign sources.

[15]The issue of global-input linkages, of course, carries over to the estimation of factor demand. The empirical analysis of Adao, Costinot and Donaldson (2017) is conducted under the assumption that the value of total factor services from a given country i sold in country j is equal to the total value of the goods sold by i in j.

ity of substitution assumption, both on the supply and demand side, though there is a tremendous amount of variation across CGE models in terms of the number of structural parameters that need to be estimated, from a single one in Eaton and Kortum (2002) to more than 13,000 in the latest model of the Global Trade Analysis Project (Hertel et al., 2012).

This leads to a trade-off. Parsimonious CGE models can be estimated in a fairly transparent manner, which has contributed to their recent popularity in the field, but their predictions require stronger functional form restrictions, with many elasticities implicitly assumed to be identical or equal to one. This is what Dawkins et al. (2001) refer to as the "idiot's law of elasticities": all elasticities are equal to one until shown otherwise. Of course, both sets of parameters—those that are estimated in a transparent manner, like the trade elasticity within an industry, and those that are not, like the elasticity of substitution between goods from different industries or the elasticity of substitution between intermediate goods and primary factors—matter for the elasticity of the demand for foreign factor services, an important limitation that should be kept in mind.[16]

3.3 So How Large Are the US Gains from Trade?

We now put together the results of the previous two subsections and discuss their implications for the gains from trade. We first present results using the ACR formula for the size of gains from trade presented earlier. Figure 5 shows the gains from trade for the United States, with $\lambda_D = 1 - \lambda_F$ equal to 92 percent and ε varying from 2 to 12, which is the range of values for ε estimated in Eaton and Kortum (2002). Not surprisingly, the figure reveals that the gains from trade are highly sensitive to the value of epsilon: they are equal to 0.7 percent for $\varepsilon = 2$ and 4.1

---

[16]In general, the elasticity of demand for foreign factors will be some average of upper-level and lower-level elasticities of substitution, with weights depending on the pattern of inter- and intra-industry trade (Ossa, 2012; Costinot and Rodriguez-Clare, 2014). Instead of assuming that the elasticity of substitution between industries is equal to one, one could therefore instead estimate that upper-level elasticity by targeting a trade elasticity for aggregate trade flows equal to the one estimated in the literature. Such a procedure would guarantee that multi-industry CGE models do not imply a demand for foreign factor services whose elasticity is counterfactually too low.
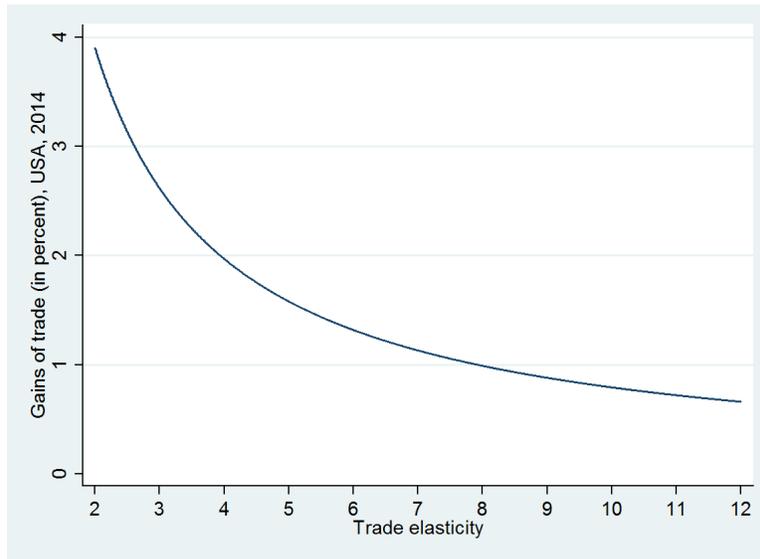
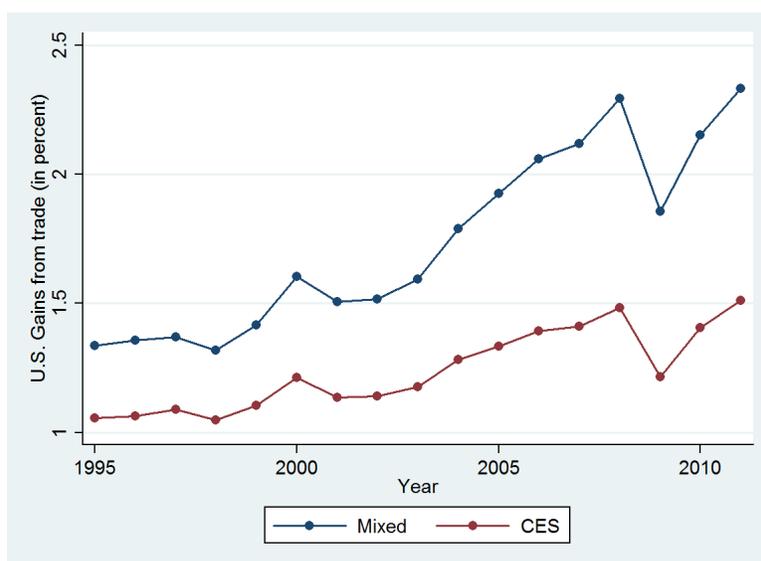**Figure 5:** The US Gains from Trade for Different Elasticities.

Notes: The figure shows the gains from trade for the US in 2014. It uses data from the WIOD release 2016. Gains are computed as in equation (3) with various values of ϵ.

percent for $\varepsilon = 12$. Evaluated at $\varepsilon = 5$, the median estimate in Head and Mayer (2013), the US gains from trade are equal to 1.7 percent. For comparison, a country like Belgium, with a much larger import share, has gains equal to 7.7 percent.

The previous estimates all implicitly rely on the assumption, embodied in a CES factor demand system, that factor services from different countries are equally substitutable. To explore the quantitative importance of this restriction, we apply the methodology described in Section 2.2 using the more general factor demand system estimated by Adao, Costinot and Donaldson (2017). Results are reported in Figure 6.[17] From 1995 to 2011, the US gains from trade estimated under mixed CES grow from about 1.3 to 2.3 percent. Using the same data, but restricting demand to be CES, one would have wrongly concluded that the US gains from trade over that same time period only grew from 1.1 to 1.5 percent.[18] The dif-

---

[17]We thank Rodrigo Adao for help with these counterfactual exercises.

[18]When restricting demand to be CES, Adao, Costinot and Donaldson (2017) estimate a trade elasticity ε around 6, hence the somewhat smaller gains from trade than before.

Figure 6: The US Gains from Trade: CES versus Mixed CES.

Notes: The figure shows the gains from trade for the US between 1995 and 2011. It uses data from the WIOD release 2013. Gains are computed using the estimated demand parameters of Adao et al. (2017).

ferential growth rates reflect the fact that over that time period, the United States not only imported more, but also imported relatively more from countries with lower GDP per capita, namely China, whose factor services have been estimated to be less substitutable to domestic factors in the US.

As mentioned previously, a more common way in which the literature has departed from a CES factor demand system is indirectly via CGE models. Costinot and Rodriguez-Clare (2014) report results for the gains from trade for the countries in the World Input-Output Database for the year 2008 under various structural assumptions. Focusing on the United States, the gains from trade increase from 1.8 percent in the model with a single sector to 4.4 percent of GDP in the multi-sector model with unitary elasticity of substitution across different industries. If one further allows for intermediate goods and assumes as in Caliendo and Parro (2015) that the elasticity of substitution between primary factors and

inputs from different sectors is again one, the implied gains from trade increase to 8.3 percent of GDP.[19]

One notable omission of the previous computable general equilibrium models is an explicit treatment of natural resources. If a country has no oil or gas resources and needs to import all that it uses, one would expect substantial losses from moving to autarky. If these resources are critical in the production of certain goods, and if those goods are not easily substitutable for other goods, this could lead to a demand for foreign factor services that becomes very inelastic as a country moves closer to autarky or that is much less elastic than the (relative) demand for factor services from different countries, as already discussed in footnote 14. Neither of these channels is present in the models reviewed in Costinot and Rodriguez-Clare (2014). In recent work, Fally and Sayre (2017) show that these considerations can lead to much larger gains from trade, especially in countries that lack diversified endowments of primary resources. For the United States, however, with its reasonably extensive endowments of natural resources, the effects that they uncover are small.

4   Growth, Distortions, and Redistribution

4.1   The Dynamic Gains from Trade

Many economists have a gut instinct that the gains from trade are much larger than those presented in the previous section. Could it be that our static approach misses important sources of "dynamic gains"? We briefly discuss a number of channels through which dynamic considerations may affect the magnitude of the gains from trade.

Perhaps more than any other dynamic consideration, innovation is most responsible for the view that the dynamic gains from trade may be large. A useful

---

[19]The result for the gains from trade in the single-sector model is again computed using $\varepsilon = 5$, while for the multi-sector model with and without intermediate goods the sector-level trade elasticities are those estimated in Caliendo and Parro (2015).

way to start thinking about this issue is to interpret the creation of new good varieties, or firm entry, in Krugman (1980) and Melitz (2003), as product innovation. The fact that these models are covered by the ACR formula suggests that the static model considered above includes an element of dynamic change. A similar insight holds for the growth model of Eaton and Kortum (2001). For dynamic gains from trade to arise, trade must lower the relative cost of innovation relative to the cost of production, as in the lab-equipment model of Rivera-Batiz and Romer (1991). Evidence on this connection is meager and contradictory. Bloom, Draca and Reenen (2016) report evidence of a positive response of innovation to Chinese import competition among European firms. In the United States, however, the results of Autor, Dorn, Hanson, Pisano and Shu (2016) point towards a negative effect of the China trade shock on innovation.

Another dynamic issue is related to frictions in the reallocation of factors of production, as emphasized, for instance, by Artuc, Chaudhuri and McLaren (2010) and Caliendo et al. (2015) in a labor market context. Intuitively, such frictions lead the economy to adjust slowly to changes in trade costs, implying a lower trade elasticity in the short run than in the long run. A sudden move to autarky would then imply losses that are high in the short run, but then decline over time as resources get reallocated. In this case, the discounted stream of losses would be higher than the steady state losses computed disregarding frictions in the static analysis of gains from trade.[20]

Our static analysis also abstracts from capital accumulation. Because some investment goods are tradable (like equipment goods), we expect capital accumulation to raise the gains from trade, just like trade in intermediate goods does. Consistent with this view, Ravikumar, Santacreu and Sposi (2017) find that the welfare effects of trade liberalization, specifically a decline of 20 percent in all international trade costs, are 23 percent higher when taking into account the impact on capital accumulation than in a static model.

More generally, very different welfare effects of trade may arise in the pres-

---

[20]Burstein and Melitz (2013) and Alessandria, Choi and Ruhl (2015) make a related point in the context of models with firm-level heterogeneity, sunk costs, and transitional dynamics.

ence of markup distortions typical in growth models, or because of knowledge spillovers within or across countries, as in some of the models covered in Grossman and Helpman (1991) as well as in more recent work by Sampson (2016), Jesse Perla and Waugh (2015), and Buera and Oberfield (2016). As emphasized by Young (1991), trade could either increase or decrease growth, with ambiguous welfare consequences. The key force in these models, however, is not dynamics per se, but the presence of distortions, to which we now turn.

4.2   Distortions and the Gains from Trade

In the earlier textbook analysis of gains from trade, the private and social marginal benefits of importing foreign factor services are equalized. In the presence of distortions, they may not be, further complicating the measurement of the welfare gains from trade.

   As a matter of theory, the gains from trade could be larger, if it alleviates distortions, or smaller, if it worsens them. In the extreme, domestic distortions could even make autarky superior to trade. This insight is just a corollary of the theory of the second best: in the presence of domestic distortions, imposing another distortion (in this, case imposing autarky through an infinite tariff) could in theory make the economy better off.

   One recent area of research has focused on the pro-competitive effects of trade and the extent to which opening up to trade may reduce markup distortions (for example, Epifani and Gancia (2011); Edmond, Midrigan and Xu (2011); Arkolakis, Costinot, Donaldson and Rodriguez-Clare (2012b)). Having calibrated their model to the US economy, Arkolakis, Costinot, Donaldson and Rodriguez-Clare (2012b) find only small differences between the overall welfare gains predicted by models with and without variable markups, though their analysis relies on strong functional-form assumptions.

   Another source of distortions that could affect the gains from trade is the presence of differential wage premia across firms or sectors (for example, Helpman, Itskhoki and Redding (2010); Davis and Harrigan (2011); Swiecki (2017)). For

instance, because wages for observably identical workers tend to be lower in agriculture than in manufacturing (and assuming that this pattern reflects differences in wage premia rather than sorting on unobservable characteristics), the gains from trade for countries that specialize in agriculture would be lower than those predicted by the earlier ACR formula. Following this logic, Swiecki (2017) estimates that the gains from trade in the United States are slightly lower than those reported in the estimates in the previous section.

4.3 Redistribution

Our discussion has focused on the aggregate gains from trade: that is, the gains that would accrue to a representative consumer. In practice, of course, trade tends to create both winners and losers. How should one think about the overall gains from trade in such a situation?

This issue can of course be analyzed under the assumptions of a benevolent social planner and lump-sum transfers, but in practice, tax instruments are limited and shaped by political-economy considerations. To shed light on the magnitude of the gains from trade in such environments, Antras, de Gortari and Itskhoki (2017) and Galle, Rodríguez-Clare and Yi (2017) propose to focus on an environment with exogenous income taxes and posit a social welfare function that displays constant inequality aversion. In the context of the United States, Galle, Rodríguez-Clare and Yi (2017) focus on $1,444$ worker groups defined by commuting zones and level of education. They find that 26 groups lose from trade, with one of those groups experiencing losses equal to 3.2 percent, while the overall gains are 1.5 percent. Poorer groups experience stronger degrees of import competition and hence have lower gains from trade, so trade worsens between-group inequality. In their preferred specification, when the gains from trade are adjusted for an inequality-averse social welfare function, the gains for the United States remain positive and only slightly lower than the standard measure which ignores inequality, 1.4 percent versus 1.5 percent, though this conclusion is clearly sensitive to the assumed degree of inequality aversion and the level of aggregation at

which gains and losses are considered.

5 Concluding Remarks

The share of US expenditure on imports is smaller than in most other countries. To a large extent, this reflects the fact that for a large country like the United States, a significant fraction of trade occurs intra- rather than internationally. This basic observation implies that that the welfare gains from international trade in the United States are smaller than in most other countries. Although magnitudes vary greatly depending on how one infers the shape of the US demand for foreign factor services, the estimates of gains from trade for the US economy that we review range from 2 to 8 percent of GDP.

Though such gains are nothing to spit at—they are an order of magnitude larger than the estimated gains from eliminating business cycle fluctuations—they may appear surprisingly small to some. It may be the case that if the United States were to approach autarky, the US demand for foreign factor services would become much less elastic, revealing the importance of some critical foreign inputs and, in turn, much larger gains from trade. Both extrapolations based on the direct estimation of demand and the predictions of computable general equilibrium models may miss that. As mentioned in our introduction, the only direct evidence of the cost autarky for the United States that we have comes from the Jeffersonian trade embargo between December 1807 and March 1809. Irwin (2005) estimates its welfare cost to be around 5 percent of US GNP in 1807. Interestingly, this is similar in magnitude to the welfare gains from trade estimated by Bernhofen and Brown (2005) in the context of Japan's emergence from autarky after 1858.

Needless to say, the previous numbers are not meant as a guide for future economic policy. Current trade volumes are crucial for measuring the welfare cost of autarky, not the potential gains from further trade expansion. If international trade flows were to grow, so would the gains from international trade.

24

References

Adao, Rodrigo, Arnaud Costinot, and Dave Donaldson, "Nonparametric Counterfactual Predictions in Neoclassical Models of International Trade," *American Economic Review*, 2017, *107* (3), 633–689. 1, 2.2, 3, 5, 3.2, 15, 3.3, 18, 6

Alessandria, George, Horag Choi, and Kim Ruhl, "Trade Adjustment Dynamics and the Welfare Gains from Trade," *mimeo University of Rochester*, 2015. 20

Alvarez, Fernando and Robert E. Lucas, "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade," *Journal of Monetary Economics*, 2007, *54* (6), 1726–1768. 12

Anderson, James E., "A Theoretical Foundation for the Gravity Equation," *The American Economic Review*, 1979, *69* (1), 106–116. 2.3, 2.3

_ , "The Gravity Model," *Annual Review of Economics*, 2011, *3*, 133–160. 13

Antras, Pol, Alonso de Gortari, and Oleg Itskhoki, "Globalization, Inequality and Welfare," *Journal of Intermational Economics*, 2017, *108*, 387–412. 4.3

_ **and** _ , "On the Geography of Gloval Value Chains," *mimeo Harvard University*, 2017. 11

Arkolakis, Costas, Arnaud Costinot, and Andres Rodríguez-Clare, "New Trade Models, Same Old Gains?," *American Economic Review*, 2012, *102* (1), 94–130. 1, 2.3, 2.4

_ **,** _ **, Dave Donaldson, and Andres Rodriguez-Clare**, "The Elusive Pro-Competitive Effects of Trade," *mimeo*, 2012. 4.2

Artuc, E., S. Chaudhuri, and John McLaren, "Trade Shocks and Labor Adjustment: A Structural Empirical Approach," *American Economic Review*, 2010, *100* (3), 1008–1045. 4.1

Autor, David, David Dorn, Gordon H. Hanson, Gary Pisano, and Pian Shu, "Foreign Competition and Domestic Innovation: Evidence from U.S. Patents," *mimeo MIT*, 2016. 4.1

Baldwin, Richard and James Harrigan, "Zeros, Quality and Space: Trade Theory and Trade Evidence," *American Economic Journal: Microeconomics*, 2011, *3*, 60–88. 2.1

Bernhofen, Daniel M. and John C. Brown, "An Empirical Assessment of the Comparative Advantage Gains from Trade: Evidence from Japan," *American Economic Review*, 2005, *95* (1), 208–225. 5

Berry, Steven, James Levinsohn, and Ariel Pakes, "Automobile Prices in Market Equilibrium," *Econometrica*, 1995, *63* (4), 841–890. 3.2

Bhagwati, Jagdish N., Arvind Panagariya, and T. N. Srinivasan, *Lectures on International Trade*, Boston, Massachussetts: The MIT Press, 1998. 1

Bloom, Nicholas, Mirko Draca, and John Van Reenen, "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity," *Review of Economic Studies*, 2016, *83* (1), 87–117. 4.1

Broda, Cristian and David Weinstein, "Globalization and the Gains from Variety," *Quarterly Journal of Economics*, 2006, *121* (2), 541–585. 2.3

Buera, Francisco J. and Ezra Oberfield, "The Global Diffusion of Ideas," 2016. 4.1

Burstein, Ariel and Marc J. Melitz, *Trade Liberalization and Firm Dynamics*, Vol. 2 of *Advances in Economics and Econometrics Tenth World Congress. Applied Economics, Econometric Society Monographs*, Cambridge, UK: Cambridge University Press, 2013. 20

Caliendo, Lorenzo and Fernando Parro, "Estimates of the Trade and Welfare Effects of NAFTA," *Review of Economic Studies*, 2015, *82* (1), 1–44. 3.2, 3.3, 19

___ , **Maximiliano Dvorkin, and Fernando Parro**, "Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock," 2015. 4.1

Costinot, Arnaud and Andres Rodriguez-Clare, "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4, North Holland, 2014, chapter 4. 10, 16, 3.3, 3.3

Davis, Donald R. and James Harrigan, "Good jobs, bad jobs, and trade liberalization," *Journal of Intermational Economics*, 2011, *84*, 26–36. 4.2

Dawkins, Christina, T.N. Srinivasan, and John Whalley, *Calibration*, Vol. 5 of *Handbook of Econometrics*, Elsevier, 2001. 3.2

de Gortari, Alonso, "Disentangling Global Value Chains," *mimeo Harvard University*, 2017. 11

Eaton, Jonathan and Samuel Kortum, "Trade in Capital Goods," *European Economic Review*, 2001, *45* (7), 1195–1235. 4.1

___ **and** ___ , "Technology, Geography and Trade," *Econometrica*, 2002, *70* (5), 1741–1779. 2.3, 2.3, 3.2, 3.3

Edmond, Chris, Virgiliu Midrigan, and Daniel Xu, "Competition, Markups and the Gains from Trade," *mimeo, Duke and NYU*, 2011. 4.2

Epifani, Paolo and Gino Gancia, "Trade, Markup Heterogeneity and Misallocations," *Journal of Intermational Economics*, 2011, *83* (1), 1–13. 4.2

Fally, Thibault and James Sayre, "Commodity Trade Matters," *mimeo UC Berkeley*, 2017. 3.3

Feenstra, Robert C., "New Product Varieties and the Measurement of International Prices," *The American Economic Review*, 1994, *84* (1), 157–177. 2.3

__ , **Philip Luck, Maurice Obstfeld, and Katheryn N. Russ**, "In Search of the Armington Elasticity," *The Review of Economics and Statistics*, 2018, *forthcoming.* 14

Galle, Simon, Andres Rodríguez-Clare, and Moises Yi, "Slicing the Pie: Quantifying the Aggregate and Distributional Effects of Trade," 2017. mimeo UC Berkeley. 4.3

Grossman, Gene and Elhanan Helpman, *Innovation and Growth in the Global Economy*, Cambridge, Massachussets: MIT press, 1991. 4.1

Hausman, Jerry A., *Valuation of New Goods under Perfect and Imperfect Competition* The Economics of New Goods, University of Chicago Press, 1996. 1

Head, Keith and Thierry Mayer, "Gravity Equations: Toolkit, Cookbook, Workhorse," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4, New York: Elsevier, 2013. 3.2, 3.3

Heathcote, Jonathan and Fabrizio Perri, "Assessing International Efficiency," in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 4, North Holland, 2014, chapter 9. 10

Helpman, Elhanan, Oleg Itskhoki, and Stephen J. Redding, "Inequality and Unemployment in a Global Economy," *Econometrica*, 2010, *78* (4), 1239–1283. 4.2

Hertel, Thomas W., Robert A. McDougall, Badri G. Narayanan, and Angel H. Aguiar, "Behavioral Parameters," in Badri G. Narayanan, Angel H. Aguiar, and Robert A. McDougall, eds., *Global Trade, Assistance, and Production: The GTAP 8 Data Base*, Center for Global Trade Analysis, Purdue University, 2012. 3.2

Irwin, Douglas A., "The Welfare Costs of Autarky: Evidence from the Jeffersonian Embargo, 1807-1809," *Review of International Economics*, 2005, *13*, 631–645. 5

Johnson, Robert C. and Guillermo Noguera, "Accounting for Intermediates: Production Sharing and Trade in Value Added," *Journal of International Economics*, 2012, *86* (2), 224–236. 3.1

Krugman, Paul, "Scale Economies, Product Differentiation, and the Pattern of Trade," *The American Economic Review*, 1980, *70* (5), 950–959. 2.3, 2.3, 5, 4.1

Melitz, Marc J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 2003, *71* (6), 1695–1725. 2.3, 2.3, 5, 4.1

Nevo, Aviv, "New Products, Quality Changes, and Welfare Measures Computed from Estimated Demand Systems," *Review of Economics and Statistics*, 2003, *85* (2), 266–275. 1

Ossa, Ralph, "Why Trade Matters After All," *mimeo*, 2012. 16

P., Dietzenbacher E. Los B. Stehrer R. Timmer M. and G. J. de Vries, "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production," *Review of International Economics*, 2015, *23*, 575–605. 9

Perla, Christopher Tonetti Jesse and Michael E. Waugh, "EQuilibrium Technology Diffusion, Trade and Growth," 2015. 4.1

Petrin, Amil, "Quantifying the Benefits of New Products: The Case of the Minivan," *Journal of political Economy*, 2002, *110*, 705–729. 1

Ravikumar, B., Ana Maria Santacreu, and Michael Sposi, "Capital Accumulation and Dynamic Gains from Trade," *Saint Louis Fed Working Paper*, 2017. 4.1

Rivera-Batiz, Luis A. and Paul M. Romer, "Economic Integration and Endogenous Growth," *Quarterly Journal of Economics*, May 1991, *Vol. CVI* (No. 425), pp. 531–555. 4.1

Sampson, Thomas, "Dynamic Selection: An Idea Flows Theory of Entry, Trade, and Growth," *Quarterly Journal of Economics*, 2016. 4.1

Shapiro, Joseph S., "Trade Costs, CO2, and the Environment," *American Economic Journal: Economic Policy*, 2016, *8* (4), 220–54. 3.2

Swiecki, Tomasz, "Intersectoral distortions and welfare gains from trade," *Journal of Intermational Economics*, 2017, *104*, 138–156. 4.2

Tinbergen, Jan, *Shaping the World Economy*, New York: The Twentieth Century Fund, 1962. 13

Young, Alwyn, "Learning by Doing and the Dynamic Effects of International Trade," *Quarterly Journal of Economics*, 1991, *106*, 396–406. 4.1