

Dave Donaldson Winner of the 2017 Clark Medal

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## Dave Donaldson: Winner of the 2017 Clark Medal

Daron Acemoglu

**T**he 2017 John Bates Clark Medal of the American Economic Association was awarded to Dave Donaldson for his path-breaking contributions in international trade. Donaldson's work sheds light on some of the central questions of international economics, ranging from the economic and welfare implications of market integration within a country to testing the core empirical predictions of models of international trade based on comparative advantage. In these areas, empirical work faces the challenge of taking into account the broader equilibrium implications of changes in policies or economic conditions—that is, the possibility that bilateral relations between two regions or countries will affect others via trade diversion or their effects on equilibrium prices. Donaldson's work has managed to address these challenges by combining careful theory with detailed and creative empirical work. Indeed, this research strategy has turned Dave into a leader in the revival of empirical work in international trade.

Dave Donaldson, a native of Canada, grew up in Toronto. He graduated from high school in 1997 and moved to Trinity College, Oxford, with a scholarship to study physics. The debates and protests about globalization in the late 1990s piqued Dave's interest in economics and carried him to the London School of Economics. Economics stuck with Dave, and vice versa, and after completing his master's degree in 2003, he continued on to the PhD program.

The questions that had motivated Dave to delve into economics combined with his childhood interests in geography and maps (his favorite sport was orienteering,

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**Dave Donaldson**

which combines cross-country running with off-trail navigation using detailed topographical maps) and led to his chosen specialization: empirical international trade that takes geography seriously. He graduated from the London School of Economics in 2009, with a dissertation focusing on the effects of railways and economic integration on cross-district inequality of economic and social outcomes in India. He joined the MIT faculty that year and spent the next five years there, while also visiting Harvard and Stanford during that period. In 2014, he moved to Stanford University, where he was a faculty member in April 2017 when he was awarded the Clark Medal. He left Stanford and returned to MIT in July 2017.

In this essay, I will attempt to put Dave's research in the broader context of work over the last several decades on market integration and various topics in international trade. I will focus on the key papers listed by number in Table 1.

## **Background**

Many of the classic works in economics such as Adam Smith's (1776) *Wealth of Nations* or David Ricardo's (1817) *Principles of Political Economy and Taxation* centered on international trade. Despite this illustrious background and some of the best minds in economics having devoted their careers to this topic, there is still much we do not know about the extent of gains from trade—and even about whether countries trade in the way that economic theories predict. Given that uncertainty, it is perhaps unsurprising that international trade is often such a controversial topic.

*Table 1*  
**Selected Papers by Dave Donaldson**

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1. “Railroads of the Raj: Estimating the Impact of Transportation Infrastructure.” Forthcoming. *American Economic Review*.
  2. “Railroads and American Economic Growth: A ‘Market Access’ Approach,” (with Richard Hornbeck). 2016. *Quarterly Journal of Economics* 131 (2): 799–858.
  3. “How Large Are the Gains from Economic Integration? Theory and Evidence from US Agriculture, 1880–1997,” (joint with Arnaud Costinot). NBER Working Paper 22946.
  4. “Who’s Getting Globalized? The Size and Implications of Intranational Trade Costs,” (joint with David Atkin). 2014. Unpublished.
  5. “What Goods Do Countries Trade? A Quantitative Exploration of Ricardo’s Ideas,” (with Arnaud Costinot and Ivana Komunjer). 2012. *Review of Economic Studies* 79(2): 581–608.
  6. “Ricardo’s Theory of Comparative Advantage: Old Idea, New Evidence,” (with Arnaud Costinot). 2012. *American Economic Review* 102(3): 453–58.
  7. “Evolving Comparative Advantage and the Impact of Climate Change in Agricultural Markets: Evidence from 1.7 Million Fields around the World,” (with Arnaud Costinot and Cory Smith). 2016. *Journal of Political Economy* 124(1): 205–248.
  8. “The Elusive Pro-Competitive Effects of Trade,” (with Costas Arkolakis, Arnaud Costinot, and Andrés Rodríguez-Clare). Forthcoming. *Review of Economic Studies*.
  9. “Nonparametric Counterfactual Predictions in Neoclassical Models of International Trade,” (with Rodrigo Adao and Arnaud Costinot). 2017. *American Economic Review* 107(3): 633–89.
  10. “The More We Die, The More We Sell? A Simple Test of the Home-Market Effect,” (with Arnaud Costinot, Margaret Kyle, and Heidi Williams). 2016. NBER Working Paper 22538.
  11. “Comparative Advantage and Optimal Trade Policy,” (with Arnaud Costinot, Jonathan Vogel, and Iván Werning). 2015. *Quarterly Journal of Economics* 130(2): 659–702.
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The readily visible costs from trade with other countries include firm shutdowns and jobs lost at those firms or in those industries, as well as reduced diversity of national production. The benefits of trade often seem less apparent.

Trade questions are some of the “big questions” of economics, and have become, if anything, more salient in recent years, not just because of the evident discontent of a large share of the public concerning international trade, but also because some prominent recent research has highlighted some of the costs of trade and the uncertainties about benefits. For example, Autor, Dorn, and Hanson (2013) study the employment losses in US local labor markets following the rise in imports from China, and find costs that are higher than many economists had presumed. Rodrik (1997) and a few others have offered an influential contrarian voice on whether the gains from globalization are as large as what many economists have argued.

Overall, measurement of gains from an expansion of trade remains difficult because of several interrelated challenges.

The first and fundamental challenge is one of counterfactual analysis: that is, a researcher does not observe what regions or countries would produce and how productively it would be produced if expanded trade had not come into existence in the first place. For example, what would the patterns of production, economic organization, and transportation have looked like across the 19th-century United States, or across 19th-century India, if the building of a vast rail network had not opened up new possibilities for market integration?

A second challenge is that any decision about linking any two local markets, whether via railways or trade agreements, involves choices made by economic and political agents, and such choices are likely to be correlated with current and future economic prospects. For example, we cannot extrapolate the estimates of increased trade from a rail link between an area with rich agricultural or mineral resources and a port city to argue that railroads connecting two isolated, resource-poor areas would have the same effects.

Third, equilibrium effects also complicate inference—linking two markets will not only change economic outcomes in these two markets, but potentially in many others. The possible changes may include diversion of imports or exports to the newly linked markets, and changes in the prices of goods and factors resulting from increased trade and specialization. Put in the language of microeconomics, when investigating within- (or, for that matter, between-) country trade, the “stable unit treatment value assumption”—the bedrock of simple empirical strategies—is violated almost by design.

Addressing these issues in a systematic way required fundamental advances within the profession to generate credible empirical designs and develop models of trade and economic geography. The former would help us to exploit sources of variation that come closer to identifying exogenous changes that arise from market integration, and the latter would discipline how we can move from local effects to an inference regarding (general) equilibrium outcomes. A major part of Dave Donaldson’s work is at the forefront of these challenges.

## Market Integration

The classic theory of international economics has been on trade *between* countries. Yet in most countries, the integration of markets has been a slow and still incomplete historical process. The study of gains from *within-country* integration illustrates the challenges facing the measurement of gains from an expansion of trade.

Robert Fogel’s (1964) seminal work revived interest in the consequences of within-country market integration and has shaped much of the literature in the subsequent five decades. The hallmark of Fogel’s work was his focus on the contribution of railroads to economic growth in 19th-century America, possibly the most iconic conduit of market integration for most countries (or at least for those countries not fortunate enough to be crisscrossed by rivers and canals). Fogel sought to

spell out an alternative history of how transportation networks like canals and roads might have evolved in the absence of the railroads, which led to his often-cited conclusion that “the railroad did not make an overwhelming contribution to the production potential of the economy” (p. 235).

Not surprisingly, Fogel’s conclusions were controversial, as captured pithily by Paul David’s (1969) memorable title “Professor Fogel on and off the Rails.” But setting aside the specifics of that debate, there was a more enduring methodological contribution in Fogel’s work: the emphasis that economists need to worry about counterfactuals. Fogel’s approach to building a counterfactual for 19th-century US railroads was ingenious, but it is fair to say that it did not fully tackle the counterfactual questions involved.

Dave Donaldson confronts this set of questions in the historical context of India in a paper [numbered 1 in Table 1] which grew out of his PhD dissertation. In several ways, this choice of context for this study is ideal. India has been an exemplar of a nonintegrated internal market for most of its history (and arguably even today). However, the railway investments of the British Raj were a huge step in bringing somewhat closer integration of Indian districts; between 1853 and 1930, British authorities laid over 67,000 kilometers of rail tracks in colonial India.

The first step in Dave’s approach is to develop a credible empirical strategy to estimate the *local* effects of railway access. At a conceptual level, the goal is to answer the question: If one Indian district is randomly allocated access to the railway network, how much does that district gain relative to another district that is randomly denied access to this network? Obviously, we don’t have this random allocation in practice, and comparing a district that does get access to the railway network, to one that doesn’t, won’t do, because there is quite a bit of planning on the part of a relatively sophisticated bureaucracy on where the railway network should be located.

Dave’s strategy here is to exploit the archival sources in several ways. He builds a new dataset of district-level real incomes in India and also obtains detailed information about the building of its railway network. He also collected information on railroad lines proposed to be built that, for some reason, did not get built or got built only with considerable delay. Using these data sources, Dave compares districts that got access to the railway network, not to all of those that didn’t, but only to those that seemed to be desirable locations for rail stations and, in fact, had a rail station planned for them, but in the end, didn’t get it. This strategy enables Dave to establish that railroads reduced interregional price differentials and, consistent with theory, reduced the responsiveness of prices to local productivity shocks. It also provides an estimate of the effects of railways on local (agricultural) incomes: districts that got further integrated with other parts of India gained about 16 percent more agricultural income relative to those that did not.

Of course, we cannot extrapolate from this 16 percent estimate of gains to specific districts to conclude that Indian incomes overall grew by 16 percent (or grew by 16 percent times the fraction of GDP that was in districts that got access to the rail network). It is possible that districts not connected to the rail network

experienced a decrease in income because trade got further diluted away from them, or going in the opposite direction, these districts may have benefited from changes in equilibrium prices. These indirect effects would need to be taken into account in any overall calculation.

One can partially deal with these concerns by looking for effects on districts neighboring those that received a rail station, where we expect indirect effects might most likely be felt. Indeed, Dave shows in the working paper version of [1] that a neighbor's access to railways reduced a district's real income level significantly. But a reduced-form empirical analysis focusing on neighbors is not sufficient; in full general equilibrium, *all* districts might be affected.

This is where [1] turns to the advances in the theory of international trade. In particular, Dave turns to the "Ricardian" mode of trade developed by Eaton and Kortum (2002; described in this journal in Eaton and Kortum 2012), which provides a tractable setup in which patterns of trade and their welfare implications can be studied in the presence of trade costs and productivity differences across locations. In Eaton and Kortum's approach, each region (or country) has different productivities in the production of different goods (which is the Ricardian element) and shipping goods from one district to another is costly. The resulting equilibrium determines factor prices within each region, which in turn pins down the cheapest producer of each good for each region after taking shipping costs into account. The model also verifies that reducing transport costs between two regions will affect equilibrium prices and thus can affect all regions. What makes the model tractable is that although there are price differences across regions even for goods with the same origin, because of trade costs, there is a straightforward pattern of flows between any two regions. These flows are related to the classic "gravity equation," which links bilateral trade between two countries to their "economic masses" (GDPs) and the geographic and other types of distance between the two.

The structure implied by Eaton and Kortum's (2002) model also links welfare gains from trade to a sufficient statistic, the "trade share" of a region's expenditure on its own goods (in autarky this trade share is of course one). This result enables Dave Donaldson to verify that this theoretical approach is a good approximation to the effects of railways on real agricultural incomes throughout India by confirming whether all of the effects of railways work through this trade share. Once the model's implications are thus validated, Dave can use its structure to estimate the overall welfare consequences of the improved transportation network in colonial India, and he infers that any spillovers on other districts are not quantitatively large. (This conclusion also explains why the estimated quantitative effects of market integration are, even if not identical, similar to those of Fogel's approach, which did not consider these indirect effects.)

This work is an excellent specimen of the style of work that has made Dave a leader in the study of empirical effects of trade across regions and countries. The project is motivated by a challenging question concerning the overall (general) equilibrium effects of a change in transport infrastructure. This question is answered by combining new data, careful reduced-form empirical work, and theory

and inference about structural parameters that are informative about equilibrium effects that go beyond local impacts.

Dave also investigated the effect of railways in joint work with Richard Hornbeck in [2] by revisiting the effects of the so-called “iron horse” in the 19th-century United States. The challenging questions again concern equilibrium effects of the massive expansion of the railway network. To tackle these questions, Dave and Richard make three methodological advances relative to previous work. First, they again use a Ricardian model of trade that builds on Eaton and Kortum (2002), where the effect of reduced transport costs on the economy of a region (here county) is linked to the “market access” of that region. The measure of market access takes into account not just the density of the railway links, but how getting connected to a hub such as Chicago provides Midwestern counties further access to other markets. This provides an alternative implementation of the same gravity-equation structure as that in [1]. Second, they focus on the value of agricultural land, which under the assumption of competitive markets should capture the current and future improvements from improved access. Third, they build a detailed county-level dataset of the railway network and canals exploiting the geographic information system (GIS) network database.

Their estimates show a strong correlation between changes in the measures of market access, driven by the rollout of the railway network, and long-run changes in the value of agricultural land. A 10 percent increase in market access is associated with a 5 percent increase in the value of agricultural land. But as in [1], this reduced-form relationship may reflect endogenous choices of where railroads were built. As a partial method to deal with this problem, the authors use the source of variation due to water market access in 1870: specifically, higher water market access in 1870 implies a lower change in overall market access due to railroads between 1870 and 1890, because high water market access counties make railways less useful at improving access at the margin. This source of variation leads to even larger estimates, now implying that a 10 percent increase in market access leads to an over 11 percent increase in the value of agricultural land.

With these estimates at hand, the paper proceeds to perform the same counterfactual as Fogel’s (1964) classic work, investigating what the consequences would be of removing all the railroads in 1890. They find that such a step would have reduced the total value of US agricultural land in 1890 by approximately 60 percent. This number is fairly large. But if we view land values as corresponding to the present discounted returns of land, assume that there was no anticipation of the expansion of the railway network before 1870 and no anticipation of further productivity-enhancing investments in affected counties, and take an interest rate of 5 percent, then the effects of railways on land values they estimate are equivalent to an increase of about 3 percent of total national income annually (which is only modestly larger than Fogel’s estimate).

While [1] and [2] focus on historical studies of railways, in [3] Dave Donaldson and his frequent collaborator and colleague Arnaud Costinot turn to the effects of overall US economic integration in the agricultural sector between 1880 and 1997,



which has dramatically reduced the role of distance and enabled much greater specialization in agriculture. This paper takes a more holistic approach to the question of gains from trade and adopts a more ambitious approach than previous work by recognizing that the productivity of different plots of land vary greatly depending on what crops are grown there. To make matters more challenging, even though we do observe the allocation of different plots of land to different crops today, we do not know what this would have been and how much productivity would have been lower had it not been for this major process of integration over the last century and a half.

To overcome this problem, the authors adapt Costinot's (2009) earlier theoretical framework to model the allocation of heterogeneous land parcels to different crops across 2,636 US counties. To implement this approach, as in any Ricardian model, one needs to have estimates of the productivity of a given land parcel for every crop—since in the absence of integration, they may have chosen to produce some of the crops that they are not currently producing. Their ingenious idea is to use the modern production function of crops to infer the comparative advantage patterns. They do this using data from the agronomic (GAEZ) project from the Food and Agriculture Organization of the United Nations. This database uses agronomic models and high-resolution data on geographic characteristics and climatic conditions to predict crop yields at the level of relatively small grid cells (roughly 10 km by 10 km at the equator) covering the entire globe. Under the assumption that within-county comparative advantage patterns of the late 19th century are not reversed today, Dave and Arnaud show how to use data on total farm sales in a county, total output per crop, and total land allocated to each crop to infer the unique vector of crop prices and crop-and-county productivity shocks that is consistent with profit-maximization and factor-market clearing in the county. They assume that production functions are linear, so they can solve for equilibrium using computationally straightforward linear programming analysis.

One way of validating this approach is to compare the price implications of the model to data. Although county-level crop prices are not observable, state-level prices are. The authors show that the implications of the model that follow from profit maximization and factor market clearing are highly correlated with observed state-prices. The same data also confirm the decline of spatial price dispersion over time.

The ultimate objective is to estimate the contribution of greater integration of agricultural markets to economic growth. Using this powerful framework, the paper estimates that a significant fraction of economic growth of agricultural output (perhaps as much as 80 percent of it) may be due to economic integration.

In Donaldson's joint work with David Atkin in [4], they take a very different approach to studying the implications of within-country trade barriers, directly measuring how prices vary within a country as a function of distance. To achieve this, they use barcode-level price data from Ethiopia, Nigeria, and the United States (included as a comparison), and collect new data on the origin of products in order to determine which are the location pairs that are trading and hence have price gaps that are directly informative of trade barriers. They then develop a model of

pass-through to discipline the empirical work and also allow for markups that vary over space, which is essential to understanding whether price differences simply reflect within-country trade costs, or also reflect differential pricing strategies and markups set by intermediaries.

Focusing on a sample of goods that are identified at the barcode level enables the authors to minimize any unobserved quality differences, and reveals sizable cross-country differences in the effects of distance on prices. In particular, the effects of distance on trade costs appear to be four or five times larger in Ethiopia and Nigeria than in the United States. But this is only part of the story. Atkin and Donaldson show that markets are less competitive in remote locations, and consequently, the gains from globalization, which reduce trade costs, are greater for consumers in locations closer to where goods originate and lower for those in distant locations. These findings imply that the gains from reduced trade costs following from globalization may not benefit some consumers as much, and in fact such gains are likely to be unequally distributed for reasons beyond those already emphasized in the literature—in particular, because of differential pass-through and markups.

## **Empirics of Comparative Advantage**

David Ricardo's (1817) classic analysis of international trade, which links trade patterns and specialization to an economy's comparative advantage, is of course one of the mainstays of the economic canon. All the same, systematic empirical investigation of the predictions of the approach have been few and far between. This is both because tractable models of Ricardian trade specifying bilateral trade flows when countries may specialize only in a subset of the available goods were not developed until recently, and also because detailed data for the empirical analysis were not widely available. To be sure, there have been plenty of empirical papers linking exports to various measures of productivity to get to one of the key implications of Ricardian comparative advantage—that countries should export more in sectors in which they are more productive. Yet often these empirical exercises can seem ad hoc because they were not explicitly linked to the predictions of a fully specified Ricardian model of trade.

However, Dave Donaldson's work offers an in-depth empirical investigation of the predictions and implications of the patterns of comparative advantage in Ricardian trade models. It is fitting that the American Economic Association awarded Dave Donaldson the Clark Medal almost on the 200th anniversary of the publication of David Ricardo's *Principles of Political Economy and Taxation* (which was published on April 19, 1817). Though they have not fully tested the implications of the Ricardian model, Dave's study [1] of the effects of railways in India and his joint work with Costinot [4] on welfare gains from economic integration in US agriculture have been important precursors of this type of research. Dave's explicit work in this area consists of several papers coauthored with with Arnaud Costinot, and in some instances with other coauthors as well.

In [5], Arnaud and Dave team up with Ivana Komunjer to overcome the challenges confronting empirical studies of the general Ricardian framework. They first develop a rich structural Ricardian model of trade. This framework goes beyond Eaton and Kortum's (2002) model to specify trade patterns as a function of productivity differences in a setting with multiple countries, several goods, and multiple varieties of each good. It explicitly allows countries to specialize in a subset of the goods depending on their comparative advantage and factor prices. The framework provides a particularly straightforward form of the basic Ricardian mechanism—whereby countries export relatively more in sectors in which they are relatively more productive—and provides closed-form expressions for bilateral flows as a function of observed productivity patterns. Crucially, the model takes into account the fact that a country will not produce all varieties of every good but rather those varieties in which it is relatively more efficient. This analytical structure implies that differences in observed productivity tend to be smaller than true differences in productivity because of a “trade selection effect”—countries tend to produce the varieties in which they are more productive.

Combining the empirical equation that emerges from the theory with data on trade flows and producer prices, which should reflect productivity, the authors establish that countries do export goods where their relative productivity is higher, as one might have expected. For example, their core estimates imply that a 1 percent increase in relative productivity is associated with a 6.5 percent increase in relative exports of a country. Using their estimate of the key structural parameter of the model—the dispersion of productivity across varieties within a sector—the authors proceed to quantify the welfare impact of this Ricardian channel across sectors. They find that cross-industry differences in productivity generate only a small part of the gains from trade, and instead it appears to be comparative advantage differences at the within-industry level that account for most of the gains from trade.

This paper [5] is an important one, because it makes significant advances relative to the previous literature on teasing out the predictions of a canonical Ricardian model of international trade and confronting them with data. Though the data used is not very fine-grained (sectoral data from the Groningen Productivity Database), the theoretical predictions are borne out in the empirical analysis, and do suggest that Ricardian comparative advantage plays an important role in the observed trade patterns and in the welfare gains from international trade.

In [6], Arnaud and Dave turn to the much more detailed agricultural data from the GAEZ database (mentioned above), which allow them to use more fine-grained variation than in [5] while tackling the fundamental problem of Ricardian trade empirics—specialization means that we do not observe the productivity of the country in the goods that it imports. They show how the parcel-level information from this database can be used to make the Ricardian model more operational. As in [5], but this time using GAEZ-predicted agricultural productivity rather than measured manufacturing productivity, the authors document a positive correlation between cross-country comparative advantage and cross-country patterns of specialization in agriculture.

In [7], Arnaud and Dave team up with Cory Smith to investigate how Ricardian trade and specialization patterns might mitigate the global implications of climate change in agricultural markets. This paper also uses the rich data from GAEZ, this time to investigate how changes in production patterns within countries might mitigate the adverse consequences of climate change. To do this, they develop a detailed micro-founded model of allocation of land to crops and trade patterns, related to [3], but now applied to over 9,000,000 grid cells from 187 countries from the GAEZ data for 10 distinct crops. Crucially, the GAEZ dataset is available both under contemporary growing conditions and under the climate change scenarios used by the UN's Intergovernmental Panel on Climate Change (IPCC), which is the core input into the paper's counterfactual exercises.

By feeding these micro-level productivity shocks into their general equilibrium trade model, Arnaud, Dave, and Cory estimate that, absent a reallocation of land parcels to crops, unmitigated climate change will translate into large negative productivity shocks for many countries around the world, decreasing world welfare substantially. However, there is enough heterogeneity in these shocks over space that the reallocation of production according to comparative advantage across crops within each field reduces the welfare impact of climate change by an order of magnitude. Furthermore, there is so much productivity heterogeneity across fields within countries that allowing countries to adjust their patterns of trade internationally appears to have very small effects on the welfare consequences of climate change. The key to reducing the very negative effects of climate change, therefore, lies in changing production patterns within countries, and not so much in international trade.

In [8], Arnaud and Dave join forces with Costas Arkolakis and Andrés Rodríguez-Clare to investigate the gains from trade when trade affects markups. Earlier work by Arkolakis, Costinot, and Rodríguez-Clare (2012) linked the gains from international trade in a range of models to bilateral trade flows (via the gravity equation) and showed that in a number of important cases, these gains are quite small. This conclusion stands in stark contrast to the large gains from trade estimated in regression studies such as Frankel and Romer (1999) and Feyrer (2009). As discussed above, Dave's work [1] on railways of India and his joint work with Arnaud [3] on US agriculture also found significant gains from economic integration. Could it be that [8] obtains different results because the effects of international trade on markups—the so-called “pro-competitive effects”—are ignored in the earlier papers? Indeed, one may have conjectured that the gains from trade could be much higher if greater trade intensifies competition.

Accordingly, [8] considers a richer class of models that allows for demand elasticities to vary with quantities, which implies that trade will alter equilibrium markups. Though this class of models is still restrictive, it nests many models with variable markups that have been used in the previous trade literature. Surprisingly, at the estimated demand parameters, in which demand elasticities decrease with the level of consumption (consistent with the common empirical finding of incomplete pass-through), the effect of trade on markups turns out to reduce, rather than increase,

the welfare effects of trade. More precisely, the welfare gains are bounded from above by the same macro-level elasticity-based estimates provided in the earlier paper.

There is a new and surprising insight underlying this seemingly paradoxical result. A reduction in barriers to trade has two opposing effects on monopoly markups: it reduces the markup of domestic firms (because they face tougher competition from abroad), but it increases the markups of foreign firms (because they now have lower costs of serving the domestic market and reductions in costs tend to be incompletely passed-through). Given their estimated demand parameters, the second effect turns out to dominate. Clearly, this result need not extend to richer market structures. Yet it qualifies the important conditions under which we may expect, and may not expect, the “pro-competitive” effects of trade to be present, and it provides yet another useful benchmark by encompassing the kinds of models that trade economists commonly use for studying the effects of trade liberalization.

Another important paper within the same research program is [9], joint with Rodrigo Adao, which develops a new methodology to construct nonparametric counterfactual predictions, free of functional-form restrictions on preferences and technology, in neoclassical trade models. To do so, Rodrigo, Arnaud, and Dave establish the equivalence between such models and “reduced exchange models” in which countries directly exchange factor services. This equivalence implies that, for an arbitrary change in trade costs, counterfactual changes in the factor content of trade, factor prices, and welfare only depend on the shape of a reduced factor demand system. They then provide sufficient conditions under which estimates of this system can be recovered nonparametrically while using the same data sources and exclusion restrictions that are typically invoked. Together, these results offer a strict generalization of the parametric approach used in so-called gravity models.

Finally, in [10], Arnaud and Dave join forces with Margaret Kyle and Heidi Williams to investigate the origins of the productivity differences that are at the root of the Ricardian models of international trade. One approach in the international trade literature to this question has been the “home market effect,” which suggests that countries should be more productive and export more in sectors where they have a larger home market. The home market effect emerges as a source of endogenous comparative advantage in models of monopolistic competition and trade costs (or nonhomothetic preferences) because a larger home market is an advantage for domestic firms and incentivizes more of them to enter and serve this greater market. This entry then leads to more varieties or other sources of greater productivity. The home market effect is also related to the endogenous direction of innovation, since one of the factors increasing an economy’s productivity in a specific sector might be greater innovative activity directed to that sector because of its greater importance, though the home market effect might also be due to other sources of industry-level economies of scale linking productivity to the level of domestic production.

The paper explores the home market effect in the context of drug exports. It builds on previous work on the effect of demographic changes on innovation and product entry such as the analysis of demographic change and new pharmaceutical

innovations in Acemoglu and Linn (2004). The bottom line result of Arnaud, Dave, Margaret, and Heidi's work is that countries that for demographic reasons are expected to have high demand for a certain type of drug are actually more likely to be net exporters of the same drugs, and in fact, the greater the home demand predicted, the greater the sales abroad. With a naïve model with fixed productivities, one would have expected the opposite—the more a country demands of a particular drug, the more of this drug it will need to import and the less it would be expected to sell to other countries. The home market effect is particularly plausible in the context of drugs because of the importance of endogenous innovation activity in this sector, a pattern consistent with the authors' evidence on the stronger response of nongeneric (relative to generic) drugs to the size of the home market.

## **Trade Policy**

The insights of Donaldson's empirical work offer indirect lessons and insights about trade policy, but in [11], Dave and Arnaud work with Jonathan Vogel and Iván Werning to investigate more explicitly the implications of Ricardian comparative advantage for the design of optimal trade policy. The theory of optimal trade policy in models of trade based on differences in factor endowments is relatively well understood (for example, Dixit 1985). However, some basic questions in realistic cases of differences in comparative advantage had not been confronted. These include, for example, whether a country should protect more in importing sectors or whether it should subsidize more in exporting sectors that already have a strong comparative advantage. The paper has a very sharp answer to these questions: optimal import tariffs should be uniform across sectors, regardless of the pattern of comparative advantage, while optimal export subsidies should be nonincreasing with comparative advantage.

Though the theoretical results in [11] are sharp, questions about the extent to which these conclusions apply in realistic contexts continue. For example, many countries protect their least competitive sectors, and some countries tend to subsidize export sectors. This might be because of additional constraints on trade policy or because of political economy considerations. But as with so many results in optimal tax theory, we need to understand the benchmark problem of a benevolent and unconstrained planner in order to move on to a deeper understanding of actual political behavior.

## **Summary**

Dave Donaldson together with colleagues and collaborators such as Arnaud Costinot and David Atkin have been at the forefront of the revival in empirical international trade. They have catapulted this field into one of the most dynamic areas of the last decade and a half.

The challenges facing empirical work in this field cannot be understated. Most questions in international trade have a major equilibrium component, and thus simple reduced-form strategies, comparing one economy, region, industry, or firm to another will not provide fully satisfactory answers. Turning to fully specified structural models is an option, but most models rely on a myriad of simplifying assumptions, and so that would not be fully satisfactory either. Dave's work has overcome these challenges by combining careful, credible, reduced-form work (based on new data and interesting institutional settings) with powerful modern trade theory to estimate not just local effects but full equilibrium impacts. In this fashion, he has spearheaded the analysis of within-country economic integration, especially owing to major advances in transport technology in the 19th and 20th centuries, and also contributed to bridging the gap between theory and empirics in the study of international trade flows.

The hallmark of Dave Donaldson's work is that it so readily combines a range of elements: construction of new datasets; credible reduced-form empirical analysis; sound economic theory targeted to the question at hand; and thoughtful estimation of structural parameters to carry out counterfactual analysis and estimate welfare effects. This style of work, combining careful reduced-form estimation together with state-of-the-art models to infer underlying structural parameters and estimate the welfare consequences of major policy changes, has not only set a high standard for empirical work in international trade, but is becoming the norm in many different areas of economics. Many young scholars in international trade and other fields will surely seek to emulate and build on Dave's approach and intellectual leadership in the years ahead.

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