



Process **Innovation** Product

The Self-Limiting Nature of Innovation

Trade stimulates innovation by exporting firms. Does this result in improved economic welfare? Surprisingly, the answer is largely no

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Editor

This article concerns international trade, innovation and the behavior of companies. But at heart, it is about economic well-being, and the complex and somewhat controversial exploration of how society's welfare is affected when the costs of trade alter incentives to innovate.

This general topic is certainly not new to economics. In some sense, David Ricardo sought to understand these matters nearly two centuries ago. But recently, economists have been forced to question what for many years has been a bedrock belief: Trade aids economic growth and promotes well-being by fueling innovation and thereby productivity.

"For the last decade or so, the idea that international trade might have extra benefits because it stimulates innovation by firms that export has been a strongly held view among economists," observed Minneapolis Fed consultant Andy Atkeson in a recent interview. "But what we're finding, in fact, is that these 'extra benefits' don't really exist."

Like their peers, Atkeson and Ariel Burstein, his colleague at the University of California, Los Angeles, believed that increased market exposure through international trade could spark innovation. If you reduce the costs of trade, the thinking went, large companies that export would suddenly be looking at a much bigger global market; that should increase their incentive to innovate so they can reduce costs while maintaining profit margins and selling to more nations. "When we started our research," recalled Atkeson, "that's what we thought was going to happen. That was the intuition."

"But what surprised us was that in a general equilibrium model, that doesn't work out," he continued. "Or rather, it does work out at the *micro* level. Lower trade costs do stimulate big changes for

some companies. But you end up having an *offsetting* effect of cutting into the production of new products by smaller companies, particularly those that are serving the domestic market."

What Atkeson and Burstein discovered, as they explain in "Innovation, Firm Dynamics, and International Trade," a Minneapolis Fed staff report (SR444, online at minneapolisfed.org) published in the *Journal of Political Economy* in June 2010, was that although lower trade costs do increase incentives of exporting firms to improve production methods—"process innovation"—the effect is counterbalanced by a reduction in "product innovation"—the market entry of new firms with new products. The net result: little or no extra benefit in terms of improvements in overall productivity due to increases in exporters' innovative activity, and so no extra increase in economic well-being.

"Now, you ask, why does that happen?" Atkeson said. "And this is what the equations say..."

Trade theory

But before we go there, it might be useful to take a short detour through international trade theory. As Atkeson noted, "For hundreds of years, economists have had as a matter of faith that free international trade is a wonderful thing. The challenge has been to discover models and mechanisms that actually say that."

The pioneer in exploration of the benefits of international trade was British economist David Ricardo. In 1817, while Great Britain was embroiled in heated debate over import tariffs, he explained that two nations would reap gains from free trade even if one of them was better (that is to say, more efficient) than the other in production of various goods. By exporting those products for which its opportunity costs were lowest and importing those with higher opportunity costs, nations could gain

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from trade. It was a concept he termed “comparative advantage.” (Another British economist, Robert Torrens, actually described the idea two years before Ricardo, in “An Essay on the External Corn Trade.”)

The notion was based largely on technological differences. Even if Portugal had technology that gave it an absolute advantage over, say, England, in production of textiles and wine, both nations would benefit from exporting those goods at which it was relatively more efficient. So, in this example, England would be better off exporting cloth to Portugal and importing wine if its opportunity cost for textile production were lower than for wine. (For a more complete explanation, see “Comparative advantage: Powerful, but not obvious” in the December 2002 *Region* at minneapolisfed.org.)

The next generation of trade models, developed in the early 1900s initially by Eli Heckscher and subsequently by Bertil Ohlin, his student, was similar to Ricardo’s, but relied more on factor endowments than technological differences. The Swedish economists showed that, given its endowments of capital and labor, a country like the United States, for instance, would be a relatively low-cost location for producing and exporting goods that needed physical capital and skilled labor. China, on the other hand, would be better suited for the production and export of goods requiring lots of unskilled labor. Trade flows of dissimilar products between nations with disparate factor endowments would therefore be the optimal pattern.

Powerful as it was, the Heckscher-Ohlin model “soon ran into a problem with the data,” noted Atkeson. “Most trade is actually between countries that are similar in their levels of development.” And much of that trade consists of similar products. For instance, the United States and Germany trade significant quantities of cars, shipping Fords or Chevrolets eastward across the Atlantic and sending Volkswagens and BMWs in the opposite direction. Existing trade theory couldn’t account for this.

Increasing returns

“Neither the extensive trade among the industrial countries, nor the prevalence in this trade of two-way exchanges of differentiated products, make much sense in terms of standard theory,” observed

Paul Krugman, in a celebrated 1980 article. “A new framework for analyzing trade is needed.”

Krugman’s theory, for which he received the Nobel prize in 2008, addressed this need by recognizing that economies of scale are crucial in production (and trade) decisions. “When ... economies of this kind are allowed to trade,” he wrote, “increasing returns produce trade and gains from trade even if the economies have identical tastes, technology, and factor endowments.”

The crucial elements of Krugman’s model were product differentiation and competition among firms with some level of monopoly power (so-called monopolistic competition). So, for example, Jettas and Chevys are the same type of product (both automobiles), but they’re different. Volkswagen has a monopoly in producing Jettas, while General Motors has a monopoly on Chevys.

And this is where economies of scale (or increasing returns) come in. Once GM has invested millions in producing the Chevrolet, and Volkswagen has done the same for building Jettas, it’s more efficient for them to specialize in those activities. It would be far too costly for GM (or Volkswagen) to build both Chevys and Jettas; far more efficient for a company to specialize in one variety of car and then trade according to tastes.

“The Krugman model is essentially that,” observed Atkeson. “Each manufacturer pays this fixed cost to start producing a variety, and it doesn’t

In Brief

A trade mirage

- Economists have long thought that international trade—beneficial in many respects—might have the “extra benefit” of stimulating innovation by exporting firms, and thereby fueling productivity and overall economic growth.
- Recent research suggests, however, that such benefits are negligible or nonexistent at the macroeconomic level. While trade does appear to stimulate improvements in production methods (*process* innovation) by exporting firms, it also diminishes *product* innovation by smaller companies primarily serving domestic markets.
- The net result: little or no gain in overall productivity due to increases in exporters’ innovative activity, and therefore no “extra” increase in economic well-being from international trade.

make sense to pay the fixed cost twice. If we open up to trade, we can have countries specialize. The U.S. produces all the Chevys for the world, and Germans will produce all the Volkswagens. Everybody gets more varieties and that makes us all better off.”

Firm-level data

But again, there was a data problem, which has come to light only in the past couple of decades. The Krugman model argues that once a firm has paid the fixed cost of producing a given product variety, it should be provided to the entire world. That suggests that virtually every company, both small and large, should trade internationally, and a high proportion of every company’s production would be exported rather than consumed in its home country.

“But when we finally got access to firm-level data, in the 1990s, we saw a picture that looked very different,” said Atkeson. In reality, very few firms actually engage in international trade, and those firms tend to be very productive and very large. Put otherwise, most companies, especially small- and medium-sized firms, produce exclusively for the home market.

Summarizing the situation in a 2007 article, Andrew Bernard and colleagues pointed out that just 4 percent of the 5.5 million companies operating in the United States were engaged in international trade in 2000, and of those, the top 10 percent accounted for 96 percent of all U.S. exports. Moreover, they wrote, exporters tended to be “larger, more productive, more skill- and capital-intensive, and to pay higher wages than nonexporting firms.”

Understanding this reality has been the next big challenge in trade theory, a challenge that persists.

It was Harvard economist Marc Melitz who, in 2003, developed a model that seemed to successfully account for these newly revealed facts. And the Melitz model promised even more: It indicated that increased trade would lead to higher total productivity and improvement in a nation’s economic well-being.

“One of the most robust results of this paper is that increases in a country’s exposure to trade lead to welfare gains,” wrote Melitz in *Econometrica*. This gain, due to higher productivity generated by

reallocations toward more efficient firms within industries, was, he suggested, “a benefit from trade that has not been examined theoretically before.”

A closer look

It was this promise that Atkeson and Burstein set out to explore. How, precisely, does exposure to trade unleash higher productivity and raise welfare? To understand this, they developed a model that could examine how a reduction in international trade costs would affect firm-level decisions to leave an industry, to export and to innovate.

Their model allows for heterogeneous companies—firms that vary in size, productivity and decisions about how to invest, how much to export and whether or not to stay in business. Moreover, it looks not only at firm-level activity (the *microeconomy*), but at general equilibrium (the entire *macroeconomy*). And again, their model incorporates a crucial distinction between two types of innovation: improvements in the methods firms use to produce their products (*process innovation*) and creation of new products altogether (*product innovation*).

The model includes final (consumption) goods and intermediate (production) goods, labor and such key variables as trade costs, investment in product and process innovation, aggregate productivity levels, export shares, economic output, consumption and welfare. And because this is, after all, a model of international trade, there are two countries exchanging goods, each nation with equal abilities, tastes and resources.

The economists first analyze their model from a purely mathematical perspective—that is, if you build an economic model with this particular set of characteristics, what do its equations tell you about innovation, productivity and welfare when the cost of trade is reduced? (The second step, discussed further below, is to broaden the analysis with several numerical experiments.)

Though the math is inevitably complex, the results are clear-cut—and strikingly at odds with interpretations of Melitz’s finding of extra benefits from reduced trade costs. “Our central finding is that, even though such a trade cost change can have a substantial impact on individual firms’ decisions, that impact is not reflected in aggregate welfare,”

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write Atkeson and Burstein. The “*response of product innovation largely offsets the impact of changes in firms’ exit, export, and process innovation decisions on ... aggregate productivity*” (emphasis added).

To be clear, cutting trade costs does, in the Atkeson-Burstein model, alter the flow of resources among firms, and it does increase international trade volumes. But it “does not have a first-order effect for the model’s implications for aggregate productivity,” they write.

In other words, Atkeson and Burstein do produce several results that closely align with Melitz and economists with similar models. They find that changes in trade costs do shift production, export share and investment in process innovation from smaller, less-productive, nonexporting firms to larger, more-productive, exporting firms, as does Melitz. And this reallocation leads to higher *average* productivity and greater productivity differences among firms.

But contrary to Melitz’s conclusions, the reallocation doesn’t result in a substantial increase in *total* productivity. And the bottom line: Nor does it raise, in any significant measure, levels of economic welfare.

Why not?

The results are striking, disturbing and also rather difficult to grasp. How can it be that general welfare wouldn’t increase in an economy that’s cutting costs, improving process innovation, increasing exports and raising average productivity? The clue rests in the nature of a competitive economy, which assumes free entry—as long as there are profits to be made, new firms will enter an industry. Or as Atkeson and Burstein put it: “The logic of our result follows from firms’ free-entry condition: the profits associated with creating a new product must be zero in equilibrium.”

In a competitive economy, with no substantial barriers (political or economic) to entry, firms will enter any industry that promises a profit opportunity and start producing. Given this, and other things equal, write the economists, “a reduction in international trade costs raises the profits associated with creating a new product. In equilibrium, to satisfy the free-entry condition, this increase in expected profits must be offset by an

increase in the real wage and a change in aggregate output, both of which are determined by aggregate productivity.”

Cutting trade costs does stimulate process innovation for exporting firms, Atkeson and Burstein agree, as firms seek to grow their profits by selling to a larger market. By producing the same product at lower cost through improved production methods, they can sell globally at a lower price, earning higher total revenues. But that increased productivity makes the market more competitive. And, for someone not yet in the industry, it becomes far less attractive to enter.

“If you make all the other firms in the economy more productive, what happens to the potential profitability of a new firm?” said Atkeson. “It drives it down, reduces entry, and so growth gets choked off. *That* is the self-limiting nature of innovation.” In other words, the stimulating effect of reduced international trade costs on exports, exit and process innovation is offset by a reduction in product innovation, or market entry. The “extra gains” vaporize.

Positive with the negative

Burstein elaborates by first emphasizing the positive impact of reduced trade cost. “The process innovation decision would have an effect on some elements in the model, like the change in the share of trade when you lower trade costs or the growth in average productivity if you look just at productivity of continuing firms,” he said. “So, some firms will become more productive; exporters will become larger over time. The productivity difference between exporters and non-exporters will become larger because exporters innovate more.”

But then the other shoe drops. “It’s just that for welfare, the welfare of the representative consumer, the increase in productivity that comes from higher innovation by firms is going to be offset by lower entry.”

Burstein cautions that market entry by new firms won’t necessarily cease. “We’re not saying that lowering international trade costs will lead to lower entry,” he clarified. “We’re saying that if you have an expansion of international trade and some firms become more productive due to innovation invest-

ment, that's going to lead to an offset in entry. But it could still be the case that net entry goes up, even if there is a partial offset."

By the numbers

In discussing their model and findings from their mathematical analysis, the economists further caution that these very stark results hold only under a certain set of rather severe assumptions. To broaden the research, they relax the assumptions and generalize the results by conducting several numerical experiments. As it happens, these quantitative experiments qualify but largely confirm their mathematical analysis.

They give the model numerical parameters for features like exporters' share of output and employment, and firm size distribution, so that the experiments resemble the U.S. economy. Then they run the numbers under several sets of assumptions about interest rates, responsiveness of process innovation to reduced trade costs, and both large and small reductions in trade costs.

Numbers from one experiment are enough to illustrate the basic story. In a model with a large reduction in trade costs and a positive interest rate, when process innovation by exporting firms is highly responsive to changes in trade costs, the cost reduction greatly stimulates innovative activity by exporters and causes a surge in average productivity. In this Atkeson-Burstein experiment, productivity of the average firm rises by a factor of 7.5 times the percentage change in trade costs. But this increase in average productivity is *almost entirely offset* by a reduction in product innovation: Product innovation *falls* by a factor of 7.4 times the percentage change in trade costs.

"The net effect of these changes in process and product innovation on total productivity turns out not to make a big difference for welfare," observed Atkeson. "And that's basically due to a combination of two things. The first is the offset, the choking off of product innovation, or entry. And the second thing is that there is a substantial delay or lag in these changes. Process innovation takes quite a long time to impact aggregate productivity."

"So, again, there are two elements to there being little improvement in welfare," explained Burstein. "These companies can start investing in process

innovation [in response to lower trade costs], but it's going to take a while before they really improve their products. That's why it takes so long. And the second part is that you're going to have Intel and Boeing, really big international companies, doing more innovation to take advantage of reduced trade costs. But the small, nonexporters—there will be less entry of those, because they're competing with globalized firms."

Again, accentuate the positive

So, once again, the message from the research comes across as rather negative. The optimistic promise of additional gains from trade appears to have been an empty one. Increased innovation of one sort is offset by reduced innovation of another.

But Atkeson and Burstein are quick to point out two positive aspects. The first, already mentioned, is simply that reduction in trade costs is likely to be transformative, shifting resources in a major way to exporters and to large companies, and leading to greater average productivity in those firms, which in turn suggests higher wages for workers at those companies.

The second positive element is that this framework holds great promise for better addressing the questions that Ricardo tried to answer two centuries ago. The Atkeson-Burstein model is likely to be very useful for "generating new answers to long-standing questions in trade," they write, such as the impact of globalization on trade volumes and comparative advantage patterns.

"The model is a framework for making a connection between the economy as a whole and these rich patterns in micro data that we're seeing in trade," noted Atkeson. "It's very helpful in connecting that back to the macroeconomy. Being able to handle the rich dynamics is a very positive message."

Indeed, as the long evolution of international trade research suggests, definitive conclusions about the impact of changing trade costs are likely to be elusive for years to come. Solid models that can explore the intricate links between the macroeconomy and micro-level firms as different as Boeing and a nearby corn farm will be essential to understanding both the global and local impact of international trade. ■