Supply Chains and Trade Facilitation*

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Abstract

How do supply chains respond to shocks that make trading easier? This paper examines U.S. buyer- foreign exporter networks following trade facilitation reforms and quantifies how the reduction in barriers that accompanies these reforms affects sourcing behavior and prices. After reforms, even though suppliers are smaller and less is traded within relationships, relationships are much more likely to remain together. These findings indicate the increased importance of relationship-specific investment in supply chains following a reduction in entry barriers, as finding the optimal supplier match becomes easier. To quantify this reduction, I estimate a discrete choice model of supplier matching and find that the benefit of staying an extra year with a partner increases by 8-17% following trade facilitation. Finally, I show that even if switching costs remained low post-reform, there is little effect on prices, as buyers have a greater preference for higher-price reliable suppliers.

JEL Codes: F1, F13, F14, F23

Keywords: Global supply chains; trade facilitation; trade relationships

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1 Introduction

International supply chains have come under increasing stress in recent years for many reasons, including natural disasters, geopolitical risks, higher trade costs and tariffs, and industrial policies aiming to centralize production of key technologies within a country. These stresses typically increase import prices (Amiti et al., 2019), reduce trade volumes, and destroy trading relationships (Handley et al., 2023). Furthermore, there is often little realistic scope for policy in partner countries to address such disruptions. What, then, can be done to mitigate the effects of supply chain disruptions? One type of policy governments often consider to counteract disruptions is "trade facilitation": simplifying border processing for exports, including via digitization. Reducing the domestic costs involved in exporting can make exporting a viable prospect for firms and maintain supply chains in a time of increased global uncertainty. Interestingly, there is some evidence that inefficiencies at the border are themselves a significant disruption: a recent OECD report on trade facilitation reported that "The most common disruptions reported by firms during COVID-19 were not so much related to their suppliers, but to difficulties at the border when exporting or importing goods."[1]. It has been shown in numerous contexts that trade facilitation policies reduce the cost of exporting and lead to greater participation of firms in international trade (Francis and Collins-Dodd (2004), Freixanet (2012)). But do these policies actually help maintain buyer-supplier networks and counteract the effects supply chain disruptions?

In this paper, I demonstrate using confidential U.S. data on buyer-supplier networks that trade facilitation policies strengthen supply chain relationships by leading to more "relational" sourcing behavior. In other words, trading relationships become more specialized and long-lasting following trade facilitation reforms– and therefore, more likely to weather supply chain disruptions. Using a structural model of supply chain formation rooted in an importing firm's decision of whether to stay with a certain supplier and estimating it on the data I show that ultimately, even though prices are not lowered by these reforms, there is a substantial increase in the net benefit of a U.S. importer staying with a supplier over time for source countries that engage in trade facilitation. The key mechanism is that having more supplier choices makes finding the optimal match easier, and that optimal match will tend to last longer. Since these type of relationships are exactly those that are more resilient in the face of negative shocks (Monarch and Schmidt-Eisenlohr (2023)), this increase in relationship-specific investment that accompanies these reforms means that supply chains grow more resilient and are more able to survive negative shocks.

The starting point of the analysis is to identify countries that underwent substantial trade facilitation activities. Relying on two World Bank databases– the Logistics Performance

[1] https://web-archive.oecd.org/trade/resilient-supply-chains/trade-facilitation/

Index (LPI) and the "Trading Across Borders" (TAB) datasets– I measure examples of trade facilitation activities for all countries between 2007 and 2014, including improvements in a country's logistics performance, the cost of exporting, the number of days needed to export, and the overall exporting environment, as well as specific reforms or the signing of trade promotion agreements with the United States. Based on these data, I identify a group of countries that demonstrated significant investments in trade facilitation activities over the years 2007–2014. For the purposes of generating a control group for comparison, I also identify a set of countries that did not make such investments.

After gathering this data on countries engaged in meaningful trade facilitation reforms, I use U.S. import data on the universe of U.S. buyer-foreign supplier combinations to examine how buyer-supplier relationships change following these reforms. Since I identified countries that engaged in trade facilitation between 2007 and 2014, I construct information on buyer-supplier networks over the years 2003-2006 and 2013–2016 for all countries exporting to the United States. I show using a difference-in-differences framework that the reforms– and greater participation in foreign exporting that accompanies them– lead to greater stickiness in relationships: U.S. buyers and their foreign suppliers are more likely stay together from one year to the next in the post-reform period. The fact that networks become more "relational" is the key mechanism through which trade facilitation affects supply chains: with buyers and suppliers forming longer-lasting relationships focused on greater specialization of the product being traded within the relationship, the vulnerability of supply chains to negative shocks declines.

Why does trade facilitation lead to an increase in relational trade? Indeed, one might expect that with more supplier choices available, buyer-supplier relationships would become more "spot", characterized by severe price competition among suppliers and more supplier switching. One likely explanation is that by eliminating barriers that prevented marginal firms from exporting, trade facilitation has made it easier for buyers to find the best supplier match sooner, eliminating the need for extensive trial-and-error in the search process. According to this logic, trade facilitation reduces informational barriers between buyers and suppliers, resulting in better matches, less churning, and an increase in the importance of relationship-specific investment in trade.

In order to quantify the effects of the reforms on matching efficiency, I set up a dynamic discrete model of supplier choice. In the model, the key determinants of a buyer's choice of supplier are relationship-specific prices, supplier quality, and a switching cost involved from changing suppliers. Taking the model to the data allows us to recover the structural elasticities of switching behavior to price and quality differences, as well as the size of relationship-level switching frictions. The structural switching cost parameters are meant to capture the host of different factors that underlie the strong observed persistence

in relationships from the data. By measuring these switching costs both before and after the undertaking of trade facilitation reforms, it is possible to benchmark the effects of reforms on underlying relationship behavior and determine the effects of such reforms on prices and buyer-supplier matching. Based on the empirical analysis above showing that relationships are more likely to remain together following the reform, the model should generate an increase in switching costs for affected countries, relative to unaffected countries.

I estimate the model on thousands of country-product-year combinations, each with hundreds of individual relationships, using U.S. import data from 2003–2006 and again from 2013–2016, both for based on the same sample of countries undertaking trade facilitation activities as well as the control group of countries. For all countries, switching costs are large and differ meaningfully across products: products that are less substitutable tend to have larger switching costs. For the sample of countries undertaking trade facilitation, relationship-level switching costs do indeed increase in the range of 7-17%, and by about 10% on average. I find no economically relevant change in switching costs for the control group of countries, and indeed, although such countries tend to have slightly higher switching costs on average, the increase in switching costs for reforming countries is notably higher.

These switching cost parameters need not be interpreted as an unfortunate burden facing U.S. importers. Indeed, an alternative interpretation of the estimated switching costs is the benefit of remaining with a supplier. The fact that they have increased means that matching is more effective in the post-reform period. In this case of a particular set of improvements in exporting conditions in a foreign country, I argue that the improvements result in more persistent relationships due to more efficient matching and greater tailoring of the relationship. This hypothesis is borne out by changes in the elasticity of relationship switching to prices– in the pre-period, higher prices tend to reduce the attractiveness of a particular supplier, while in the post-period, higher prices increase the attractiveness of a supplier.

Although trade facilitation reforms are meant to both reduce information barriers and alter the composition of exporting firms, the fact that relationship switching declines following reforms indicates that the improved composition of exporters is the dominant result of the policy. To quantify these effects on prices, I use the structural model to generate a counterfactual experiment in which the switching costs remain at their lower pre-reform level, but the composition of exporters reflects the post-reform economy. In this case, as expected, relationship switching increases, with lower relationship switching costs leading to about 6% less relationships remaining together than in the actual data. However, the decline in U.S. import prices is less than 0.5% on average: even with improved switching opportunities, the higher weight placed on higher-price suppliers in the importer's objective function means that switching is not occurring in order to obtain lower prices. Thus trade

facilitation reforms do not lead to lower prices. Rather, higher prices are seen as indicative of a more specialized supplier more attune to its buyer's needs. That these changes arise due to greater competition in the reforming country shows that this channel has the most relevant impact on buyer-supplier relationships following trade facilitation. However, it is also the case that better matches are more resilient to negative shocks, and thus, trade facilitation reforms are an effective way to counteract supply chain disruptions, as they lead to longer-lasting buyer-supplier relationships.

A number of studies have provided empirical insight into relationships between importing and exporting firms. Kamal and Sundaram (2016) use the same U.S. Customs data to determine the likelihood that textile producers in Bangladeshi cities will follow other exporters in their same city and export to a particular partner, while Heise (2016) also uses this data to study exchange rate pass-through in the life cycle of importer-exporter relationships. Bernard et al. (2018) develop a model of relationship-specific fixed costs to exporting using Norwegian buyer-supplier trade data, while Blum et al. (2010) use exporter-importer pair data on Chile to study the effects of intermediaries. The distinction between spot and relational sourcing, and how a greater focus on supplier quality led to more relational sourcing for buyers of garments made in Bangladesh was explored in Cajal-Grossi et al. (2023). This paper shows that relationships between U.S. buyers and their suppliers tend to be more persistent following trade facilitation reforms.

The effects of trade facilitation reforms and how governments justify them are also an area of ongoing work. Martincus et al. (2015) show that customs delays such as those addressed by trade facilitation tend to have a strong negative effect on firm-level exports. Beverelli et al. (2015)and Beverelli et al. (2023) study the effects of the WTO's Trade Facilitation Agreement (TFA) on global trade and income. Duval and Utoktham (2022) found that TFA participation reduces trade costs by 1 to 4 percent on average. The effect of reforms that make exporting easier on firms are also studied by Carballo et al. (2022). González and Sorescu (2019) show that, overall, smaller firms gain more from trade facilitation compared to larger firms. Their analysis also indicates that certain trade facilitation measures are more effective in addressing fixed versus variable costs for small and medium enterprises.

Engman (2005) evaluated the economic effects of trade facilitation and concluded that enhancing and streamlining customs procedures would greatly benefit trade flows. In evaluating the advantages of trade facilitation, Wilson et al. (2005) found that the benefits of unilateral trade facilitation reforms can be significant, primarily driven by an increase in exports. Using The Organization for Economic Cooperation and Development (OECD) trade facilitation indicators, Fontagné et al. (2020) found heterogeneous effects of trade facilitation on exporters of different sizes. The adoption of digital telecommunication services can facilitate firms' trade participation. Reddy and Sasidharan (2024) found that improving the

digital communication infrastructure can facilitate trade by enabling better coordination and information exchange. This paper uses two-sided trade data to determine the effects of such reforms on supply chains.

The rest of the paper is organized as follows. Section 2 describes the U.S. import data and the data on trade facilitation reforms by countries throughout the world. Section 3 presents the empirical results. Section 4 lays out the structural model, while Section 5 describes how the model is estimated. Section 6 describes the results and counterfactual experiment. Section 7 concludes.

2 Data

2.1 U.S. Import Data

The research question of interest is how buyer-supplier relationships change following trade facilitation reforms. The relationship data that I use includes the universe of U.S. import transactions over $200, the the Linked-Longitudinal Firm Trade Transaction Database (LFTTD), which is collected by U.S. Customs and Border Protection and maintained by the U.S. Census Bureau.[2] Every transaction in which a U.S. company imports a product requires the filing of Form 7501 with U.S. Customs and Border Protection, and the LFTTD contains the information from each of these forms[3]. There are typically close to 40 million transactions per year.

The data is available from the late 1990s through 2018, and includes the quantity and value exchanged for each transaction, Harmonized System (HS) 10 product classification, date of import and export, country of origin, and a foreign supplier identifier. The foreign supplier identifier, known as the *manufacturing ID*, or *MID*, contains limited information on the name, address, and city of the foreign supplier[4]. Kamal and Monarch (2018) and Monarch (2022) find substantial support for the use of the MID as a reliable, unique identifier, both over time and in the cross section. A number of papers have used this supplier identifier, and in particular Redding and Weinstein (2017) show that many of the salient features associated with exporting activity (such as the prevalence of multi-product firms and high rates of product and firm turnover) are replicated for MID-identified suppliers. I define a "trade relationship" to be the combination of a U.S. importing firm, an MID, and an HS10

[2]Transactions less than $500 are excluded from the data.

[3]Approximately 80 to 85 percent of these customs forms are filled out electronically (Kamal and Krizan (2012)).

[4]Specifically, the MID contains the first three letters of the producer's city, six characters taken from the producer's name, up to four numeric characters taken from its address, and the ISO2 code for the country of origin.

product taken in any year of the data, with total trade within that relationship in a year being the sum of trade values across all transactions within that year.

2.2 Trade Facilitation

The next goal is identifying examples of countries that undertook substantial trade facilitation activities. To do this, I rely on two datasets maintained by the World Bank– the Logistics Performance Index (LPI) database and the "Trading Across Borders" (TAB) database. The LPI reflects perceptions of a country's logistics performance based on the efficiency of the customs clearance process, the quality of trade- and transport-related infrastructure, the ease of arranging competitively priced international shipments, the quality of logistics services, the ability to track and trace consignments, and the frequency with which shipments reach the consignee within the scheduled time. An overall "LPI score" overall score is available for the years 2007, 2010, 2012, 2014, 2016, and 2018, and ranges from 1 to 5. The TAB dataset, which is part of the World Bank's Doing Business Indicators, includes a number of variables that capture how easy it is for countries to engage in importing and exporting, including the cost per container exported and the number of days needed. This dataset also includes an overall "Trading Across Borders Score" ranging from 0 to 100. The methodology for computing these variables is available regularly starting with 2006 data and features a different methodology starting with 2015 data. Given the non-overlapping availability of these two datasets, in order to establish a time series for changes in relevant variables, I rely on the 2006–2015 vintage of the TAB data, and evaluate countries by the size of the change in the three indicators from the TAB data as well as the LPI index between the years 2007 to 2014. All variables can have either negative or positive values. The TAB dataset also includes a textual description of specific business reforms related to trading across borders.[5]

Since the relationship data that I use is based on U.S. importer records, I also ensure that the set of countries is relevant for U.S. imports. Thus, for the same time frames as the datasets discussed above, I also condition on the country being among the top 60 sources of U.S. imports (roughly, in the top one-third of exporting parnters).

The full set of countries that a) had a significant improvement in trade facilitation from 2007 to 2014, according to the above measures, and b) are one of the top 60 U.S. import partners is shown in Table 1. I define a significant improvement in trade facilitation as that country having an improvement greater than the mean in at least 2 of the 4 categories. The "Export Reform" column indicates whether countries in this list have a specific reform listed in the TAB dataset over this time period.[6]

[5] `https://subnational.doingbusiness.org/en/data/exploretopics/trading-across-borders/reforms`

[6] The full set of reforms underlying this indicator for these countries are transcribed in Appendix A.

Table 1. Change in Trade Facilitation Measures, 2007–2014

Country	ΔLPI	$\Delta Days$	$\Delta Cost$	$\Delta Score$	Export Reform	Import Rank
Korea, Rep.	0.15	-5	-205	15.3	✓	6
Thailand	0.12	-10	-484	25.7	✓	19
Colombia	0.14	-20	-248	13.8	✓	25
Iraq[(1)(2)]		-22	-3643	12.4		28
Costa Rica	0.15	-22	-876	19.1	✓	35
South Africa	-0.1	-9	-53	11.9	✓	37
Turkey	0.35	-7	-220	15.5	✓	39
Angola[(1)]	0.07	-24	-1714	18.9	✓	43
Algeria[(1)(2)]	0.59	2	-1577	10.9		50
Dominican Republic	0.48	-9	-109	12.1	✓	51
Argentina[(2)]	0	-4	-2657	15.6		53
Guatemala[(1)]	0.27	-1	-1239	7.6	✓	54
Nicaragua	0.44	-15	-795	14.9	✓	59
Cambodia	0.24	-15	-207	15.5	✓	60
Mean	0.17	-4.2	-635	7.3		

Mean is calculated over 136 countries for the LPI and 176 countries for the three TAB data series. Specific export reforms are from the Doing Business Indicators, with the full set of reforms listed in the Appendix. U.S. import rank is from 2014 annual "customs basis" data, from the December 2014 FT900 U.S. Census release Exhibit 6.

Table 1 gives a first pass at a large set of U.S. export sources of the United States that had substantial trade facilitation activities. However, I refine the set of countries in two ways, resulting in dropping some of the sources from this list: 1) Iraq, Angola, and Guatemala are characterized in the U.S. import data by a small number of exported products, complicating their inclusion in any regression using product information or the structural estimation which will take place product-by-product; 2) Iraq, Algeria, and Argentina did not have any specific example provided of reforms making exporting easier (in fact, Algeria and Argentina had "reforms" making exporting harder). Thus I reduce the set of countries above to include only the 9 remaining source countries. Using the same data, I also generate a control set of countries exporting to the United States that did not have any improvement in trade facilitation activities. In particular, Appendix Table A1 shows the data for all countries that both a) had an improvement in export conditions less than the mean in *all 4* categories, as well as b) a worsening over time of at least 2 categories.[7] Table 2 presents the full set of "treated" countries undertaking trade facilitation and "control" countries, along with their importance in U.S. imports. The control group is a bigger source of exports to the United States on average, so in the analysis below, I control for source country GDP and population.

[7]I choose to drop Austria, which had an trade facilitation reform, as well as Hong Kong, which is a Special Autonomous Region of China, from the full set of countries shown in Appendix Table A1.

Table 2. Trade Facilitation: Treatment and Control Groups

Trade Facilitation	Import Rank	No Trade Facilitation	Import Rank
Korea, Rep.	6	Germany	5
Thailand	19	Ireland	13
Colombia	25	Switzerland	14
Costa Rica	35	Singapore	26
South Africa	37	Sweden	33
Turkey	39	Denmark	38
Dominican Republic	51	Norway	44
Nicaragua	59	Finland	48
Cambodia	60	New Zealand	55
Mean	36.8		30.7

Notes: Import Rank is rank of exporting country to the United States in 2014.

3 Empirics

In order to study the effects of trade facilitation activities on relationships, I connect the list of countries from Table 2 to the U.S. import data, and look at trading relationships during a three-year period prior to the reforms (2003–2006) as well as a three-year period post-reform. (2013–2016).

3.1 Effects of Trade Facilitation on Sourcing

One of the key effects of trade facilitation is to increase the participation of small and medium enterprises in exporting (González and Sorescu, 2019). I begin by examining whether the composition of suppliers changed substantially as a result of the reforms using the buyer-supplier ("relationship") level data. We can examine how buyer-supplier relationships differ before and after the trade facilitation actions. The first specification takes the following form:

$$\ln X_{mxhct} = \beta Post_t + \delta_t + \delta_h + \delta_c + G_{ct} + \varepsilon_{mxhst} \tag{1}$$

This "before-after" regression restricts the sample only to source countries in with trade facilitation activities, and regresses each outcome variable X_{hct} on a $Post_t$ indicator capturing whether it is a pre-EP year (2003-2006) or a post-EP year (2013-2016). The observations are at the buyer-supplier-HS10 product-source country-year ($mxhct$) level, and include HS10 product and year fixed effects, to control for any product-level or time-specific trends. The key regressors are the amount being traded within a relationship, $Value_{mxhct}$,

the total size of a supplier $SupplierSize_{xhct}$, and the number of suppliers used by a buyer ($SupplierCount_{mhct}$). We include product and source fixed effects, and country-time controls for GDP and population. The results are shown in Table 3.[8]

Although the fixed effects in Equation (1) help to sweep out some sources of variation affecting these outcomes, a difference-in-differences setup controls for additional unobservables that may be affecting supply chains. Thus, I compare how U.S. sourcing from countries that underwent trade facilitation changed, both compared to *all countries* that the U.S. imports from, as well as the control group highlighted in Table 2 that did not have substantial trade facilitation activities. I thus generate a treatment group indicator EP_c, and determine how the key outcomes change for two different sets of control group countries. The outcomes variables of interest are again U.S. imports, the number of U.S. buyers, the number of foreign suppliers, and the total number of relationships, all at the product-source level. The specification is:

$$\ln X_{mxhct} = \beta Post_t \times EP_c + \delta_t + \delta_h + \delta_c + G_{ct} + \varepsilon_{mxhst} \tag{2}$$

The $Post_t$ dummy again distinguishes annual data taken from the pre-EP period (2003–2006) versus the post-EP period (2016–2016), with year, HS10 product, and country fixed effects included. Source-year controls G_{ct}, both log GDP and log population from the CEPII database, are also included. The results are shown in Table 3, with the top panel showing the before-after specification, the middle panel showing how each outcome changes relative to all U.S. sources, and the bottom panel showing how each outcome changes relative to the smaller subset of sources with no (or little) trade facilitation activity.

There are three key takeaways from Table 3. First, it is clear that following trade facilitation activities being undertaken by a source country, the amount being traded *within relationships* with U.S. buyers declines. This holds both in an absolute sense (as shown in the before-after regression), and relative to other source countries– relationships are smaller compared all other countries, as well as compared to our selected subsample of countries with no improvement in exporting conditions. Suppliers in these relationships also tend to be smaller. Finally, buyers tend to be using *more* of these smaller suppliers than before, compared to non-reforming countries. Overall, the results demonstrate that the nature of sourcing adjusts following trade facilitation reforms: relationships between U.S. buyers and suppliers in those countries are characterized by smaller trade flows, suppliers themselves tend to be smaller, and U.S. buyers are using more suppliers than before, compared to other countries.

[8]The coefficients for GDP and population are omitted from the table for brevity.

Table 3. Trade Facilitation and Relationships

	(1)	(2)	(3)
	$\ln Value_{hmxct}$	$\ln SupplierSize_{xhct}$	$\ln SupplierCount_{bhct}$
Before-After			
$Post_t$	-0.18***	-0.24***	-0.04***
	(0.03)	(0.03)	(0.00)
Observations	723,000	723,000	1,121,000
Relative to All Countries			
$Post_t$	0.03***	0.38***	-0.09***
	(0.02)	(0.03)	(0.00)
$Post_t \times EP_c$	-0.26***	-0.53***	0.03***
	(0.02)	(0.03)	(0.00)
Observations	45,690,000	45,690,000	19,590,000
Relative to Control Group			
$Post_t$	0.16***	0.57***	-0.08***
	(0.02)	(0.03)	(0.00)
$Post_t \times EP_c$	-0.37***	-1.04***	0.03***
	(0.03)	(0.03)	(0.00)
Observations	1,491,000	1,491,000	2,921,000

Notes: Observation counts rounded to comply with Census Bureau disclosure avoidance rules.

Trade facilitation is often justified as a way to eliminate barriers to entry for firms that would otherwise find exporting too costly. The results above are consistent with this intuition, indicating that smaller firms are indeed more likely to be exporting to the United States following trade facilitation activities. This results in greater competition among suppliers following these reforms. Thus trade facilitation reforms change the composition of firms exporting to the United States, rather than expanding the total set of firms.

3.2 Effect of Trade Facilitation on Relationship Stickiness

An additional justification for trade facilitation is that, by making exporting easier, it reduces frictions involved in the matching process between buyers and suppliers. Matching frictions, and their associated effects on encouraging existing relationships to stay together, have been shown to be important in a number of different contexts, including demonstrating that macroeconomic shocks propagate differently through products characterized by sticky relationships (Martin et al. (2020)), and that prices tend to be higher as a result of such frictions (Monarch (2022)). Such frictions are likely to be especially acute in a develop-

ing economy context (Atkin and Khandelwal (2020)), and indeed, most of the countries highlighted above as having major trade facilitation reforms are developing economies.

We can use the same relationship-level data as above to study how relationship stickiness has changed in the wake of trade facilitation activities. In this case, one possibility is that having more choices of supplier would result in more switching of suppliers by U.S. importers– having better information would make it easier for buyers to find and/or drop suppliers, reducing the benefits from engaging in long-term relationships.

In order to examine this hypothesis, I define a dummy variable $Stay_{hmcxt}$ to capture whether a relationship stayed together from time $t-1$ to t. In this case, as above, I define a relationship to be the combination of an importer m purchasing an HS10 product h from supplier x located in country c. We are interested in how this measure of relationship stickiness changed following trade facilitation reform.

There are a number of other important variables we would expect to affect this measure of relationship stickiness. Prior work has shown that higher prices (in time $t-1$) are more likely to lead to relationships ending (in time t), while relationships involving suppliers with higher quality are more likely to remain together.[9] The total size of both the importing and exporting firm are also key predictors of whether a relationship stays together. Thus, for the next set of results in Table 4, I estimate the following specification:

$$Stay_{hmxct} = \beta Post_t \times EP_c + \beta_p \ln p_{hmxc,t-1} + \beta_\lambda \lambda_{xt} + \delta_t + \delta_h + G_{ct} + \varepsilon_{hmxct} \tag{3}$$

A striking takeaway from Table 4 is that relative to countries that did not engage in trade facilitation, relationships are *more likely* to stay together following trade facilitation. In other words, after reforms to make exporting easier, a greater number of importer-supplier relationship combinations survive from year to year. In this sense, whatever frictions within trade relationships are resolved via exporting reforms, the eventual effect is to lead relationships to stay together and for importers to switch suppliers less often. The result is counter-intuitive: if export reforms lower switching costs, one might expect this to lead to pervasive supplier-switching decisions by an importer– essentially a frictionless economy. However, it mirrors findings from the empirical industrial organization literature for consumer grocery purchases in which *higher* switching costs can lead to *more competitive* markets. These findings are justified with a model in which producers defend themselves against other producers' attempts to steal their customers by strategically investing in customer acquisition and maintenance. Thus higher switching costs are a reflection of a more competitive market.

[9]There is little variation in estimated quality λ_{xht} over time.

It is this insight that I take to the data with the structural model of supplier decisions in the later section.

Table 4. Trade Facilitation and Staying

	(1)	(2)	(3)
	Before-After	Relative to All Countries	Relative to Control Countries
	$Stay_{hmxct}$	$Stay_{hmxct}$	$Stay_{hmxct}$
$Post_t$	0.02***	-0.01***	0.03***
	(0.00)	(0.00)	(0.00)
$Post_t \times EP_c$		0.02***	0.08***
		(0.00)	(0.01)
$\log p_{hmxct}$	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)
λ_{xt}	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)
$\log Size_{mt}$	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)
$\log Size_{xt}$	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)
$logGDP_{ct}$		0.05***	-0.12***
		(0.00)	(0.01)
$logPop_{ct}$		-0.27***	0.05*
		(0.02)	(0.03)
Observations	723,000	45,690,000	1,491,000

Notes: Observation counts rounded to comply with Census Bureau disclosure avoidance rules.

Table 4 also indicates that there are other important factors driving the decision of whether an importer stays with their supplier over time. Consistent with prior work, there is a clear relationship between prices, quality, and the decision to stay with a partner: lower prices and higher supplier quality makes a relationship more likely to stay together from year to year. These features are important to include in our model of supplier deicsions as well. Finally, the table shows larger importers are more likely to switch suppliers, while large suppliers are more likely to remain with their partner, demonstrating the different incentives for continuing relationships between importers and suppliers.

To briefly summarize the empirical findings, our results have shown that there are substantial changes in U.S. sourcing patterns from countries that undertake trade facilitation activities. The composition of suppliers that are exporting to the U.S. has changed– suppliers tend to be smaller, individual importer-supplier relationships trade less, and U.S. importers are using more of these smaller suppliers. The reforms also lead to more relationships remaining together over time. All of these results are consistent with greater competition

among suppliers following the reforms leading to more relationship-specific investment by suppliers.

3.3 Effects of Trade Facilitation Policies on Country Aggregates

Finally, I next consider how U.S. sourcing changed in response to trade facilitation activities at a more aggregate level, namely, the foreign source-HS10 product level. In particular, Table 5 presents results for how U.S. import values, the number of U.S. buyers, the number of foreign suppliers, and the number of relationships changed for the group of countries that underwent substantial trade facilitation activities highlighted above. The before-after specification is now:

$$\ln X_{hct} = \beta Post_t + \delta_t + \delta_h + \varepsilon_{hst} \tag{4}$$

Table 5 shows that, accounting for product and time specific factors, the value of U.S. imports from these countries, as well as the the total number of suppliers exporting to the United States from these countries, shows no significant change from over the trade facilitation period. Over the same period, however, the number of U.S. importers buying from those countries, as well as the total number of buyer-supplier relationships formed from those countries, increased.

Table 5. Trade Facilitation and Source-Product Aggregates

	(1)	(2)	(3)	(4)
	$\ln Value_{hct}$	$\ln Buyers_{hct}$	$\ln Suppliers_{hct}$	$\ln Relationships_{hct}$
$Post_t$	-0.02	0.05***	0.01	0.02***
	(0.02)	(0.01)	(0.01)	(0.01)
Observations	196,000	196,000	196,000	196,000

Notes: Observations are at the product-source-year level. HS10 product and year fixed effects are included. Standard errors are clustered by HS10 product category. Observation counts rounded to comply with Census Bureau disclosure avoidance rules.

As above, I also make use of a treatment effect specification via a difference-in-differences methodology. The outcomes variables of interest are again U.S. imports, the number of U.S. buyers, the number of foreign suppliers, and the total number of relationships, all at the product-source level. The specification is:

$$\ln X_{hct} = \beta Post_t \times EP_c + \delta_t + \delta_h + \delta_c + G_{ct} + \varepsilon_{hst} \tag{5}$$

The $Post_t$ dummy again distinguishes annual data taken from the pre-EP period (2003–2006) versus the post-EP period (2016–2016), with year, HS10 product, and country fixed effects included. Source-year controls G_{ct}, both log GDP and log population from the CEPII database, are also included. The results are shown in Table 6, with the top panel showing how each outcome changes relative to all U.S. sources, while the bottom panel showing how each outcome changes relative to the smaller subset of sources with no (or negative) trade facilitation activity.

Table 6. Trade Facilitation and Country Aggregates

	(1)	(2)	(3)	(4)
	$\ln Value_{hct}$	$\ln Buyers_{hct}$	$\ln Suppliers_{hct}$	$\ln Relationships_{hct}$
Relative to All Countries				
$Post_t$	0.11***	0.18***	0.03***	0.09***
	(0.01)	(0.00)	(0.00)	(0.01)
$Post_t \times EP_c$	-0.26***	-0.15***	-0.09***	-0.13***
	(0.01)	(0.01)	(0.01)	(0.01)
$logGDP_{ct}$	0.21***	0.04***	0.12***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
$logPop_{ct}$	-0.57***	-0.20***	-0.24***	-0.20***
	(0.05)	(0.02)	(0.02)	(0.02)
Observations	2,025,000	2,025,000	2,025,000	2,025,000
Relative to Control Group				
$Post_t$	0.23***	0.20***	0.06***	0.13***
	(0.02)	(0.01)	(0.01)	(0.01)
$Post_t \times EP_c$	-0.29***	-0.14***	-0.06***	-0.10***
	(0.02)	(0.01)	(0.01)	(0.01)
$logGDP_{ct}$	-0.00	-0.05***	-0.07***	-0.07***
	(0.03)	(0.01)	(0.01)	(0.01)
$logPop_{ct}$	-0.29**	-0.07	0.22***	0.15***
	(0.12)	(0.04)	(0.05)	(0.05)
Observations	473,000	473,000	473,000	473,000

Notes: Observation counts rounded to comply with Census Bureau disclosure avoidance rules.

Column (1) of Table 6 shows that although the value of U.S. imports rose generally (as indicated by the non-interacted baseline post-period indicator), U.S. buyers tended to source *less* imports from countries that underwent trade facilitation activities relative to either set

of other countries. This result accounts for country, product, and time-specific variation, as well as country-time variation in GDP or population. Columns (2)-(4) demonstrate that this relative decline in imports from countries with trade facilitation occurred as there was less (relative) participation in international trade across all dimensions: fewer U.S. importers sourced from these countries, fewer suppliers exported to the United States, and, overall, there were fewer buyer-supplier relationships. Thus even though the total number of potential suppliers increased as a result of making exporting easier (as shown in earlier research), when controlling for product, time, and source fixed effects, there were actually less suppliers exporting to the United States relative to countries without trade facilitation. These results fit with the earlier intuition that trade facilitation leads to more specialized relationships that may be smaller, but are overall more resilient.

4 Model

I next describe a dynamic discrete choice framework that I use to model U.S. importer decisions of supplier choice. The goal of the model is to generate structural estimates of relationship frictions involved in an importer's choice of supplier. By applying the model to importer-supplier relationships in many different countries in many different time periods, we can examine how trade facilitation reforms affected these frictions.

4.1 The Supplier Choice Problem

Different suppliers set different prices for the same product j and have heterogeneous quality. Importers of products in that industry make a decision each period about which firm to import from, based on both their current supplier and information about other available price and quality menus. Switching suppliers involves payment of a set of per-unit costs, including both an overall switching cost and an additional cost to be paid if an importer finds a new partner in a new city. Each individual supplier of product j at time t is denoted as $x_{j,t}$, and suppliers are distinguished both by the price they charge to importer m, $p^m_{x,j,t}$ and by the quality of their individual variety $\lambda_{x,j,t}$. If importer m chooses the supplier indexed $x_{j,t}$, I denote this match as $x^m_{j,t}$.

How does an importer decide which supplier maximizes profits? I set up a maximization problem of discrete choice, along the lines of Fox (2010) and Monarch (2022). Within each product j, expected profits are calculated for each choice, and the supplier generating the highest expected profits will be chosen. Dropping the subscript j for now, I define the

supplier-specific expected log profit term for any choice x_t^m as $\overline{\pi}_t^m\left(x_t^m, \boldsymbol{\beta}\right)$:

$$\overline{\pi}_t^m\left(x_t^m, \boldsymbol{\beta}\right) = \xi\lambda_{x,t} + \beta_P \mathbb{E}\left[\ln p_{x,t}^m\right] - \beta_X 1\{x_t^m \neq x_{t-1}^m\} \tag{6}$$

where ξ is a quality shifter, β_P is a price shifter, and β_X represents the cost of switching that is paid when using a supplier different from the one used last period. I summarize the vector of unknown parameters as $\boldsymbol{\beta} = \{\beta_P, \beta_X, \xi\}$.

The final element of the importer's decision is a stochastic profit shock. For the dynamic profit problem, as in Rust (1987), I allow for a shock from choosing x_t that is observable to the importer, $\epsilon_{x,t}^m$. This profit shock stands in for all of the other unobservable traits not included in Equation (6) that may result in a match.

Equation (6) is the cornerstone of my estimation strategy. To summarize this equation in words, if importer m chooses a different supplier than it used in the previous period, then this firm must pay β_X. The parameter β_p is a measure of how sensitive switching is to changes in price, while ξ is a of measure of how sensitive switching is to quality. Estimating $\{\beta_P, \beta_X, \xi\}$ for each country-product will provide a measure of the frictions firms face in switching partners and locations, and it will enable the posing of a counterfactual to consider the price effects from changing such frictions. Importers pick the supplier that delivers the highest $\overline{\pi}_t^m$. Thus, the model solution is the set of parameter values by which observed supplier choices in the data deliver the highest expected profits for all importers compared to other potential choices.

4.2 Suppliers

Within any product category j there are numerous suppliers (indexed by x) producing individual varieties. They set price at time t based upon their firm-specific marginal cost, which in turn depends on their quality choice $\lambda_{x,t}$. I follow the same functional form for supplier quality as in Hallak and Sivadasan (2013), and continue to drop the j subscript. The optimal price is

$$p_{x,t} = \mu_x MC_{x,t} = \mu_x \frac{w_{x,t}}{z_x}\left(\lambda_x\right) \tag{7}$$

where z is the idiosyncratic productivity of supplier x, w is the wage, and, as before, λ is quality. I assume that suppliers simply set a constant markup μ_x over time. This functional form allows an importer to form price expectations for every supplier according a density $f\left(p_{x,t}|\mathbf{p_{t-1}}, x_{t-1}\right)$, where $\mathbf{p_{t-1}}$ is the set of all supplier prices charged in the previous period.

This setup imposes two key assumptions on supplier quality, λ_x. First, quality does not vary over time. Second, estimating quality according to Khandelwal (2010) as in the

empirical section forces me to ignore the potential for a supplier to offer different qualities of its variety to different importers.

4.3 Value Function

Entering period t, importer m has a collection of state variables that affect its optimal choice x_t^m, following the supplier-specific profit term given by $\overline{\pi}_t^m\left(x_t^m, \boldsymbol{\beta}\right)$ in Equation (6). Those state variables are the identity of the supplier used the previous period, x_{t-1}^m with location c_{t-1}^m, and (in order to form price expectations) the set of prices charged by all suppliers the previous period $\mathbf{p}_{t-1}$. Based on these state variables, the profit shock $\epsilon_{x,t}^m$, the costs of switching one's supplier, and the other components of $\boldsymbol{\beta}$, the importing firm will choose which supplier to use in the current period, x_t^m. After all choices are made, the true vector of prices $\mathbf{p_t}$ is realized, as is the matrix of next period's profit shocks $\boldsymbol{\epsilon_{t+1}}$. These states evolve according to the joint density $h\left(\mathbf{p_t}, \boldsymbol{\epsilon_{t+1}}\right)$.

Infinitely lived importer m chooses an supplier x in each period in order to maximize the present discounted stream of expected profits. With single-period expected profits described by Equation (6), the infinite-time problem for any importer (dropping the m superscript) is summarized by the following value function:

$$V\left(x_{t-1}, \mathbf{p_{t-1}}, \boldsymbol{\epsilon_t}\right) = \max_{\{x_t, x_{t+1}, \ldots\}} \mathbb{E}\left[\sum_{\tau=t}^{\infty} \delta^{\tau-t}\left(\overline{\pi}_\tau\left(x_\tau, \mathbf{p_{\tau-1}}, x_{\tau-1}, \boldsymbol{\beta}\right) + \epsilon_{x,\tau}\right)\right] \tag{8}$$

where the expectation is taken over the importer's knowledge about the possible evolution of $(p_{x,t}, \epsilon_{x,t+1})$, governed by the density $h\left(p_{x,t}, \epsilon_{x,t+1}\right)$ at every period t. The price from choosing supplier x_t is not known before making the choice, but it is predicted based on $\mathbf{p_{t-1}}, x_{t-1}$ and x_t, according to the density function $f\left(p_{x,t} | \mathbf{p_{t-1}}, x_{t-1}\right)$.

Writing the one-step ahead value of any variable a as a', the value function in Equation (8) can be rewritten as a Bellman Equation:

$$V\left(x, \mathbf{p}, \boldsymbol{\epsilon'}\right) = \max_{x'} \ \ \overline{\pi}\left(x', \mathbf{p}, x, \boldsymbol{\beta}\right) + \epsilon'\left(x'\right) + \delta EV\left(x', \mathbf{p}, x, \boldsymbol{\epsilon'}\right) \tag{9}$$

for

$$EV\left(x', \mathbf{p}, x, \boldsymbol{\epsilon'}\right) = \int_{\mathbf{p}'} \int_{\boldsymbol{\epsilon''}} V\left(x', \mathbf{p}', \boldsymbol{\epsilon''}\right) h\left(\mathbf{p}', \boldsymbol{\epsilon''} | \mathbf{p}, x, x', \boldsymbol{\epsilon'}\right) d\mathbf{p}' d\boldsymbol{\epsilon''}.$$

4.4 Switching Costs and the Role of Competition

The setup described above is a standard one in the empirical demand literature. Applications of the model often reflect the conventional wisdom that switching costs are the a hallmark of

less competititve markets- meaning, the presence of switching costs is consistent with higher overall prices and less competition. In the context of trade facilitation, this idea would be reflected in the fact that by inducing greater competition among exporters, trade facilitation will lead to lower switching costs between buyers and their suppliers. Importantly, this logic is separate from the idea that information frictions are reduced after trade facilitation; rather, more competition from the lowering of export barriers leads to lower prices and more switching. This is why the empirical results laid out in Section 2, in which the share of relationships staying together over time *increases* following trade facilitation, seem puzzling.

However, Dubé et al. (2009) show that the above model also fits neatly with a result in which greater competition goes alongside higher, rather than lower, switching costs. They show that under the same model, there can be scenarios in which firm pricing behavior actually induces the opposite result from the above intuition. Under the above model of competition with switching costs, firms have two competing incentives for their pricing behavior: firms can "harvest" a loyal customer by charging higher prices, or they can invest in future loyalty by charging lower prices. The extent to which either channel dominates is an empirical question, rather than baked into the model. Therefore, by inducing greater competition via trade facilitation reforms, the decision of firms to lower their prices can be thought of as one form of investment in maintaining their existing buyers rather than as an option needed to attract new customers, and this this additional investment may generate higher switching costs in the data, rather than lower switching costs.

Another way to think about this idea is that, in the context of Equation 6, the sensitivity of buyers to prices when considering which supplier to buy from β_P is less strong. Although there will be increased competition between sellers following the reform, especially in the context of differentiated products, buyers can become more choosy and look to be in relationships featuring a greater level of tailoring to their specific needs. Thus, movements in prices are no longer as important in determining their supplier of choice. To the extent that this hypothesis is borne out by the data, we would thus expect to see a shift in β_P such that the prices are less important in driving switching behavior. At the same time, the change in the relationship switching cost β_X will reflect both this competition channel as well as any decline in information frictions that makes it easier for buyers to switching their suppliers.

5 Implementation

This section describes how I take the model to the data. I begin by discussing the standard assumptions on the error terms $\epsilon^m_{x,t}$ that generate the probability of observing any particular match.

5.1 Conditional Choice Probability

First, as is common in the discrete choice literature, I make a key assumption about the joint density of the state variables and the profit shock: they evolve separately from each other.

Assumption 1. (Conditional Independence) *The joint transition density of* $p_{x,t}$ *and* $\epsilon_{x,t+1}$ *can be decomposed as* $h\left(p_{x,t}, \epsilon_{x,t+1}\right) = g\left(\epsilon_{x,t+1}\right) f\left(p_{x,t} | \mathbf{p_{t-1}}, \mathbf{x_{t-1}}\right)$.

I also assume that the profit shock ϵ is distributed according to a multivariate extreme value distribution, with known parameters:

Assumption 2. *The profit shock is distributed Type I Extreme Value (Gumbel). The cumulative distribution function* G *is* $Pr\left(\epsilon_t < y\right) = G\left(y\right) = \exp\left\{-\exp\left\{-y - \gamma\right\}\right\}$, *for* $\gamma = 0.577...$ *(Euler's constant).*

These assumptions allow computation of conditional choice probabilities for any outcome.[10]

Proposition 1. *Let the value of a present time variable a one period ago be written as* a_{-1}, *and one period in the future be written as* a'. *Given Assumptions 1 and 2, and grouping together the state variables as* $s = \left\{\mathbf{p_{-1}}, x_{-1}\right\}$, *the probability of observing a particular supplier choice* x^C *conditional on state* s *and parameters* $\boldsymbol{\beta}$, $P\left(x^C | s, \boldsymbol{\beta}\right)$, *is*

$$P\left(x^C | s, \boldsymbol{\beta}\right) = \frac{\exp\left[\overline{\pi}\left(x^C, s, \boldsymbol{\beta}\right) + \delta EV\left(x^C, s\right)\right]}{\sum_{\widehat{x} \in X} \exp\left[\overline{\pi}\left(\widehat{x}, s, \boldsymbol{\beta}\right) + \delta EV\left(\widehat{x}, s\right)\right]} \tag{10}$$

where the function $EV\left(x, s\right)$ *is the solution to the fixed point problem:*

$$EV\left(x, s\right) = \int_{s'} \log\left\{\sum_{x' \in X} \exp\left[\overline{\pi}\left(x', s', \boldsymbol{\beta}\right) + \delta EV\left(x', s'\right)\right]\right\} f\left(s' | s\right) \tag{11}$$

Proof *See Monarch (2022) Appendix B.*

5.2 Maximum Likelihood Estimation

The parameters $\boldsymbol{\beta}$ can be computed via maximum likelihood estimation. Let x_t^m be the observed choice of supplier at time t for importer m. Then the likelihood of observing m choosing x_t^m is

$$L\left(x_t^m | \mathbf{p_{t-1}}, x_{t-1}^m, \boldsymbol{\beta}\right) = P\left(x_t^m | x_{t-1}^m, \mathbf{p_{t-1}}, \boldsymbol{\beta}\right) \cdot f\left(p_{x,t}^m | \mathbf{p_{t-1}}, x_{t-1}^m\right)$$

[10] Artuç and McLaren (2015) derive a very similar conditional choice probability function for their model of mobility costs for workers affected by offshoring.

Thus, the total likelihood function for the set of importer choices ($m = 1, ...M$) at time t is:

$$\mathcal{L}(\boldsymbol{\beta}) = \prod_{m=1}^{M} P\left(x_t^m | x_{t-1}^m, \mathbf{p_{t-1}}, \boldsymbol{\beta}\right) \cdot f\left(p_{x,t}^m | \mathbf{p_{t-1}}, x_{t-1}^m\right)$$

The constraints for the maximization problem are the system of fixed point equations defined by Equation (11). To solve this problem, I follow the MPEC approach as described in Su and Judd (2012) and Dubé et al. (2012), namely an inner loop for solving the fixed point problem in Equation (11) for the constraint vector **EV** and $\boldsymbol{\beta}$, and testing each candidate $\boldsymbol{\beta}$ within the (log) likelihood function to see where the function is maximized. Thus the problem to solve is

$$\max_{\boldsymbol{\beta}} \log \mathcal{L}(\boldsymbol{\beta}) =$$

$$\max_{\boldsymbol{\beta}} \sum_{m=1}^{M} \log \frac{\exp\left[\overline{\pi}_t^m\left(x_t^m, s_t^m, \boldsymbol{\beta}\right) + \delta EV\left(x_t^m, s_t^m\right)\right]}{\sum_{\widehat{x}_t^m \in X} \exp\left[\overline{\pi}_t^m\left(\widehat{x}_t^m, s_t^m, \boldsymbol{\beta}\right) + \delta EV\left(\widehat{x}_t^m, s_t^m\right)\right]} + \sum_{m=1}^{M} \log f\left(p_{x,t}^m | s_t^m\right) \tag{12}$$

$$s.t.$$

$$EV(x_t, s_t) = \int_{s_{t+1}} \log \left\{ \sum_{x_{t+1} \in X} \exp\left[\overline{\pi}_{t+1}\left(x_{t+1}, s_{t+1}, \boldsymbol{\beta}\right) + \delta EV\left(x_{t+1}, s_{t+1}\right)\right] \right\} f\left(s_{t+1} | s_t\right) \tag{13}$$

Solving this problem produces maximum likelihood estimates for $\boldsymbol{\beta}$ for each product.

In order to estimate the above model, I need to solve the system of equations defined by Equation (13) for the unknown elements EV and $\boldsymbol{\beta}$. To do this, I discretize the price state space into N intervals, allowing me to rewrite Equation (13) as:

$$EV\left(x_t, \widehat{s}_t\right) = \sum_{\widehat{s}_{t+1}=1}^{N} \log \left\{ \sum_{x_{t+1} \in X} \exp\left[\overline{\pi}_{t+1}\left(x_{t+1}, \widehat{s}_{t+1}, \boldsymbol{\beta}\right) + \delta EV\left(x_{t+1}, \widehat{s}_{t+1}\right)\right] \right\} Pr\left(\widehat{s}_{t+1} | \widehat{s}_t, x_t\right) \tag{14}$$

where $\widehat{s}_t = \{\widehat{p}_{t-1}, x_{t-1}\}$, and $\widehat{p}$ is the midpoint of each price interval, chosen such that $\frac{1}{N}$ of all firms are in each interval. The MPEC maximization protocol uses values of the vector $\boldsymbol{\beta}$ that satisfy the fixed point Equation (14), given expected prices and price transition probabilities for each potential choice, and selects the vector that delivers the highest likelihood. As an example to fix ideas, suppose there are 30 exporters in an industry and N discrete price states. Then there are $30N$ possible state values and 30 possible choices, meaning that the vector **EV** contains $900N$ elements, one for each value of $EV\left(x_t, \widehat{s}_t\right)$. Thus, the constraint set in Equation (14) is a fixed point problem of $900N$ equations and $900N + 4$ unknowns, where the additional three unknowns are $\boldsymbol{\beta} = \{\beta_P, \beta_X, \xi\}$. Each of the possible values of $\boldsymbol{\beta}$

and **EV** that satisfy these constraints are tested in the objective function Equation (12) to see which gives the closest match between the estimated probabilities of a set of choices and the true choices. Asymptotic normal standard errors are calculated following Rust (1994). I set the number of discrete price states at $N = 5$.

Taking a step back, it is worth noting the important assumptions that the estimation procedure relies on for identification of the structural parameters. In particular, the model is designed so that there is no cross-product coordination between buyers and suppliers (a scenario considered in Blaum et al. (2018)), no size or market power effect on the decision of which supplier to buy from or what price would be charged, and no capacity constraint for suppliers. An additional assumption that underlies the model is that any supplier with the lowest price, accounting for quality, would be desired by all buyers if switching costs were minimal. Finally, the model assumes that switching costs are paid as per-unit costs, rather than as fixed costs. Each of these properties is likely violated to some degree in the buyer-supplier matches observed in the data, so the actual estimates of switching costs should be considered together with those caveats.

5.3 Data Requirements

In order to implement the model laid out above, I use the same U.S. import data as in Section 2. For any year of the import data, for each product j, I have data on matches between U.S. importers (m) and foreign suppliers (x), x_t^m, as well as the price paid for that particular match $p_{x,t}^m$ and the quality estimate for supplier $\lambda_{x,t}$.

Focusing on the effects of trade facilitation reforms on relationship frictions means that we require data for both pre-reform and post-reform periods. Thus I use relationship data from both "treatment" and "control" sources described in Table 2 for the years 2003–2006, as well as for the years 2013–2016, and estimate the dynamic discrete choice problem in each set of adjoining years. In other words, for any source country c, I estimate the parameter vector $\boldsymbol{\beta}$ product-by-product using supplier decisions over three pre-reform periods (2003-4, 2004-5, and 2005-6) and the three post-reform periods (2013-4, 2014-5, and 2015-6). Altogether, I run the estimation routine on over 5,000 different product-country-year combinations.

6 Results

In this section, I first summarize the estimated structural parameters. I then present results from a counterfactual experiment in which I change the value of the the switching costs while leaving the underlying the supplier-level data the same as the pre-period.

6.1 Parameter Estimates

Table 7 reports the weighted average estimates of the relationship switching friction β_X for each country that underwent trade facilitation reforms. In the table, I take the estimated product-level switching cost parameters by product-country-year, weight them by that product's share of total exports from that country in that year, then take the simple average of this weighted aggregate of the parameters.[11]

Table 7. Supplier Switching Cost Estimates

Country	$\bar{\beta}_{X,03-06}$	$\bar{\beta}_{X,13-16}$	% Change
Korea, Rep.	-3.13	-3.42	9.3
Thailand	-3.10	-3.47	11.9
Colombia	-2.52	-2.72	7.9
Costa Rica	-3.18	-3.59	12.9
South Africa	-2.68	-3.14	17.2
Turkey	-3.11	-3.33	7.1
Dominican Republic	-3.12	-3.57	14.4
Nicaragua	-2.90	-2.94	1.4
Cambodia	-2.96	-3.25	9.8
Mean	-2.97	-3.27	10.2

Notes: This table includes the simple average over annual switching cost parameter estimates for each time period, in which the annual switching cost parameter estimates are the import-weighted aggregate of product-specific switching costs.

The table shows that, as expected from the reduced form analysis that showed longer relationships in these countries (Column (1) of Table 4), we see an *increase* in switching costs after the trade facilitation reforms are undertaken for these countries. Across all these countries, the estimated β_X terms increase about 10% on average over this time.[12]

The empirical section showed the key finding that not only did relationship stickiness increase over time for these countries, but it also increased *relative to* countries that did not undertake reforms. Although the nature of the structural problem means that computing switching costs for all trading partners in all products would be too cumbersome, it is possible to consider the same experiment as above– examining changes in relationship switching costs relative to a control group of countries that did not undertake reforms. Table 8 runs the same specifications as above to determine if there are differential trends in the switching cost parameters. All columns include both HS10 product and country fixed effects. Columns (1)

[11] There are typically about 100-200 HS10 products per year for each source.

[12] In the description of how I selected the subset of source countries that undertook trade facilitation activities, I relied on a number of indicators, including the change in the overall Logistics Performance Index score, and from the World Bank "Trading Across Borders" dataset, the change in the cost per container exported, the change in the number of days needed to export, and the change in the overall "Trading Across Borders" score. I do not find evidence that any of these individual measures are correlated strongly with the change in the average switching costs.

and (2) conduct "before-after" regressions, showing that for countries engaging in trade facilitation, relationship switching costs grow larger (in absolute value) in the post-reform period, while for our control set of countries, there is no appreciable change in switching cost estimates over the two periods. The constant in each regression also shows that in the pre-period, switching costs were about 5% higher in the control group of countries, consistent with slightly higher relationship stickiness on average. Column (3) confirms that there is also a differential change between the treatment and control group: pooling all the estimates together shows that sources undertaking trade facilitation reforms had an increase in switching costs that is significantly different from the change in switching costs in countries that did not have such reforms. This matches the finding that relationships were more likely to stay together in these countries.

Table 8. Parameter Estimates: Reduced-Form Tests

	(1)	(2)	(3)	(4)	(5)	(6)
	β_X $EP_c = 1$	β_X $EP_c = 0$	β_X	β_X	β_P $EP_c = 1$	ξ $EP_c = 1$
$Post_t$	-0.45***	-0.05	-0.16***		0.86***	-0.18***
	(0.04)	(0.06)	(0.01)		(0.09)	(0.02)
$Post_t \times EP_c$			-0.18***			
			(0.01)			
σ				0.014***		
				(0.005)		
Constant	-2.91***	-2.98***	-2.95***	-3.12***	-0.67***	0.16***
	(0.02)	(0.04)	(0.02)	(0.03)	(0.05)	(0.01)
Observations	3,200	1,600	4,800	4,800	3,200	3,200

Notes: Observation Counts are rounded to comply with Census disclosure rules.

There is substantial variation in estimated switching costs across products. The share of importer-supplier relationships that remain together in a product is strongly correlated with the size of the estimated switching costs– the larger the switching cost, the more relationships remain together. Such a correlation is not surprising, since it is variation in such rates that identifies the switching costs. One other interesting finding from explaining differences in switching costs is related to the estimated elasticity of substitution for a particular product. Although earlier work (Monarch (2022)) showed that there is no meaningful correlation between switching cost estimates and substitution elasticity estimates estimated from U.S. aggregate import data as in Broda and Weinstein (2006), the existence of relationship-level prices allows for estimating the product-level elasticity at a finer level of disaggregation. Building on Hottman and Monarch (2020), Hottman and Monarch (2023) generate these elasticities at the HS6 level using U.S. import data from 1996-2018. Regressing these esti-

mates on the structural switching costs also reveals a strong correlation: Column 4 of Table 8 shows that the for more substitutable products (higher σ), switching costs tend towards zero, implying that switching is easier in products that are more substitutable.

Is there evidence that the trade facilitation reforms actually led to greater competition among suppliers? The estimates of the other structural parameters can help consider this question. Column (5) of Table 8 reports how the price elasticity of switching β_P changed for countries that engaged in trade facilitation. In the pre-period, the constant term demonstrates that elasticity is negative on average, meaning that higher prices generate lower supplier-specific profits for a U.S. importer and thus are likely to encourage greater switching behavior. Switching is correlated with a "race to the bottom" among suppliers. Interestingly however, in the post period, this elasticity increases and flips sign, such that now higher prices make supplier more attractive and are less likely to generate switches. Thus movements in the structural price elasticity estimates point to a story of greater competitive pressures in the source markets. A similar story emerges from examining the structural quality elasticity ξ in Column 6. In the pre-period, the relationship between quality and supplier-specific profits is positive: higher quality suppliers are attractive to U.S. importers, making switching away from them less likely. However, following the trade facilitation reforms, the sensitivity of U.S. importers to quality changes to be about neutral in total. Thus quality (i.e. price-adjusted market share of a supplier) is less important for the switching decision, consistent with the fact that we see U.S. buyers buying from smaller suppliers in the post-period, and again indicating that competitive pressure have risen following the reforms.

6.2 Counterfactual Experiment

I have shown above that relationship switching declines following trade facilitation reforms indicates that the improved composition of exporters is the dominant result of the policy. My next goal is to quantify the contribution of this improved composition of suppliers on prices.

In order to do this, I use the structural model to generate a counterfactual experiment in which the switching costs remain at their lower pre-reform level, but the composition of exporters reflects the post-reform economy. In other words, for each source country, I use the $\overline{\beta}_{X,03-06}$ estimates from Table 7 and include them in the supplier-specific profit equation for each post-reform year alongside the observed relationship data on prices and quality as well as the other structural parameters. I generate 1,000 Monte Carlo runs of data from the model in which buyers can potentially switch suppliers under the new parameter set but the same state variables as before, and and take the median change in realized prices, median realized quality, and median share of supplier switches across runs. I then weight prices

and quality by the importer's weight in a particular product (and sum supplier switches), then weight all three variables by the importance of that product in the overall sample of products. This allows me to determine via the structual model the effect of changes to the relationship switching costs. I use realized prices, rather than discretized prices to generate model results.

In this case, as expected, relationship switching increases, with lower relationship switching costs leading to about 6% less relationships remaining together than in the actual data. However, the decline in U.S. import prices is less than 0.5% on average: even with improved switching opportunities, the higher weight placed on higher-price suppliers in the importer's objective function means that switching is not occurring in order to obtain lower prices. Rather, higher prices are seen as indicative of a more specialized supplier more attune to its buyer's needs. That these changes arise due to greater competition in the reforming country shows that this channel has the most relevant impact on buyer-supplier relationships following trade facilitation.

7 Conclusion

This paper examines the effects of trade facilitation campaigns on relationships between U.S. buyers and foreign suppliers, quantify the resulting change in relationship switching frictions. U.S. sourcing patterns from countries that undertake trade facilitation activities change notably: compared to non-reforming sources, there are declines in U.S. imports and the total number of importer-supplier relationships following these reforms. These declines are driven by a changed composition of suppliers exporting to the U.S.- the typical supplier is smaller, there is less trade in the typical relationship, and the typical U.S. buyer uses more suppliers than before. Importantly, trade facilitation reform also leads to a more relationships staying together over time.

I consider these findings using a structural model in which higher switching costs between importers and suppliers arise alongside an increase in competition: there are strong incentives for differentiated suppliers to strategically invest in customer acquisition and maintenance. Estimating the structural model on the relationship data shows that relationship switching costs increase in the range of 7-18% following trade facilitation campaigns. Higher prices also become much less likely to lead to relationship switching than prior to reforms. I interpret these results as evidence of greater relationship-specific investment. I show in a counterfactual experiment that even if the lower level of switching costs prevailed in the later period, the effects on prices are minimal: although there would be significantly more switching, the changed composition of suppliers, and the greater competition between suppliers means that realized prices are little changed. Thus the effects on trade prices of any

reduction in information frictions due to trade facilitation are outweighed by the effects of greater supplier competition that arise through such campaigns.

References

Amiti, Mary, Stephen J. Redding, and David Weinstein, "The Impact of the 2018 Trade War on U.S. Prices and Welfare," *Journal of Economic Perspectives*, 2019, *33* (4), 187–210.

Artuç, Erhan and John McLaren, "Trade policy and wage inequality: A structural analysis with occupational and sectoral mobility," *Journal of International Economics*, 2015, *97* (2), 278–294.

Atkin, David and Amit K Khandelwal, "How distortions alter the impacts of international trade in developing countries," *Annual Review of Economics*, 2020, *12*, 213–238.

Bernard, Andrew B., Andreas Moxnes, and Karen Helene Ulltveit-Moe, "Two-sided heterogeneity and trade," *Review of Economics and Statistics*, 2018, *100* (3), 424–39.

Beverelli, Cosimo, Isabella Gourevich, Inga Heiland, Alexander Keck, Mario Larch, and Yoto Yotov, "Trade and welfare effects of the WTO Trade Facilitation Agreement," Technical Report, WTO Staff Working Paper 2023.

_ , Simon Neumueller, and Robert Teh, "Export diversification effects of the WTO trade facilitation agreement," *World Development*, 2015, *76*, 293–310.

Blaum, Joaquin, Claire Lelarge, and Michael Peters, "The gains from input trade in firm-based models of importing," *American Economic Journal: Macroeconomics*, 2018, *10* (4), 77–127.

Blum, Bernardo S, Sebastian Claro, and Ignatius Horstmann, "Facts and Figures on Intermediated Trade," *American Economic Review*, 2010, *100* (2), 419–23.

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

Cajal-Grossi, Julia, Rocco Macchiavello, and Guillermo Noguera, "Buyers' sourcing strategies and suppliers' markups in bangladeshi garments," *The Quarterly Journal of Economics*, 2023, *138* (4), 2391–2450.

Carballo, Jerónimo, Alejandro G Graziano, Georg Schaur, and Christian Volpe Martincus, "The effects of transit systems on international trade," *Review of Economics and Statistics*, 2022, pp. 1–41.

Dubé, Jean-Pierre, Günter J Hitsch, and Peter E Rossi, "Do switching costs make markets less competitive?," *Journal of Marketing research*, 2009, *46* (4), 435–445.

_ , Jeremy T Fox, and Che-Lin Su, "Improving the numerical performance of static and dynamic aggregate discrete choice random coefficients demand estimation," *Econometrica*, 2012, *80* (5), 2231–2267.

Duval, Yann and Chorthip Utoktham, "Has the WTO trade facilitation agreement helped reduce trade costs?: an ex-post analysis," 2022.

Engman, Michael, "The economic impact of trade facilitation," 2005.

Fontagné, Lionel, Gianluca Orefice, and Roberta Piermartini, "Making small firms happy? The heterogeneous effect of trade facilitation measures," *Review of International Economics*, 2020, *28* (3), 565–598.

Fox, Jeremy T, "Estimating the employer switching costs and wage responses of forward-looking engineers," *Journal of Labor Economics*, 2010, *28* (2), 357–412.

Francis, June and Colleen Collins-Dodd, "Impact of export promotion programs on firm competencies, strategies and performance: The case of Canadian high-technology SMEs," *International Marketing Review*, 2004, *21* (4/5), 474–495.

Freixanet, Joan, "Export promotion programs: Their impact on companies' internationalization performance and competitiveness," *International Business Review*, 2012, *21* (6), 1065–1086.

González, Javier López and Silvia Sorescu, "Helping SMEs internationalise through trade facilitation," 2019.

Hallak, Juan Carlos and Jagadeesh Sivadasan, "Product and process productivity: Implications for quality choice and conditional exporter premia," *Journal of International Economics*, 2013, *91* (1), 53–67.

Handley, Kyle, Fariha Kamal, and Ryan Monarch, "Supply Chain Adjustments to Tariff Shocks: Evidence from Firm Trade Linkages in the 2018-2019 US Trade War," Technical Report, National Bureau of Economic Research 2023.

Heise, Sebastian, "Firm-to-Firm Relationships and Price Rigidity Theory and Evidence," 2016.

Hottman, Colin and Ryan Monarch, "A Matter of Taste: Estimating Import Price Inflation Across U.S. Income Groups," *Journal of International Economics*, 2020, *127*.

_ **and** _ , "Who's Most Exposed to International Shocks? Estimating Differences in Import Price Sensitivity across US Demographic Groups," *International Finance Discussion Paper*, 2023, (1380).

Kamal, Fariha and Asha Sundaram, "Buyer-Seller Relationships in International Trade: Do Your Neighbors Matter?," *Journal of International Economics*, 2016, *102*, 128–140.

_ **and CJ Krizan**, "Decomposing Aggregate Trade Flows: New Evidence from US Traders," *US Census Bureau Center for Economic Studies Paper No. CES-WP-12-17*, 2012.

_ **and Ryan Monarch**, "Identifying foreign suppliers in US import data," *Review of International Economics*, 2018, *26* (1), 117–139.

Khandelwal, Amit K, "The Long and Short (of) Quality Ladders," *The Review of Economic Studies*, 2010, *77* (4), 1450–1476.

Martin, Julien, Isabelle Mejean, and Mathieu Parenti, "Relationship stickiness, international trade, and economic uncertainty," 2020.

Martincus, Christian Volpe, Jerónimo Carballo, and Alejandro Graziano, "Customs," *Journal of international economics*, 2015, *96* (1), 119–137.

Monarch, Ryan, ""It's Not You, It's Me": Prices, Quality, and Switching in US-China Trade Relationships," *Review of Economics and Statistics*, 2022, *104* (5), 909–928.

_ **and Tim Schmidt-Eisenlohr**, "Longevity and the value of trade relationships," *Journal of International Economics*, 2023, *145*, 103842.

Redding, Stephen J and David E Weinstein, "Aggregating from micro to macro patterns of trade," Technical Report, National Bureau of Economic Research 2017.

Reddy, Ketan and Subash Sasidharan, "Trade Facilitation and Global Value Chain Participation: Cross-country Analysis," *Foreign Trade Review*, 2024, p. 00157325241239720.

Rust, John, "Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher," *Econometrica: Journal of the Econometric Society*, 1987, pp. 999–1033.

_ , "Structural Estimation of Markov Decision Processes," in "Handbook of Econometrics, Volme IV," Elsevier Science B.V., 1994, pp. 3081–3143.

Su, Che-Lin and Kenneth L Judd, "Constrained optimization approaches to estimation of structural models," *Econometrica*, 2012, *80* (5), 2213–2230.

Wilson, John S, Catherine L Mann, and Tsunehiro Otsuki, "Assessing the benefits of trade facilitation: A global perspective," *World Economy*, 2005, *28* (6), 841–871.

A Appendix

Table A1. Change in Trade Facilitation Measures, 2007–2014

Country	ΔLPI	$\Delta Days$	$\Delta Cost$	$\Delta Score$	Export Reform	Import Rank
Germany	0.02	1	76	-1		5
Ireland	-0.05	0	113	-0.5		13
Switzerland	-0.17	0	295	-1.1		14
Singapore	-0.19	0	-10	0		26
Austria	-0.41	-1	122	-0.2	✓	31
Sweden	-0.11	0	64	-0.3		33
Denmark	-0.08	0	29	-0.2		38
Hong Kong SAR, China	-0.18	-1	2	0.4		42
Norway	0.15	0	320	-2.5		44
Finland	-0.19	0	75	-0.4		48
New Zealand	-0.1	0	20	0.3		55
Mean	0.17	-4.2	-635	7.3		

A.1 List of Reforms

- Countries identified as having trade facilitation reforms:
  - Korea, Rep.: 2009-Korea made trading across borders easier by upgrading the electronic data interchange system.
  - Thailand: 2009- Thailand reduced the time and number of documents for exporting and importing by upgrading the electronic data interchange system.
    2008-Thailand reduced the time required for trading across borders by implementing a system allowing electronic submission of customs declarations and simultaneous verification of data by different agencies.
  - Colombia: 2009- Colombia reduced the time for exporting and importing through the implementation of risk management procedures, electronic data interchange and electronic payment of customs duties and through improvements in the banking sector.
    2008- Colombia made trading across borders easier by extending operating hours for customs and the port in Cartagena.
  - Iraq: None
  - Costa Rica: 2008-Costa Rica made trading across borders easier by improving its electronic data interchange system and allowing electronic submission of cargo manifests before arrival of the goods.
  - South Africa: 2013- South Africa reduced the time and documents required to export and import through its ongoing customs modernization program.

- Turkey: 2008-Turkey made trading across borders easier by introducing an electronic data interchange system, improving information technology infrastructure and training some 2,500 customs officers and 14,000 traders.
- Angola: 2011- Angola reduced the time for trading across borders by making investments in port infrastructure and administration.
  2010-Angola made trading across borders easier through a customs improvement program that streamlined procedures and reduced the time and cost of trade.
- Algeria: 2008- Algeria made trading across borders more difficult by increasing the number of inspections carried out.
- Dominican Republic: 2009- The Dominican Republic reduced the time for exporting and importing through improvements in the online portal for customs documents, in risk-based inspections and in the banking sector.
  2008-The Dominican Republic made trading across borders easier by reducing the documentation requirements.
- Argentina: 2013- Argentina increased the time, cost and number of documents needed to import by expanding the list of products requiring nonautomatic licenses and introducing new preapproval procedures for all imports.
- Guatemala: 2008- Guatemala made trading across borders easier by implementing a new electronic data interchange system, training customs staff and improving its risk-based inspection system.
- Nicaragua: 2011- Nicaragua expedited trade by migrating to a new electronic data interchange system for customs, setting up a physical one-stop shop for exports and investing in new equipment at the port of Corinto.
- Cambodia: 2011- Cambodia eliminated preshipment inspections, reducing the time and number of documents required for importing and exporting.

- Countries identified as having not trade facilitation reforms:
  - Germany :None
  - Ireland :None
  - Switzerland :None
  - Singapore :None
  - Austria: 2008-Austria made trading across borders easier by introducing an electronic customs clearance system and a risk-based inspection system.
  - Sweden :None
  - Denmark :None
  - Hong Kong SAR, China :None
  - Norway :None
  - Finland :None
  - New Zealand :None

Source: https://subnational.doingbusiness.org/en/data/exploretopics/trading-across-borders/reforms