Trade Integration and the Fragility of Trade Relationships: Theory and Empirics

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Abstract

We provide a theoretical framework to analyze the effects of economic integration agreements on the stability of product-level trade relationships and verify the predictions empirically. Specifically, we examine how economic integration agreements affect the value of trade at the start of a new trade relationship, the length of trade relationships, and how quickly trade grows within a relationship. Using annual trade data at the 5-digit SITC level for over 180 countries from 1962 to 2005, we find evidence of an interesting dichotomy which highlights the relevance of trade costs. While economic integration increases the length and growth of trade relationships which started prior to the agreement, it reduces the length and growth of those started after the agreement. With respect to the starting size of trade relationships, economic integration lowers initial transaction volumes.

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1 Introduction

Economic integration agreements (EIA) are more common now than they have ever been with more than 50% of all observed trade taking place between countries which are economically integrated to some extent. The effects of EIAs on disaggregated trade outcomes, however, remains unexplained. While a removal of trade barriers can generally be expected to increase trade, the economic effects of formal arrangements are a matter of much empirical debate. In this paper we use a strategy that combines theory and emprics to test the effects of EIAs on trade outcomes.

We develop a dynamic model of international trade which allows us to track the entire evolution of a trade relationship: the size of initial exports, the duration, and the rate of growth. We do so by combining Meltiz and Ottaviano (2008) with Klepper and Thompson (2006), the former guiding the firm decision and the latter describing the evolution of the aggregate trade relation. As is common in most modes of trade with heterogeneous firms, a firm's decision to enter a market depends on its productivity and the characteristics of the destination market: size, trade barriers, and competitive environment. In our model, however, the decision to enter is only half of the story. Here, we require a firm to identify a possible partner in the country of destination and if it is successful in acquiring a partner, both parties establish a business relation. Business partners in the destination market appear and disappear following a process that is independent of the firm in the country of origin. Using this set-up we are able to track the evolution of trade relationships, which are the aggregation of business relations across the same country of origin and country of destination in a specific product category.

This model delivers predictions confirming many of the results of the duration of trade literature: trade relationships can and do cease to exist, the longer they remain active the less likely they are to cease, and the larger the relationship the less likely it is to cease. In addition to providing a theoretical grounding for these established results, our model also shows that the growth of a trade relationship is decreasing in its size and duration. Furthermore, the model generates clear and start predictions about the effect of economic integration agreements on disaggregated trade patterns. Trade relationships which are active when an agreement begins benefit from the agreement by becoming less likely to cease (longer in duration) and by growing faster. However, trade relationships which begin after the agreement are more fragile starting with lower values of trade, being more likely to cease (shorter in duration), and grow less.

The theory model contributes to an increasing literature that relates to exports dynamics. Most of this literature concentrates on the expansion of the geographical coverage of trade relations as a firm continues to access more distant markets. Chaney (2014) provides theory and evidence on the expansion of trade networks and the dynamic evolution of trade frictions. Albornoz et al. (2012) and Defever, Heid, and Larch (2010) using a simpler model of market access, provide evidence that current export relations influence the decision of where to export next. Complementary to those models, we provide the first theoretical model able to capture the dynamic evolution of existing trade relations. While we can provide static results pertaining to extensive margin of trade, we are more interested in characterizing the dynamics of the intensive margin of trade. This model is complementary to a recent set of papers that focus on the destination market, more so than on the firms in the country of origin. Bernard, Moxnes, and Ulltveit-Moe (2014) show that heterogeneity in the characteristics of the buyers in the destination market matters for explaining trade relationships. Using highly disaggregated Norwegian data, they find that the extensive margin of the number of buyers plays an important role in explaining variation in exports at the aggregate level and at the firm level. Carballo, Ottaviano, and Volpe Martincus (2013) use highly disaggregated data from Costa Rica, Ecuador, and Uruguay to show that while most firms serve only very few buyers abroad, the number of buyers and the skewness of sales across them increases with the size and the accessibility of destinations. Because we assume the process by which buyers are generated varies across destinations, we are able to explain the results in these papers. On this note, the process by which new possible business partners arrive is exogenous, but can be readily internalized along the lines presented in Arkolakis (2008). We sacrifice this elvel of complexity in the name of clarity.

In our empirical application we focus on the effects of trade liberalization on duration and growth of already active trade relationships and those which begin after trade liberalization, as well as the initial volumes with which these two types of trade relationships commence with. We do so by focusing on product level trade flows. The specific trade liberalization episodes we examine are not unilateral reductions in tariffs, but rather the initiation of bilateral or multilateral economic integration agreements.

A large and still growing literature aims to examine the effects of economic integration agreements (EIAs) on trade. The majority of papers in this literature focus on aggregate effects of integration agreements.[1] The most disaggregated approach using the gravity framework is offered by Anderson and Yoto (2011) who examine the effects of free trade agreements using 2-digit manufacturing goods data. Our contribution to the literature is to provide a comprehensive investigation of the effects of integration agreements on as detailed a level of analysis as possible.

The object of our investigation is a trade relationship defined as a pair of countries exchanging a product, for example, Argentina exporting beef to the United States. While the removal of trade barriers may affect trade relationships along many dimensions, we explore three specific aspects of trade relationships: the value with which a relationship starts, the uninterrupted length or duration of a trade linkage, and the growth rate of the volume of trade. According to our model, duration and growth

[1] See for example Baier and Bergstrand (2007) who estimate that free trade agreements, on average, double trade between member countries. While some studies, such as Carrère (2006) and Kohl (2012), allow for differences across individual arrangements, others estimate an average effect, based on a single dummy variable for all arrangements.

should increase for trade relationships active when liberalization takes place, while these features should decrease for trade relationships established after liberalization. The model also predicts that trade liberalization will have a negative effect on initial transaction volumes.

To conduct our investigation we analyze annual 5-digit SITC revision 1 imports data for the period from 1962 and 2005. We combine the trade flow data with the Database on Economic Integration Agreements constructed by Scott Baier and Jeffrey Bergstrand (2007). The database provides annual information on the existence of (various types of) economic integration agreements annually between pairs of countries.

Our model predicts and empirical results confirm that to fully understand the effects of economic integration agreements on product-level patterns of trade, it is of crucial importance to take into account the timing of a trade relationship relative to the timing of the agreement. More precisely, in the analysis, one must carefully specify when an agreement begins and whether a trade relationship started before or after the agreement. In terms of the hazard of trade ceasing, for example, using a single dummy variable to identify when an agreement is in effect results in an increased hazard rate of relationships in the wake of the agreement. However, adding a dummy identifying relationships which start *after* the agreement indicates a dichotomy in the agreement's effect. Relationships which started *before* the agreement receive a boost in the form of a *reduced* hazard, while those that start *after* the agreement face a *higher* hazard than those starting before. In addition, when we include a variable indicating how long an agreement exists, we find that the longer an agreement has been in place the higher the hazard faced by all active trade relationships.

Our results for growth rates and initial volumes are equally interesting. Results for trade growth are parallel to those for the hazard of trade ceasing. A single dummy variable identifying when an agreement is in place indicates that trade relationships covered by the agreement grow at a reduced rate. But this is a compositional effect whereby relationships already active when the agreement commences experience an increase in their rate of growth, while those which start after the agreement took effect experience a decrease in their rate of growth. Moreover, as the agreement grows older the growth rate of trade decreases at an increasing rate. Finally, an economic integration agreement reduces the initial volume with which relationships commence, with the effect being small at the beginning of the agreement and becoming larger as the agreement itself grows older.

Most similar to our work in terms of the hazard effects is Kamuganga (2012) who shows that regional trade cooperation within Africa reduces the hazard of exports ceasing across all types of agreements. Unlike our work, he specifies a single dummy variable to identify the existence of an agreement. As we demonstrate below, however, the effect of an agreement critically depends on whether the affected trade relationship started before or after the agreement. As a result our preferred specification includes several dummies to precisely identify all aspects of the timing of the effect of an agreement. In addition, our effort differs in methodology as Kamuganga (2012) uses the semiparametric Cox proportional hazard model, which has been shown to be ill-equipped to handle discrete data most common in trade applications (see Hess and Person 2012). We use random effects probit to estimate the hazard.

Much research has recently been devoted to investigating the duration of trade and determinants of the hazard of trade relationships ceasing. Besedeš and Prusa (2006a,b) first documented that U.S. imports relationships are predominantly of short duration and that duration depends on the nature of the product traded, with differentiated goods exhibiting a lower hazard than homogeneous goods. Subsequent research has shown that short duration is a universal characteristic, irrespective of whether product- or firm-level data are used or which country's relationships are examined.[2] More recently this literature has turned to examine the effect of trade policy on the hazard of trade ceasing. Besedeš (forthcoming) finds that NAFTA had a differential effect on the hazard of the three members' exports ceasing. Besedeš and Prusa (2012) note that, at least in the case of the U.S., antidumping increases the hazard of trade ceasing in an economically significant way.

The growth rates of active trade relationships and their determinants have been examined in several studies. Araujo, Mion, and Ornelas (2011), for example, use Belgian firm-level data to show that countries with weaker institutions experience faster growth of exports from a given exporting firm. Muûls (2014) also uses Belgian firm level data to examine the role of credit constraints on firm's exports, including their growth. Besedeš, Kim, and Lugovskyy (2014) find that more credit constrained exporters have faster growing relationships, conditional on survival. Our effort in this paper is much simpler in nature as we investigate the correlation between economic integration agreements, their starting point, and the growth of the volume, without providing a rigorous theoretical mechanism for the underlying effects.

Unlike the issue of the hazard of trade ceasing and trade growth, the final element of our investigation has rarely been studied before. Besedeš and Prusa (2006b) is one of a few papers to analyze the initial volume of trade at the start of a relationship; they show that trade in differentiated goods typically starts with lower volumes relative to homogeneous goods. Besedeš (2008) was the first to systematically investigate how initial volumes affect the survival probability of a trade relationship, showing that larger initial volumes are associated with longer lasting relationships and lower hazard rates.[3] In this paper we provide a novel analysis of how economic integration

[2]Using product-level data, Nitsch (2009) finds that German imports were of short duration, Jaud, Kukenova, and Strieborny (2009) note that exports of a large set of countries are similarly short, while Besedeš and Prusa (2011) and Carrère and Strauss-Khan (2012) report the same for a large set of developing countries. Görg, Kneller, and Muraközy (2012) arrived to similar results using Hungarian firm-level export data as do Cadot et al. (2013) for firm-level exports of four African nations.

[3]Most papers investigating the hazard of trade ceasing use the initial volume as an explanatory variable for the hazard reflecting a relationship's initial conditions, but few papers focus on

agreements affect the initial volume of trade.

2 Model

Assume two countries, origin o and destination d. We start with a few of definitions. A *business relation* consists of a firm in country o selling its product to a firm in country d. We refer to firms in the country of origin as *sellers* and firms in the country of destination as *buyers*. A *trade relationship* is an origin-destination-product triplet and it is the collection of all business relations trading in the same product category between the origin and the destination countries. Finally, a *trade spell* is a realization of a trade relationship or the period of time during which the trade relationship is active. Among other things, we are intereted in characterizing trade spells.

At the beginning, a seller identifies potential buyers and bids for a business opportunity to sell its product. We follow Klepper and Thompson (2006) and assume potential buyers of a particular product in the destination country appear following a Poisson process with parameter λ. Once a seller successfully contracts with a buyer, the business relation is active only for an exogenously determined length of time, z, drawn from the exponential distribution $H(z) = 1 - e^{-z/\mu}$ with mean μ. After period z, the buyer disappears.[4]

The probability that a seller will enter the destination market is θ and the size of the business relation is randomly drawn from a distribution $F(r)$ where r is the revenue of the seller. While most of the results below are independent of the exact form of θ and $F(r)$, we are interested in studying trade policy that affects these quantities. We can borrow the characterization of these two quantities from Melitz

understanding the determinants of the initial volume.

[4]The buyer disappears for at least two reasons. First, it could be that it went out of business following a random idiosyncratic shock. Second, it is possible the seller was replaced by a new firm selling the product to the buyer. This process of creative destruction is not modelled explicitly in this paper, but it can be rationalized along the lines of Klette and Kortum (2004). It is also possible to reconcile the idea of business relations with a model of advertising developed in Arkolakis (2008).

and Ottaviano (2008). In their model, firms in the origin country selling in the destination country incur per-unit trade costs $\tau > 1$. Trade liberalization is modelled as a reduction in τ, and Melitz and Ottaviano (2008) show that the probability of entry and the expected size and variance of the distribution of revenues increase as τ decreases.[5] That is:

$$\frac{\partial \theta}{\partial \tau} < 0 \tag{1}$$

$$\frac{\partial E[r]}{\partial \tau} < 0 \tag{2}$$

$$\frac{\partial var[r]}{\partial \tau} < 0 \tag{3}$$

2.1 Characterizing trade spells

Define $v_k(t)$ as the probability that a trade spell has exactly k business relations at time t. This probability is distributed according to:[6]

$$v_k(t) = e^{-\theta\rho(t)} \left(\theta\rho(t)\right)^k / k! \tag{4}$$

which is a Poisson distribution with parameter $\theta\rho(t) = \theta\lambda\mu\left(1 - e^{-t/\mu}\right)$. This is the probability that k firms draw costs lower than the cutoff cost $c < \hat{c}$ and that they had successfully bid for a business opportunity in the destination country. Notice that as time approaches infinity, $\rho(t)$ approaches $\lambda\mu$ and the stationary distribution is $v_k = e^{-\theta\lambda\mu}(\theta\lambda\mu)^k/k!$. In the long run, the probability that a trade spell has exactly k business relations is a function of the probability of entry and parameters associated with the process that generates buyers in the destination market. Because the probability of entry θ is affected by terms of trade trade policy affects the long

[5]While the results in Melitz and Ottaviano (2008) are well known in the field, we present in an appendix a simplified approach to characterize this solution.

[6]The proofs and several other derivations are in Klepper and Thompson (2006). We also replicate them here for completeness.

term stationary distribution of trade relationships.

2.1.1 Size, Duration, and Survival

Trade spells can become active or inactive at many points in time. A trade spell starts when a business relation was not present in period t and at least one exists in period $t + \Delta t$. Symmetrically, a trade spell ceases to exist when at least one business relation existed in period t and no such relation exists in $t + \Delta t$. The *duration* of a trade spell, $s(t)$, is then defined as the length of time that has elapsed since it was last inactive. In our model, trade relations can disappear and appear at various occasions across time. That is, there could be multiple spells of the same trade relationship.

The number of business relations in a trade spell is a function of the duration of the spell. Define $w_k(s(t), t)$ as the probability that a spell with duration s at time t has exactly k active business relations at time t. Then $w_k(s(t), t)$ is distributed Poisson according to:

$$w_k(s(t), t) = e^{-\theta\rho(s)} \left(\theta\rho(s)\right)^k / k! \tag{5}$$

with mean given by $\theta\rho(s) = \theta\lambda\mu\left(1 - e^{-s/\mu}\right)$, which is increasing in the duration of trade, s. Longer lasting spells should be larger if trade costs are lower.

Denote by $n(t)$ the number of business relations in a trade spell at time t. The size of the trade spell is $y = \sum_0^{n(t)} r$, where $n(t)$ is a random number and each term in the sum is a random draw from $F(r)$. It can be shown that the distribution of sizes of all active trade spells has mean

$$E[y] = E[r]\theta\rho(s) \tag{6}$$

and variance

$$\text{var}[y] = E[r^2]\theta\rho(s) \tag{7}$$

The quantities θ, $E[r]$ and $Var[r]$ increase when τ decreases, thus:

Result 1 *Holding everything else equal, more open trade relationships (with a lower τ) are necessarily larger and have a higher variance when compared to trade relationships with larger trade barriers (large τ).*

Because we have assumed the distribution $H(z)$ is exponential, the arrival of new sellers is independent of the duration of previous relationships and $n(t)$ is enough to explain the probability of exit. In other words, the more business relations in a trade spell, the lower the chance of a trade spell ending in any finite time period.

Result 2 *For any $t, T \in (0, \infty)$, the probability of a trade spell ending by time $(t+T)$ is strictly decreasing in $n(t)$.*

Moreover, both the duration and size of a spell are related to $n(t)$, but in different ways because size is drawn from a distribution that is independent of $n(t)$ and the process that generates clients. Therefore, the probability of exit will decline with the size of the trade spell, holding duration constant, and will decline with duration, holding firm size constant.

Result 3 *For any $t, T \in (0, \infty)$, the probability of a trade relationship stopping by time $(t + T)$ is decreasing in its size, $y(t)$, and age, $s(t)$.*

2.1.2 Growth

The model also allows us to describe the relationship between the growth rate of a trade spell and its size and duration. The growth rate of a trade spell is given by

$$g_y(t, t+T; y, s) = \frac{E(y(t+T|s)) - y(t,s)}{y(t,s)} = \left(\frac{\theta\lambda\mu E(r)}{y} - 1\right)\left(1 - e^{-\frac{T}{\mu}}\right) \tag{8}$$

which is a decreasing function of y, but is independent of the duration conditional on y.

Conditioning on survival, however, increasing the size of the trade spell, y, decreases the average growth rate. Smaller trade spells have a greater probability of disappearing, which reduces the overall growth rate. Thus, conditioning on survival increases the growth rates of younger spells more than older ones. Denote the mean growth rate of surviving trade spells as $g_y(t, t+T; y, s|n(t+T) > 0)$ and note the growth rate of disappearing trade spells as -1. The probability of trade spells disappearing is given by $\Pr\{n(t+T) = 0|y(t), s(t)\}$, then we can write the growth rate as

$$\begin{aligned} g_y(t, t+T; y, s) = {} & g_y(t, t+T; y, s|n(t+T) > 0)(1 - \Pr\{n(t+T) = 0|y(t), s(t)\}) \\ & + \Pr\{n(t+T) = 0|y(t), s(t)\}(-1) \end{aligned}$$

Now we can solve for the average growth rate, conditional on survival

$$g_y(t, t+T; y, s|n(t+T) > 0) = \frac{g_y(t, t+T; y, s) + \Pr\{n(t+T) = 0|y(t), s(t)\}}{1 - \Pr\{n(t+T) = 0|y(t), s(t)\}} \tag{9}$$

Given that the probability of a trade spell disappearing is decreasing in the duration and size of the spell, we obtain the following result:

Result 4 *Conditional on firm survival, the growth rate of a trade spell is strictly decreasing in size conditional on duration and strictly decreasing in duration conditional on size.*

2.2 Trade liberalization

There are two important results concerning the effects of trade liberalization on trade relationships: the fraction of firms exporting increases and the average size of the

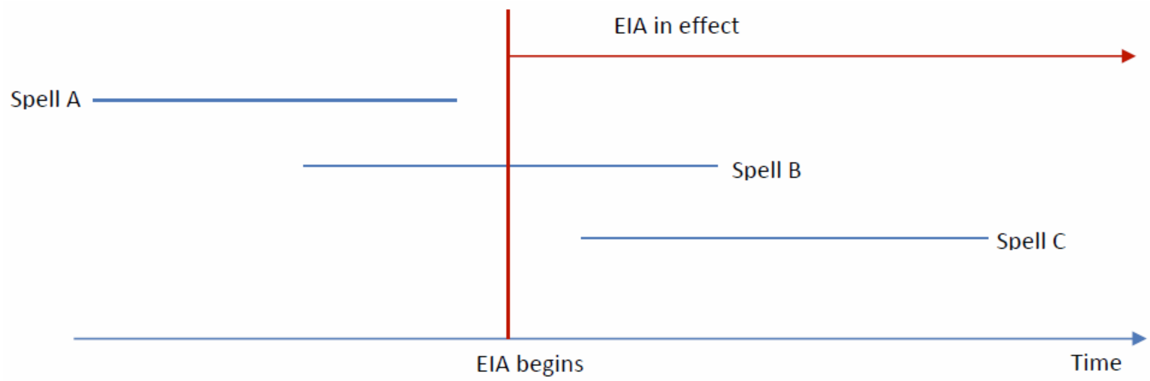

Figure 1: **Effects of trade liberalization on trade**

exporting firm increases. Characterizing the dynamic behavior of trade allows us to understand the effects of trade liberalization and to differentiate these effects depending on the timing of the trade liberalization event. Namely, we expect the effects of trade liberalization to affect existing trade spells differently than new trade spells formed after the event of trade liberalization.

To fix ideas, Figure 1 provides a schematic illustration of the types of trade spells a pair of countries can have as they relate to a trade agreement, or more generally an economic integration agreement (EIA), the countries enter into. The advent of an EIA allows us to distinguish between three types of spells. There will be spells such as spell A, which begin and end before the agreement goes into effect. These spells are unaffected by the agreement. There are also spells such as spell B which start before the agreement, but do not end until after the agreement goes into effect. These spells will be directly affected by the agreement. Finally, there are also spells, such as spell C, which only start after the agreement has been established.

In our model, trade spells formed before the episode of trade liberalization, such as B, are different from those formed after trade liberalization, such as C, for two reasons. First, business relations already in place receive an increase in their individual size because, while holding their productivity constant, they incur lower trade costs. As shown above, size, duration, and growth of a trade spell are inversely related to trade costs. Second, new business relations in the market are formed with less productive sellers than those that existed before trade liberalization. New entrants are marginal firms that are able to export only because their effective costs have been reduced. These two reasons combined allow us to characterize the behavior of trade relationships depending on when trade liberalization takes place:

Result 5 *Trade spells that started before the episode of trade liberalization last longer and grow faster as a result of trade liberalization. Trade spells starting after the episode of trade liberalization start smaller, exhibit lower growth, and have shorter duration than those that began before trade liberalization.*

Note that we have three sets of results, the empirical verification of which is solely a function of available data. Results 1 and 2 are verifiable only with very detailed firm-level data, where one observes some form of a business relation. This could be a destination-product pair, or if taken very literally, every single business partner a firm obtains in a foreign market. While the former types of data have become more readily available, the detailed nature on the latter types of data are not yet readily available.

Results 3 and 4 are the second set of results our model generates and pertain to spells of trade. Since spells of trade are some form of aggregation of the fundamental business relations our model is based on, required data to examine results 3 and 4 are more readily available. One could examine them using the aforementioned firm-level data or country-product- or country-industry-level data.

The third set of results are summarized by result 5 and pertain to the effect of trade liberalization on incumbent and newly started trade spells. To investigate this set or results we must combine trade flow data at the firm or more aggregated levels along with data on various kinds of economic integration agreements. In order to cast as wide a net as possible in terms of various kinds of economic integration agreements, we chose to conduct our empirical investigation using as large as possible data set with the richest coverage of both products, countries, and economic integration agreements. As a result, we use SITC revision 1 5 digit level data, which we describe next along with all other data we employ.

3 Data

We combine data from two sources. Trade flow data come from UN's Comtrade. We use the longest possible panel available with trade recorded annually from 1962 until 2011 using the 5-digit SITC revision 1 classification.[7] As Comtrade provides data on both imports and exports, we chose to use data as reported by importers given their widely perceived greater accuracy.[8] However, we shall, for the most part, simply use the term trade to avoid any confusion.

Data on economic integration agreements come from the Database on Economic Integration Agreements compiled by Scott Baier and Jeffrey Bergstrand (2007).[9] It collects data on various economic integration agreements as entered into by 195 countries on an annual basis between 1950 and 2005. Our sample observations are defined by the temporal intersection of our two sources, between 1962 and 2005.

One advantage of using trade data at the SITC revision 1 level, reaching back to 1962, is the relative paucity of economic integration agreements at the beginning of the sample period. Thus, for the vast majority of EIAs that have been in existence in the post-World War II period, we observe their effect from the start of the agreement itself. This would not be the case if we used data at the 6-digit HS product level as HS data start in 1989. In addition, most firm-level data sets are available for a period of time shorter than the 6-digit HS based datasets. To illustrate, consider Figure 2 where we plot the fraction of bilateral pairs of countries which have an active EIA in

[7] At the 5-digit level, there are 944 product categories.

[8] Since we use imports of all countries available through Comtrade, our analysis can be equivalently thought of as an analysis of imports or of exports.

[9] Available at `http://www.nd.edu/~jbergst`.

every year between 1950 and 2005.[10] We refer to this fraction as the EIA utilization rate. In 1950 the utilization rate is less than a half a percent. In other words, for 200 randomly chosen pairs of countries that could have an EIA, at most one actually had an EIA in place. In 1962, when our sample begins, the utilization rate increases to 1.1 percent. Thus, not taking into account the exact starting point of this small number of EIAs likely generates a small bias. By 1989, when the HS data become available, the utilization rate increases by an order of magnitude to 14.8 percent. The utilization rate reaches 21 percent by the end of our sample period.[11]

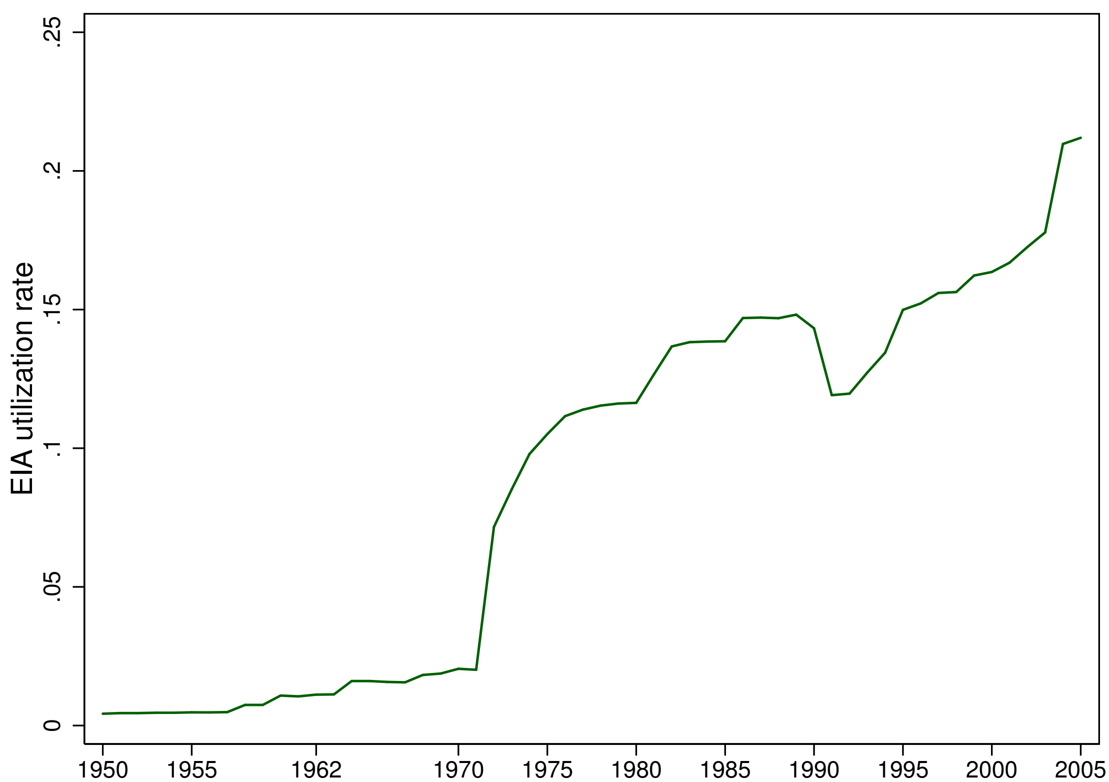

Figure 2: **Utilization of EIA over Time**

[10]This figure is similar to Figure 1 in Bergstrand, Egger, and Larch (2012) who investigate the determinants of the timing of preferential trade agreements using a duration framework. The two plots differ somewhat due to their inclusion of only PTAs, FTAs, and currency unions, and the fact that their plot is based only on agreements used in estimation. Our plot is based on all available data on agreements.

[11]The drop in the utilization rate in the early 1990s (1991 through 1994 to be precise) likely stems for the break up of the eastern block countries in Europe, Czechoslovakia, Soviet Union, and Yugoslavia. By 1995 the utilization rate returns to its pre-breakup levels.

Type of agreement	Number of observations	Number of observations used in estimation
None	16,990,281	15,237,989
Non-Reciprocal Preferential Trade Agreement	2,468,555	2,389,726
Preferential Trade Agreement	1,459,940	1,418,321
Free Trade Agreement	3,736,467	3,274,454
Customs Union	1,404,939	907,092
Common Market	1,122,545	906,884
Economic Union	465,962	375,559
Total	27,649,671	24,510,480

Table 1: **Number of Observations by Agreement Type**

There are a total of 29,671,095 observations on (positive) trade flows between 1962 and 2005. Of these we have no information on economic integration agreements for 2,021,121 observations (about 7% of trade flow observations), which account for 1.7% of total observed trade in our sample. In other words, these are bilateral observations on which the Database on Economic Integration Agreements provides no information. Most often this pertains to instances of trade with very small economies, or countries which disappeared during the observed period as the database does not offer a historical perspective on agreements involving countries which no longer exists (such as the former Soviet Union, Yugoslavia, or Czechoslovakia).[12]

Of the remaining 27,649,671 observations, some 61% involve pairs of countries which have no economic integration agreement in place at any point during the observed period of time. These observations account for 41.5% of all observed trade. The remaining observations account for 56.7% of all observed trade and belong to the six types of agreements in the data: non-reciprocal preferential trade agreements (NR-PTA), (reciprocal) preferential trade agreements (PTA), free trade agreements (FTA), currency unions, common markets, and economic unions. FTAs are the most common type of an integration agreement accounting for 14% of observed disaggre-

[12]One could interpret these as no agreement existing, but that would be incorrect as one would have to make sure no agreement in fact was in place.

gated trade flows, followed by non-reciprocal PTAs with 9% and PTAs with 5% of observations. Deeper integration schemes are typically less frequent. Currency unions account for roughly 5% of the pair-wise trade observations, while common markets account for 4% and economic unions for 2%. For the purpose of understanding the effect of economic integration on the product-level patterns of trade, we do not distinguish between the different types of agreements, but rather focus on the sheer existence of an agreement of some sort. This simplifying assumption allows to ignore issues arising from countries upgrading or downgrading shared agreements.[13]

While we are primarily interested in the effects of economic integration agreements we include standard variables capturing country characteristics, as is consistent with the Melitz and Ottaviano (2008) model. We use the CEPII gravity data as the source for both the exporter's and the importer's GDP, distance, and existence of a common border and a common language.[14]

Since we examine the effect of economic integration agreements on trade relationships we define as a unit of observation a continuous spell of service involving two countries and a specific product. By this we mean consecutive years, beginning with the clearly observed starting point, during which a trade relationship is active. We differentiate between spells and relationships since a relationship denotes an exporter-importer-product triplet, while a spell indicates a period of time when that relationship is active, as is consistent with our model.

In the forty four years in our data set relationships may be characterized, and frequently are, by multiple spells of service, a fact our model accounts for. There are a total of 3,109,559 trade relationships in our data with 7,191,964 observed active spells, or 2.3 per relationship. Some 45% of all trade relationships have only one

[13] The former is far more common than the latter. As an example, Germany and Austria signed a free trade agreement in 1973, upgraded it to a common market in 1994, and again to an economic union in 1999. To properly investigate the effects of specific types of agreements, we would need to control for such changes dynamically. We felt this worthy task is better left for a future paper.

[14] Available at `http://www.cepii.fr/anglaisgraph/bdd/gravity.htm`.

active spell, with 22% having two active spells, and less than 7% having six or more active spells. Table 2 shows that the vast majority of observed spells of trade are of very short duration, with slightly more than 55% of all spells observed for just a single year and 90% observed for seven or fewer years.

Spell length	Number of spells	Fraction of spells
1	4,009,321	55.7%
2	1,109,540	15.4%
3	507,534	7.1%
4	294,258	4.1%
5	213,270	3.0%
6	174,633	2.4%
7	115,726	1.6%
8	99,488	1.4%
9	80,455	1.1%
10	80,313	1.1%
11-20	327,288	4.6%
21-30	82,061	1.1%
31-43	98,077	1.4%
Total	7,191,964	100.0%

Table 2: **Distribution of Spell Lengths**

The last column of Table 1 shows the number of observations on each type of an agreement in the dataset used in estimation. Our estimation sample is smaller by 3,139,494 observations, or some 10%, due to two factors. The majority of these observations, 2,843,686 to be precise, have been deleted since they belong to spells of trade that are left censored from the point of view of conducting a duration analysis. For all spells which are active in the first year in which an importing country reports data, the actual beginning is not observed. For example, the first year in which the U.S. reports imports in our data set is 1962. Consequently, all spells involving the U.S. in 1962 are left censored, and we omit all such observations from our analysis. The remaining observations, almost 300,000, have missing gravity data and are not used.

4 Methodology

We are interested in three attributes of trade spells: the volume of trade in the first year, the growth of the volume of trade while the spell is active, and the conditional probability it will cease to be active or the hazard rate. As our model shows, when thinking about the effect of EIAs, the timing of the agreement as it relates to spells of trade is of critical importance. To put it differently, it is important to differentiate spells relative to the starting point of an agreement and to identify whether spells are active when the agreement starts or whether spells start after the agreement is in place.

The existence of different types of spells, such as B and C in Figure 1, guide our choice of the empirical specification. In order to properly capture all effects of economic integration agreements we use four variables. One variable, labeled 'EIA exists', identifies all pairs of countries which have ever had an agreement; this variable consistently takes on the value of one for a country pair which had an agreement over some subset of observed years, irrespective of its year of establishment. This variable allows us to examine whether spells such as A in Figure 2 exhibit a different hazard than spells of trade among countries which never enter into an EIA.

The second dummy variable, 'EIA in effect,' identifies the years during which an agreement is in force, thus identifying the differential effect of the agreement itself. Since our model predicts that relationships or spells which start after the agreement are different from already active ones, we use a thrid dummy variable, 'Spell starts after EIA,' which identifies all spells which started after the agreement is put in force. This variable identifies the differential effect on spells newly created after the agreement, such as spells C. Thus, the 'EIA in effect' variable identifies the effect on spells such as B, those already active when the agreement starts. The 'EIA in effect' and 'Spell starts after EIA' variables in conjunction identify the effect on spells which begin after the agreement is in effect.

The fourth variable measures how long, in logarithms, an agreement has been in place. This variable identifies at a micro level whether the effect of an agreement depends on how long it has been in place, as has been shown to be the case in aggregate measures by Baier and Bergstrand (2007) and Baier, Bergstrand, and Feng (2011).

5 Results

We discuss our empirical results in the same order as they were derived in Section 2. Since our data are not sufficiently detailed to examine Results 1 and 2, we first discuss Results 3 and 4. These two results have already been shown to hold in the literature, thus our discussion is purposefully brief and is included for completeness. We devote most of our discussion to Result 5, a result new to the literature.

5.1 Duration and Growth

Result 3 states that the probability of a trade relationship ceasing is decreasing in its size and age or duration. A natural way to examine this result is to estimate a hazard model where the hazard of interest is that of a trade relationship ceasing. Result 4 states that the growth rate is decreasing in size conditional on duration and decreasing in duration conditional on size. Both of these results have been examined empirically[15]. Our innovation is providing a theoretical model capable of delivering predictions about both duration and growth. As a result, our discussion of the first set of results is cursory.

To estimate the hazard of trade ceasing we estimate a random effects probit regression, while we use OLS to estimate the gross growth rate. We use the same set of explanatory variables in both regressions. We include the standard gravity variables,

[15] See Besedeš and Prusa (2006b), Nitsch (2009), and Besedeš, Lugovskyy, and Kim (2014) among others.

GDP of both the importer and the exporter, distance between the two, as well as a dummy indicating the existence of a common border and a common language that the two countries share. As implied by our model we include duration or age of a spell and its current size measured as the value of trade. The latter is the biggest departure in our analysis from the extant duration literature. The standard size variable used in the literature is the initial value of trade. Our specification for the growth regression is similar to Muûls (2014), who also includes the volume of trade in period t to explain the growth of firm-level trade from t to $t+1$.

	Hazard (RE probit)	Growth (OLS)
Duration	-0.433***	-0.080***
	(0.001)	(0.001)
Size (ln)	-0.126***	-0.224***
	(0.000)	(0.000)
Importer GDP (ln)	-0.013***	0.061***
	(0.000)	(0.000)
Exporter GDP (ln)	-0.086***	0.029***
	(0.000)	(0.000)
Distance (ln)	0.123***	-0.026***
	(0.001)	(0.000)
Contiguity	-0.110***	0.072***
	(0.002)	(0.002)
Common language	0.000	0.002**
	(0.001)	(0.001)
Constant	1.328***	0.873***
	(0.006)	(0.015)
Observations	24,510,480	17,335,923
Relationships	3,109,593	1,841,746
R^2	.	0.116
Log-Likelihood	-10,174,305	-29,288,034
ρ	0.168***	

Robust standard errors in parentheses, with *, **, *** denoting significance at 10%, 5%, and 1%.

Table 3: **Hazard and Growth Regressions**

Results collected in Table 3 are consistent with the predictions of our model and are in line with the literature. Both the hazard and the growth rate are decreasing in duration, indicating that longer lived spells are less likely to cease and also grow less. Both are also decreasing in size, indicating that larger spells are less likely to cease and also grow less. Our results for growth are consistent with Muûls (2014) who examines firm-level growth and finds it to be decreasing in age as well as size. We show in the appendix that the size of a trade relation , in expected value, is increasing in the size of the markets they attend to. Accordingly, as following directly from Result 3, spells involving larger countries are less likely to fail and grow faster. Simiarly, trade barriers decrease the probability fo entry and the expected size of the business relation. Thus, as expected, distance increases the hazard and reduces the growth rate, while contiguity has the opposite effects reducing the hazard and increasing the growth. Common language has no effect on the hazard and only a small marginally significant effect on the growth.

5.2 Effects of Economic Integration Agreements

We examine how economic integration agreements affect three characteristics of trade relationships: initial size, hazard of ceasing, and growth rate. For each of these characteristics, we examine the effect of a generic economic integration agreement. To do so we add three dummy variables to the set of variables used in Table 3: the existence of an agreement between two countries (EIA exists), the agreement being in effect (EIA in effect), and a spell of trade starting after the agreement is in effect (Spell starts after EIA). We then examine a specification which includes a variable measuring how long the agreement has been in place. We collect all results in Table 4.

5.2.1 Initial volume of trade

Our first investigation pertains to the effect of economic integration agreements on the initial volume of trade. Since we are examining a single value at the starting point of a spell, our ability to identify different effects of economic integration agreements

	Initial Value (OLS) (1)	Hazard (RE probit) (2)	Growth (OLS) (3)	Initial Value (OLS) (4)	Hazard (RE probit) (5)	Growth (OLS) (6)
Duration		-0.423***	-0.085***		-0.424***	-0.085***
		(0.001)	(0.001)		(0.001)	(0.001)
Imports (ln)		-0.126***	-0.225***		-0.126***	-0.225***
		(0.000)	(0.000)		(0.000)	(0.000)
Importer GDP (ln)	0.163***	-0.010***	0.063***	0.170***	-0.010***	0.063***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Exporter GDP (ln)	0.102***	-0.087***	0.028***	0.103***	-0.087***	0.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance (ln)	-0.190***	0.108***	-0.030***	-0.176***	0.106***	-0.030***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Contiguity	0.218***	-0.114***	0.075***	0.233***	-0.115***	0.075***
	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)
Common language	0.030***	-0.003**	0.004***	0.058***	-0.004***	0.004***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
EIA exists	0.075***	-0.084***	0.004***	0.121***	-0.094***	0.004***
	(0.003)	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
EIA in effect	-0.374***	-0.189***	0.044***	-0.168***	-0.249***	0.045***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
Spell started after EIA		0.255***	-0.099***		0.249***	-0.098***
		(0.002)	(0.002)		(0.002)	(0.002)
Duration of EIA				-0.017***	0.006***	-0.000**
				(0.000)	(0.000)	(0.000)
Constant	7.260***	1.455***	0.914***	7.023***	1.538***	1.055***
	(0.010)	(0.006)	(0.016)	(0.010)	(0.007)	(0.016)
Observations	7,174,557	24,510,177	17,335,722	7,174,557	24,510,177	17,335,722
Relationships	3,109,593	3,109,593	1,841,746	3,109,593	3,109,593	1,841,746
R^2	0.035		0.116	0.038		0.116
ρ		0.166			0.166	
Log-Likelihood	-15,454,211	-10,166,236	-29,284,109	-15,445,077	-10,165,975	-29,284,106

Robust standard errors in parentheses for OLS regressions with *, **, *** denoting significance at 10%, 5%, and 1%.

Table 4: **Effects of Economic Integration Agreements**

is reduced. A spell either starts before or after the agreement. As a result, the effect of an agreement taking effect only applies to spells starting after the agreement. We use an identifier of pairs of countries which have an agreement at some point during our sample period (EIA exists), a dummy variable identifying the years when the agreement is in effect (EIA in effect), and a variable reflecting how long the agreement has been in effect when a spell starts.

We obtain intuitive results for the standard gravity variables also predicted by our model. Larger economies, both on the exporting and the importing side, typically start their trade relationship with larger initial volumes. Distance reduces initial volumes, while contiguity and common language increase it. Turning to our measures of interest, we find that countries which at some point have an economic integration agreement start their trade relationships at the product level with 0.075 to 0.121 log points larger initial volumes. However, this advantage is more than completely eliminated once an agreement is in effect. Initial volumes are 0.168 to 0.374 log points smaller after the start of an agreement. In addition to the fixed (with respect to time) effect of an agreement, a reduction of 0.168 log points, there is a time-dependent (length of an agreement) effect as well of 0.017 log points per year indicating a decrease in initial volumes as the duration of an agreement increases.

5.2.2 Hazard of trade ceasing

We estimate the hazard of trade ceasing by using random effects probit technique, which allows us to take into account unobserved heterogeneity. The use of a probit estimator necessitates that we specify how the hazard depends on the duration of a spell for which we use the logarithm of the current length of the spell (age) at every point in time (measured in years). To evaluate whether a variable has a significant effect on the hazard we first calculate the predicted hazard at the mean of every variable and then calculate the predicted hazard while changing the value of the variable of interest. For example, to evaluate whether spells of trade between countries with an economic integration agreement have a significantly different hazard, we would calculate and plot the estimated hazard with the EIA exists dummy first set to zero and then set to one, while keeping all other variables at their respective means. We plot both the estimated hazard along with the 99th percentile confidence interval, which is plotted with dotted lines.[16] As long as the confidence intervals do not overlap, the effect of common border is deemed to be statistically significant.[17] In fact, in virtually every plot we examine below, we find that the differences are statistically significant. Such an approach to examining the effect of a covariate is necessary as the effect and the precision with which it is estimated depend on the standard errors of all estimated coefficients, all pairwise covariances, and the distributional specification of the probit model.

Results in Table 4 for gravity variables are in line with the literature. Trade involving larger countries is less likely to cease, as is trade between neighbors and countries sharing a common language, though the latter has a very small effect. Distance increases the likelihood that trade ceases, resulting in shorter spells between trading partners farther apart. Longer lasting spells are less likely to cease as are larger spells.

Turning to the effects of economic integration agreements, countries which at some point share an agreement have trade spells which are less likely to cease. As predicted by our model, the effect of an agreement on already active spells is to reduce their likelihood of ceasing, thus making them longer. However, spells which begin after the agreement is in place are more likely to cease. As indicated by results in column (5),

[16]We include confidence intervals for every plotted curve throughout the paper. The corresponding confidence interval is always represented with a dotted line and of the same color as the curve depicting the predicted hazard. In most instances the confidence interval is imperceptible given the high precision of our estimated coefficients and the large number of observations on which they are based.

[17]See Sueyoshi (1995) for a longer discussion of how to evaluate whether the effect of a variable is significant when using a probit approach to estimate the hazard and Besedeš and Prusa (2012) for an application in international trade.

the longer an agreement is in place, the more likely are new spells to cease.

While our results indicate that economic integration agreements have the effects our model predicts, the estimate coefficients themselves are silent on the magnitude of these effects. To examine the magnitude and properly evaluate the statistical significance of the effects, we turn now to predicted hazards. Since our results and our model indicate that taking into account the timing of when an agreement takes effect and when a spell starts is important, we evaluate the effects of these variables under the following set of arbitrarily chosen characteristics. As our benchmark we will compare the hazard for pairs of countries with and without an agreement at some point (as identified by the variable 'EIA exists'). For the latter group, we will also examine the effect of the onset of an agreement. According to the results reported in Table 4, the onset of an agreement affects the hazard of a relationship ceasing. We will examine, for illustrative purposes, the hazard profile for spells which are in their sixth year as the agreement comes in effect.[18]

There is an additional effect for spells active when the agreement goes into force due to the length of the agreement being in effect. For spells which start after the agreement we assume that they start in the sixth year of the agreement being in effect. Given the small magnitude of the coefficient on the length of an agreement, changing in which year of the spell an agreement starts or in which year of the agreement a spell starts, only has minimal effects on our plotted hazard profiles.

We note that when examining the effect of an EIA on either already active spells or spells which start after the EIA, we evaluate the effect for the remaining possible duration of a spell given the time span of our data. Thus, for those spells affected by an EIA in their sixth year, we examine the effect during the remaining 37 possible years, even though the vast majority of spells do not make it into year six, let alone

[18]Note that given the distribution of spell lengths (as tabulated in Table 2), a full 85% of spells do not make it into year six, our chosen year to illustrate the effects of EIA. This should not be particularly troubling as year six was chosen purely for illustrative purposes. Moving the onset of the EIA to an earlier year of the spell would not drastically affect our conclusions.

year 40. For spells which begin after the EIA, we plot the estimated hazard for 43 years, even though we can observe only a handful of such spells. To summarize the effect of an EIA, we average the differences between different hazard profiles over all available years. To summarize the effect of an EIA on already active spells, we calculate the difference in the hazard of spells affected by an EIA and those unaffected over the years 6 through 43, average the difference and divide it by the average hazard over years 6 through 43 for unaffected spells.

We collect the plots in Figure 3 where the plots corresponding to column (2) of Table 4 are in the first row and those corresponding to column (5) are in the second row. Plots are organized by columns as well, with the first column showing the difference in the hazard profile for pairs of countries with and without an agreement. The second column shows the effect on an active spell of an agreement starting in the spell's sixth year of activity. Finally, the third column shows the effect on spells which start once the agreement is in its sixth year of existence.

The difference between the hazard for country pairs that have an agreement and those without an agreement is small in an absolute sense, averaging 0.89 percentage points, and ranging from 3.35 percentage points in the first year of a spell and 0.14 percentage points in year 43. These small absolute differences are larger in a relative sense, with countries with an agreement having on average 17.36% lower hazard ranging from 7.05% lower hazard in the first year and 21.29% lower hazard in the last year. These differences are slightly larger for the plot in the second row, corresponding to column (5) of Table 4, which average to a relative difference of 18.85%.

The signing of an agreement reduces the hazard by an average of 1.42 percentage points, which is a relative reduction of 49.03%. Accounting for how long an agreement has been in place amplifies the differences, increasing the absolute effect to 1.82 and the relative effect to 54.77%. For spells which start after the agreement the hazard is almost identical to that for countries without an agreement. The absolute difference

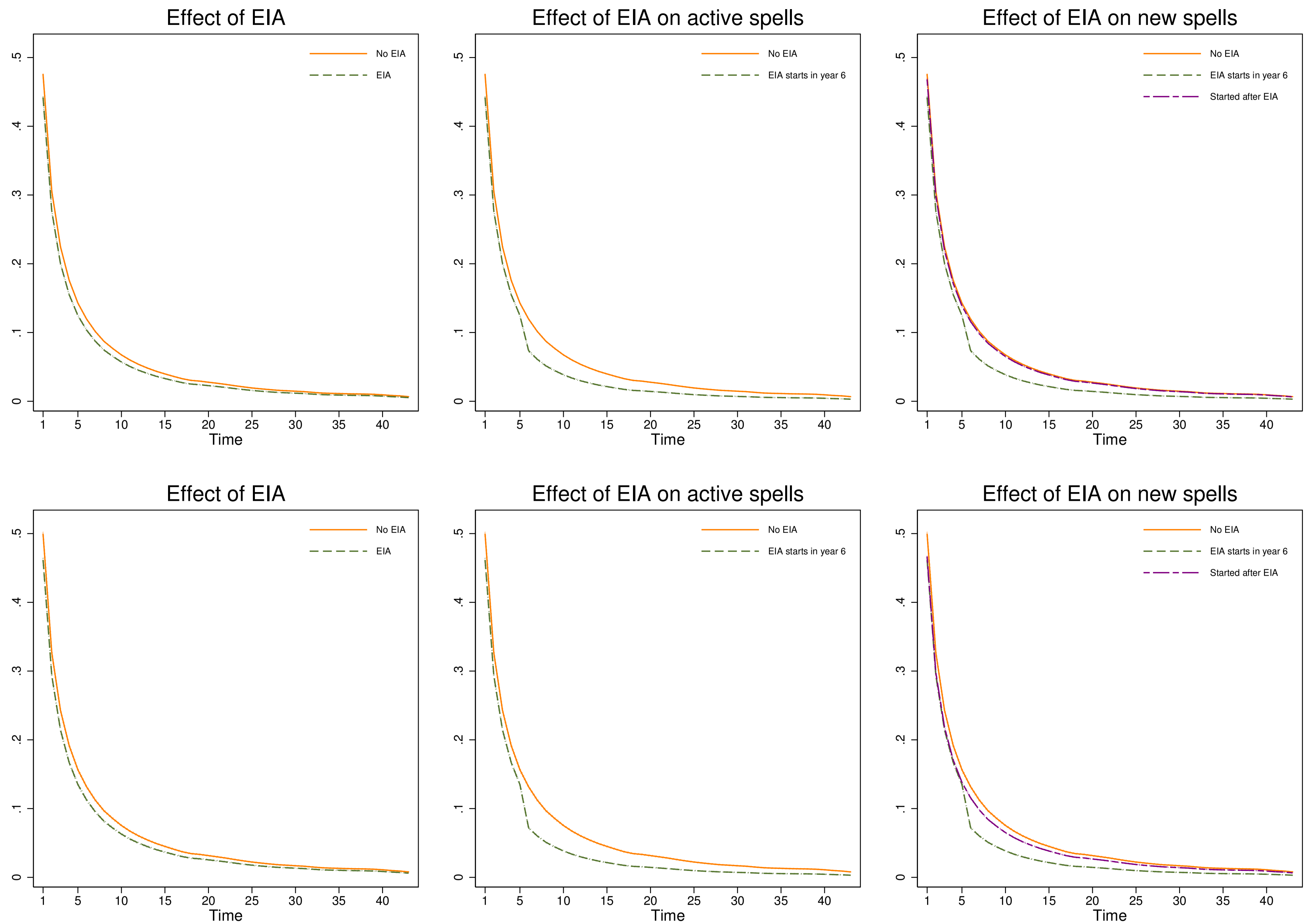

Figure 3: **Simulated Effects of EIAs on Hazard**

between the two is just 0.12, with spells started after an agreement having the lower hazard, which averages to a relative difference of just 4.34%.

To better understand the impact of each of the four EIA related variables used in the third specification, we offer Figure 4. In each panel we plot the estimated hazard with each of the four variables set to zero and one. Thus, the relevant comparison is to the hazard faced by spells of trade between countries that never share an agreement. This illustrates the pure effect over the entire possible length of a spell of each variable in turn in the absence of the other three variables. Clearly, some of these effects are impossible to observe in some circumstances,[19] but these plots allow us to clearly illustrate the effect of each variable and better understand how they combine to affect the hazard of trade ceasing.

The four plots in Figure 4 indicate that the smallest effect is exerted by the length of the agreement which increases the hazard. The effect is barely noticeable and averages just 0.13 percentage points or 4.8%. Countries which at some point enter into a mutual agreement face a lower hazard for their spells of trade, with the effect averaging 0.63 percentage points, or 19.85% lower hazard. The effect of the agreement going into effect is also to reduce the hazard, on average by 1.47 percentage points, or 45.07% lower hazard. Spells which start after an agreement face on average a 2.23 percentage point, or 73.24% *higher* hazard. Thus, while potentially appearing low, the effects of economic integration agreements are economically large. Note that the full effect of an agreement on spells which start after the agreement is composed of the beneficial effect of the agreement itself and the negative effect of having started after the agreement, with the negative effect dominating.

Thus, we can conclude that an economic integration agreement has a dual effect on the hazard of trade ceasing, just as our model predicted. It reduces the hazard for spells already active, but increases it for any spell which starts subsequent to the

[19]For example, any spell already active when the agreement starts cannot be affected by the agreement in the spell's every year of duration.

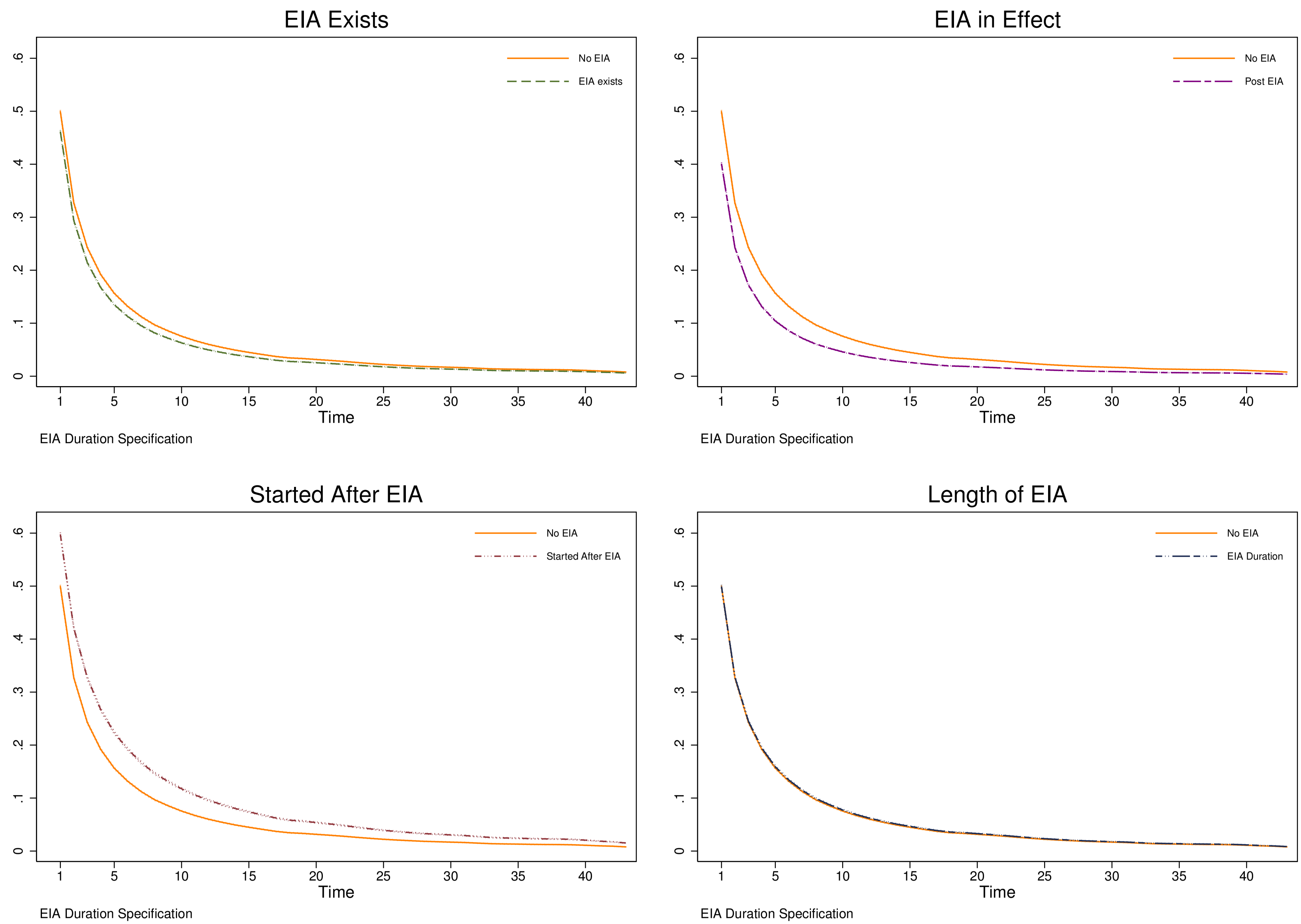

Figure 4: **Pure Effects of EIAs on Hazard**

agreement. To put it in different terms, economic integration seems to promote the stability of trade spells active when the agreement is signed and reduces the stability of those which commence in its wake.

5.2.3 Growth of trade

We now turn to examining the effect of economic integration agreements on the growth of trade embodied in active spells. In particular, we examine the growth of trade conditional on spell survival. To put it differently, we are not concerned with explaining the negative growth that occurs with the complete decrease in the volume once the spell ends. In our specification of the growth of trade regression we follow Besedeš, Kim, and Lugovskyy (2014) and include spell number, calendar year, spell length, and 3-digit SITC level fixed effects.[20] Our results are collected in columns (3) and (6) of Table 4.

Similar to the results of Besedeš, Kim, and Lugovskyy (2012), we find that the rate of growth of trade within a spell decreases the longer the duration of the spell, just as our model predicts. Larger spells grow less. Distance reduces the rate of growth, while contiguity increases it as does common language.

The effect of economic integration agreements is as our model predicts. Countries with an agreement have a slightly higher growth of their trade, by 0.4%. The agreement increases that effect ten-fold to an additional 4.4% faster growth for already active spells, but spells which start after the agreement have a significantly lower rate of growth, by 9.9%. The longer the agreement is in place, the lower is the rate of growth of new spells, though the effect is economically insignificant, being smaller than 0.1%.

To illustrate these magnitudes we produce Figure 5, which is similar in nature to

[20] The additional fixed effects are not used in the hazard analysis due to their computational infeasibility, both in terms of the length of computation and the fact that probit does not lend itself very well to a specification with many fixed effects.

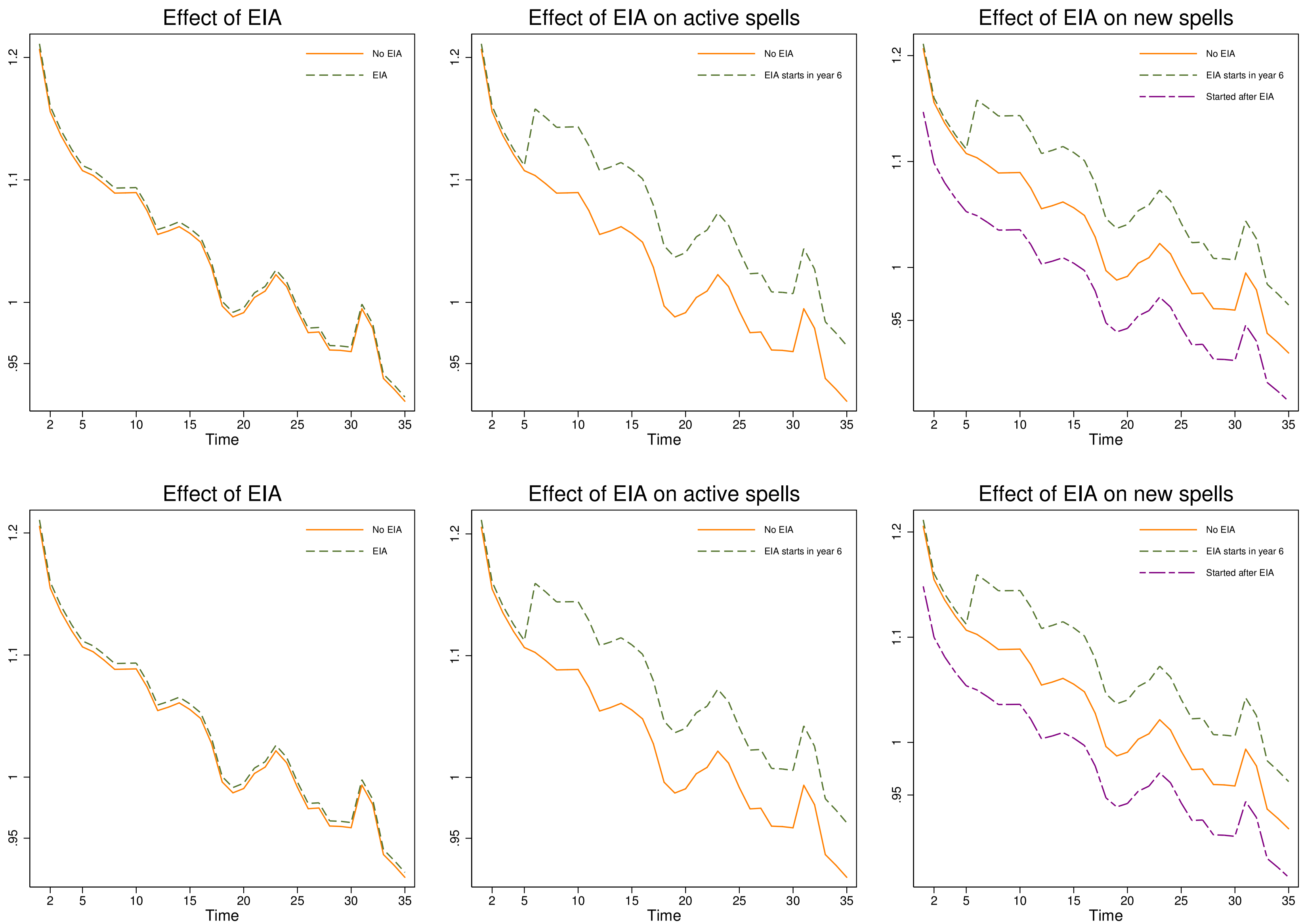

Figure 5: **Simulated Effects of EIAs on Growth**

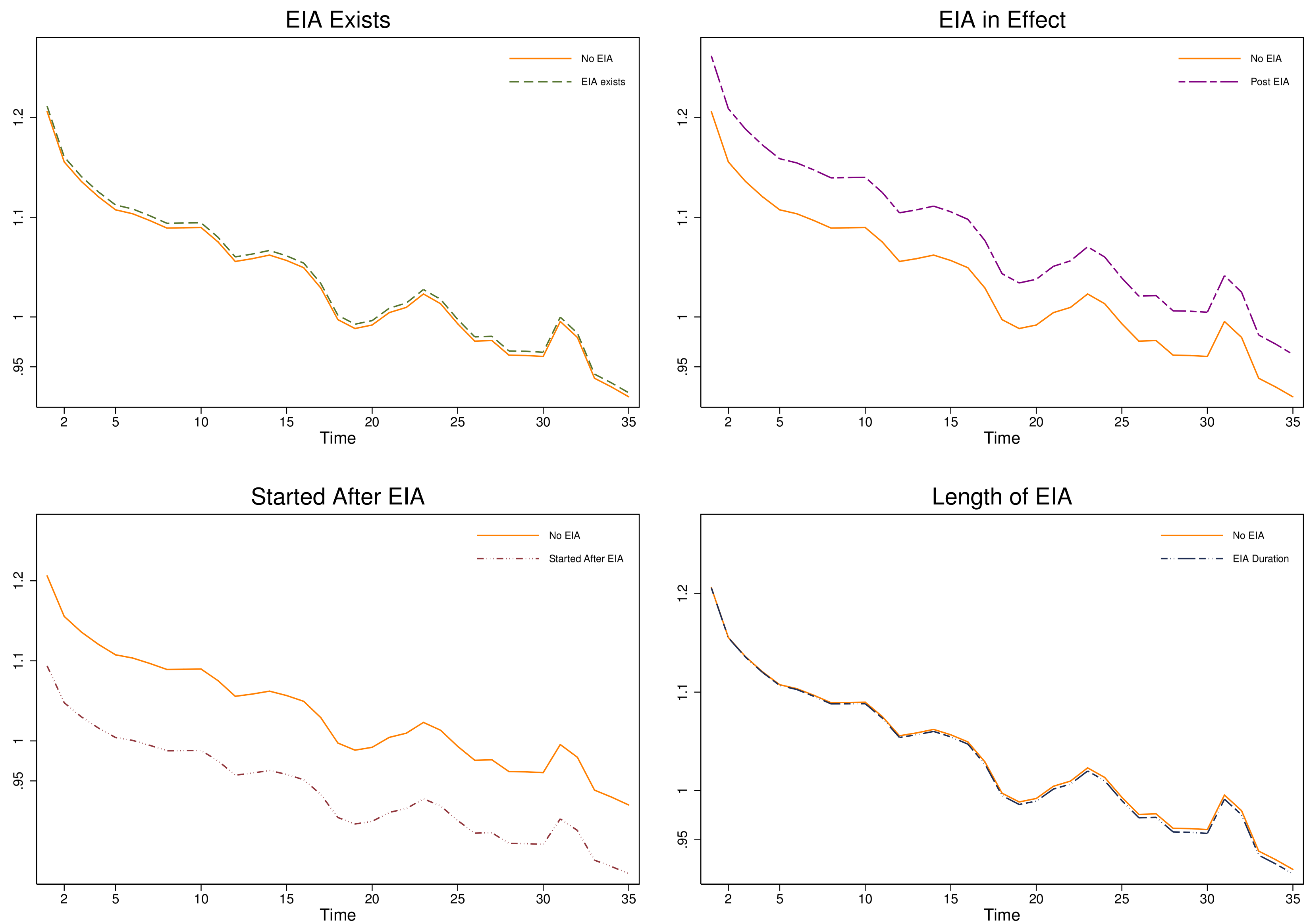

Figure 6: **Pure Effects of EIAs on Growth**

Figure 3. We fit our model at the average of all our variables and examine the effect of EIA on the predicted growth rate. The reduction in the growth rate for spells which start after the agreement is stark. Figure 6 illustrates the pure effects graphically.

Thus, we can conclude that economic integration agreements have a positive effect on the growth of spells already active when an agreement starts but a much limited effect on spells which started after the agreement.

6 Conclusion

In this research we characterize the dynamic behavior of trade, on both the intensive and extensive margin, and analyze the effects of trade liberalization on trade dynamics. We start by building a theory model that characterizes aggregate trade behavior starting from firm decisions. We characterize the decision of the firm using Melitz and Ottaviano (2008) and aggregate to the trade relation using an stochastic model as in Klepper and Thompson (2006). By accumulating new business relations, an exporter can grow its presence in the market. If an exporter looses all business relations the relationship will go dormant until a new business relation is acquired by an exporter. Our model is thus able to generate both exit of once active trade relationship as well as their regeneration. This feature matches a fact present in international trade data that a number of trade relationships are present in multiple distinct instances.

Our model creates predictions about both duration and growth of trade of active spells of trade, an active instance of a trade relationship. Duration increases in size and age of a spell (and its converse, the hazard, is decreasing in both). The growth rate of a spell is decreasing in duration as well as its size. Both of these predictions are borne by our data.

Using the model we are able to predict some of the effects of economic integration agreements on trade. We examine three attributes of trade embodied in trade relationships defined as importer-exporter-product triplets: the initial value of trade, the hazard of trade ceasing, and the growth of trade within a spell. Our model predicts that a economic integration agreement will reduce the likelihood of trade ceasing and will increase the growth of trade in an active spell. However, the effect will be reversed for spells started after the agreement, which start with lower values, are more likely to cease, and grow less. Using revision 1 SITC 5-digit level data in concjunction with Baier and Bergstrnad (2007) data on economic integration agreements spanning the periof between 1962 and 2005, we empirically confirm all theoretical predictions.

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A Melitz and Ottaviano Framework

Consider two countries, origin o and destination d. Countries are identical in all respects. Firms choose where and how much to produce and whether or not to enter a market. The origin and destination markets are segmented, but firms can sell in both markets.

A.1 Preferences

Consumers in both countries have the same preferences defined over a continuum of differentiated goods indexed by $n \in [0, \bar{N}]$. The utility of the representative consumer is given by a quasilinear utility function of the form

$$U = q_o + \alpha \int_0^{\bar{N}} q^n dn - \frac{\gamma}{2} \int_0^{\bar{N}} [q^n]^2 dn - \frac{1}{2} \left[\int_0^{N} q^n dn \right]^2 \tag{A.1}$$

where q^n is the quantity of variety $n \in [0, \bar{N}]$ demanded by each consumer, q_o is the quantity of the homogeneous good, and γ captures love for variety in the consumption of goods.

It follows from this definition of utilities that the inverse demand for each variety is given by

$$p_n = \alpha - \gamma q^n - Q \tag{A.2}$$

where $Q = \int_0^{\bar{N}} q^n dn$ is total consumption over all varieties. The residual demand curve for good n is then given by

$$q_n \equiv L q^n = \frac{L}{\gamma} \left[\frac{\gamma + N\bar{p}}{\gamma + N} - p_n \right] \tag{A.3}$$

where $\bar{p}$ is the average price across varieties that are consumed in positive quantities, indexed by N. Prices are such that

$$p_n < \frac{\gamma + N\bar{p}}{\gamma + N} \equiv p_{max} \tag{A.4}$$

This bounded marginal utility result, characterized by a choke price, implies firms with high marginal costs will not be able to survive in a market. Moreover, as competition toughens, less firms will be able to survive.

A.2 Production

Labor is immobile and it is supplied inelastically. The numeraire good is homogeneous and produced under constant returns to scale at a unit cost in a competitive market. The numeraire is traded at no cost fixing the wage.

For a firm in the country of origin, the costs of entering the differentiated product sector in the destination country are f_e. Once a firm is established it produces output using a constant returns to scale production function with marginal costs equal to c. The unit costs of production are randomly drawn from a distribution $G(c)$ with support $[0, \bar{c}]$. We assume that productivity draws $1/c$ follow a Pareto distribution with lower productivity bound$1/\bar{c}$ and shape parameter $b > 1$ given by:

$$G(c) = \left(\frac{c}{\bar{c}}\right)^b, \text{ for } c \in [0, \bar{c}] \tag{A.5}$$

Following a monopolistic competition structure, firms maximize profits using the demand function (A.3) taking the average price, $\bar{p}$, and the number of firms, N, as given. Firms from o selling in d incur a per-unit trade costs, $\tau > 1$. We model bilateral trade agreements as a reduction in τ.[21]

[21] In this model, fixed costs of export are not necessary to induce selection into export markets. The linear demand system alone can create this effect.

The operating profits of a firm in o selling in d are given by:

$$\pi_o^d(c) = (p^d(c) - \tau c) q_o^d(c) \tag{A.6}$$

We are interested here in the behavior of exporting firms only, therefore we assume that exporting firms do not serve their home market. The first order conditions for problem (A.6) implies

$$q_o^d(c) = \frac{L^d}{\gamma}(p^d(c) - \tau c) \tag{A.7}$$

Since fixed costs are sunk, firms that are able to cover their marginal costs produce, the rest leaves the market. Define $\hat{c}$ as the marginal cost of the firm that is indifferent between producing or exiting the foreign market. For this firm we have $p(\hat{c}) = \tau\hat{c}$. Any firm with $c < \hat{c}$ earns positive profits and remains in the market. Because any truncation of the cost distribution from above will retain the same distribution function as the original Pareto distribution, the productivity distribution of surviving firms is given by:

$$G^D(c) = \left(\frac{\tau c}{\hat{c}}\right)^b, \text{ for } c \in [0, \hat{c}] \tag{A.8}$$

Set equation (A.3) equal to (A.7) to find profit maximizing prices:

$$p(c) = \frac{1}{2}\tau\left(\hat{c} + c\right) \tag{A.9}$$

where

$$\hat{c} = \frac{\gamma + N\bar{p}}{N + \gamma} \tag{A.10}$$

Replacing back in equation (A.7) we find

$$q(c) = \frac{L}{2\gamma}\tau\left(\hat{c} - c\right) \tag{A.11}$$

and replacing $p(c)$ and $q(c)$ in equation (A.6) we find the flow of profits of a firm of type c:

$$\pi(c) = \frac{L}{4\gamma}\tau^2\left(\hat{c} - c\right)^2 \tag{A.12}$$

Revenues are given by:

$$r(c) = \frac{L}{4\gamma}\tau^2(\hat{c}^2 - c^2) \tag{A.13}$$

As expected, firms with lower costs earn higher revenues and profits, produce more and charge lower prices.

A.2.1 Free entry equilibrium

Firms enter the market if expected profits are larger that the entry costs f_e. In our set-up, The firm identifies a potential buyer in the destination country and bids for a business opportunity to sell its product. We follow Klepper and Thompson (2006) and assume potential buyers of a particular product appear following a Poisson process with parameter λ. Buyers are active only for a length of time, z, drawn from the exponential distribution $H(z) = 1 - e^{-z/\mu}$.

Assuming there is no time discounting, the value of the firm is then given by

$$\nu(c) = \max\left\{0, \int_o^\infty \pi(c)dH(z)dz\right\} = \max\left\{0, \frac{\pi(c)}{\mu}\right\} \tag{A.14}$$

Notice that the role of μ is equivalent to a time discounting factor, thus expanding the analysis to include discounting is straight forward.

The free entry condition is given by:

$$\frac{L}{4\gamma\mu}\int_0^{\hat{c}}(\hat{c}-c)^2 dG(c) = f_e \tag{A.15}$$

Using the Pareto distribution described above we get a cut-off value given by

$$\hat{c} = \left(\frac{2(2+b)(1+b)\bar{c}^b\gamma f_e\mu}{L}\right)^{\frac{1}{2+b}} \tag{A.16}$$

We assume that $\hat{c} < \bar{c}$ so that exit is possible. Having identified these cutoff we have fully characterized the profits of a firm as identified in equation (A.12). Profits are increasing in the cutoff $\hat{c}$ which is in turn decreasing with market size, increasing in the fixed cost. Also, if the economy is more productive, $(1/\bar{c})$ increases, then the cutoff falls.

The distribution of firm revenues operating in the market is given by $F(r) = \left(\int_{c(r)}^{\hat{c}/\tau} dG(c)\right)/(1-G(\hat{c}/\tau))$ where $c(r) = \frac{1}{\tau}\left(\hat{c}^2 - \frac{4\gamma}{L}r\right)^{1/2}$ is the cost draw that yields an optimal revenue r. The expected value of the size of the exporting firm is then given by

$$E[r] = \int_0^{\hat{c}/\tau} r dG(c) = \frac{L}{2\gamma}\frac{\hat{c}^2}{2+b}\left(\frac{\hat{c}}{\tau\bar{c}}\right)^b. \tag{A.17}$$

In summary, the probability that a firm enters the market is given by $\theta = G(\hat{c})$, which is common across firms in a market. The size of a spell of service is given by its revenue r, which remains constant for the duration of the spell and goes to zero as soon as the buyer disappears. The size is drawn randomly from a distribution $F(r)$.

A.3 Gravity

The Melitz and Ottaviano framework also allows us to think of trade between multiple countries and generates a gravity equation. While it is beyond the point of the current appendix to replicate those results, we briefly characterize trade flows between two countries.

An exporter with costs c from country m selling in country l generates exports sales equal to $r_{ml}(c) = p_{ml}(c)q_{ml}(c)$. The prices and quantities are given by:

$$\begin{aligned} p_{ml}(c) &= \frac{1}{2}\left(c_D^m + \tau c\right) \\ q_{ml}(c) &= \frac{L_m}{2\gamma}\left(c_D^m - \tau c\right) \end{aligned} \tag{A.18}$$

where γ is an index of product differentiation across varieties. c_D^m is the cutoff value for which firm in market m will cease to exist:

$$c_D^m = \left[\frac{\gamma\phi}{L_m(1+\tau^{-b})}\right]^{1/(2+b)} \tag{A.19}$$

where $\phi = 2(b+1)(b+2)\bar{c}^2 f_e$. Firms in country m with $c < c_D^m$ will serve the local market and firms with $c < c_D^m/\tau \equiv c_X^m$ will also export to country l. This cutoff value decreases with the size of the market, L_m, and decreases with the accessibility of the market, measured as reduction in τ. As τ is reduced, average productivity increases because less productive firms are driven out of the market. Notice that any truncation of the cost distribution from above will retain the same distribution function as the original Pareto distribution. That is, the productivity distribution of surviving firms is given by:

$$G^D(c) = \left(\frac{c}{c_D^m}\right)^b, \text{ for } c \in [0, c_D^m] \tag{A.20}$$

and the fraction of entrants in the home market is $G(c_D^m)$. The number of firms selling in country m is given by

$$N_m = 2(b+1)\gamma\frac{\alpha - c_D^m}{c_D^m} \tag{A.21}$$

while the number of firms from country m serving country l is given by $N_E^m G(c_X^m)$ with N_E^m being the number of potential entrants in country m:

$$N_E^m = \frac{2(\bar{c})^b(b+1)\gamma}{(1-\tau^{-2b})}\left[\frac{\alpha - c_D^m}{(c_D^m)^{b+1}} - \tau^{-b}\frac{\alpha - c_D^l}{(c_D^l)^{b+1}}\right] \tag{A.22}$$

With these results, we can write trade flows as

$$EXP_{mh} = \frac{1}{2\gamma(b+2)} N_E^m(\bar{c}^m)^b L^m (c_D^h)^{b+2}\tau^{-b} \tag{A.23}$$

As stated in Melitz and Ottaviano (2008), in equilibrium, the trade flow between two countries will be a log-linear function of the size of the country, technological and geographical characteristics, and trade flows.

B Klepper and Thompson Framework

As we mentioned in the paper, most proofs follow directly from the results found by Klepper and Thompson (2006). Those results, in turn, follow from the proof of a fundamental result in queueing theory.

Preliminary results: We start by characterizing the process that generates buyers in the destination country, d. Suppose $N(t)$ buyers have been generated by time t. New buyers disappear after some length of period distributed exponentially. So the probability of the $i^t h$ buyers still being active at time t is $1-H(t-t_i)$. Because the arrival of new buyers is distributed according to a Poisson process, that means arrival times are distributed uniformly on $(0,t]$. Then, the probability that the $i^t h$ buyer is still alive at time t is given by

$$\Pr(\text{buyer } i \text{ is active at } t) = \frac{\int_0^t 1 - H(v)dv}{t} \tag{B.1}$$

It follows that, conditional on there being $N(t)$ buyers, the number of buyers alive at time t, apart from the first, $n^*(t)$, is binomial:

$$Pr(n^*(t) = k|N(t)) = \binom{N(t)}{k} \left[\frac{1}{t}\int_0^t (1 - H(v))dv\right]^k \left[\frac{1}{t}\int_0^t H(v)dv\right]^{N(t)-k} \tag{B.2}$$

Next, recall that $N(t)$ is distributed Poisson with parameter λt so the CDF is given by

$$CDF = \sum_{N=k}^{\infty} \frac{(\lambda t)^N e^{-\lambda t}}{N!} \tag{B.3}$$

Then the unconditional distribution is

$$p_k(t) = \sum_{N=k}^{\infty} \frac{(\lambda t)^N e^{-\lambda t}}{N!} \binom{N}{k} \left[\frac{1}{t}\int_0^t (1 - H(v))dv\right]^k \left[\frac{1}{t}\int_0^t H(v)dv\right]^{N-k} \tag{B.4}$$

$$= \sum_{N=k}^{\infty} \frac{(\lambda t)^N e^{-\lambda t}}{N!} \frac{N!}{k!(N-k)!} \left[\frac{1}{t}\int_0^t H(v)dv\right]^{N-k} \tag{B.5}$$

$$= \frac{\lambda^k e^{-\lambda t}}{k!} \left[\int_0^t (1 - H(v))dv\right]^k \sum_{N=k}^{\infty} \frac{\lambda^{N-k}}{(N-k)!} \left[\int_0^t H(v)dv\right]^{N-k}$$

We can change variables, $z = N - k$, to obtain

$$p_k(t) = \frac{\lambda^k e^{-\lambda t}}{k!} \left[\int_0^t (1 - H(v))dv\right]^k \sum_{z=0}^{\infty} \frac{\lambda^z}{z!} \left[\int_0^t H(v)dv\right]^z \tag{B.6}$$

and using the series expansion $e^x = \sum_{z=0}^{\infty} x^z/z!$ we can rewrite the expression above as

$$p_k(t) = \frac{\lambda^k e^{-\lambda t}}{k!} \left[\int_0^t (1 - H(v))dv\right]^k e^{\lambda \int_0^t H(v)dv} \tag{B.7}$$

$$= \frac{1}{k!} \left[\lambda \int_0^t (1 - H(v))dv\right]^k e^{-\lambda \int_0^t (1-H(v))dv}$$

$$= \frac{\rho(t)^k}{k!} e^{-\rho(t)} \tag{B.8}$$

where $\rho(t) = \lambda\mu\left(1 - e^{-t/\mu}\right)$. Finally the probability of the first buyer still being alive is $1 - H(t)$. With these results in hand, we can write the probability of exactly k buyers being active at time t as

$$\text{(B.9)} \qquad \Pi_k(t) = \begin{cases} H(t)p_k(\rho(t)) & k = 0 \\ (1 - H(t))p_{k-1}(\rho(t)) + H(t)p_k(\rho(t)) & k = 1, 2, 3, \ldots \end{cases}$$

where we have shown $p_k(\rho(t))$ is the probability of exactly k events from a Poisson distribution with mean $\rho(t) = \lambda \int_0^t (1 - H(v))dv$. Because we have assumed $H(z)$ is exponential with mean μ we find $\rho(t) = \lambda\mu\left(1 - e^{-t/\mu}\right)$. As t approaches infinity, the first market vanishes with probability 1, and the stationary distribution is Poisson with mean $\lambda\mu$.

Now we are ready to show our first result. The number of business relations in a trade spell, excluding the first buyer, is the sum of n Bernoulli trials with probability of success θ where n is distributed Poisson with mean $\rho(t)$. The distribution of this random sum is

$$\text{(B.10)} \qquad p_k(t) = \sum_{n=k}^{\infty} \binom{n}{k} \frac{e^{-\rho(t)}\rho(t)^n}{n!} \theta^k (1 - \theta)^{n-k}$$

which following the same steps as above we can write as

$$\text{(B.11)} \qquad p_k(t) = \frac{e^{-\theta\rho(t)}(\theta\rho(t))^n}{n!}$$

Adding to this the probability $\theta(1 - H(t))$ that the business relation with the first buyer is still active at time t, we find

(B.12)

$$v_k(t) = \begin{cases} (\theta H(t) + (1 - \theta))p_k(\theta\rho(t)) & k = 0 \\ \theta(1 - H(t))p_{k-1}(\theta\rho(t)) + (\theta H(t) + (1 - \theta))p_k(\theta\rho(t)) & k = 1, 2, 3, \ldots \end{cases}$$

As $t \to \infty$ the first buyer dies and the stationary distribution is Poisson with parameter $\theta\rho(t)$.

Because we define the duration of a trade spell as the time that has elapsed since the trade spell became active again, and because buyers die independently of new arrivals, the duration of a trade relation is independent also independent of new arrivals. Then, the distribution for $w(s(t), t)$, is the same as $v_k(t)$ replacing t by s and ignoring the first buyer.

We are finally ready to proof **Result 1**. To to this, recall the size of a trade spell is given by $y(t) = \sum_0^{n(t)} r$, where $n(t)$ is a random number following the distribution $w(s(t), t)$ and r is a random draw from the distribution $F(r)$. We can use the result that the characteristic function of a sum of random variables is equivalent to the multiplication of their characteristic functions. The characteristic function for the unconditional distribution of trade spell sizes is obtained by taking the expectation over all n

$$
\begin{aligned}
\text{(B.13)} \qquad \phi_y(u; s) &= E_n[\phi_r(u)^n | s] \\
&= \sum_{k=0}^{\infty} w(s(t), t)\phi_r(u)^k \\
&= \sum_{k=0}^{\infty} \frac{e^{-\theta\rho(s)}(\theta\rho(s))^n}{n!}\phi_r(u)^k \\
&= e^{\theta\rho(s)(\phi_r(u)-1)}
\end{aligned}
$$

To find the expected value we calculate

$$
\text{(B.14)} \qquad E[y] = \frac{\partial\phi_y(u; s)}{\partial u}|_{u=0} = \theta\rho(s)\frac{\partial\phi_r(u)}{\partial u}|_{u=0} = E[r]\theta\rho(s)
$$

and to find the variance we calculate

$$
\begin{aligned}
E[y^2] &= \frac{\partial^2 \phi_y(u;s)}{\partial u^2}|_{u=0} \\
&= \theta\rho(s)\frac{\partial^2 \phi_r(u)}{\partial u^2}|_{u=0} + \left[\theta\rho(s)\frac{\partial \phi_r(u)}{\partial u}|_{u=0}\right]^2 \\
&= \theta\rho(s)\frac{\partial^2 \phi_r(u)}{\partial u^2}|_{u=0} + E[y]^2 \qquad \text{(B.15)}
\end{aligned}
$$

Form here we find

$$\text{var}[y] = \theta\rho(s)E[r^2] \qquad \text{(B.16)}$$

Result 1 follows directly from these outcomes.

To show **Result 2**, we first need a definition and a result. Let $G_n(\tau|z_1, z_2, \ldots, z_n)$ denote the distribution of the first passage time, τ, to a state of zero active business relations for a trade spell with n business relations of ages z_i. Now add one business relation of age z_{n+1}. By construction, the first passage distribution is given by

$$
\begin{aligned}
G_{n+1}(\tau|z_1, z_2, \ldots, z_n, z_{n+1}) &= \frac{H(z_{n+1}+\tau) - H(z_{n+1})}{1 - H(z_{n+1})} G_n(\tau|z_1, z_2, \ldots, z_n) \\
&< G_n(\tau|z_1, z_2, \ldots, z_n)
\end{aligned}
$$

Then, for **Result 3**, we recognize that $n(t)$ is positively related to duration, $s(t)$, according to Result 1. Since the size of a trade spell equals the product of $n(t)$ and the average size of business relations in each trade spell, it is also positively related to $n(t)$. Duration and size are related to $n(t)$ in different ways, and thus both will be positively related to $n(t)$ even conditional on the other. A more direct proof is provided by Klepper and Thompson (2006).

Result 4 is more complicated to show and it requires one more definition and a result. Let's define $G(z; s)$ as the distribution of ages of all the business relations in a trade relation of duration s. In the case of $H(z)$ exponential, the distribution $G(z;s)$ is equal to

$$G(z;s) = \frac{1 - e^{-z/\mu}}{1 - e^{-s/\mu}} \tag{B.17}$$

which is the exponential $H(z)$ with the support truncated at s. This is the simplicity afforded by the exponential distribution. The future depends only in the current state of affairs.

With this result in hand, we proceed to calculate the growth rate of a trade spell. Consider a business relation of duration z. Then, the probability that it vanishes in the subsequent period T is simply given by

$$\frac{\int_z^{z+T} dH(z)}{1 - H(z)} = 1 - e^{-T/\mu}$$

. Taking expectations over all possible ages, $z \in [0,s]$, using the distribution $G(z;s)$, we find

(B.18)

$$E[\text{Number of lost business relations after interval } T|s] = n(s)\frac{\int_0^s e^{-z/\mu}(1 - e^{-T/\mu})dz}{\mu(1 - e^{-s/\mu})}$$

where each lost relation has an expected size $\bar{r}_n$ which is independent of n.

Using the distribution for $w(s(t),t)$, the expected number of new business relations appearing in the interval of length T is given by

$$E[\text{Number of new business relations during interval } T|s] = \theta\rho(T) \tag{B.19}$$

Each new relation has an expected size $E[r]$.

We can define the growth rate as the difference between the new arrivals and the losses:

$$\text{(B.20)} \qquad g_y(t, t+T; y, s) = \frac{E(y(t+T|s)) - y(t,s)}{y(t,s)}$$
$$= \frac{E[r]\theta\rho(T)}{y(t,s)} - (1 - e^{-T/\mu})$$
$$= \left(\frac{E[r]\theta\mu}{y(t,s)} - 1\right)(1 - e^{-T/\mu})$$

Let's denote the growth of trade spell that survive the interval time T as $g_y(t, t+T; y, s|n(t+T) > 0)$ and the probability of dying as $\Pr\{n(t+T) = 0|y(t), s(t)\}$. Then, it follows that

(B.21)

$$g_y(t, t+T; y, s) = (1 - \Pr\{n(t+T) = 0|y(t), s(t)\})g_y(t, t+T; y, s|n(t+T) > 0) + \Pr\{n(t+T) = 0|y(t), s(t)\}(-1)$$

from where

$$\text{(B.22)} \quad g_y(t, t+T; y, s|n(t+T) > 0) = \frac{g_y(t, t+T; y, s) + \Pr\{n(t+T) = 0|y(t), s(t)\}}{1 - \Pr\{n(t+T) = 0|y(t), s(t)\}}$$

We showed that the probability of a trade spell ceasing to exist is decreasing in its size and age, thus mean firm growth decreases with size and age, as described in **Result 4**.