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Distance(s) and the volatility of international trade(s)

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Abstract

We show that distance matters for the volatility of international trade and financial transactions on top of its well-known impact for their levels. We conduct event studies on the global financial crisis and the Covid-19 pandemic with country-level and product-level data, and a longer panel data analysis. We consider measures of physical, virtual, and language distance jointly – the latter two proxying for ease of communication. We find evidence of larger trade declines in more distant country dyads and underscore the relevance of information frictions rather than shipment costs. Physical distance matters for trade volatility beyond goods, as do virtual and language distances. Physical and virtual distances amplify each other's effects at the country level, as do virtual and language distances at the product level. Distance effects are also weaker for homogenous products and foreign direct investment and banking activity entailing local presence, again pointing to the importance of information frictions.

Keywords: Distance, gravity, volatility, international trade, international finance, Great Trade Collapse, Covid-19 pandemic

JEL classification: F10, F30

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1. Introduction

The gravity effect that the level of international trade and financial linkages is inversely proportional to the distance between countries is a well-established result in international economics.[1] Leamer (2007, p. 11) calls it "the only important finding" having withstood "the scrutiny of time and the onslaught of economic techniques" in international economics.

While policymakers care about the level of international linkages, they are also equally concerned – if not more – about the volatility of these linkages. This is because international real and financial connections are powerful channels of transmission of economic shocks and policies, and such spillovers are a central element that policymakers need to consider to manage business cycles. This is particularly the case when fluctuations are large, as in a financial crisis. This begs the question of whether distance also matters for the volatility of international trade and financial linkages. Do international linkages contract more in adverse times between more distant countries?

This paper addresses the question by taking a broad view of various forms of international linkages, approaches, and measures of distance, to shed light on the underlying economic mechanisms. While the effect of distance on the level of trade is theoretically clear, its impact on volatility is much less obvious. In terms of trade, a first "footloose" view is that exporters faced with challenging conditions pull back more from distant markets. An opposite "beachhead" view is that because gaining a market share in a distant country is hard, exporters take a long-term view and do not abandon these markets easily.[2] While we most commonly think of physical distance as connected to the cost (financial or in time) of transporting goods, it can be related to a broader pattern. In an uncertain economic environment, agents need to understand the true state of economic conditions at the level of a country or sector. Doing so can be more challenging for markets farther away, be it physically or in the sense that communicating with the markets in question is harder, or that cultural differences make it more

[1] See Anderson and van Wincoop (2004), (2003) or Head and Mayer (2014) for a recent survey, as well as Tinbergen (1962) or Krugman (1997) for earlier discussions.

[2] There is an old tradition in the theory of international trade on the role of "beachhead" or "hysteresis" effects (see e.g. Baldwin (1988), Baldwin and Krugman (1989) and Dixit (1989)).

challenging to assess economic conditions. Distance can therefore also proxy for information frictions.

We conduct an analysis of international interactions at the bilateral country pair level and consider a broad range of trade and financial interactions at a macroeconomic (country) level, as well as trade transactions at a more granular product level. We do not limit ourselves to physical distance but consider also ease of communication proxied by virtual (internet) and language distance. We use macro and product-level data to conduct event studies of two noteworthy episodes of large contractions in international economic activity: the 2007-09 global financial crisis and the 2020 Covid-19 pandemic outbreak (the product-level data focus on trade in goods for each country dyads). These two events represent major disruptions to trade and financial globalization. During the global financial crisis, linkages fell abruptly after several years of a steadily increasing trend. The Covid-19 pandemic also led to a major decline in international economic activity and bottlenecks hitherto thought to be unrealistic. Given the large economic consequences of such disruptions, understanding what drives international spillovers is a major policy issue. At the same time, we aim to look beyond such exceptional times and to assess whether distance also plays a role in fluctuations of a more usual magnitude. We do so by taking a longer view with a panel analysis of macro data on trade in goods from 1950 to 2015.

Our event studies of the global financial crisis and the pandemic outbreak episode rely on a cross-section of 186 countries.[3] Our measures of bilateral international linkages cover imports of goods and services (with further disaggregation of the total for each of the two), portfolio investment positions in bonds and equities, foreign direct investment positions, and bank loans and deposits in terms both of positions and flows. Our metrics of distance are the standard physical distance, virtual (or internet) distance, and language distance, the last two proxying for ease of communication. In addition to the direct impact of these metrics of distance, we consider whether they amplify each other's marginal effects and whether their

[3] The "Great Trade Collapse" refers to the sizeable decline in international trade that accompanied the global financial crisis and recession of 2007-09 (see e.g. Ahn et al. (2011) or Bems et al. (2013)). Although many papers have been written on the collapse in question, it is still not fully understood. Most papers have focused on demand conditions in the destination countries or supply effects in the source countries (see also e.g. Bussière et al. (2013) on the role of the composition of demand). Evidence that brings both dimensions together via e.g. distance between source and destination countries is more limited, however.

impact depends on economic volatility in the destination country.[4] As macro evidence can be affected if the composition of interactions themselves varies with distance (countries may export different goods to nearby countries than to more distant ones), we also conduct our two event studies at the product-country-pair level with a stringent set of fixed effects, including up to 7,000,000 observations in each of the two time periods.

Our findings point to a clear "yes" answer to the question of whether international linkages are more volatile among more distant country pairs. They point to information frictions as being the central mechanism at play, notwithstanding some nuances as can be expected from the panoramic approach we take. During the global financial crisis of 2007-09, international real and financial linkages declined more for distant country-pairs, in line with the "footloose" view. While physical distance clearly mattered – as can be expected – it did so beyond trade in goods, and we also find a robust role for the other two measures of language distance and virtual distance. This points to information frictions, which are more pronounced in more distant countries, as the main mechanism. Furthermore, virtual distance increases the marginal impact of physical distance (and vice-versa). The impact of distance displays heterogeneity across the various forms of international trade transactions. While physical and language distances broadly matter, virtual distance plays a limited role for the volatility of foreign direct investment (FDI) and banking activity, possibly because these linkages often include local presence in the country of destination, which alleviates information frictions. Virtual and language distance also have a limited role for the volatility of imports of commodity and energy products, which can reflect the more homogenous nature of these products, which reduces the dispersion of information.

The effect of distance is economically substantial. Our estimates indicate that an increase in physical distance between two countries by one standard deviation decreased trade in goods by 23%, with the corresponding decreases for virtual and language distances being equal to

[4] Linguistic distance is considered in e.g. Isphording and Otten (2013) or Melitz and Toubal (2014). Virtual distance or internet connectedness is considered in e.g. Freund and Weinhold (2004), Blum and Goldfarb (2006), Chung (2011) or Hellmanzik and Schmitz (2017). In exploratory work we also considered a measure of genetic distance between the populations of two nations in the spirit of Spolaore and Wacziarg (2016). Giuliano, Spilimbergo and Tonon (2013) as well as Fensore, Legge and Schmid (2016) examined the impact of genetic distance on bilateral trade levels, for instance. However, we did not succeed in obtaining consistent results on the impact of this measure on the volatility of trade and hence chose not to report them here. But the results in question are available from the authors upon request.

15% and 5%, respectively. Interestingly, while physical distance has received the bulk of attention in the literature, it is not always the measure with the largest effects. For instance, virtual distance had larger impacts on international transactions in services or changes in cross-border portfolio investment positions.

The impact of the various measures of distance is not confined to the global financial crisis. The macro level evidence for bilateral trade in goods during the Covid-19 pandemic of 2020 also points to disproportionately large declines for more distant country-pairs, as posited by the "footloose" view – and that physical and virtual distance amplified each other's impacts. The distance effect at the macro level is not driven by composition effects that would occur if trade to more distant countries were dominated by goods for which flows are always more volatile. Our product-level estimates for trade in goods confirm the results obtained with macro-level data, with clear evidence in support of the "footloose" view. During the global financial crisis of 2007-09 and pandemic outbreak episodes, imports of products contracted more for distant countries. This is even more so the case for differentiated products than homogeneous products, which are likely to have more predictable demand compared to differentiated products. The results are observed both at the intensive and extensive margins of trade. The product- and country-level results provide similar evidence in favor of the "footloose" view, notwithstanding more nuanced patterns in terms of direct and interacted effects.

Our panel analysis of trade in goods brings an additional confirmation that physical and virtual distances matter, with trade being similarly more volatile between countries that are farther away. In addition, the two metrics of distance again magnify each other. The impact of distance measures other than physical is, however, weaker when we consider longer horizons in panel analyses. This suggests that information frictions are more pronounced in times of economic turmoil, such as the global financial crisis or the pandemic outbreak.

In terms of economic mechanisms, several dimensions of our results point to a major role of information frictions. Physical distance not only impacts trade in goods but also affects trade in services and financial linkages which are not subject to physical shipping constraints. Other measures of distance, virtual and language, also matter. Distance affects differentiated products more than homogeneous products, with the latter likely being less exposed to

information frictions. The impact of physical distance remains significant even after controlling for ease of communication, it is reduced for country pairs where communication is easier (i.e. less virtual distance). Moreover, linkages entailing a local presence (FDI and banking) are less sensitive to distance, which suggests that the ability to develop a better understanding of conditions in the destination country matters. At the macro level, the effect of distance is larger for trade in services and trade in goods (the latter in the Covid-19 event) for exports towards countries with more volatile business cycles, that is countries for which gaining an accurate understanding of their economic situation is more challenging. Finally, broadening the sample beyond crisis times shows a reduced impact of language and virtual distance on the volatility of trade in goods.

The rest of the paper is set out as follows. Section 2 reviews the related streams of literature. Section 3 discusses testable hypotheses to distinguish between mechanisms identified in the literature. Section 4 discusses our empirical approach and presents the data. Section 5 presents the empirical results from the various approaches and syntheses them in terms of the testable hypotheses. Section 6 concludes.

2. Literature

2.1 *Distance and the level of trade*

The fact that more distant countries trade less in goods and services with each other is a well-known feature. It rests on established theoretical foundations in the form of gravity models with iceberg costs of trading that are proportional to distance, reflecting for instance travel time (see the review in Anderson and van Wincoop ((2003), (2004)).[5] Allen (2014) documents the role of information frictions. Focusing on agricultural trade between regions of the Philippines, he shows a higher price dispersion and more two-way trade between regions with more limited information access (proxied by mobile phone usage). He also shows that the

[5] They relate bilateral trade to nations' economic size, trade barriers (including distance), and multilateral resistance (e.g. distance with respect to all nations other than the two nations in the trading pair or other unobserved effects). Empirically, multilateral resistance terms are estimated by importer and exporter fixed effects (see Head and Mayer (2014)).

pass-through of costs to prices is affected by information frictions, which particularly matters for smaller producers.

A large body of research has assessed the role of distance for the trade of financial assets and international lending. Empirical studies find that distance matters for the level of bilateral financial investment, in particular for information-sensitive assets such as equities (see e.g. Portes, Rey and Oh (2001), Portes and Rey (2005), Aviat and Coeurdacier (2007), Brei and von Peter (2018)). In contrast to the solid theoretical underpinnings of the impact of distance for goods and services, Ozawa and van Wincoop (2012) caution that the foundations are more fragile for international financial transactions. Brüggeman, Kleinert and Prieto (2011) derive a gravity equation for bank lending showing a role for distance, but Niepmann (2015) shows that such a specification is sensitive to the specifics of the model (such as the heterogeneity of banking sector efficiency across countries).

2.2 *Distance and changes in the level of trade*

While the literature on the effect of distance on the level of international trade is large, there are relatively fewer studies on the effect of distance on the changes in international trade following business cycle shocks. A simple model with iceberg costs explains well the effect on the level of trade but is hard-pressed in accounting for different changes depending on the distance. This is because iceberg costs just lead to a constant scaling effect on demand in the destination country. This is a substantial limitation, as understanding the effect of distance on the fluctuations of international linkages is highly relevant for policy makers.[6]

In addition to iceberg costs, trade economists have long recognized that considering fixed costs of exporting is a relevant feature, for instance, to explain why only more productive firms export. However, the implications in terms of dynamics are not obvious. Under a "footloose" view one would expect that in bad times exporters pull out proportionally more from more distant destinations that account for a smaller share of their sales. However, because gaining access to these destinations was costlier in the first place, forward-looking exporters may

[6] For instance, G20 Leaders have sought to take actions to increase the resilience of their economies to "volatile capital flows" at their Cannes summit of 2011 (Group of Twenty (2011)).

instead choose to stick with distant markets to avoid losing the initial investment made. This "beachhead" view has long been identified as a driver of hysteresis in trade (Baldwin 1988, Baldwin and Krugman 1989, and Dixit 1989). Alessandria, Arkolakis, and Ruhl (2020) consider a model where exporters must incur a large sunk cost for entering a market and a more moderate fixed cost for remaining active. They show that trade reacts gradually to shocks, as the sunk cost of re-entering a market after having left it introduces strong forward-looking considerations into exporters decisions.

The empirical evidence is that imports are more volatile than domestic sales. Alessandria and Choi (2019) show that importing establishments are more sensitive to the business cycle than domestic ones. They consider the same structure of cost as Alessandria, Arkolakis, and Ruhl (2021). When these costs are counter-cyclical, a downturn raises them and breaks importing relationships. This leads to a more procyclical (albeit less persistent) activity of importers than domestic establishments. Without the fixed costs, importers' activity would instead be procyclical. While Alessandria and Choi (2019) do not consider the effect of distance on import flows, assuming that fixed costs are larger for more distant destinations would lead the pattern they document to be more pronounced with distance. A further challenge is that the relationship between firm-level and aggregate dynamics can be subtle. Alessandria and Choi (2007) show that when different traded goods are close substitutes, the aggregate flows are not very sensitive to the richer dynamics at the disaggregated level because consumers are not sensitive to whether their import purchases consist of large amounts of a few brands or small amounts of many brands.

The adjustment of inventories is another dimension along which imports and domestic sales differ. Alessandria, Kaboski, and Midrigan (2011) show that importing firms hold more inventories than firms selling to the domestic market. They account for this in a model where importers face longer and more uncertain delivery schedules from their suppliers, in a context of uncertain demand. The ensuing optimal inventory choice leads to larger holding for importers. During a recession, the fall in sales leads to larger excess inventories for importers than for domestically oriented firms, which translates into a large contraction of imports to bring inventories back to the optimal proportion of sales. While the paper does not consider the

role of distance, we can consider that the need for inventory buffers is larger for firms buying from more distant supplies, leading to more volatile import flows.

Another mechanism focuses on time-varying markups. These can generate heterogeneous adjustments of trade, provided the number of exporting firms is limited. In an earlier working paper version of our analysis (Mehl, Schmitz and Tille (2019)), we developed a nested CES model based on Atkeson and Burstein (2008). Exporters face a fixed cost of being present in a market (and potentially selling there), and another fixed cost for actually serving the market. In addition, different goods from the same country of origin are closer substitutes than imported and domestic goods. A contraction in demand reduces the profitability of exporters and leads them to exit the market. This reduces the elasticity of demand faced by the remaining exporters and leads them to raise their markup, further reducing demand and trade flows. This effect is stronger when there are few exporters, i.e. when the presence of fixed costs is high.[7]

The contributions listed above consider the behavior of trade during standard business cycles and do not specifically explore the impact of distance. By contrast, Berman et al. (2013) focus on the role of trade finance costs during the global financial crisis of 2007-09. The relevance of finance is directly linked to the time spent in transit by shipments, i.e. to distance. The financial crisis leads to higher costs of trade finance and can be understood as an increase in the iceberg cost that was more pronounced for more distant destinations. Berman et al. (2013) show that the adverse impact of the financial crisis on trade was indeed stronger for destinations with longer time to ship.

Uncertainty of economic conditions and policies matters for trade. Carballo, Handley, and Limão (2022) document how trade falls more when the uncertainty of economic conditions increases in the destination country. Higher policy uncertainty, in the form of a higher tariff risk in the destination, also weighs on trade but also amplifies the impact of economic uncertainty. The authors show that during the global financial crisis, trade contracted more in

[7] The model can generate a footloose or a beachhead effect depending on whether distance affects the cost of being present in the market, or the cost of actually producing. If the cost of producing is higher for more distant destination, a given contraction in demand will make firms exit and raise the markup. In that case trade falls by more for more distant destinations (footloose pattern). If the cost of presence is higher for more distant destinations, the firms that are present have already incurred it, and their profits after the cost are then high in normal times. A small contraction in demand will not lead to exit as the profits remain positive (abstracting from the sunk entry cost). In that case, trade falls by less for more distant destination (beachhead pattern).

countries with more uncertain prospects, and this channel was less pronounced between countries linked by a preferential trade agreement that limited the risk of protectionist measures. While the analysis does not consider the role of distance, uncertainty is likely larger when exporters assess prospects in faraway countries. Indeed, Békés et al. (2017) use French custom data to examine how exporting firms handle demand uncertainty. They show inter alia that firms send less frequent, larger shipments to more uncertain markets, and that the effect of demand volatility is magnified on markets with longer time-to-ship.

Another related strand of literature focuses on the role of supply chains in the international transmission of shocks, which came back into the limelight with the Covid-19 pandemic.[8] Demand shocks in a country may be passed upstream through the global production network to input suppliers, with the initial shock being magnified by the "bullwhip effect" (Alessandria et al. (2011)), while supply disruptions can, in turn, be transmitted downstream.[9] In line with this interpretation, the marked decline in trade in goods in the wake of the Covid-19 pandemic has been largely ascribed to disruptions in global value chains further to the lockdown measures taken by many economies to combat the virus, among other factors. COVID-19 has struck value chains in Asia, Europe, and the Americas, raising the risk of a domino effect with feedback loops that could amplify the collapse in global trade (Cigna and Quaglietti 2020).

There is also evidence that distance affects the behavior of financial flows. Galstyan and Lane (2013) show that geographical distance matters for the pattern of adjustment in bilateral portfolio investment positions during the global financial crisis of 2007-09, with investors pulling their assets more from more distant markets. While the financial literature focuses on empirical findings, the role of economic and policy uncertainty identified in the trade literature can also apply. Investment is highly exposed to asymmetric information challenges, especially for more distant countries. We can also consider the framework of fixed costs of financial presence (instead of exporting), with similar implications to the one described above. By

[8] The complex network of supply linkages is potentially an important factor in the transmission of shocks across countries insofar as trade in intermediate goods accounts for more than 40% of world trade and more than 20% of world imports serve as inputs in domestic production processes and are embedded into goods which are subsequently re-exported.

[9] The "bullwhip effect" refers to situations in which a shock triggers disruption to demand for parts and components, which increases the further upstream a firm is located in the supply chain. Firms are induced to adjust their inventories along the supply chain to meet new expected levels of demand.

contrast, explanations in terms of inventories or time to travel are unlikely to be as relevant for financial transactions as they are for trade flows.

2.3 *Measures of distance*

Our work finally relates to the studies of various concepts of distance. The most common concept is physical distance, which reflects the geographical separation of two countries.

Other measures focus on the ability of agents in various countries to communicate. A first approach looks at the availability of communication channels. While earlier studies focused on volumes of phone calls, the measures have recently been broadened with a focus on the impact of the internet (Blum and Goldfarb (2006), Chung (2011), Freund and Weinhold (2004), Hellmanzik and Schmitz (2017)). A second angle aims at capturing how easily people can understand each other. This is done by a metric of how close various languages are to each other (e.g. Isphording and Otten (2013), Melitz and Toubal (2014)).

A final dimension of distance, which we do not consider, examines the genetic distance between the populations of various countries, taking account of past migration patterns (e.g. Fensore, Legge and Schmid (2022), Giuliano, Spilimbergo and Tonon (2013), Spolaore and Wacziarg (2016)).

3. Testable hypotheses

While developing a comprehensive model of the role of distances on the volatility of trade and financial linkages is beyond the scope of this paper, we structure the insights of the various contributions to the literature in a series of hypotheses that we then bring to the data. As discussed in more detail in Section 4, we rely on data on trade (goods, services) and financial linkages (portfolio, FDI, banking). Our distance measures include physical distance, virtual distance (as a proxy for ease of communication), and language distance.

Several frictions are related to distance. The first is the cost of physically transporting traded goods. A second friction is the cost of financing goods during transit (Berman et al. 2013). Both frictions are related to physical distance, as it takes more time in general to transport goods between countries that are further apart. Note that these first two frictions are

related to the extent to which sending exports from one country to another takes time, leading to our first testable hypothesis:

> *Hypothesis #1: shipment channel. If physical distance proxies for the costs of shipping goods, it should matter for the volatility of trade in goods but not for trade in services and financial interactions.*

A third friction related to distance pertains to information. Firms interacting with more distant countries have a harder time getting a clear sense of the economic situation and prospects there. In adverse economic times, higher uncertainty around expected demand raises the tail probability of low sales. This makes it more likely that firms facing a fixed cost of operations cut back on their activity in countries afar. In terms of financial interactions, information frictions can reduce the appeal of investing in more distant countries in several ways. Higher uncertainty worsens the risk-return tradeoff of investors at times of low expected returns. If times of low economic activity are also associated with higher uncertainty, this increase can be more pronounced for countries for which assessing the situation is already challenging. Such a "footloose" pattern with larger contractions among more distant country pairs is however not a given. Indeed, firms with a long-term view that operate in more distant countries may have made substantial investments to cope with the challenge of gaining reliable information and be inclined to maintain their activity to reap benefits from their earlier investments, leading to a "beachhead" view.

The challenge of gaining a reliable view of conditions in more distant countries reflects two dimensions, namely the ability to communicate (the virtual distance) and the ability to understand the information coming from abroad (the language distance). As language distance can also proxy for a broad range of cultural differences, it should be more robustly relevant than virtual distance if the friction is more about understanding than communicating. Information frictions are related to the ease with which firms and investors can gather information on the destination country and process it. Measures of informational distance should thus matter in the presence of information frictions. This does not mean that physical distance does not matter per se, as it may proxy for the level of uncertainty that firms face. The ability to compile and process the information on a country is related to virtual and linguistic distance, but proximity along these dimensions is more valuable for destinations that are more

challenging to assess. In that case, information proximity should matter more when physical distance is larger. This leads to the following three additional hypotheses.

Hypothesis #2: information channel. If distance reflects information frictions, virtual and /or language distance should matter.

Hypothesis #3: understanding channel. If information frictions are about the ability to understand each other more than the ability to communicate, language distance should have a more robust effect than virtual distance.

Hypothesis #4: information complementarity channel. If physical distance reflects higher challenges in assessing economic prospects, virtual and /or language distance should amplify the effect of physical distance.

Better information helps to assess the economic situation of the destination country. It should therefore be particularly valuable for countries with volatile business cycles. If so, international trade and financial linkages should vary more between country pairs that are not only distant but also where the business cycle in the destination country is more volatile. A caveat is that firms doing business with countries where economic conditions are volatile may have invested in capacities allowing them to follow conditions more closely. We formulate this as our fourth hypothesis.

Hypothesis #5: economic volatility channel. If virtual and /or language distance affects the ability to gauge economic conditions, their effect should be larger when growth in the destination country is historically more volatile.

Our discussion of the role of distance so far implicitly assumes that firms and investors assess the conditions of the specific country from their own location. This is however not necessarily the case, as firms can establish a local presence through a subsidiary. In that case, staff in local offices have the same access to information as local agents. Local presence is particularly relevant for foreign direct investment, as multinationals have local operations, and banking activity as banks often have local affiliates. A related aspect is that for some goods transacted in global markets information is less dispersed, with a limited need to have specific local information. This is the case for instance of homogeneous goods, such as commodities. These points are formulated in the following hypothesis.

Hypothesis #6: local presence channel. Distance should have a more moderate effect for economic interactions that entail a local presence (FDI or banking) or for which information is available globally (commodities).

While frictions in gathering information about a distant country are always present, they can be particularly relevant during exceptional times, such as the global financial crisis or the pandemic outbreak. While firms and exporters can acquire experience in dealing with a country and reduce information frictions in normal times, that experience might be less valuable in exceptional times. If so, information distance should then be particularly relevant in crises, leading to our final hypothesis.

Hypothesis #7: crisis information channel. Distances, especially virtual and /or language, should have a more pronounced role during crisis events than over long periods.

4. Empirical analysis: specification and data

4.1 *Empirical specifications*

4.1.1. *General approach*

We test the hypotheses listed in Section 3 using both cross-sectional event studies and panel estimation methods. Our event studies cover two episodes where international interactions contracted to a major extent. The first is the global financial crisis of 2007-09, for which we consider various measures of international trade flows, namely cross-border transactions in goods (with a further distinction between manufactured goods and commodities), services (with a breakdown of the latter by categories), as well as changes in cross-border financial positions (portfolio, FDI, and banking). The second event is the Covid-19 pandemic of 2020, where we focus on trade in goods due to data availability.[10] The analysis of both events is conducted at the country pair level. In addition to the analysis using macro-

[10] Global data on bilateral trade in services and in international financial positions are produced with a significant lag and were not available for the Covid-19 pandemic period yet. Moreover, those data do not go far back in time, which prevented us from obtaining similar panel estimates as for trade in goods over a long period.

level variables, we assess the evidence for trade in goods during both events at the more granular product–country pair level.

We first conduct our event analysis at the level of country-pairs, taking a macroeconomic perspective. Our results are thus informative for policy-makers who take a macroeconomic view. Macro results however include both the distance impact at the level of individual transactions and the composition of transactions. This raises the question of the exact nature of the distance effect at that level. If countries export different goods to nearby and distant countries, and if the exports to the latter consist of goods with more volatile demand, the macro analysis will associate distance with more volatility of trade, even though the trade of a specific good may not be affected by distance. To assess whether our results mirror such composition effects, we dive more deeply into trade flows by conducting a granular product-level analysis of the effect of distance.

In our final step, we go beyond the two specific crisis times, which are unusual, and take a long-term view using a panel of trade in goods data from 1950 to 2015. In all steps, we consider various measures of distances (physical, language, and virtual) as detailed below.

While both approaches aim at accounting for the drivers of movements in international linkages, the specific form of the dependent variable differs. More precisely, the event study approach considers the percent change over the window of the event, while the panel approach considers volatility in the sense of the standard deviation over a window of several years.

In this section, we first present our econometric approach for the event studies and panel analysis. We then introduce the sources for the various data used.

4.1.2. *Event studies on macro data*

Our event studies consist of a broad cross-sectional analysis of bilateral trade and financial linkages between up to 186 countries during the two episodes of major contraction in international linkages. Following Galstyan and Lane (2013) we estimate the following specifications for the global financial crisis of 2007-2009, based on annual data:

$$\ln(Y)_{i,j,2009} - \ln(Y)_{i,j,2007} = \sum_{k} \alpha_k Dist(k)_{i,j}$$

$$+\boldsymbol{\gamma}'\mathbf{X}_{\mathbf{i,j,2007}} + \delta \ln(Y)_{i,j,2007} + FE_i + FE_j + \varepsilon_{i,j} \quad (1a)$$

$$\ln(Y)_{i,j,2009} - \ln(Y)_{i,j,2007} = \sum_k \alpha_k Dist(k)_{i,j} + \sum_k \beta_k Dist(k)_{i,j} Volatility(j)$$
$$+\boldsymbol{\gamma}'\mathbf{X}_{\mathbf{i,j,2007}} + \delta \ln(Y)_{i,j,2007} + FE_i + FE_j + \varepsilon_{i,j} \quad (1b)$$

$$\ln(Y)_{i,j,2009} - \ln(Y)_{i,j,2007} = \sum_k \alpha_k Dist(k)_{i,j} + \sum_h \sum_k \beta_{k,h} Dist(k)_{i,j} Dist(h)_{i,j}$$
$$+\boldsymbol{\gamma}'\mathbf{X}_{\mathbf{i,j,2007}} + \delta \ln(Y)_{i,j,2007} + FE_i + FE_j + \varepsilon_{i,j} \quad (1c)$$

where Y is a measure of real transactions or bilateral changes in cross-border financial positions between countries i (source) and j (destination), detailed below, *Dist* is a measure of distance indexed by k between the two countries detailed below, $Volatility(j)$ is the standard deviation of GDP growth in the destination country over the previous 15 years, **X** is a vector of controls measured in 2007, and FE_i and FE_j are country-source and country-destination fixed effects.[11] Our estimates also control for the pre-crisis level of bilateral trade and investment positions for the corresponding trade or investment measures. We estimate (1a)-(1c) using OLS with standard errors robust to heteroscedasticity.

We consider three main variants of our specification. We first look at the impact of various measures of distance on their own (variant (1a)), where a larger decline of trade during the crisis for more distant countries corresponds to $\alpha_k < 0$. Variant (1b) allows for the effect of distance to differ across destination countries depending on the volatility of their business cycle, with a negative value of β_k in (1b) indicating a larger contraction in connection with more volatile destinations.[12] The final variant (1c) includes both the direct impact of the various distance measures and the interactions between them. A negative coefficient $\beta_{k,h}$ in (1c) indicates that the two measures of distance k and h amplify each other.

We conduct a similar analysis of (1a)-(1c) for the Covid-19 pandemic episode. Due to limited data availability, we focus on bilateral trade in goods. Using quarterly data, the

[11] Equation (1a-c) is a generalization of the model estimated by Galstyan and Lane (2013), who restricted their attention to changes in bilateral portfolio investment positions and to the role of physical distance. Note that destination fixed effects absorb variables such as the magnitude of the recession in the destination country during the crisis.

[12] The direct effect of $Volatility(j)$ is absorbed by the destination fixed effects.

dependent variable is the difference between 2020 Q1 and 2019 Q1, which we regress on the full array of distance and control variables including the level of trade in goods in 2019 Q1.

4.1.3. *Event studies on product-level data*

We sharpen our identification strategy by considering the evidence at a more disaggregated level than country pairs. Specifically, we focus on goods for which granular product-dyad data are available at an annual frequency, as detailed below. We consider the growth rate of trade flows between 2007-2009 (the global financial crisis period) and 2019-2020 (the Covid-19 pandemic), respectively. At this more granular level, several observations are zeros. We, therefore, analyze first product-country pairs with positive trade flows in both the starting and ending years (intensive margins), and then consider pairs where at least one observation is zero (extensive margin). Specifically, we compute the growth rate of trade using both the log change in imports (intensive margin) as well as the mid-point growth rate of imports (extensive margin),[13] where the growth rate is computed as the ratio between the change in trade, $Y_{i,j,p,t+h} - Y_{i,j,p,t}$, and the average value in the two periods, $\left(Y_{i,j,p,t+h} + Y_{i,j,p,t}\right)/2$ (rather than the value in the initial period $Y_{i,j,p,t}$). This approach allows us to study the growth rate of trade flows (*Y*) between time periods *t* and *t+h* at the source (*i*)-destination (*j*)-product (*p*) level accounting for the entry and exit of triplets (see Vannoorenberghe et al., 2016 or Davis et al., 2006).

Our analysis at the product-country-pair level relies on around 7,000,000 observations in each of the two time periods considered for the extensive margin when all the controls are included. The specifications are analogous to the ones using aggregated goods data (1a-1c):

$$LHS_{i,j,p} = \sum_k \alpha_k Dist(k)_{ij} + \boldsymbol{\gamma' X_{i,j,2007}} + \delta ln(Y)_{i,j,p,2007} + FE_{ip} + FE_{jp} + \varepsilon_{i,j,p} \qquad (2a)$$

$$LHS_{i,j,p} = \sum_k \alpha_k Dist(k)_{ij} + \sum_k \beta_k Dist(k)_{ij} * Volatility_{jp}$$

[13] The advantage of this measure is that it is bounded and symmetric around zero. Between 2007 and 2009, 55% of total trade flows (defined as source-destination-product triplets) are present in both years, against 63% between 2019 and 2020.

$$+\boldsymbol{\gamma}'\boldsymbol{X_{i,j,2007}} + \delta ln(Y)_{i,j,p,2007} + FE_{ip} + FE_{jp} + \varepsilon_{i,j,p} \quad (2b)$$

$$LHS_{i,j,p} = \sum_k \alpha_k Dist(k)_{ij} + \sum_h \sum_k \beta_{k,h} Dist(k)_{i,j} Dist(h)_{i,j}$$

$$+\boldsymbol{\gamma}'\boldsymbol{X_{i,j,2007}} + \delta ln(Y)_{i,j,p,2007} + FE_{ip} + FE_{jp} + \varepsilon_{i,j,p} \quad (2c)$$

where $LHS_{i,j,p}$ is either the log change of imports between country i (source) and j (destination) for product *p*, or the midpoint growth rate of the triplet in question. $Volatility_{jp}$ is the standard deviation of the product-level growth rate of imports in the destination country over the previous 15 years, while $ln(Y)_{i,j,p,2007}$ is the initial level of trade at the product-level. The standard errors are clustered at the dyad level.

Our identification strategy in the product-level analysis uses the most stringent set of fixed effects, namely source country-product and destination country-product fixed effects. This strategy aims at controlling for supply-side explanations due to differences in the type of product traded (e.g., intermediate inputs versus final goods, or goods relying on trade finance). These fixed effects also allow us to control, among others, for the average number of firms in the destination-origin-country-per-product dimension (or local presence at product-destination in the initial year). The remaining terms in the specification (2a)-(2c) are analogous to those in the aggregate-level analysis (1a)-(1c).

We estimate specification (2a)-(2c) both for all goods, as well as separately for differentiated and homogeneous goods. In the presence of information frictions related to distance, our prior is that homogeneous products have more predictable demand and are less affected by distance than differentiated products.

4.1.4. *Panel analysis on macro data*

Our final approach takes a long-term view. We revert to a macro-level view and estimate a panel regression on dyadic (country pair) observations for bilateral trade in goods from 1950 to 2015. We specifically link the volatility of trade to our measures of distance and controls:

$$SD(Y)_{ij,t} = \sum_k \alpha_k Dist(k)_{ij}$$

$$+\boldsymbol{\gamma}'\mathbf{X_{i,j,t}} + FE_{i,t} + FE_{j,t} + \varepsilon_{i,j,t} \quad (3a)$$

$$SD(Y)_{ij,t} = \sum_k \alpha_k Dist(k)_{ij} + \sum_h \sum_k \beta_{k,h} Dist(k)_{ij} Dist(h)_{ij} + \boldsymbol{\gamma' X_{i,j,t}} + FE_{i,t} + FE_{j,t} + \varepsilon_{i,j,t} \quad (3b)$$

where the periods indexed by t are non-overlapping 5-year windows, and $SD(Y)_{ij,t}$ is the standard deviation of the annual log difference in bilateral imports of goods over the window. $FE_{i,t}$ and $FE_{j,t}$ are time-varying country-source and country-destination fixed effects. The remaining variables and parameters are defined as in equations (1a)-(1c). Specification (3a) considers the direct impact of the various measures of distance, with a positive value of α_k indicating more volatile trade flows between more distant countries. Specification (3b) also considers the interaction between the various distance measures. If they amplify each other, the coefficient $\beta_{k,h}$ is negative.

Given the high dimensionality of the time-varying fixed effects, we use the estimation method of Guimaraes and Portugal (2010), which draws on an iterative (Gauss-Seidel) approach to fit linear regression models with two or more high-dimensional fixed effects under minimal memory requirements. We cluster the standard errors by dyad.

4.2 *Data*

4.2.1 *Macro data on trade and financial linkages*

We consider a broad range of bilateral international transactions at annual frequencies, namely annual totals for flows (trade in goods and services, financial flows) and year-end values for stocks (holdings of debt, equity, and banking positions).

We rely on several measures of trade. For trade in goods, we take the imports (in value) from the IMF's Direction of Trade Statistics. In addition to total trade, we consider manufactured goods, as well as commodity and energy products, retrieved from the United Nations' Comtrade database. For trade in services, we rely on several sources for the value of imports.[14] In addition to the total, we consider 10 categories of services.[15]

[14] The sources in question include Eurostat, the OECD statistics on international trade in services, and the United Nations' Services Trade database. We rely on the standard "mirror data approach" if one country does not report bilateral transactions with a partner country, and use the data reported by the partner-country in question instead.

We use five measures of international financial linkages. The first two are bilateral portfolio investment holdings of debt (short and long maturity) and equities (listed shares and investment funds), both taken from the IMF's Coordinated Portfolio Investment Survey (CPIS).[16] The third measure is the bilateral foreign direct investment position (FDI), taken from the OECD's FDI statistics.[17] Our final two measures pertain to international bank linkages from the BIS locational banking statistics.[18] They consist of bilateral banking positions (loans and deposits), and the corresponding banking flows adjusted for valuation effects arising from exchange rate movements.[19]

4.2.2 *Product-level data on trade in goods*

The product-level analysis relies on the BACI dataset (based on UN COMTRADE), which provides data on (reconciled) bilateral trade flows in goods at the 6-digit product level between country-pairs (See Gaulier and Zignago, 2010 for a full description of the data).[20] The product-level trade data are matched with the Rauch (1999) classification to distinguish between homogeneous and differentiated products.[21] We also use the BACI dataset to compute product-level volatility of imports in the destination country over the previous 15 years, which we use as the standard deviation of the growth rate of imports.[22]

[15] Transportation, tourism, construction, insurance, financial, communication, computer and information services, royalties and license fees, personal, government and other business services.

[16] The CPIS database is a standard source in the literature on international financial integration (see e.g. Lane and Milesi-Ferretti (2008)).

[17] According to the 3rd OECD benchmark definition of foreign direct investment (BMD3).

[18] Our results are robust when we use BIS consolidated banking positions instead.

[19] In the case of banking flows, we use annual bilateral transactions. If these are negative (indicating a retrenchment), we follow Levy Yeyati et al. (2007) and take the logarithm of the absolute value and multiply it with -1 to remain in line with a gravity model specification.

[20] The data are publicly available and accessible at http://cepii.fr/cepii/en/bdd_modele/bdd_modele_item.asp?id=37. We use the 1992 revision of the Harmonized System classification.

[21] The Rauch (1999) classification is publicly available at https://econweb.ucsd.edu/~jrauch/rauch_classification.html. Given that products in the Rauch (1999) are coded at the SITC Rev.2 level, while they are coded at the HS1992 level in the BACI dataset, we use the conversion tables from SITC Rev.2 to HS1992 (available at https://wits.worldbank.org/product_concordance.html and https://unstats.un.org/unsd/classifications/Econ) to match the two classifications.

[22] When computing volatility of imports, we use the standard deviation of log changes of trade flows for the intensive margin analysis, and midpoint growth rates for the extensive margin analysis.

4.2.3 *Measures of distance*

We consider three metrics of distance, capturing different dimensions. The first measure is the standard physical distance, defined as the logarithm of the kilometer distance between two nations' capital cities (using the latitudes and longitudes of the cities and question as well as the great circle formula). The figures are taken from CEPII's GeoDist database.[23]

Our second measure is the bilateral virtual distance, following Hellmanzik and Schmitz (2017). It captures the extent of internet connections between two nations and is the inverse of the measure of virtual proximity of Chung (2011). Chung (2011) relies on bilateral inter-domain hyperlinks connecting webpages for 87 countries.[24] The data cover the entire universe of websites registered on Yahoo in 2009, hence mitigating sampling bias. We take the logarithm of his measure and multiply it by -1 so that higher values indicate countries that are more distant in virtual terms.[25]

Our final metric is the bilateral language distance, taken from Melitz and Toubal (2014). It is based on an index of linguistic proximity capturing several dimensions, including whether a dyad has a common official language, spoken language, or native language and whether their respective languages are considered by linguists as close. The index takes values between zero and one, with higher values indicating closer linguistic proximity. We transform the measure

[23] See Mayer and Zignago (2011).

[24] Chung's data were constructed in May 2009 using Yahoo's search function and LexiURL Searcher, a social science web analysis tool developed by Thelwall (2009). Yahoo index covered about 47 billion websites, with more than 9.3 billion hyperlinks included in 33.8 billion sites from 273 different top-level domains (so-called ccTLDs, such as ".de" for Germany or ".it" for Italy). Due to the bidirectional nature of the data, bilateral hyperlinks are the number of links from websites with domain.xx (i.e. from the country with domain.xx) to domain.yy (i.e. to the country with domain.yy) and vice versa. Classifying source and host countries is a relatively easy task as long as one uses country top-level domains (ccTLD). It is more challenging for non-national domain names, such as ".org" or ".edu" or ".com". Chung (2011) developed an attribution method to identify the host country of such non-national domain names. It relies on webcrawling on the 20,000 most visited webpages to allocate web traffic to the ".com" domain to a specific host country (correcting for repeated visits). As website visits in the sample follow a power law, the webcrawling results are extrapolated for webpages with less traffic. This allocation of the large ".com" domain to specific countries makes the data much richer.

[25] For inclusion in our panel analysis, we estimate a time series of virtual distance for a set of 34 countries over 1998 to 2014 (the time series in question are available upon request). We regress in a log-log specification 2009 bilateral hyperlinks on the number of internet hosts within a dyad, as reported in the OECD Digital Economy Outlook 2015. With the obtained elasticities we can backcast a full time-series of bilateral hyperlinks.

by taking the logarithm of (1 plus the index) and multiplying it by -1 so that higher values indicate countries that are more distant in linguistic terms.

While virtual and language distance both relate to information frictions, they bring complementary angles. Virtual distance proxies for the ease with which communication can take place between two countries. Language distance measures the ease with which understanding actually takes place in a communication. Even when communication can easily take place, differences in cultures and customs may hinder the transmission of information. Considering both measures allows us therefore to assess whether it is limited communication or limited understanding that matters.

The three distance measures are standardized to facilitate comparison of the economic magnitude of their estimated effects on international linkages.

4.2.4 *Additional control variables*

The vector **X** of control variables in (1a)-(3b) includes the measures typically used in gravity models insofar as they are known to influence the geography of international trade and finance.

Specifically, we include binary dummy variables equal to one if two countries are contiguous (common border), share a common legal system (common law), share a currency (common currency) and were ever in a colonial relationship (common colony).[26] These variables aim at capturing transaction costs or information asymmetries that affect trade and financial relations between nations; they are sometimes described as picking up "familiarity" or "connectivity" frictions. The data are from CEPII's GeoDist database.[27] We also include as control variables the index of religious proximity of Melitz and Toubal (2014), a dummy equal to one if the countries have a trade agreement, and time zone differences.

Finally, our analysis of trade in goods in the event study includes a measure of bilateral integration in global value chains (GVC) taken from the Eora Multi-Regional Input-Output

[26] See e.g. Portes and Rey (2005) and Aviat and Coeurdacier (2007) for earlier discussions of these variables.
[27] See Mayer and Zignago (2011).

(MRIO) database.[28] For instance, if our dependent variable is the change in bilateral German imports from the US, the GVC variable (in log level) measures the pre-crisis value-added produced by the US which is contained in German exports (i.e. German imports from the US in value-added terms which Germany uses in its exports).

5. Empirical analysis: results

This section presents the results of our empirical analysis. We first consider the event studies based on macro data, covering the global financial crisis and the Covid pandemic (the latter for trade in goods). We then discuss the evidence based on more granular product-level data for the two events, focusing on trade in specific products. We finally present the long panel approach on trade in goods. As the analysis provides a rich set of results, the final subsection takes stock of the overall evidence.

5.1 *Cross-sectional evidence from the global financial crisis of 2007-09 with macro data*

5.1.1 *Baseline estimates*

To start, Table 1 reports the estimated coefficients of specification (1a) by including all three metrics of distance. The first three columns show the evidence for imports of goods (total, manufacturing, commodity, and energy). The results for imports of services are presented in column (4), and those for holdings of portfolio equity and debt by foreign investors in the destination country (liabilities) are shown in columns (5) and (6), the value of FDI holdings is presented in column (7), while the last two columns are for stocks and flows of banking investments. The dependent variable is the log difference of the respective international bilateral linkage between 2009 and 2007, so that a negative value represents a larger contraction. For brevity, the coefficients on the other controls (pre-crisis level of bilateral linkage, and gravity controls) and source- and destination-country fixed effects are not reported. The main message is that all three forms of distance jointly matter, with larger

[28] This database provides data on input-output linkages between 189 countries and 26 sectors (including services) over the period 1990-2019 (see e.g. Ignatenko et al. (2019)).

contractions of economic linkages between more distant countries. The specific estimates for bond and equity investments are close to those of Galstyan and Lane (2013).

The results suggest that the various measures of distance are not mere proxies for each other. Even when controlling for virtual and language distances, physical distance has a sizable and significant negative impact on all forms of trade, as well as most forms of financial linkages (except portfolio equity and bank flows). The relevance of physical distance beyond trade indicates that it does not merely reflect the cost of shipping goods.[29] Moreover, while physical distance is clearly relevant, it is not the whole story, as ease of communication and understanding are also relevant. Virtual distance plays a significant role, albeit with some heterogeneity. It is most relevant for trade in goods and services (except for commodities and energy) and portfolio investment, but it plays a limited role for FDI and banking linkages. Language distance also plays a sizable role, affecting all types of relations (except commodity and energy trade).

[Table 1 about here; "Tables_1_to_7.xlsx", sheet "Table_1"]

The effect of distance is economically substantial. The estimates of column 1 of Table 1 show that an increase in physical distance between two countries by one standard deviation decreased trade in goods by 23% during the global crisis, the corresponding decreases for virtual and linguistic distances being 15% and 5%, respectively. This said, while physical distance has received the bulk of attention in the literature, it is not always the measure with the largest effects. For instance, virtual distance had a larger impact on transactions in services or portfolio investments (Table 1, columns 4 to 6).[30]

[29] The coefficients on physical distance are not materially affected by the inclusion of the other two measures, and remain very close to those in Table A1in appendix where only physical distance is included.

[30] In line with Galstyan and Lane (2013), we find a significantly negative coefficient on the pre-crisis level of real and financial trade, thus indicating that the pull back during the crisis was stronger in percentage terms for country-pairs with more intensive pre-crisis trade. This holds in particular for portfolio investment, which is in line with "reversion to the mean" behavior of investors scaling back "overweight" pre-crisis positions. Notice also that it is not clear that the estimated elasticity of services imports with respect to language distance of Table 2 is significantly different from the elasticity of goods imports with respect to language distance; with coefficient estimates of -0.035 and -0.049 and standard errors of 0.018 and 0.016, respectively, the resulting 95% confidence intervals surrounding the point estimates are overlapping. Using a common language dummy in lieu of the index of language distance yields similar results: the coefficient estimate for services imports is not statistically different from the coefficient estimate obtained for goods imports. Moreover, when we use the common language dummy instead of the language distance with the product-level analysis (see below), the information friction mechanism is in fact confirmed and stronger since (a) effect on common language dummy is positive (as expected) and

Our results hold across an extensive series of robustness checks. We first assess whether controlling for bilateral integration in global value chains impacts the results for trade in goods (Table A2). The first column reports the baseline estimates (identical to Table 1, column 1), and the second one controls for GVC integration. The effects of physical and language distance are robust (with a smaller magnitude for physical distance). The coefficient on virtual distance on the other hand is no longer significant, suggesting that higher bilateral value chain participation constitutes a source of information that offsets the limits on communication. Excluding virtual distance from the estimation (column 3) substantially increases the number of observations and raises the effects of physical and linguistic distance to even larger values than in the baseline estimates (column 1).[31]

The second robustness check considers the 2008-9 change in the dependent variable, instead of the 2007-9 change. This reduces the effects of distances (appendix Table A3), in particular for financial linkages.[32] By contrast, the results for trade in goods and services remain robust, albeit somewhat weaker in economic magnitude.

In the next robustness test, we compute separate estimates across country groups. Specifically, we split the country pairs into three groups to focus on linkages between (i) advanced economies only, (ii) emerging market economies only, and (iii) advanced economies and emerging market economies.[33] The results are reported in Panels A, B, and C of Appendix Table A4. The effect of distance is weakest (mainly statistically insignificant) for linkages between advanced economies and strongest for linkages between advanced economies and emerging market economies. This is not surprising, as over half of the advanced economies are in Europe and much closer to each other in terms of the various distance measures than they are to emerging market economies.

significant for the differentiated goods only; (b) Virtual distance for homogeneous goods becomes insignificant as well.

[31] Pre-crisis bilateral global value chain integration itself shows a significant positive sign indicating that larger bilateral integration was associated with a smaller decline in trade flows during the crisis. This may reflect that higher bilateral GVC integration is associated with a more stable bilateral trade relationship and thus more difficult to terminate during a crisis.

[32] This is likely due to the fact that 2008 observations are affected by developments following the collapse of Lehman Brothers, while this is not the case for 2007 observations.

[33] The classification between advanced and emerging economies follows the IMF's definitions.

Next, we control for the growth in international trade over the period 2005-07 to check whether our estimates merely pick up a "payback" drop effect for pairs where linkages surged just before the crisis. The results remain largely robust (appendix Table A5), with a reduced effect of language distance. We also consider whether the distance effect is symmetric, i.e. whether the country pairs that experienced larger declines in the global financial crisis of 2007-09 were also those that experienced larger post-crisis booms in trade from 2009 to 2012 (appendix Table A6). We find that the effect of distance is much more limited during the recovery, and only the effect of physical distance was significant for trade in goods and services.[34] This indicates that information frictions (i.e. the effect of virtual and language distance) are an issue during crisis times, but not during the subsequent recovery.

In the final robustness check, we split trade in services into 10 categories (Appendix Table A7). Physical and virtual distance matter for all of them, indicating a role for uncertainty and information frictions. Interestingly, information frictions manifest themselves via the availability of communication channels (virtual distance), but not via the extent of understanding, as language distance is only relevant for "other business services" (which includes services such as consulting and research and development). Furthermore, transportation services are only affected by physical distance. This could be because firms operating in that sector have long been in contact with their foreign counterparts, or have a presence in the destination country, thereby alleviating information problems.

5.1.2 *Distance and business cycle volatility*

Our next step considers whether distances have a higher impact for destination countries where the business cycle is more volatile. The effect is ambiguous a priori. On the one hand, exporting and investing in more volatile countries could make the information frictions particularly relevant, leading to a larger impact of distance (the footloose view). On the other hand, exporters and investors in volatile countries may have invested in information gathering capabilities (the beachhead view), which should dampen the effect of distance.

[34] In banking, we still see crisis patterns, likely reflecting persistent banking deleveraging, in particular in Europe in line with Emter et al. (2019).

We measure economic volatility by the volatility of GDP growth over the previous 15 years, which we interact with the measures of distances as presented in specification (1b). Table 2 shows the results. In terms of direct impact, physical distance still broadly matters as in the baseline results (Table 1). The impact of virtual distance remains for trade in manufactured goods and services, as well as for portfolio investment. The coefficients are of similar magnitude as in Table 1, except for services. The direct impact of language distance is, however, weaker, and concentrated in portfolio investment and banking. In terms of the interaction of distance measures with business cycle volatility, our estimates show that it is mostly insignificant. Imports of services are the only exception, with the impact of all three measures of distance being significantly stronger for destinations with more volatile economic conditions.

[Table 2 about here; "Tables_1_to_7.xlsx", sheet "Table_2"]

To ease the interpretation of the effect of distances, Figure 1 shows the average marginal effects (AME) of distance on imports of services to ease the interpretation of the effects of the distance measures across various deciles of the distribution of growth volatility. Higher growth volatility is associated with a stronger (more negative) effect of the three distance measures (physical, virtual, and language), in line with the footloose hypothesis. This is observed over the entire volatility distribution for physical and virtual distances, while for language distance the negative impact on services trade is significant mostly for larger levels of volatility (i.e. from the mean onwards).

[Figure 1 about here,
EEREV-D-23-00197R2_Figure_1_top_left_physical.png
EEREV-D-23-00197R2_Figure_1_top_right.png
EEREV-D-23-00197R2_Figure_1_bottom_left_language.png]

5.1.3 *Complementarities between distance measures*

We next assess the extent to which our alternative measures of distance complement or substitute each other. Table 3 presents the estimates of specification (1c) and considers both the direct impact of the three distance measures, and all three interactions among them.

Compared to Table 1, the direct effect of physical distance remains significantly negative and of a larger magnitude for nearly all linkages, but it is no longer significant for banking. While the direct impact of language distance remains significant for imports of goods and services, it is no longer so for other variables and its sign changes for banking. Virtual distance no longer has a significant direct impact across the various linkages. This does not mean that virtual and language distances no longer matter, but they do so more through interactions. Specifically, there is a significant negative interaction between physical and virtual distance for trade in goods and services, as well as for portfolio equity. In other words, virtual distance amplifies the impact of physical distance. While banking positions are not affected by the physical-virtual interaction, the interaction of physical and language distance is significantly negative for them. This suggests that banking operations, which often entail a presence through affiliates, are not sensitive to the ability to communicate but are affected by the ability to understand, which amplifies the impact of physical distance. Finally, virtual and language distance amplify each other's impact on trade in goods, services, and portfolio debt, although significance is limited.

[Table 3 about here; "Tables_1_to_7.xlsx", sheet "Table_3"]

Taking a closer look at the categories of services, the direct effect of physical distance remains significant. While the direct impact of virtual distance is reduced compared, it now manifests itself in the form of an amplification effect between physical and virtual distances across most services (Appendix Table A8).

5.2 *Cross-sectional evidence from the Covid-19 pandemic with macro data*

We undertake a similar analysis for the other major crisis event study, namely the Covid-19 pandemic, focusing on trade in goods in the first quarter of 2020. For brevity, we focus on the discussion of results and leave the tables in the appendix.

Table A9 shows the estimated coefficients of equation (1a), with the dependent variable being the log difference in bilateral trade in goods between 2019 Q1 and 2020 Q1.[35] The main

[35] While the pandemic led to lockdown measures that substantially reduced economic activity and were heterogeneous across countries, their effect is absorbed by the source- and destination fixed effects.

message is that the results are like those for the global financial crisis, with a weaker impact of virtual distance. The coefficients on physical and linguistic distance are negative and highly significant, while the effect of virtual distance is not significant (column 1). Excluding virtual distance from the estimation (column 2) substantially increases the number of observations and makes the effects of physical and linguistic distance stronger and closer in economic magnitude to those of the baseline estimates for the global financial crisis of 2007-09. The estimates are robust to controlling for the level of bilateral GVC integration measured in 2019 (columns 3 and 4), although the economic magnitude of the estimated effect of physical distance declines slightly in the estimates obtained without virtual distance (see column 4).[36]

As before, we also assess whether the effect of distances is affected by the volatility of business cycles in the importing country. Table A10 shows that this is indeed the case, to a stronger extent than during the global financial crisis (Table 2). The direct effects of distances are similar to Table 2, and the interaction effect of volatility and physical distance is always negative and statistically significant (unlike Table 2). The amplification is however not present for the other distance measures. Specifically, the impact of language distance, while significant on its own, is not affected by business cycle volatility. The results are similar whether we consider the narrow sample for which we have information on virtual distance (columns 1 and 3) or on the broad sample where we only look at physical and language distances (columns 2 and 4), and if we control for GVC integration (columns 3 and 4).

We finally assess whether the various distance metrics amplify each other's impacts. Table A11 shows that, just as during the global financial crisis (Table 3), virtual distance raises the impact of physical distance, with a statistically significant negative coefficient on their interaction. As in Table 3, the interaction leads to a positive direct effect of virtual distance which is more significant during the Covid episode. The pattern is not sensitive to controlling for global value chain integration (column 2).

5.2 *Cross-sectional evidence with product-level data*

[36] As in the global financial crisis episode, pre-Covid-19 global value chain integration itself shows a significant positive sign, indicating that larger bilateral integration was associated with a smaller decline in trade flows.

To gain a more granular understanding of the role of distances, we compute our estimates at the product level (specifications (2a)-(2c)) for trade in goods. The main finding is that our core country-level results for trade in goods are robust and also observed at the product level.

Table 4 presents the event study results for the 2007-09 global financial crisis. The first three columns show the results for the intensive margin, including growth rates for dyads that trade in both years, while the last three columns show the extensive margin based on mid-point import growth rates to account for products being introduced and dropped between the two years. In both cases, Table 4 shows the results for all products, as well as for homogeneous goods and differentiated goods separately. All coefficients are negative and highly significant, showing that imports of products contracted more for distant country-pairs, whether distance is measured by physical, virtual, or language distance. This is in line with the country-level results of Table 1, supporting the "footloose" view that firms faced with challenging conditions pull back more from more distant markets.

Strikingly, the magnitude of the estimated economic effects from product-level data is higher than those obtained using the macro data in Table 1. Our estimates indicate that an increase in physical distance between by one standard deviation decreases trade in a particular product by 29%, with the corresponding decreases for virtual and language distances reaching about 30% and 7%, respectively. This compares with 24%, 15%, and 5% for the effects obtained on macro data with the basic specification (Table 1, column 1).

The magnitude of the estimated effects differs across types of products, in line with theoretical priors. They tend to be stronger for differentiated goods than for homogeneous goods, especially for virtual and language distances (columns 2 and 3 as well as columns 5 and 6). This is consistent with the conjecture that homogeneous products are less subject to information frictions than differentiated products. Finally, the results are quite similar in terms of intensive or extensive margin, as coefficients based on mid-point import growth as the

dependent variable are close to those based on import growth (columns 1-3, compared to columns 4-6).

[Table 4 about here; "Tables_1_to_7.xlsx", sheet "Table_4"]

We subject our findings to various sensitivity checks that confirm their robustness. The estimates for the Covid-19 period are similar to those for the global financial crisis of 2007-09. Imports of products contracted more during the pandemic – and to an economically similar extent as during the global financial crisis– for more distant country pairs (Table A12) across all three measures of distance. The effect is again stronger for differentiated products than for homogeneous products, and similar across the intensive (growth) and extensive (mid-point) margins of trade, as in Table 4. The effects are again stronger than at the country level (Table A9), with virtual distance being significant at the product level. In terms of identification strategy, our findings are also robust to controlling for separate source country, host country and product country fixed-effects in lieu of (more demanding) source-country-product and host-country-product fixed effects of the baseline specification.[37] In another robustness check, we compute separate estimates across country groups as done in Appendix Table A4 for country-level data and find similar results. Distance matters most between advanced economies and emerging market economies.[38]

We next assess whether they amplify each other's marginal effects, including all three interactions between the distance measures. Table 5 shows the estimates for specification (2c) for the global financial crisis. The negative and significant direct effect of all distances is robust. In terms of the interactions, the pattern differs from that obtained from the country-level data in Table 3. Specifically, physical and virtual distances do not amplify each other any longer. However, virtual distance has a clear negative direct effect in our product-level

[37] The results are not shown for brevity, but are available upon request.

[38] This probably reflects the fact that over half of the advanced economies are in Europe and much closer to each other than they are to emerging market economies. The results are not shown for brevity, but are available upon request.

analysis, which it does not have at the country-level. By contrast, virtual and language distance amplify each other, especially at the intensive margin. This indicates that a more limited ability to communicate (larger virtual distance) is particularly detrimental when combined with more challenges in terms of understanding (larger language distance). Physical and language distances offset each other, but only at the intensive margin. This is consistent with the beachhead view in terms of interactions. In destinations that are both physically distant and where the understanding of local business practices is more challenging (higher language distance), exporters have invested more efforts in setting up their presence and are less inclined to abandon the market. The offsetting pattern between physical and language distances is a noteworthy new result, which connects well with papers such as Baldwin and Harrigan (2011) who point out that the most productive firms trade with more distant destinations because they can absorb the required fixed costs, unlike the least productive firms. Despite the interaction, the strong negative direct impact of both distances unambiguously support the footloose view. Overall, in terms of direct impacts the findings support the footloose view, while in terms of interaction they support both the footloose (virtual and language distances) and beachhead (physical and language distances) views are confirmed. These results are confirmed, and if anything strengthened, in Covid 19 pandemic period.[39]

[Table 5 about here; "Tables_1_to_7.xlsx", sheet "Table_5"]

We finally assess whether the effects of distance depend on import volatility, using specification (2b) that interacts volatility with the measures of distance. The interacted effect of import volatility is negative for language distance but positive for physical and virtual distances, respectively.[40] Figure 2 shows the average marginal effects (AME) on imports of goods at the product level of the three distance measures for various deciles of previous import volatility, with the dots indicating the point estimates and the whiskers 95% confidence

[39] The results are not shown for brevity, but are available upon request.

[40] The results are not shown here to save space but are available upon request.

intervals.[41] While the country-level estimates on trade in services (Figure 2) show that all three effects decrease as volatility increases, this is now only the case for language distance (for trade in goods). By contrast, the impact of physical and virtual distance is moderated when volatility is higher, even though the effect remains negative.

[Figure 2 about here, EEREV-D-23-00197R2_figure2.png]

5.4 *Panel estimates*

5.4.1 *Baseline results*

Our analysis so far considered large, but exceptional, episodes. The question remains as to whether the impact of distances only applies under unusual circumstances or is a more general feature also seen in more normal times. We address this question using the panel model of specifications (3a). Data limitations require focusing on trade in goods, with the dependent variable being the standard deviation of the annual growth rate in bilateral imports over 5-year non-overlapping windows.

Distance measures matter, in a heterogeneous way, as shown in Table 6, which for brevity again presents only the coefficients on the measures in question.[42] When considering all measures (column 1), we find that virtual distance leads to more volatile trade flows, while physical and linguistic distances play no role. A caveat is that considering virtual distance substantially limits the sample, as the measure is only available in recent years and for a relatively small set of countries. Focusing only on physical and language distance raises the sample size by a factor of four. Doing so, we find that physical distance matters for trade volatility, as does language distance albeit to a more marginal extent (column 2). The impact of distance is thus not limited to the global financial crisis and pandemic periods, but instead seen more broadly.

[Table 6 about here; "Tables_1_to_7.xlsx", sheet "Table_6"]

[41] The AME on the extensive margin are analogous to those on the intensive margin and available upon request.

[42] The regressions include the control variables of model equation (1a) as well as time-varying source- and destination-country fixed effects.

We perform several robustness checks. We first compute estimates excluding the global financial crisis of 2007-09 to ensure that the surge in volatility in that period doesn't drive the results (appendix Table A13). The impact of physical distance is very similar, but the role of language distance is less significant. This indicates that physical distance has a general impact, while language distance matters more during exceptional times.

We also assess whether the length of the window used for volatility matters. To do so, we consider windows of 10 years instead of 5 (appendix Table A14). The results are similar, with again a weaker effect of language distance. Finally, we assess whether the volatility of trade is linked to its level in two ways (Table A15). We first take the coefficient of variation as the dependent variable, instead of the standard deviation (columns 1 to 4).[43] We find again that physical distance amplifies trade volatility. We then revert to using the standard deviation as the dependent variable and control for lagged average bilateral trade (columns 5 to 8). We see that volatility is lower when the trade volume is higher, and physical distance still amplifies trade volatility.[44]

Another concern is that the correlation between GDP growth could be different depending on distance, which would affect the volatility of trade flows. While controlling for bilateral GDP growth correlations (within the same time windows) reduces the number of observations by about one-third, we still find that physical distance raises trade volatility, with a marginally significant effect of language distance (when we abstract from virtual distance), as shown in Appendix Table A16.

5.4.2 *Complementarities between distance measures*

We now assess whether the measures of distance amplify each other in terms of their impact on trade volatility. Table 7 presents the results of estimating specification (3b) including interactions between our various metrics. Interactions are included jointly in column (1) and individually in columns (2) to (4).

[43] In other words, we scale the standard deviation of the annual growth rate in bilateral imports of goods over non-overlapping 5-year windows of observations by the average level of bilateral trade during this period.

[44] We do not control in this specification for the standard gravity covariates as they are obviously correlated with lagged average trade; but we use time-varying exporter and importer fixed-effects throughout.

When considering virtual distance (columns 1, 2, and 4), we find that it amplifies the impact of the other two measures, confirming the results from the event studies. As pointed out above, the sample including virtual distance is however limited. If we focus on the much larger sample with only physical and language distances (column 3), we see that physical distance raises trade volatility, but its impact is not amplified by language distance. The results are very similar if we omit the crisis years (appendix table A17), or when considering windows of 10 years instead of 5 years (appendix table A18).

[Table 7 about here; "Tables_1_to_7.xlsx", sheet "Table_7"]

5.5 *Taking stock of the results*

Our analysis highlights a rich set of results through complementary angles. This section takes stock of the main ones and uses them to assess the hypotheses presented in section 3.

The major results of our analysis are as follows. First, there is clear and robust evidence that distance matters for changes in international linkages, pointing to a "footloose" effect where in adverse times linkages shrink more between more distant country pairs. Second, the effect goes well beyond physical distance and well beyond trade in goods. Controlling for physical distance, we find similar effects for virtual and language distances. The footloose pattern is also present across various international linkages, including trade in services and various forms of financial investments. Third, product-level evidence for trade in goods is very similar to the evidence at the country level. If anything, the impact of distances is larger and more significant at the more granular level, with for instance an impact of virtual distance during the Covid-19 crisis that is not significant at the country level.

Fourth, the various measures of distance interact with each other, with the pattern varying somewhat with the degree of granularity. At the country level, physical and virtual distances amplify each other, leading to particularly large contractions in country pairs that are physically far away and not well connected. At the product level, virtual and language distances amplify each other, while physical and language distances offset each other's effects, thereby pointing to a beachhead effect for that interaction, even though the direct impact of all distances clearly supports the footloose view.

Fifth, the impact of distance measures is also seen in a long sample that goes beyond times of major crises, with physical distance playing the clearest role from this perspective.

Our analysis also points to some nuances when going beyond the direct impact of distances. That impact shows some connection with business cycle volatility in the receiving countries. This is seen for trade in services at the macro level during the global financial crisis, with a larger effect of all distance measures when GDP in the importing countries is more volatile. Similarly, physical distance had a larger effect for more volatile destinations during the Covid 19 pandemic. The product-level data show a significant effect of volatility for trade in goods, with contrasts. All three measures of distance indicate larger contractions for country-pairs that are further apart, at all levels of volatility. This footloose pattern is larger for language distance for pairs with more volatile imports, while volatility reduces (but does not overturn) the footloose effect for the other two measures of distances.

In terms of mechanisms, the fact that the impact of distance significantly goes beyond physical distance and trade in goods indicates that the costs of physical transportation or storage are not the core drivers. Instead, our results are consistent with distance bringing frictions largely in terms of information, with firms dealing with more distant countries facing a harder time getting a clear understanding of local conditions. This interpretation is supported by the findings that virtual and language distances matter; that the effect is seen for financial linkages (and less so for forms of investment that entail a local presence such as FDI and banking); that the effect of some distance measures tends to be larger for relations with countries with more volatile conditions; and that the effect of virtual and language distances are most prominent in times of crisis when it is particularly challenging to make accurate assessments.

Our results indicate that of the two measures of information frictions, the language distance appears more relevant (albeit not exclusively so). Specifically, the effect of language distance is more robust across various forms of linkages during the global financial crisis, and its effect on trade in goods is more robust to the inclusion of global value chains than the effect of virtual distance. The effect of language distance is also seen during the Covid19 pandemic. The product-level analysis furthermore indicates that the two information frictions interact and

amplify their respective effects. This suggests that the ability to communicate (virtual distance) is not enough and that one also needs the ability to understand each other (language distance). Interestingly, the product-level analysis shows that language and physical distances offset each other. A possible explanation is that exporters selling to countries that are far away and with very different languages and cultures take more care in setting up local presence, and are then less likely to cut their activity in challenging times, thus dampening the effect of distances (a beachhead effect).

We can now assess the testable hypotheses of section 3 using our results from the event and long-term panel analysis.

> *Hypothesis #1: shipment channel. If physical distance proxies for the costs of shipping goods, it should matter for the volatility of trade in goods but not for trade in services and financial interactions.*

We clearly reject this hypothesis. Tables 1 show that physical distance matters beyond trade in goods, including financial linkages that do not entail a physical dimension.

> *Hypothesis #2: information channel. If distance reflects information frictions, virtual and /or language distance should matter.*

We accept this hypothesis. Table 2 shows that virtual and language distance both matter, with larger contractions of economic linkages between more distant countries, even when controlling for physical distance. Table A4 also shows that the distance effects are smallest between advanced economies and largest for linkages between an advanced and an emerging economy. If we consider that information to gauge conditions in advanced economies is more widely available than for emerging markets, and that firms and investors in advanced economies are more unfamiliar with conditions in emerging markets than in advanced economies, the results point to the relevance of information frictions. Moreover, our product-level evidence corroborates their relevance: we found evidence of stronger footloose effects for differentiated products than for homogeneous products, in line with the prior that homogeneous products have more predictable demand compared to differentiated products – and are therefore less affected by information frictions.

Hypothesis #3: understanding channel. If information frictions are about the ability to understand each other more than the ability to communicate, language distance should have a more robust effect than virtual distance.

We accept this hypothesis. Table 1 shows that language distance matters even for linkages where virtual distance is not significant, and Table A2 shows that language distance is robust to the inclusion of global value chains. Table A10 shows that during the Covid19 pandemic language distance has a more robust effect.

Hypothesis #4: information complementarity channel. If physical distance reflects higher challenges in assessing economic prospects, virtual and /or language distance should amplify the effect of physical distance.

This hypothesis is accepted. Table 3 and A11 shows that higher virtual distance amplifies the impact of physical distance. As the direct effect of virtual distance is much reduced when controlling for interactions, our results indicate that the role of physical distance proxies for information frictions that can be addressed when communication is easier (i.e. lower virtual distance). Being able to communicate does not play a role per se, but only to the extent that there are information frictions to overcome. The product-level evidence of Table 5 also indicates that a better ability to communicate (low virtual distance) is most useful when the ability to understand each other is also high (low language distance).

Hypothesis #5: economic volatility channel. If virtual and /or language distance affects the ability to gauge economic conditions, their effect should be larger when growth in the destination country is historically more volatile.

We partially accept this hypothesis, as the evidence is mixed. Table 2 shows that during the global financial crisis imports of services are the only international transaction where the negative impact of all distances was higher for trade towards countries with more volatile fundamentals. Table A10 shows a larger effect of physical distance for shipments of goods towards more volatile destinations. The product-level evidence of Figure 2 shows that while language distance has a larger impact for exports of goods to volatile destinations, the pattern is opposite for physical and virtual distance (but the effect remains overall negative). The

absence of a volatility effect in several forms of linages could reflect an endogenous adjustment by firms who developed stronger information processing capabilities when dealing with more volatile countries.

Hypothesis #6: local presence channel. Distance should have a more moderate effect for economic interactions that entail a local presence (FDI or banking) or for which information is available globally (commodity trade).

We accept this hypothesis. Table 1 shows that virtual distance, which proxies for the ability to communicate, does not matter for imports of commodities, as well as investment in the form of FDI and banking. As multinationals and banks often have a presence in the destination country, they are not as sensitive to information frictions as much as firms of investors operating in the source country. The absence of effect for imports of commodity and energy goods can reflect the fact that these goods are homogenous, and hence with less dispersed information. Table 3 provides additional support for the pattern, as virtual distance does not amplify the impact of physical distance for FDI and banking linkages.

Hypothesis #7: crisis information channel. Distances, especially virtual and /or language, should have a more pronounced role during crisis events than over long periods.

We find evidence supporting this hypothesis. First, table A6 shows that while distance matters during the global financial crisis, it did not during the subsequent recovery. The evidence from the panel analysis of Tables 6 and 7 shows a reduced role for virtual and language distances once we look beyond the global financial crisis. Physical distance clearly matters, with higher volatility of trade flows between more distant countries. While virtual distance matters, and amplifies the impact of physical and language distances, data limitations limit the length of the panel for which we can control for virtual distance. Taking a longer panel and focusing on physical and language distance shows that the latter has only a weak direct role and no amplification role.

We conclude this section by contrasting the results for trade in goods between the country-level and the product-level analyses. Both show a clear negative direct effect of all distances (Table 1 and Table 4). When allowing for both direct and interacting effects (Table 3 and Table 5), the pattern varies but still overall supports the footloose view. Virtual and language distances amplify each other, especially at the product level, showing that a limited ability to communicate is particularly costly when understanding is more limited to start with. Virtual distance manifests itself through an amplification of physical distance at the country-level, but directly at the product level. This suggests that the product mix varies with physical distance, with for instance shipments to destinations that are further away consisting more of products for which the information friction is larger. Physical and language distances only interact at the product level, where this interaction tends to offset the direct adverse effects of both distances. Overall, we view the two levels of results as largely confirming the footloose pattern of distances, with possibly different product mixes across destinations that are close or far leading to some difference in terms of the exact channel (direct or interactions) through which distances affect trade fluctuations.

6. Conclusion

This paper studies whether distance impacts the volatility of international trade and financial linkages. While the relevance of distance is well established theoretically and empirically for the level of trade, its impact on the volatility is more ambiguous a priori, with possible beachhead and footloose effects going in opposite directions. We assess the role of distance by looking at a broad range of international linkages and metrics of distance. We perform an event study of country pairs at the macro level during the global financial crisis of 2007-09 and the Covid-19 pandemic of 2019-2020, focusing on trade in goods in the latter case. International trade in goods, services, and finance linkages contracted more for countries that are more distant in terms of geography, language, and internet connections, with some heterogeneity. The effect is not limited to physical distance, as virtual and language distances also matter, with some of the measures showing amplification effects. We find similar

evidence when looking at product-level data on trade in goods. We also take a longer view through a panel analysis, which shows that distance is associated with more volatile trade flows, with the effect being strongest for physical distance.

Our findings point to information frictions as a major dimension. First, virtual and language distances matter even when controlling for physical distance. Second, distance has a much weaker effect for linkages of FDI and banking activities that entail a local presence offering firms more accurate information, or linkages that operate through homogenous goods for which information is less dispersed such as commodities. Third, while physical distance remains relevant even when controlling for language and virtual distance, its effect is dampened by easier communication. Fourth, the role of language and virtual distance is weaker when looking beyond crisis times when communication is most important. Fifth, at the macro level the effect of all three measures of distance on trade in services and goods is larger for exports to countries with more volatile conditions. Finally, the distance effects are stronger for differentiated products than for homogeneous products, as expected if homogeneous products have a more predictable demand compared to differentiated products.

While our empirical analysis does provide a normative metric, and formally assessing the welfare implications goes beyond the scope of this paper, our results point to possible welfare costs. One of our salient findings is that frictions in the transmission of information lead to a larger contraction in trade and financial linkages during crisis times. This amplification could make the firms' assessment of the economic situation in the exporting and investing countries even more challenging, further increasing the challenge of establishing a reliable assessment of economic fundamentals. Such a feedback loop between uncertainty and volatility could make the effects of international spillovers inefficiently large for distant country pairs. A policy response could be to promote the dissemination of information both before times of economic turmoil, so that foreign agents can build a better understanding of local economies, and during crisis times to clarify the evolving situation.

Even aside from potential inefficiencies, our evidence informs the policy discussion about international spillovers through trade and financial linkages. Such spillovers are a major issue for policymakers concerned with the volatility of economic activity, and our findings suggest that they apply particularly to more distant partners. Furthermore, we find evidence that

effective distance increases in times of turmoil, as virtual and language distances are then more relevant. A policy maker concerned about her country's exposure to the global cycle should therefore not necessarily focus only on her trading partners with the largest volume of linkages, which are likely to be nearby countries but take account of flows to more distant partners that could prove more volatile in crisis times, and thereby contribute disproportionately to the overall volatility of the country trade and financial flows.

While physical distance is a given, policy could shrink distance in terms of transmission of information. This could be done by strengthening the connectivity of a country with the rest of the world by e.g. investing in infrastructure increasing internet broadband and latency. This shortening of virtual distance, for instance, could limit volatility, both directly and by reducing the impact of physical distance. However, our results suggest that such policies – though necessary – would not be necessarily sufficient if language distance remains sizable.

Our analysis can be expanded along several lines. The role of information frictions could be assessed more finely with granular data on investors' holdings. The sensitivity of equity investment to distance could be different for investment in sectors with more volatile and uncertain prospects. The sensitivity of cross-border banking could differ across individual banks depending on the extent of their local presence in foreign markets, as such a presence is a way to limit information asymmetries. The state-contingent pattern, with a larger role of information frictions in times of large fluctuations, could be assessed beyond the two events that we considered to see whether this role is observed when business cycle fluctuations are merely large, or whether they only manifest themselves in large crisis times. We leave these questions for future research.

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Table 1: Event study of the global financial crisis of 2007-09 – Broad impact of distances

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy imports	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.235***	-0.167***	-0.265***	-0.152***	-0.077	-0.145***	-0.140***	-0.187***	0.393
	(0.029)	(0.019)	(0.033)	(0.028)	(0.053)	(0.054)	(0.041)	(0.064)	(0.345)
ln(virtual distance)	-0.148**	-0.175***	-0.079	-0.361***	-0.509***	-0.335**	-0.025	0.087	-0.848
	(0.064)	(0.038)	(0.071)	(0.084)	(0.165)	(0.140)	(0.117)	(0.180)	(0.919)
ln(1+language distance)	-0.049***	-0.025**	-0.017	-0.035**	-0.127***	-0.063*	-0.061**	-0.103**	-0.579**
	(0.018)	(0.011)	(0.022)	(0.016)	(0.036)	(0.038)	(0.027)	(0.044)	(0.249)
Observations	6,566	5,058	5,058	2,935	1,631	1,800	1,288	1,509	1,576
R^2	0.194	0.310	0.258	0.211	0.385	0.316	0.300	0.235	0.165
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2: Event study of the global financial crisis of 2007-09 – Distance measures and volatility

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy imports	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.233***	-0.175***	-0.244***	-0.127***	-0.054	-0.198***	-0.191***	-0.155*	0.713*
	(0.033)	(0.024)	(0.038)	(0.033)	(0.070)	(0.066)	(0.059)	(0.082)	(0.427)
× growth volatility (15-year) at destination	-0.276	0.298	-1.075	-1.861**	-1.106	1.989	2.238	-1.302	-14.054
	(0.680)	(0.594)	(0.938)	(0.941)	(1.819)	(1.412)	(1.942)	(2.182)	(9.386)
ln(virtual distance)	-0.079	-0.166***	0.008	-0.196**	-0.671***	-0.492***	-0.076	-0.029	-0.859
	(0.070)	(0.047)	(0.092)	(0.093)	(0.204)	(0.160)	(0.158)	(0.213)	(1.120)
× growth volatility (15-year) at destination	-2.053**	-0.253	-2.854	-4.159**	4.649	2.919	1.542	2.561	-4.045
	(1.007)	(0.947)	(2.315)	(1.668)	(3.635)	(2.722)	(3.546)	(2.954)	(13.140)
ln(1+language distance)	-0.017	-0.012	-0.041	0.009	-0.152***	-0.118**	-0.063	-0.167***	-0.950***
	(0.022)	(0.016)	(0.032)	(0.024)	(0.048)	(0.056)	(0.040)	(0.061)	(0.320)
× growth volatility (15-year) at destination	-1.116	-0.493	0.815	-1.996**	1.273	2.600	-0.023	2.416	12.833*
	(0.683)	(0.498)	(1.036)	(0.889)	(1.869)	(1.883)	(1.171)	(1.524)	(7.271)
Observations	6,566	5,058	5,058	2,935	1,631	1,800	1,288	1,509	1,576
R^2	0.196	0.310	0.259	0.216	0.386	0.318	0.301	0.240	0.166
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1b) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, their interaction with growth volatility (15-year) at the destination, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3: Event study of the global financial crisis of 2007-09 – Complementarities between distance measures

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy imports	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans	(9) Bank loans (flows)
ln(physical distance)	-0.333***	-0.265***	-0.430***	-0.368***	-0.684***	-0.435**	-0.303**	-0.310	-1.671*
	(0.072)	(0.046)	(0.086)	(0.095)	(0.192)	(0.181)	(0.129)	(0.203)	(0.957)
ln(virtual distance)	0.252	0.184	0.417	0.218	1.219**	0.298	0.433	0.199	3.570
	(0.217)	(0.139)	(0.265)	(0.271)	(0.578)	(0.523)	(0.372)	(0.576)	(3.017)
ln(1+language distance)	-0.234**	-0.027	0.035	-0.204*	-0.086	-0.034	-0.048	0.810***	3.486*
	(0.093)	(0.062)	(0.126)	(0.117)	(0.211)	(0.249)	(0.171)	(0.300)	(2.061)
ln(physical distance) × ln(virtual distance)	-0.039**	-0.032***	-0.047**	-0.059**	-0.162***	-0.064	-0.042	-0.007	-0.403
	(0.018)	(0.012)	(0.022)	(0.024)	(0.046)	(0.042)	(0.031)	(0.049)	(0.260)
ln(physical distance) × ln(cultural distance)	0.012	0.003	-0.008	-0.000	-0.009	-0.030	-0.001	-0.049**	-0.270*
	(0.009)	(0.006)	(0.011)	(0.008)	(0.017)	(0.019)	(0.013)	(0.021)	(0.161)
ln(virtual distance) × ln(cultural distance)	-0.024*	0.007	-0.010	-0.045*	-0.016	-0.076*	0.001	0.102**	0.322
	(0.014)	(0.009)	(0.020)	(0.025)	(0.041)	(0.041)	(0.030)	(0.040)	(0.262)
Observations	6,566	5,058	5,058	2,935	1,631	1,800	1,288	1,509	1,576
R^2	0.196	0.311	0.259	0.214	0.393	0.322	0.301	0.239	0.171
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade / position	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1c) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance and their interactions, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: Event study of the global financial crisis of 2007-09: Product Level

	(1) Intensive Margin	(2) Intensive Margin	(3) Intensive Margin	(4) Extensive Margin	(5) Extensive Margin	(6) Extensive Margin
	All Products	Homogeneous Products	Differentiated Products	All Products	Homogeneous Products	Differentiated Products
ln(physical distance)	-0.290***	-0.269***	-0.297***	-0.229***	-0.230***	-0.231***
	(0.012)	(0.012)	(0.013)	(0.009)	(0.008)	(0.009)
ln(virtual distance)	-0.295***	-0.218***	-0.315***	-0.162***	-0.115***	-0.177***
	(0.040)	(0.049)	(0.041)	(0.025)	(0.029)	(0.025)
ln(1+language distance)	-0.065***	-0.056***	-0.067***	-0.044***	-0.037***	-0.047***
	(0.009)	(0.010)	(0.010)	(0.006)	(0.006)	(0.007)
Observations	4,180,542	897,533	3,094,326	6,800,011	1,609,681	4,888,648
R^2	0.374	0.404	0.366	0.516	0.550	0.506
Exporter-Product fixed effects	yes	yes	yes	yes	yes	yes
Importer-Product fixed effects	yes	yes	yes	yes	yes	yes
Pre-crisis trade/position	yes	yes	yes	yes	yes	yes
GVC integration	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a') obtained by OLS where the dependent variable is, respectively, the log change (columns (1)-(3)) and the midpoint growth rate (columns (4)-(6)) of bilateral trade in goods at the product level over 2007-2009. Bilateral transactions in goods are regressed on the three alternative measures of distance, the pre-crisis levels of the trade in goods, the gravity controls and source-product and destination-product fixed-effects as well as on pre-crisis bilateral integration in global value chains. The standard errors reported in parentheses are clustered at the source-destination level; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Product-level event study of the global financial crisis of 2007-09 --Complementarities between distance measures

	Intensive Margin	Intensive Margin	Intensive Margin	Extensive Margin	Extensive Margin	Extensive Margin
	All Products	Homogeneous Products	Differentiated Products	All Products	Homogeneous Products	Differentiated Products
	(1)	(2)	(3)	(4)	(5)	(6)
ln(physical distance)	-0.310***	-0.203***	-0.336***	-0.264***	-0.237***	-0.279***
	(0.039)	(0.041)	(0.041)	(0.028)	(0.029)	(0.029)
ln(virtual distance)	-0.420***	-0.550***	-0.389***	-0.238***	-0.261***	-0.218**
	(0.122)	(0.125)	(0.128)	(0.089)	(0.091)	(0.092)
ln(1+language distance)	-0.330***	-0.272***	-0.348***	-0.101***	-0.109***	-0.103***
	(0.051)	(0.055)	(0.053)	(0.034)	(0.035)	(0.036)
ln(physical distance) x ln(virtual distance)	0.004	0.026**	-0.001	0.001	0.008	-0.002
	(0.010)	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
ln(physical distance) x ln(1+language distance)	0.016***	0.014**	0.017***	0.003	0.004	0.003
	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
ln(virtual distance) x ln(1+language distance)	-0.030***	-0.021**	-0.033***	-0.009+	-0.009+	-0.009+
	(0.009)	(0.009)	(0.010)	(0.006)	(0.006)	(0.006)
Observations	4,206,654	902,162	3,114,679	6,862,080	1,622,203	4,935,548
R^2	0.374	0.403	0.365	0.516	0.549	0.505
Exporter-Product fixed effects	yes	yes	yes	yes	yes	yes
Importer-Product fixed effects	yes	yes	yes	yes	yes	yes
Pre-crisis trade/position	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1c') obtained by OLS where the dependent variable is, respectively, the log change (columns (1)-(3)) and the midpoint growth rate (columns (4)-(6)) of bilateral trade in goods at the product level over 2007-2009. Bilateral transactions in goods are regressed on the three alternative measures of distance, and their interactions, the pre-crisis levels of the trade in goods, the gravity controls and source-product and destination-product fixed-effects. The standard errors reported in parentheses are clustered at the source-destination level: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15.

Table 6: Panel estimates on the 1950-2015 period

	(1)	(2)
ln(physical distance)	-0.001	0.030***
	(0.008)	(0.010)
ln(virtual distance)	0.006***	
	(0.001)	
ln(1+language distance)	-0.002	0.009+
	(0.005)	(0.006)
Observations	6,599	27,367
R^2	0.232	0.253
Time-varying exporter fixed effects	yes	yes
Time-varying importer fixed effects	yes	yes
Other gravity controls	yes	yes

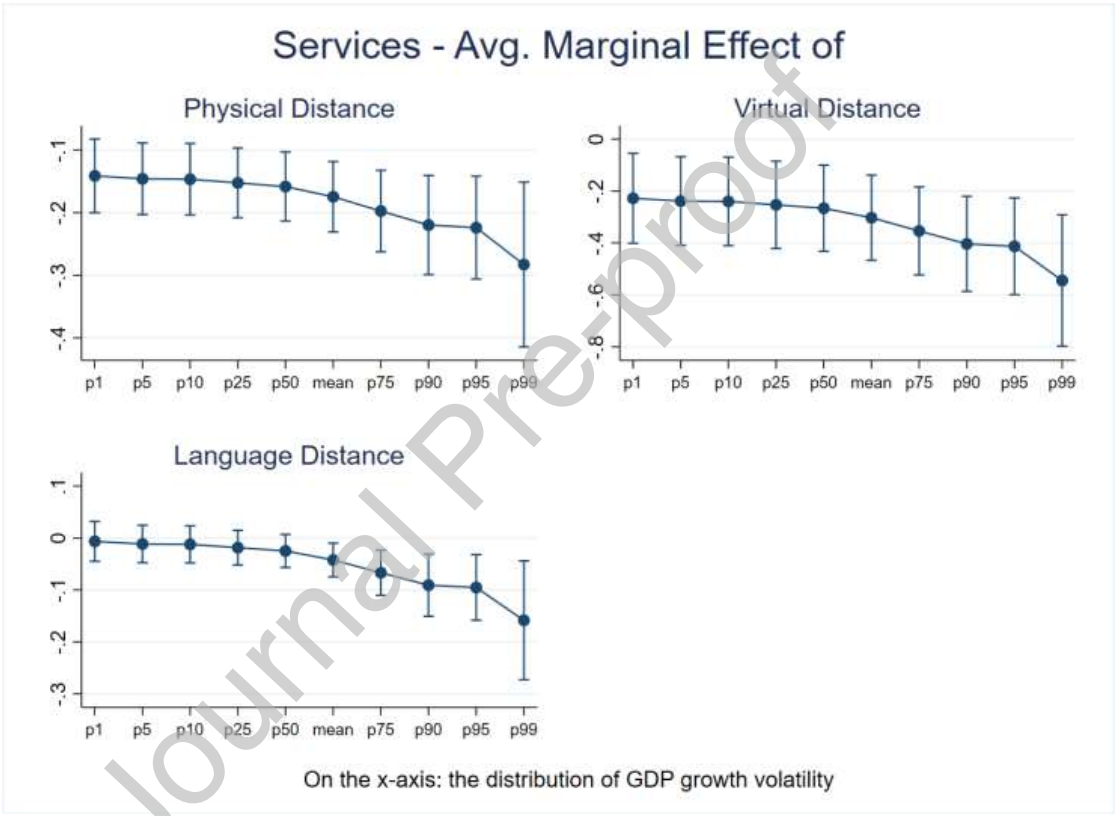
Notes: The table reports panel estimates of model equation (2a) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable. The three measures of distance are entered jointly as explanatory variables in the specification of column (1), while virtual distance (for which data availability is poorer) is excluded from the specification of column (2). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{+}$ $p<0.15$.

Table 7: Panel estimates on the 1950-2015 period – Complementarities between distance measures

	(1)	(2)	(3)	(4)
ln(physical distance) × ln(virtual distance)	0.002***	0.002***		
	(0.000)	(0.000)		
ln(physical distance) × ln(language distance)	-0.000		0.001	
	(0.003)		(0.003)	
ln(language distance) × ln(virtual distance)	0.002***			0.002***
	(0.000)			(0.000)
ln(physical distance)	0.006	0.006	0.033***	
	(0.010)	(0.008)	(0.012)	
ln(virtual distance)	-0.010**	-0.015***		0.010***
	(0.004)	(0.004)		(0.001)
ln(1+language distance)	0.005		-0.005	0.006
	(0.025)		(0.031)	(0.006)
Observations	6,599	6,599	27,367	6,599
R^2	0.239	0.236	0.253	0.235
Time-varying exporter fixed effects	yes	yes	yes	yes
Time-varying importer fixed effects	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes

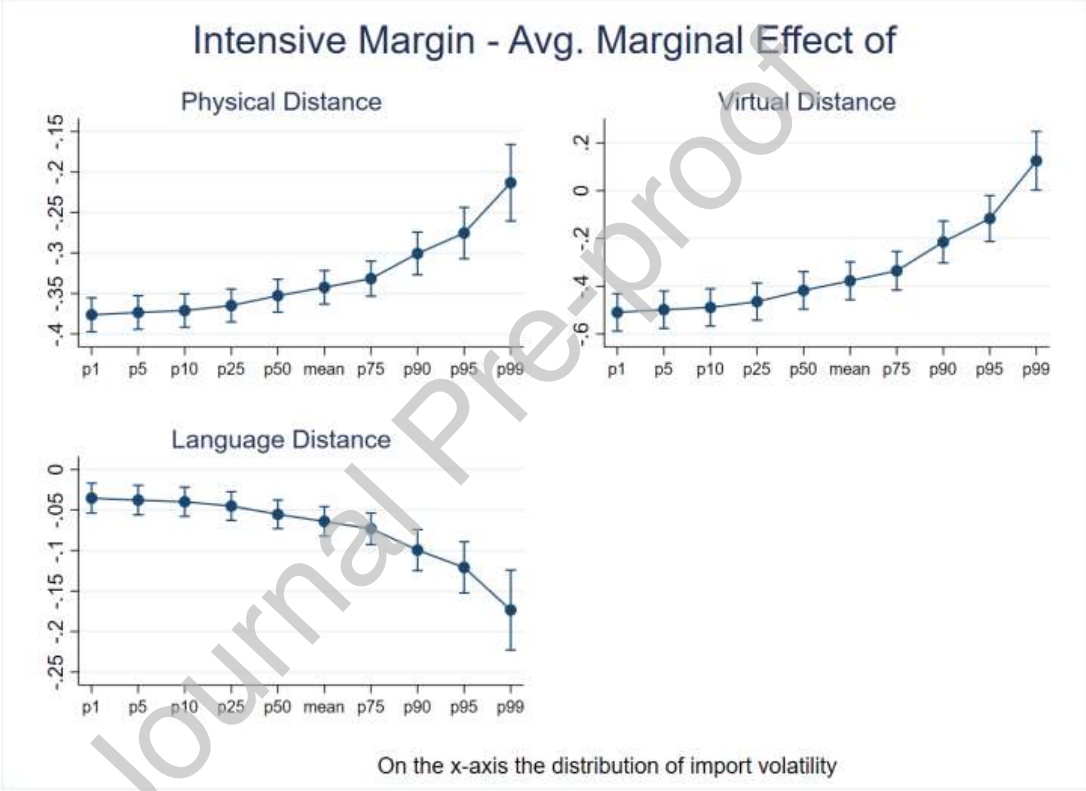
Notes: The table reports panel estimates of model equation (2b) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable. The regressions include the measures of distance and their interacted effects, which are included jointly in the specification of column (1) and individually in the specifications of columns (2) to (4). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{+}$ $p<0.15$.

Figure 1: Average marginal effects – Services imports



Notes: The figure plots the average marginal effects (AME) of the three distance measures on services trade, based on Table 4. The dots indicate the point estimates and the whiskers at the 95% confidence intervals. The distribution of GDP growth volatility is shown on the *x*-axis.

Figure 2: Average marginal effects – Intensive margin, product-level imports



Notes: The figure plots the average marginal effects (AME) of the three distance measures on the intensive margin. The dots indicate the point estimates and the whiskers the 95% confidence intervals. The distribution of import volatility at the product-destination level is shown on the *x*-axis.

ONLINE APPENDIX: NOT FOR PUBLICATION

Table A1: Event study of the global financial crisis of 2007-09 – Impact of physical distance

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy imports	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.266***	-0.188***	-0.280***	-0.180***	-0.169***	-0.219***	-0.155***	-0.214***	0.139
	(0.028)	(0.019)	(0.033)	(0.028)	(0.052)	(0.053)	(0.042)	(0.064)	(0.345)
Observations	6,566	5,058	5,058	2,935	1,631	1,800	1,288	1,509	1,576
R^2	0.192	0.305	0.258	0.204	0.372	0.310	0.297	0.231	0.158
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on physical distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A2: Event study of the global financial crisis of 2007-09– Controlling for global value chains

	(1) Goods imports	(2) Goods imports	(3) Goods imports
ln(physical distance)	-0.235***	-0.138***	-0.260***
	(0.029)	(0.029)	(0.023)
ln(virtual distance)	-0.148**	-0.056	
	(0.064)	(0.066)	
ln(1+language distance)	-0.049***	-0.054***	-0.064***
	(0.018)	(0.018)	(0.014)
Observations	6,566	6,348	15,672
R^2	0.194	0.212	0.226
Exporter fixed effects	yes	yes	yes
Importer fixed effects	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes
GVC integration	no	yes	yes
Other gravity controls	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a) obtained by OLS where the log change in bilateral trade in goods over 2007-2009 is the dependent variable. Bilateral transactions in goods are regressed on the three alternative measures of distance, the pre-crisis levels of the trade in goods, the gravity controls and source- and destination-country fixed-effects as well as on pre-crisis bilateral integration in global value chains. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A3: Event study of the global financial crisis – Cross-sectional estimates for 2008-2009

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.190***	-0.121***	-0.211***	-0.084***	-0.037	-0.066	-0.069*	-0.041	0.861***
	(0.025)	(0.018)	(0.030)	(0.023)	(0.049)	(0.047)	(0.041)	(0.049)	(0.323)
ln(virtual distance)	-0.104**	-0.181***	-0.069	-0.074	-0.530***	-0.290**	0.018	-0.036	0.065
	(0.047)	(0.037)	(0.064)	(0.069)	(0.153)	(0.123)	(0.121)	(0.161)	(0.828)
ln(1+language distance)	-0.052***	-0.028***	0.020	-0.035**	-0.073**	-0.057	-0.028	-0.017	-0.147
	(0.014)	(0.011)	(0.017)	(0.014)	(0.031)	(0.035)	(0.022)	(0.029)	(0.235)
Observations	6,607	5,001	5,001	3,017	1,676	1,785	1,413	1,538	1,578
R^2	0.154	0.216	0.240	0.172	0.272	0.283	0.133	0.182	0.189
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2008-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A4: Event study of the global financial crisis of 2007-09 – Cross-sectional estimates by country groups

A. *Only advanced economies*

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy imports	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.028	-0.024	-0.040	-0.072***	-0.127*	0.017	-0.050	-0.085	0.702
	(0.025)	(0.024)	(0.050)	(0.025)	(0.068)	(0.076)	(0.055)	(0.111)	(1.018)
ln(virtual distance)	-0.141	-0.048	-0.339*	-0.324***	-0.646***	0.001	0.029	-1.040***	-6.181*
	(0.093)	(0.073)	(0.174)	(0.104)	(0.224)	(0.287)	(0.182)	(0.372)	(3.412)
ln(1+language distance)	-0.024*	-0.034**	-0.016	-0.016	0.062	-0.037	0.003	-0.098	-0.729
	(0.014)	(0.013)	(0.028)	(0.015)	(0.043)	(0.048)	(0.043)	(0.078)	(0.703)
Observations	525	525	525	503	457	474	382	334	335
R^2	0.347	0.351	0.334	0.324	0.435	0.539	0.253	0.282	0.250
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

B. *Only emerging market economies*

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.361***	-0.202***	-0.344***	-0.371***	-0.357**	-0.235	-0.296	-0.040	1.775*
	(0.053)	(0.036)	(0.063)	(0.085)	(0.162)	(0.149)	(0.248)	(0.240)	(0.916)
ln(virtual distance)	-0.160	-0.255***	-0.229*	-0.686***	0.346	-0.379	0.187	0.188	-1.229
	(0.103)	(0.058)	(0.120)	(0.261)	(0.411)	(0.393)	(0.423)	(0.536)	(1.833)
ln(1+language distance)	-0.071**	-0.031	-0.039	-0.105**	-0.159	-0.230	0.153	-0.068	0.351
	(0.031)	(0.020)	(0.039)	(0.054)	(0.115)	(0.142)	(0.162)	(0.178)	(0.675)
Observations	3,138	2,085	2,085	667	248	274	137	212	230
R^2	0.213	0.327	0.298	0.392	0.616	0.540	0.655	0.566	0.428
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

C. *Advanced economies to/from emerging market economies*

	(1) Goods imports	(2) Manuf. goods imports	(3) Commod. and energy	(4) Services imports	(5) Portfolio Equity	(6) Portfolio Debt	(7) FDI	(8) Bank loans (stocks)	(9) Bank loans (flows)
ln(physical distance)	-0.210***	-0.190***	-0.236***	-0.193***	-0.134	-0.264***	-0.259***	-0.379***	-1.038**
	(0.043)	(0.033)	(0.057)	(0.039)	(0.095)	(0.102)	(0.082)	(0.126)	(0.507)
ln(virtual distance)	-0.121	-0.088	0.054	-0.291***	-0.648**	-0.400*	0.030	0.174	-1.661
	(0.101)	(0.079)	(0.149)	(0.100)	(0.279)	(0.225)	(0.155)	(0.226)	(1.102)
ln(1+language distance)	-0.063**	-0.018	-0.078**	-0.072***	-0.169**	-0.212***	-0.109**	-0.149*	-0.686**
	(0.026)	(0.021)	(0.033)	(0.027)	(0.073)	(0.080)	(0.047)	(0.078)	(0.279)
Observations	2,855	2,444	2,444	1,750	924	1,040	766	952	998
R^2	0.292	0.329	0.280	0.260	0.466	0.398	0.330	0.277	0.234
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2008-2009 is the dependent variable and the estimates are restricted to three country groups: (i) advanced economies only (Panel A); (ii) emerging market economies only (Panel B); (iii) advanced economies to/from emerging market economies (Panel C). Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A5: Event study of the global financial crisis of 2007-09 – Robustness check on "payback" drop bias

	(1) Goods imports	(2) Services imports	(3) Portfolio Equity	(4) Portfolio Debt	(5) FDI	(6) Bank loans (stocks)
ln(physical distance)	-0.163***	-0.108***	-0.028	-0.101**	-0.150***	-0.140**
	(0.025)	(0.026)	(0.057)	(0.049)	(0.045)	(0.064)
ln(virtual distance)	-0.124**	-0.213***	-0.426**	-0.283*	-0.102	0.030
	(0.060)	(0.076)	(0.166)	(0.146)	(0.142)	(0.177)
ln(1+language distance)	-0.022	-0.019	-0.072**	-0.047	-0.037	-0.120***
	(0.017)	(0.014)	(0.034)	(0.038)	(0.028)	(0.040)
Observations	6,459	2,791	1,396	1,585	1,034	1,406
R^2	0.267	0.257	0.423	0.339	0.321	0.261
Exporter fixed effects	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects as well as the change in the measure of cross-border transactions in question over 2005-07 to capture any "payback" drop effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

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Table A6: Event study of the global financial crisis of 2007-09 – Robustness check on post-crisis recovery

	(1) Goods imports	(2) Services imports	(3) Portfolio Equity	(4) Portfolio Debt	(5) FDI	(6) Bank loans (stocks)
ln(physical distance)	0.060**	-0.033	-0.029	-0.072	0.036	-0.166**
	(0.030)	(0.027)	(0.075)	(0.069)	(0.046)	(0.069)
ln(virtual distance)	0.006	0.034	-0.089	0.382**	-0.082	-0.026
	(0.070)	(0.089)	(0.191)	(0.162)	(0.151)	(0.246)
ln(1+language distance)	0.015	0.026	0.033	-0.009	0.063*	-0.017
	(0.022)	(0.018)	(0.038)	(0.046)	(0.037)	(0.048)
R^2	6,614	2,966	1,714	1,816	1,362	1,543
Exporter fixed effects	0.096	0.173	0.258	0.258	0.232	0.256
Importer fixed effects	yes	yes	yes	yes	yes	yes
2009 level of trade/positions	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral cross-border transactions/positions over 2009-2012 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, the 2009 levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

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Table A7: Event study of the global financial crisis of 2007-09 – Trade in services by type

	(1) Total	(2) Transport	(3) Travel	(4) Communi-cation	(5) Construct-ion	(6) Insurance	(7) Financial services	(8) Computer services	(9) Royalties	(10) Other business services	(11) Personal services
ln(physical distance)	-0.152***	-0.139***	-0.119***	-0.224***	-0.569***	-0.020	-0.263***	-0.294***	-0.206**	-0.154***	-0.296***
	(0.028)	(0.039)	(0.025)	(0.059)	(0.118)	(0.068)	(0.080)	(0.069)	(0.081)	(0.045)	(0.096)
ln(virtual distance)	-0.361***	-0.130	-0.250**	-0.401**	-0.863**	-0.689***	-0.940***	-0.561***	-0.470*	-0.364**	-0.595**
	(0.084)	(0.107)	(0.106)	(0.182)	(0.395)	(0.242)	(0.259)	(0.194)	(0.273)	(0.169)	(0.260)
ln(1+language distance)	-0.035**	0.003	-0.015	-0.048	-0.055	-0.017	-0.039	-0.030	-0.059	-0.063**	-0.005
	(0.016)	(0.020)	(0.016)	(0.035)	(0.063)	(0.042)	(0.047)	(0.039)	(0.052)	(0.027)	(0.049)
Observations	2,935	1,703	1,514	1,364	928	1,205	1,190	1,232	1,125	1,622	1,026
R^2	0.211	0.345	0.232	0.352	0.447	0.353	0.469	0.340	0.366	0.409	0.403
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral trade in services broken down by type over 2007-2009 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the three alternative measures of distance, their interactions and the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A8: Event study of the global financial crisis of 2007-09 – Complementarities between distance measures for trade in services by type

	(1) Total	(2) Transport	(3) Travel	(4) Communi-cation	(5) Construct-ion	(6) Insurance	(7) Financial services	(8) Computer services	(9) Royalties	(10) Other business services	(11) Personal services
ln(physical distance)	-0.368***	-0.598***	-0.267***	-0.776***	-0.703	-0.119	-0.948***	-0.421*	-0.034	-0.543***	-0.844***
	(0.095)	(0.137)	(0.087)	(0.215)	(0.459)	(0.247)	(0.243)	(0.228)	(0.258)	(0.171)	(0.264)
ln(virtual distance)	0.218	1.090***	0.091	0.887	-0.825	-0.020	0.905	-0.748	-1.239	0.521	0.570
	(0.271)	(0.385)	(0.253)	(0.575)	(1.242)	(0.785)	(0.679)	(0.667)	(0.773)	(0.502)	(0.733)
ln(1+language distance)	-0.204*	0.067	-0.110	-0.546*	-0.414	0.366	-0.239	0.038	0.159	-0.302	0.890**
	(0.117)	(0.171)	(0.116)	(0.322)	(0.557)	(0.317)	(0.309)	(0.285)	(0.349)	(0.246)	(0.399)
ln(physical distance) × ln(virtual distance)	-0.059**	-0.118***	-0.038*	-0.148***	-0.031	-0.033	-0.189***	-0.014	0.059	-0.100**	-0.119*
	(0.024)	(0.034)	(0.021)	(0.050)	(0.112)	(0.066)	(0.058)	(0.059)	(0.065)	(0.041)	(0.063)
ln(physical distance) × ln(1+language distance)	-0.000	-0.007	-0.003	-0.012	-0.022	0.042	0.011	-0.076***	-0.046	-0.014	-0.064**
	(0.008)	(0.011)	(0.008)	(0.019)	(0.035)	(0.029)	(0.025)	(0.021)	(0.030)	(0.015)	(0.030)
ln(virtual distance) × ln(1+language distance)	-0.045*	0.002	-0.030	-0.152**	-0.143	0.198***	-0.024	-0.162**	-0.057	-0.094*	0.076
	(0.025)	(0.037)	(0.026)	(0.069)	(0.119)	(0.070)	(0.064)	(0.064)	(0.077)	(0.057)	(0.073)
Observations	2,935	1,703	1,514	1,364	928	1,205	1,190	1,232	1,125	1,622	1,026
R^2	0.214	0.353	0.236	0.368	0.449	0.361	0.476	0.349	0.369	0.418	0.410
Exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pre-crisis trade / position	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1) obtained by OLS where the log change in bilateral trade in services broken down by type over 2007-09 is the dependent variable. Each measure of bilateral cross-border transactions is regressed on the interaction of physical distance and virtual distance, as well as on the three alternative measures of distance, the pre-crisis levels of the transactions in question, the gravity controls and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A9: Event study of the Covid-19 pandemic of 2020– Cross-sectional estimates

	(1) Goods imports	(2) Goods imports	(3) Goods imports	(4) Goods imports
ln(physical distance)	-0.146***	-0.212***	-0.122***	-0.148***
	(0.027)	(0.020)	(0.026)	(0.021)
ln(virtual distance)	-0.062		-0.038	
	(0.057)		(0.059)	
ln(1+language distance)	-0.057***	-0.051***	-0.056***	-0.046***
	(0.018)	(0.013)	(0.018)	(0.013)
Observations	6,512	16,484	6,298	15,374
R^2	0.132	0.136	0.136	0.143
Exporter fixed effects	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes
GVC integration	no	no	yes	yes
Other gravity controls	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a) obtained by OLS where the log change in bilateral trade in goods between 2020 Q1 and 2019 Q1 is the dependent variable. Bilateral transactions in goods are regressed on the three alternative measures of distance, the 2019 Q1 level of trade in goods, the gravity controls, the 2019 level of bilateral integration in global value chains (columns 3 and 4) and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A10: Event study of the Covid-19 pandemic of 2020 – Distance measures and volatility

	(1)	(2)	(3)	(4)
ln(physical distance)	-0.121***	-0.194***	-0.096***	-0.129***
	(0.028)	(0.023)	(0.028)	(0.023)
× growth volatility (15-year) at destination	-0.725**	-0.601**	-0.735**	-0.624**
	(0.304)	(0.271)	(0.308)	(0.281)
ln(virtual distance)	-0.058		-0.032	
	(0.059)		(0.062)	
× growth volatility (15-year) at destination	-0.286		-0.297	
	(0.501)		(0.571)	
ln(1+language distance)	-0.053***	-0.059***	-0.053***	-0.055***
	(0.020)	(0.014)	(0.020)	(0.014)
× growth volatility (15-year) at destination	-0.079	0.233	-0.051	0.250
	(0.193)	(0.175)	(0.214)	(0.180)
Observations	6,512	16,142	6,298	15,089
R^2	0.133	0.137	0.137	0.144
Exporter fixed effects	yes	yes	yes	yes
Importer fixed effects	yes	yes	yes	yes
Pre-crisis trade/positions	yes	yes	yes	yes
GVC integration	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1b) obtained by OLS where the log change in bilateral trade in goods between 2020 Q1 and 2019 Q1 is the dependent variable. Bilateral transactions in goods are regressed on the three alternative measures of distance, their interaction with growth volatility (15-year) at the destination, the 2019 Q1 level of trade in goods, the gravity controls, the 2019 level of bilateral integration in global value chains (columns 3 and 4) and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A11: Event study of the Covid-19 pandemic of 2020 – Complementarities between distance measures

	(1)	(2)
ln(physical distance)	-0.310***	-0.288***
	(0.063)	(0.065)
ln(virtual distance)	0.583***	0.580***
	(0.180)	(0.182)
ln(1+language distance)	-0.161*	-0.114
	(0.093)	(0.092)
ln(physical distance) × ln(virtual distance)	-0.059***	-0.057***
	(0.015)	(0.016)
ln(physical distance) × ln(1+language distance)	0.010	0.005
	(0.009)	(0.009)
ln(virtual distance) × ln(1+language distance)	-0.003	-0.005
	(0.012)	(0.012)
Observations	6,512	6,298
R^2	0.135	0.139
Exporter fixed effects	yes	yes
Importer fixed effects	yes	yes
Other gravity controls	yes	yes
GVC integration	no	yes

Notes: The table reports cross-sectional estimates of model equation (1c) obtained by OLS where the log change in bilateral trade in goods between 2020 Q1 and 2019 Q1 is the dependent variable. Bilateral transactions in goods are regressed on the three alternative measures of distance, their interactions, the 2019 Q1 level of trade in goods, the gravity controls, and source- and destination-country fixed-effects. The standard errors reported in parentheses are robust to autocorrelation and heteroskedasticity; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A12: Event study of the global financial crisis of the Covid pandemic of 2020: Product Level

	Intensive Margin	Intensive Margin	Intensive Margin	Extensive Margin	Extensive Margin	Extensive Margin
	All Products	Homogeneous Products	Differentiated Products	All Products	Homogeneous Products	Differentiated Products
	(1)	(2)	(3)	(4)	(5)	(6)
ln(physical distance)	-0.240***	-0.212***	-0.251***	-0.221***	-0.213***	-0.227***
	(0.009)	(0.009)	(0.010)	(0.008)	(0.008)	(0.009)
ln(virtual distance)	-0.256***	-0.180***	-0.278***	-0.190***	-0.155***	-0.206***
	(0.030)	(0.034)	(0.031)	(0.024)	(0.027)	(0.024)
ln(1+language distance)	-0.047***	-0.033***	-0.052***	-0.046***	-0.035***	-0.051***
	(0.007)	(0.007)	(0.008)	(0.006)	(0.006)	(0.007)
Observations	5,028,728	1,127,952	3,678,091	7,254,671	1,722,469	5,210,152
R^2	0.290	0.310	0.285	0.414	0.427	0.412
Exporter-Product fixed effects	yes	yes	yes	yes	yes	yes
Importer-Product fixed effects	yes	yes	yes	yes	yes	yes
Pre-crisis trade/position	yes	yes	yes	yes	yes	yes
GVC integration	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	yes	yes

Notes: The table reports cross-sectional estimates of model equation (1a') obtained by OLS where the dependent variable is, respectively, the log change (columns (1)-(3)) and the midpoint growth rate (columns (4)-(6)) of bilateral trade in goods at the product level over 2019-2020. Bilateral transactions in goods are regressed on the three alternative measures of distance, the 2019 level of the trade in goods, the gravity controls and source-product and destination-product fixed-effects as well as the 2019 level of bilateral integration in global value chains. The standard errors reported in parentheses are clustered at the source-destination level; *** p<0.01, ** p<0.05, * p<0.1.

Table A13: Panel estimates on the 1950-2015 period – Excluding the global financial crisis

	(1)	(2)
ln(physical distance)	-0.001	0.024**
	(0.009)	(0.010)
ln(virtual distance)	0.008***	
	(0.001)	
ln(1+language distance)	-0.003	0.008#
	(0.006)	(0.006)
Observations	5,653	23,319
R^2	0.243	0.248
Time-varying exporter fixed effects	yes	yes
Time-varying importer fixed effects	yes	yes
Other gravity controls	yes	yes

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable, excluding the 2007-09 global financial crisis period. The three measures of distance are entered jointly as explanatory variables in the specification of column (1), while virtual distance (for which data availability is poorer) is excluded from the specification of column (2). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{+}$ $p<0.15$, $^{\#}$ $p<0.20$.

Table A14: Panel estimates on the 1950-2015 period – 10-year windows

	(1)	(2)
ln(physical distance)	-0.009	0.023**
	(0.008)	(0.011)
ln(virtual distance)	0.005***	
	(0.001)	
ln(1+language distance)	0.001	0.008#
	(0.005)	(0.006)
Observations	3,779	15,961
R^2	0.296	0.319
Time-varying exporter fixed effects	yes	yes
Time-varying importer fixed effects	yes	yes
Other gravity controls	yes	yes

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 10-year windows of observations is the dependent variable. The three measures of distance are entered jointly as explanatory variables in the specification of column (1), while virtual distance (for which data availability is poorer) is excluded from the specification of column (2). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{+}$ $p<0.15$, $^{\#}$ $p<0.20$.

Table A15: Panel estimates on the 1950-2015 period – Controlling for the average level of trade (5-year windows)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(physical distance)	0.002**	0.002***			0.010*	0.011**		
	(0.001)	(0.001)			(0.005)	(0.005)		
ln(virtual distance)			0.001***				-0.005***	
			(0.000)				(0.000)	
ln(1+language distance)	0.001+			0.001**	0.003			0.007*
	(0.000)			(0.000)	(0.004)			(0.004)
Lagged average trade					-0.053***	-0.054***	-0.036***	-0.055***
					(0.002)	(0.002)	(0.002)	(0.002)
Observations	27,367	28,204	6,599	27,367	25,195	25,964	6,125	25,195
R^2	0.242	0.241	0.233	0.241	0.315	0.313	0.345	0.315
Time-varying exporter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Time-varying importer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes	no	no	no	no

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods over non-overlapping 5-year windows is scaled by the average level of bilateral trade during this period in columns (1) to (4); the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable in columns (5) to (8). The regressions include the remaining control variables as in model equation (1) in the first four columns but not in the remaining ones where lagged average trade is used as control variable; country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads.

Table A16: Panel estimates on the 1950-2015 period – Controlling for GDP growth correlations
(5-year windows)

	(1)	(2)
ln(physical distance)	-0.004	0.024**
	(0.007)	(0.011)
ln(virtual distance)	0.003***	
	(0.001)	
ln(1+language distance)	-0.001	0.010+
	(0.004)	(0.007)
Observations	4,759	19,322
R^2	0.305	0.305
Time-varying exporter fixed effects	yes	yes
Time-varying importer fixed effects	yes	yes
Other gravity controls	yes	yes

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable. The three measures of distance are entered jointly as explanatory variables in the specification of column (1), while virtual distance (for which data availability is poorer) is excluded from the specification of column (2). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout, and control for bilateral GDP growth correlations. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{+}$ $p<0.15$.

Table A17: Panel estimates on the 1950-2015 period
Complementarities between distance measures – Excluding the global financial crisis

	(1)	(2)	(3)	(4)
ln(physical distance) × ln(virtual distance)	0.002***	0.002***		
	(0.000)	(0.000)		
ln(physical distance) × ln(language distance)	-0.000		0.001	
	(0.003)		(0.003)	
ln(language distance) × ln(virtual distance)	0.002***			0.002***
	(0.001)			(0.001)
ln(physical distance)	0.002	0.003	0.027**	
	(0.011)	(0.009)	(0.013)	
ln(virtual distance)	-0.009**	-0.015***		0.012***
	(0.004)	(0.004)		(0.001)
ln(1+language distance)	0.006		-0.007	0.003
	(0.028)		(0.032)	(0.006)
Observations	5,653	5,653	23,319	5,653
R^2	0.247	0.246	0.248	0.245
Time-varying exporter fixed effects	yes	yes	yes	yes
Time-varying importer fixed effects	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 5-year windows of observations is the dependent variable. The regressions include the measures of distance and their interacted effects, which are included jointly in the specification of column (1) and individually in the specifications of columns (2) to (4). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads.

Table A18: Panel estimates on the 1950-2015 period
Complementarities between distance measures (10-year windows)

	(1)	(2)	(3)	(4)
ln(physical distance) × ln(virtual distance)	0.003***	0.003***		
	(0.000)	(0.000)		
ln(physical distance) × ln(language distance)	0.007		0.030	
	(0.026)		(0.030)	
ln(language distance) × ln(virtual distance)	0.013***			0.016***
	(0.004)			(0.004)
ln(physical distance)	0.004	0.004	0.038**	
	(0.013)	(0.011)	(0.017)	
ln(virtual distance)	-0.017***	-0.022***		0.009***
	(0.004)	(0.004)		(0.001)
ln(1+language distance)	0.011		-0.181	0.075*
	(0.194)		(0.259)	(0.045)
Observations	3,779	3,779	15,961	3,779
R^2	0.307	0.305	0.319	0.300
Time-varying exporter fixed effects	yes	yes	yes	yes
Time-varying importer fixed effects	yes	yes	yes	yes
Other gravity controls	yes	yes	yes	yes

Notes: The table reports panel estimates of model equation (2) where the standard deviation of the annual log change in bilateral imports of goods between countries measured over non-overlapping 10-year windows of observations is the dependent variable. The regressions include the measures of distance and their interacted effects, which are included jointly in the specification of column (1) and individually in the specifications of columns (2) to (4). The regressions include the remaining control variables as in model equation (1); country-time fixed effects are also included throughout. Given the high dimensionality of the fixed effects in question, we use the method developed by Guimaraes and Portugal (2010). Standard errors are clustered by dyads.