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International Tradability Indices for Services

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Abstract

This paper uses a theoretically grounded model of international trade to estimate the cross-border tradability of services. The resulting indices cover up to 99 countries and ten sectors. The results show that information and communications technology capital and legal institutions are particularly important determinants of a country's ability to successfully export services. The tradability indices are strongly correlated with outcome indicators, such as trade shares of individual countries. In addition, they are strongly correlated with important inputs, including country productivity and size, factor endowments, trade costs, and regulatory measures. In particular, the results suggest that a more restrictive regulatory environment significantly reduces the international tradability of services.

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International Tradability Indices for Services

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Introduction

The services sector was long considered “non-tradable”, primarily because services transactions were generally thought to require physical proximity between the producer and the consumer. That view changed significantly in the 1980s and 1990s, and became crystallized in the General Agreement on Trade in Services (GATS), one of the pillars of the World Trade Organization (WTO), which entered into force in 1995. Many services are now considered tradable in principle, even if they are difficult to trade because of, for example, substantial levels of trade costs in services markets (Miroudot et al., Forthcoming).

Under the GATS, there are four ways in which services can be traded, known as modes of supply. Mode 1 is pure cross-border trade in services in which the producer and consumer remain remote from one another. It corresponds most closely to the paradigm of trade in goods. An example is business process outsourcing, in which some functions such as bookkeeping are performed remotely by a service provider in a different country, who communicates with the consumer by telephone and internet. Under Mode 2, the consumer moves to the producer’s location in order to consume the service. A typical example is tourism. Mode 3 is a common mode of supply for many services, and requires commercial establishment by a foreign service provider in the consumer’s country. Sales by that service provider are then counted as exports by the service provider’s country to the consumer’s country, as recorded in Foreign Affiliate Trade Statistics (FATS). An example is establishment of a local subsidiary by a foreign bank, which then provides financial services in the consumer’s country. The final mode of supply, Mode 4, involves temporary movement by individual service providers (natural persons) from the producer’s country to the consumer’s country. An example is an information technology specialist being sent temporarily from his home country to the consumer’s country to set up a new network.

As this introduction makes clear, all services are in principle tradable under one of the four GATS modes of supply. They can no longer be regarded as a non-tradable sector. However, the paradox remains that in most countries, only a small proportion of services GDP is in fact directly exported, although recent

work on trade in value added makes clear that a more substantial proportion is traded indirectly, i.e. is embodied in traded goods. From a development policy point of view, there is considerable scope for low- and middle-income countries to expand their exports and imports of services with corresponding benefits for consumers and producers. However, there is as yet no cross-country quantitative tool for making an assessment of the sectors in which increased trade is likely to take place, with which partners, and the position of one country relative to others from a competitiveness standpoint.

The present paper makes a first attempt at filling that gap in the literature. Due to data constraints, it focuses exclusively on pure cross-border trade (GATS Mode 1), and to some extent movement of the consumer (Mode 2) through travel services. The approach could in principle be extended to other modes of supply as better data become available for a wider range of countries. The core idea of the paper is that tradability in the modern sense—the likelihood (probability) of trade taking place—is determined by the interplay of three factors—trade costs, technology, and comparative advantage (including in institutions)—as well as exporter-, importer-, and sector-specific factors. Van der Marel (2011) shows that the theoretical model due to Chor (2010), which includes these sets of variables, can be expanded to deal with the case of cross-border trade in services. Specifically, that model makes it possible to derive a gravity-like equation in which trade flows between country pairs are determined by trade costs, as in a standard gravity model, along with technology (Ricardian productivity differences), and factor endowments including institutions. The other specific factors are included as fixed effects. Following the exploratory analysis of Chor (2010) for goods trade, we convert services trade data to a binary dependent variable and then estimate via Logit. The estimated probabilities provide us with four outputs. The first of them is an estimated probability of observing trade for each exporter-importer-sector triad. That number is an index bounded by zero and unity, which indicates how likely it is that a given country exports to a given partner country in a particular sector—the tradability of that service for those countries. In addition, the model produces three other outputs: average tradability indices based on the simple average estimated probabilities for each exporter, each importer, and each sector. The average indices provide a starting point for interpreting our results across countries and sectors, and the

more detailed estimated probabilities offer analysts the possibility of drilling down to the country pair-sector level to conduct country-based policy analysis.

The only other papers of which we are aware that seek to quantify the tradability of services are Jensen and Kletzer (2005), Gervais and Jensen (2013), and Borchsenius et al. (2010). Gervais and Jensen (2013) is the most developed contribution, and adopts a methodology that is generally representative of the other two. The authors use detailed micro-data for the USA to build indices of tradability for services sectors based on the observed level of geographical dispersion: an industry must be tradable within the USA if it is highly geographically concentrated, on the assumption that a few locations thereby provide services for the rest of the country. Conversely, if an activity is highly geographically dispersed, it must be relatively non-tradable because the supplier and the consumer presumably need to be in the same location.

In addition to providing a descriptive analysis of the tradability of different services sectors compared with manufacturing, Gervais and Jensen (2013) also use their data on the geographical distribution of demand and supply to back out estimated trade costs from a model in which trade is determined by the interplay between agglomeration forces (scale economies), and dispersion forces (trade costs). Trade within the USA is relatively "free" compared with trade between countries, so the authors interpret their trade cost estimates as "technological constraints that cannot be reduced by trade policies" (Gervais and Jensen, 2013, p. 31). Even on this restricted reading of their finding, domestic trade costs are very high in services compared with manufacturing: 80% ad valorem in wholesale and retail trade, 87% in business services, and 102% in personal services; for manufacturing, the comparable figure is 33%. Their findings therefore align well with recent work on international trade costs in services, which show that ad valorem equivalents are up to twice or three times higher in services than in manufacturing (Miroudot et al., Forthcoming).

Gervais and Jensen (2013) give their paper an international scope by using their model and estimates of tariff equivalents for services drawn from other sources to estimate the welfare and employment effects

of trade liberalization in services. Because the services sector is so large relative to manufacturing, and many services industries are, according to their analysis, tradable, there is significant potential for liberalization to give rise to trade and employment effects. They also extend their analysis to tariff equivalents for the BRICs and the EU, again drawn from external sources.

The approach we take in this paper is complementary to, but different from, the one adopted by Gervais and Jensen (2013). It is primarily driven by the desire in the policy community for indicators of tradability in services that cover multiple countries, including developing countries. Although the production data approach can in principle be replicated, it is a country by country exercise, and data constraints mean that it is only likely to be practical in developed, transition, and some middle income countries. Service sector technologies are likely significantly different across countries, which means that so too is the degree of tradability. Our point of departure is, therefore, the importance of a cross-country approach.

As noted above, these considerations necessarily mean that we must rely on international trade statistics to draw inferences as to tradability. Our approach is therefore closer in spirit to an analysis of revealed comparative advantage than to an analysis of sectoral characteristics, as in earlier work. Gervais and Jensen (2013) note the limitations of this approach relative to theirs, and most particularly the limited sectoral scope of trade data relative to national production data of the type they consider. Our results are therefore much less sector-specific than theirs. However, we gain considerably in country coverage, as we are able to provide indices for up to 99 countries, including some developing countries. The two approaches are, therefore, strongly complementary. In qualitative terms, so too is the core result: many services are highly tradable under GATS Mode 1, i.e. through pure cross-border trade.

Against this background, the paper proceeds as follows. The next section defines tradability in the sense in which we use it in this paper, and discusses its main determinants. Section 3 then presents our empirical model and dataset. The following section discusses our econometric results, highlights our key

findings, and presents indicators for individual countries and sectors. We also conduct an external validation exercise, in which we show that our indicators are strongly correlated with important outcome and input indicators that we would expect to be associated with tradability. Section 5 discusses the potential policy implications of our work, focusing on ways in which analysts can use our findings to inform more detailed country-level work. Section 6 concludes.

1 Factors Influencing the Tradability of Services

As noted above, the view that services are essentially non-tradable at the international level has evolved markedly since the entry into force of the GATS in 1995. Under the four GATS modes of supply, there is no longer any service that is not tradable—in principle, at least. That is not to say, of course, that all services are in fact traded, or that they are traded similarly by all countries. Focusing attention on just Mode 1 (and, through travel services, Mode 2), as this paper does, narrows the field further, by limiting the scope of services trade to just pure cross-border trade with geographically separate producers and consumers. Clearly, not all services are frequently traded in that way, and some countries are much more active than others in terms of their Mode 1 exports.

One way of operationalizing the concept of tradability is in terms of the likelihood that trade takes place. One service is more tradable than another if the probability that it is in fact traded is higher. Similarly, the services sector can be seen as more tradable in general in a country that has a high probability of actually engaging in services trade with its partners than in a country that has a low probability of doing so. We focus on this approach to tradability in our empirical model below, which forms the basis for the indices we produce.

What sorts of factors influence tradability understood in this way, and should therefore be accounted for in any index of tradability? In our view, and based on standard trade theories, three sets of factors together determine a country's ability to export services at the sectoral level. The first is technology, or relative productivity in a Ricardian sense. Clearly, a country's ability to compete on world markets is

determined in part by the productivity of its firms relative to those in other countries. Ricardian specialization by comparative advantage suggests that differences in relative productivity can play an important role in shaping the pattern of production and trade across countries. Such is the basic approach of the Eaton and Kortum (2002) model, upon which our paper builds (see further in the next section). A second aspect of technology that is relevant is whether or not it is technically feasible to trade a particular service via Mode 1. By using micro-data on domestic trade, the type of analysis conducted by Jensen and Kletzer (2005), Gervais and Jensen (2013), and Borchsenius et al. (2010) sheds significant light on this question. A sector is considered to be in principle tradable internationally if it is already heavily traded across geographical entities domestically. Since domestic trade costs are likely to be relatively low for services, however, such an approach must be interpreted primarily in terms of technological feasibility—as the authors themselves suggest—rather than the likelihood that particular services will in fact be traded on international markets by a given country. To take just one example, regulatory differences are far more significant between countries than within them—even in the case of federations like the USA—which means that international trade costs due to a lack of regulatory harmonization are likely to be very significant.

The second set of factors influencing a country's ability to export services is trade costs. Natural and regulatory barriers to services trade remain significant, and some evidence suggests that despite recent technological advances, they remain much higher in ad valorem equivalent terms than trade costs in goods markets (Miroudot et al., Forthcoming). In a world without trade costs, the cross-country pattern of specialization and trade is determined by comparative advantage (relative productivity and relative endowments). In a world with trade costs, however, they interact with comparative advantage factors to produce the final pattern of production and trade. The likelihood that a country can trade in a particular type of service therefore depends not only on its endowments and productivity, but also on the level of trade costs faced by its firms (actual and potential exporters).

The third set of factors that influence a country's ability to trade in services is its relative endowments. In goods markets, it is typical to see endowments as primarily encompassing different types of labor and capital. In services, however, a broader set of endowments plays a role, since institutional quality and regulation are core factors that can influence a country's competitiveness in the world market for services. Reasoning in terms of relative endowments as a source of comparative advantage comes from the well-known Heckscher-Ohlin model of trade. At a sectoral level, however, what matters is not just relative endowments, but their interaction with sector-specific factor intensity (see further below for references on this point). In the relative endowments framework, specialization by comparative advantage implies that countries tend to produce and trade services that are relatively intensive in the endowments with which they are relatively abundant.

In our view, it is important for an index of tradability to take account of all three sets of factors. The existing work on services tradability that we have referred to focuses primarily on technology. Since it uses data for a single country only—Denmark or the USA—it cannot take account of relative differences in endowments or international trade costs across countries and sectors. The approach to measuring tradability that we develop in the next section and implement empirically in Section 4 is based on a theoretical model that indeed takes account of all three sets of factors simultaneously. Our results should therefore provide an important complement to previous work on tradability by taking into account a wider range of factors. This approach also has more direct policy applications, especially in the developing country context, as it provides a starting point for countries interested in identifying sectors that can potentially experience export or import growth in the future.

2 Empirical Model and Data

2.1 Theoretical Background

As indicated at the outset, our approach relies heavily on the model of Chor (2010), as extended by Van der Marel (2011) to cover the case of services. Chor (2010) builds on the familiar Ricardian trade model

of Eaton and Kortum (2002), and extends it to cover the case of industry-level trade flows. The model can therefore explain the observed pattern of specialization and industry-level trade across countries. The main departure from the original Eaton and Kortum (2002) model lies in the specification of a productivity term that contains both a systematic and a stochastic component. The former is driven by interaction effects between country features and industry characteristics, in a way that is reminiscent of previous comparative advantage work, such as Romalis (2004). The idea is that industries vary in the factors and institutional conditions needed for production, and countries differ in their ability to provide those requirements. Comparative advantage therefore stems from the interaction between the two components, one country-specific and one industry-specific.

One major advantage of the Chor (2010) model is that it produces a simple expression for bilateral trade at the industry level in the form of a gravity-like equation. The main difference with the traditional gravity model lies in the specification of terms to capture Ricardian (productivity) effects, Heckscher-Ohlin (factor abundance) effects—which we take to include institutions—and trade costs. All of these factors together drive trade between country pairs. The empirical results reported in Chor (2010) show that the model fits the data well for the case of goods trade: trade costs variables have the signs and significance levels that are expected from the gravity model literature, while the Heckscher-Ohlin terms and many of the institutional terms also have the expected signs and are statistically significant.

Van der Marel (2011) extends the Chor (2010) framework to the case of trade in services. As we do here, he restricts the analysis to pure cross-border trade (Mode 1), which most closely resembles the goods trade paradigm of geographically separate producers and consumers. To capture in more detail the types of effects that are likely to matter in services markets, he treats information and communication technology (ICT) capital separately from other types of capital. Econometric results again show that the model fits the data well: two of his three Heckscher-Ohlin variables have the expected signs and are statistically significant, and the same applies to the institutional variables when, as in Chor (2010), they are entered one-by-one into the estimating equation.

The framework in this paper builds on an observation in Chor (2010) that his model can be used not just to predict trade intensity, i.e., the level of bilateral trade, but also to predict the probability that two countries engage in trade at all (trade propensity, or in terms of the concepts developed above, tradability). There are strong reasons to believe that the same factors influencing the intensive margin of trade also influence the extensive margin. To take this proposition to the data, Chor (2010) contains estimates from a Probit model with a binary dependent variable—non-zero trade observations are coded as unity, and zero trade observations are coded as zero—to supplement the OLS results for the intensive margin gravity model. The econometric results are again strong for the case of goods trade: the Heckscher-Ohlin variables have the expected signs and are statistically significant, and the same is true of three of the six institutional variables. The preliminary evidence therefore strongly suggests that the Chor (2010) model, as extended by van der Marel (2011) to deal with services, is an effective and theoretically-grounded way of explaining the likelihood that countries engage in bilateral trade, in addition to explaining the amount of that trade.

In this paper, we apply the binary dependent variable approach of Chor (2010) to the area of services trade. We estimate the model using a binary dependent variable rather than a continuous one, such as the value of exports, because the binary choice model has a natural interpretation in terms of tradability: estimated values equate to the likelihood (estimated probability) of observing non-zero trade for a particular exporter-importer-sector triad. Although this approach necessarily entails some loss of information, it does not appear to be great in this case: estimated probabilities from the binary choice model correlate very strongly with fitted values from an OLS regression using export value as the dependent variable (rho = 0.898). The interpretational benefit of using a binary dependent variable model—which is logically associated with the concept of tradability, as discussed above—more than compensates for this small difference in results.

Concretely, we estimate the following model by fixed effects Logit:

$$(1)\ Pr.\left(exports_{ijk}=1\right)$$

$$= f\left(\sum_{l} b_l trade\ costs_{ij}^{l} + \sum_{m} c_m endowments_{i}^{m} * factor\ intensity_{k}^{m}\right.$$

$$\left. + \sum_{n} d_n institutions_{i}^{n} * institutional\ intensity_{k}^{n} + \sum_{i} f_i + \sum_{j} f_j + \sum_{k} f_k\right)$$

where: $exports_{ijk}$ is a dummy variable equal to unity if country i exports services to country j in sector k; trade costs represents a set of bilateral variables that influence trade costs between countries i and j; endowments represents a set of variables capturing factor endowments in the exporting country; factor intensity is an interaction term capturing the intensity with which each sector uses a given factor; institutions is a set of variables capturing institutional quality in the exporting country; institutional intensity refers to the intensity with which each sector relies on high quality institutions in its production process; and the f terms are fixed effects in the exporter, importer, and sector dimensions. In the next section, we describe the sets of variables included under each of the summation indicators, and discuss sources. A full summary is provided in Table 1, and summary statistics are in Table 2.

Before turning to the data, however, it is useful to provide some intuitive interpretation for the various sets of terms in equation (1). Trade costs should be negatively and statistically significantly associated with the probability that one country exports to another in a given sector (tradability). The gravity model literature typically focuses on these factors, and it is now well-established that they can apply to the probability of trade, as well as to its intensity (Helpman et al., 2008). The country-sector interaction terms for endowments and factor intensity should be positively and statistically significantly associated with the probability of trade (tradability), because they reflect Heckscher-Ohlin comparative advantage forces. For example, if it is true that countries well-endowed with physical capital have a higher probability of exporting capital intensive industries, this interaction term should be positive and significant. Romalis (2004) shows that such variables provide a powerful explanation of trade shares, and Chor (2010) finds that they explain both the probability of observing trade and its level in the

context of goods markets. Next come the interaction terms between country-level institutions and institutional intensity in each sector, as measured by sector complexity and intermediate input use (see further below). Again, we expect these variables to be positively signed and statistically significant. There is now an extensive literature demonstrating the important influence that institutions can have on trade (e.g., Levchenko, 2007), and Chor (2010) shows that similar interaction terms to the ones used here affect goods trade in the expected way both in terms of trade probabilities (tradability), and trade intensities. For instance, some sectors are more dependent on a country's strong rule of law since they are vulnerable to hold-up problems in the supply chain. In such cases, the interaction term of a country characteristic (rule of law) with a measure assessing a sector's sensitivity to hold-up problems—which is part of what our product complexity indicator measures—should become positive and significant.

The final terms that need to be interpreted are the fixed effects.[2] As is typical in gravity models, they capture factors such as country income, resource endowments, and institutional quality that do not vary according to trading partner or sector. They are therefore included here as control variables, to take account of observables and unobservable characteristics that vary in the relevant dimensions.

We use the model to produce information on tradability by first calculating estimated probabilities of trade, based on the regression results.[3] These estimated probabilities are available on request, along with the full dataset used to calculate them. In the results section of this paper, we focus on aggregate indices created using the estimated probabilities. Concretely, we take simple averages by exporter, by importer, and by sector to create an index of exporter tradability, an index of importer tradability, and an index of sectoral tradability. A country that scores higher on the exporter index, for example, can be considered to have a more tradable services sector on average than a country that scores lower. The

[2] We use a different fixed effects specification from Chor (2010): he includes fixed effects by exporter, and by importer-sector, whereas we include them by exporter, importer, and sector. Little turns on the choice in terms of results: results are qualitatively identical in both cases (i.e., the signs and statistical significance of the coefficients of interest do not change). We therefore prefer the simpler formulation due to greatly decreased computing time.

[3] For the general Logit model $\Pr(Y = 1|x) = \frac{e^{xb}}{1+e^{xb}}$, with x defined as a matrix and b as a vector, the transformation used to produce estimated probabilities for each observation is $\frac{e^{xb}}{1+e^{xb}}$.

importer and sectoral indices are defined analogously. Although these three sets of indices are useful for their indicative value, more detailed analytical work—and particularly the kind of diagnostic work undertaken on a country level to identify prospective export sectors—would need to rely on the estimated probabilities from the full Logit model. One way in which they could be used at the country level would be for the analyst to compare estimated probabilities for a given sector across a range of trading partners, and then return to the data to identify the sources for any large differences. The full dataset for this paper would allow analysts to consider the sectors in which a country is specializing, relevant country characteristics, and the properties of each sector that interact with them to produce sectoral growth over time. It may also be that trade costs or importer-specific factors—such as market access—are in part responsible for the difference. After confirming such an intuition on the ground, it would be possible to identify policies that could be used to improve a country's export probability for that sector with the importing countries in question. We return to this issue in Section 5, after discussing results and comparing them with other available indicators.

2.2 Data and Sources

In terms of data, many of our sources are standard, but some have been constructed for this paper. Our export data come from Version 8.9 of the Trade in Services Database (Francois and Pindyuk, 2013) and represent a consolidation, cleaning, and mirroring of trade flows reported to Eurostat, the IMF, the OECD, and the United Nations. The Trade in Services Database thus represents the current best state of data in respect of Mode 1 trade flows. The data are disaggregated bilaterally (by exporter and importer), and at the sectoral level, by three-digit Extended Balance of Payments Services (EBOPS) classification. For full details of the classification schemes used and the issues associated with them, see Francois and Pindyuk (2013). It is well known that services data become increasingly inaccurate as they are disaggregated, so we include data for 10 macro-sectors only. They correspond to the best-known categories of Mode 1 services trade at an aggregate level: transportation; travel; communications; construction; insurance; financial services; computer and information services; other business services;

personal, cultural, and recreational services; and government services. To avoid giving undue importance to very small trade flows that might represent misreporting rather than genuine trade, we code our dependent variable to be unity whenever a trade flow is greater than one million dollars, and zero in all other cases.[4] Due to limitations on the availability of other data, we use trade data for 2009 only, which is in line with previous work on comparative advantage.[5]

Data on trade in services suffer from a number of important issues that could cause difficulties for the results reported here. One is that our source only covers trade in Mode 1 and some Mode 2 trade (travel and related services). It does not cover Mode 3, which is an important means of entry in many sectors. Secondly, services trade is sometimes misreported by businesses, and ends up being recorded as a residual in the balance of payments statistics. There is no way to overcome this difficulty, but it is one from which all empirical work on services trade suffers. Thirdly, particular sectors, such as cultural and recreational services, sometimes suffer from additional problems of misreporting, due to the importance of royalties. Again, all empirical work using this kind of services trade data suffers from these potential drawbacks. Nonetheless, we are confident that our data represent the best source currently available on cross-border trade in services.

In including data on the sources of trade costs, we generally follow the specifications in Chor (2010) and van der Marel (2011), which draw on the standard gravity model literature. Although trade costs are more difficult to conceptualize in the services sector—because there is no equivalent of ad valorem tariffs, for example—they are nonetheless believed to be very large (Miroudot et al., Forthcoming). Costs include communication—which can be proxied by geographical and cultural distance—as well as trade policies that tend to open markets or reduce regulatory heterogeneity, such as RTAs.

Concretely, we specify:

[4] Our results are qualitatively very similar if we use alternative thresholds, such as $0.5m or $0.18m (the tenth percentile of the trade data). These robustness checks are available on request.
[5] Although a cross-sectional approach is appropriate in light of previous work, the use of data for 2009 is not unproblematic because it might be affected by the global financial crisis.

$$(2)\ \sum_{l} b_l trade\ costs_{ij}^{l}$$

$$= b_1 \log distance_{ij} + b_2 contiguous_{ij} + b_3 common\ official\ language_{ij}$$
$$+ b_4 colony_{ij} + b_5 RTA_{ij}$$

For our data on geographical and historical linkages, we use a standard source (the CEPII distance dataset). The data include the international distance between countries (in logarithms), and dummy variables equal to unity for countries that are geographically contiguous (share a common border), have a common official language, or were in a colonial relationship. In addition to these exogenous sources of trade costs, we are also interested in capturing the effects of policy. We therefore include a dummy equal to unity for countries in the same regional trade agreement (RTA) covering services. The variable was constructed for this paper using information from the WTO.[6]

As in van der Marel (2011), we expand on the Chor (2010) model when it comes to the data on Heckscher-Ohlin forces. Specifically, we specify the endowment/intensity interaction terms as follows:

$$(3)\ \sum_{m} c_m endowments_{i}^{m} * factor\ intensity_{k}^{m}$$

$$= c_1 \log(high - skill\ labor_i) * \log(high - skill\ intensity_k)$$
$$+ c_2 \log(non - ICT\ capital\ stock_i) * \log(non - ICT\ capital\ intensity_k)$$
$$+ c_3 \log(internet\ users\ per\ 100\ people_i) * \log(ICT\ capital\ intensity_k)$$

As in van der Marel (2011), we treat ICT capital separately from non-ICT capital. In both cases, as noted above, we are interested in the interactions between country- and industry-specific factors.[7] To calculate the country-specific factors for labor, we take the proportion of high-skill (tertiary educated) employees in the population aged 25 and over (in logarithms). These data are sourced from the Barro and Lee (Forthcoming) dataset, with interpolation where necessary. These data give us measures of

[6] In additional results, available on request, we show that our results are robust to the use of a variable capturing RTAs in goods sectors instead of services.

[7] Typically, the inclusion of interaction terms in the model would also necessitate including each variable in levels. However, the fixed effects used here absorb the country- and industry-specific factors when they are not interacted, so separate specification is unnecessary.

high-skilled factor abundance of country i. We interact them with factor intensities for each sector k calculated using data for the USA from EU-KLEMS, averaged over the years 2003-2004; this approach is in line with previous work on comparative advantage. Specifically, skill-intensity is calculated as the ratio of the hours worked by high-skilled labor to the total number of hours worked by all types of skills in a sector. To get a measure of intensity, this ratio is multiplied by the total share of high-skilled labor in value added. The country-specific factors for capital are calculated by using the Conference Board and Groningen Center for Growth databases. Specifically, we take non-ICT capital, measured as the share of the non-ICT capital stock in the total capital stock. In addition, we use the World Development Indicators to source data on internet users per 100 people as an indicator of ICT capital. The interaction term is again formed by multiplying the factor abundance terms by factor intensities calculated using data from EU-KLEMS. Non-ICT capital intensity is first measured as the ratio of non-ICT capital compensation to total capital compensation. This measure is multiplied by the total share of non-ICT capital in value added. We perform similar calculations for ICT capital intensity, which is measured as the share of total ICT capital compensation in total value added for each sector. All three factors correct for material input use, and closely follow Romalis (2004).

The final set of variables represents institutional quality in each country interacted with the intensity of institution use in each sector. We use two measures, as follows:

$$(4)\ \sum_n d_n institutions_i^n * institutional\ intensity_k^n$$
$$= d_1 legal_i * complexity_k + d_2 legal_i * Herfindahl_k$$

The first variable in each interaction term measures the quality of the legal system and security of property rights in each exporting country, and is taken from Gwartney and Lawson (2004) and the Fraser Institute. The industry characteristic in the first interaction term represents a measure that assesses the complexity of the services sector using the methodology due to Costinot (2009). It is computed based on PSID survey data, which ask how long it takes for each employee to be fully educated and qualified for

the job in each services sector, hence it measures the magnitude of fixed training costs. This measure can be calculated for all services sectors next to the goods industries originally used in Costinot's work, and is equal to the average number of months an employee needs to be fully trained and qualified for working in the service sector under consideration. The 2-digit industry data on complexity are manually converted into the 3-digit EBOPS classification similar to the trade data, because no correspondence table exists between the PSID and EBOPS for services industries. The correspondence table is available from the authors on request.

Finally, the second interaction term of industry characteristics measures the extent to which sectors are vulnerable to hold-up problems due to the concentration of input contracts each producer has within an industry. This variable is based on Levchenko (2007) and calculates an index of product complexity for each services industry based on US Input-Output use tables. Specifically, for each 6-digit output industry the Herfindahl index is calculated (multiplied by -1) based on each sectoral input use. The index measures input use concentration or, in other words, institutional intensity. This variable is then interacted with our country measure of rule of law so that a positive coefficient tells us that countries with better legal systems are better placed to export in industries with high-input use concentration and, thus, are sensitive to hold-up problems. All industry data are again converted into the 3-digit EBOPS classification system similar to our trade data by manually creating an appropriate correspondence table between EBOPS and the IO classification of the Bureau of Economic Analysis. The correspondence table is available from the authors on request.

3 Results and Discussion

3.1 Econometric Results

Combining equations (1) through (4) gives us an estimating equation that can be taken to the data. We estimate by fixed effects Logit, with coefficients converted to marginal effects evaluated at the mean.[8] Results are in Table 3, where we progressively add the three sets of explanatory variables, namely trade costs, comparative advantage in terms of endowments, and comparative advantage in terms of institutions; technology (productivity) is accounted for by the exporter and sector fixed effects. A comparison of columns 1 through 3 shows that the estimated marginal effects are quite consistent in sign, magnitude, and statistical significance across models. We can therefore focus the discussion exclusively on column 3, which includes all three sets of variables. As an intuitive measure of goodness of fit, we calculate the count R2 for the model in column 3. It is equal to 0.810, which means that in 81% of cases, the model correctly predicts whether the exports dummy variable is equal to one (estimated probability greater than or equal to 0.5) or zero (estimated probability less than 0.5). The model therefore provides a very good fit with the data in this case.

We analyze the trade costs variables first. As expected, distance has a negative and 1% statistically significant impact on the probability that Mode 1 trade in services takes place (i.e., tradability in the sense in which we are using that term). Interestingly, the magnitude of the distance effect is larger in absolute value than the one reported by Chor (2010, Table 2 column 2) for the case of goods. Given that services do not have to be transported in the same way goods do, it is therefore likely that the distance variable is capturing other issues, such as cultural or regulatory distance between countries, which are strongly correlated with geographical distance. Of the other geographical and historical variables, only the existence of a prior colonial relationship has a positive and statistically significant (1%) impact on trade probability; the other variables have statistically insignificant coefficients. The policy variable in our trade costs specification, a dummy equal to unity for joint membership of a services RTA, has a

[8] See Greene (2003) pp. 695-700 on the estimation of this class of models.

positive and 1% statistically significant coefficient. This result accords with recent work showing that RTAs in services tend to reduce trade costs (Miroudot and Shepherd, 2013), which in turn should boost trade probabilities. It is important to note, however, that many RTAs do not in fact embody genuine bilateral liberalization, but simply reflect unilateral measures taken by each partner individually—which is one possible mechanism behind the result in Miroudot and Shepherd (2013) to the effect that services RTAs tend to be relatively non-discriminatory. As for other variables in the model, however, this result reflects Chor (2010), but the magnitude is noticeably larger in the case of services.

The next set of variables accounts for comparative advantage by specifying interactions between factor endowments and intensities. All three interaction terms have positively signed coefficients that are statistically significant at the 5% level or better. This finding is exactly in line with expectations: a country is more likely to export services that are intensive in their use of factors with which it is relatively well endowed. Results are in line with those of Chor (2010) and van der Marel (2011), but have a greater level of disaggregation than the former. In particular, our results show that both non-ICT and ICT-capital endowments are relevant for the probability of exporting services. Interestingly, the coefficient on the ICT interaction term is much stronger than for either of the two other comparative advantage terms. This finding suggests that building up ICT capital is a potentially important way for countries to ensure that they are more likely to export services.

The final variables are the institutions interaction terms. They are both positively signed and 1% statistically significant, which is in line with expectations given the results reported by Chor (2010) for goods, and van der Marel (2011) for services trade values. This finding suggests that institutional quality is indeed important for services export propensity. Indeed, the marginal effect for the complexity interaction term is larger than for any of the traditional comparative advantage terms (high-skill labor, non-ICT capital, and ICT capital), which suggests that improving institutions is potentially a more powerful lever than some more recognized comparative advantage factors for countries interested in developing their services export capabilities.

3.2 Tradability Indices

Chor (2010) and van der Marel (2011) interpret their regression results in terms of the impact of various trade cost, endowment, and institutional factors on bilateral trade flows. In this section, we take the analysis one step further by calculating tradability indices. We are interested in three sets of indices: exporter-level tradability, importer-level tradability, and sector-level tradability. The first is the simple average of the estimated probability of trade taking place for a given exporter based on the factors included in the model: trade costs, comparative advantage including institutions, and importer, exporter, and sector factors (which cover technology and productivity). The second is the average estimated probability of a country importing services under the same conditions. The third is a sectoral index, namely the average estimated probability of observing trade in a specific sector, after controlling for the same set of factors.

As discussed briefly above, we construct the three indices by first calculating estimated probabilities at the exporter-importer-sector level using the standard Logit transformation. The advantage of this transformation is that it can be naturally interpreted in terms of a probability of observing trade based on the variables—including fixed effects—contained in the model. It also has the advantage of producing a number between zero and unity, which is useful as a scaled, intensive index. This advantage is an important one when compared with simpler approaches, such as using the estimated fixed effects themselves, as index numbers, because they are arbitrarily scaled depending on the regression constant and the omitted factor. It is also an advantage when compared with the idea of using fitted values or fixed effects from an OLS regression as the basis for calculating the index: again, there is no natural scaling factor, and in addition, OLS estimates are subject to the difficulty of interpreting "over-trading", i.e. cases in which the estimated value of trade is less than the actual value—a mathematical certainty for at least some observations due to the property of OLS that the residuals must sum to zero.

To calculate indices by exporter, importer, and sector, we use simple averages of the estimated probabilities. We do not interpret these numbers in a strictly cardinal (probabilistic) sense, but instead in

an ordinal sense only: a higher score indicates that, for example, a given sector is more tradable in our sense than another sector.

3.2.1 Analysis by Sector

We first present tradability indices by sector (Table 4). As indicated in the data section, we use an aggregated classification corresponding to EBOPS macro-sectors because data on services become increasingly unreliable as they are disaggregated. As can be seen from the table, the two most tradable services (i.e., those with the highest index scores) are other business services and travel.[9] It is important to recall at this point that our trade data only cover transactions recorded in the EBOPS statistics, i.e. Mode 1 and some elements of Mode 2. This result does not therefore mean that these services are the most tradable across all modes, only that they are the most tradable EBOPS services. With this restriction in mind, the result is not surprising. Business services include those activities associated with business process offshoring, which have enjoyed strong growth in recent years thanks to developments in ICTs. The increasing reality of North-South services offshoring, using hubs such as India and the Philippines, is proof of the relatively high level of tradability of these services. Travel, on the other hand, is a very large sector in our dataset, accounting for 23% of total trade value, which is usually traded via Mode 2 (movement of the consumer). The conclusion that these two sectors are highly tradable therefore accords with both the data and prior expectations.

The next group of sectors is composed of: personal, cultural, and recreational services; communications services; and computer and information services. Based on the difference in index scores with the first group of sectors, these sectors can be considered as moderately to highly tradable. The cases of communications and computer services again accord well with intuition, because technological change over recent years has made at least some elements of these activities highly tradable across borders. In particular, the rise of ICTs in combination with the relaxation of traditionally restrictive regulatory strategies has given rise to new types of trade in telecommunications services, such as voice over

[9] Again, we stress that we do not put a probabilistic interpretation on the average index numbers: they are interpreted in terms of rank ordering only.

internet services like Skype. The increasing tradability of communications services is supported by casual empiricism, which demonstrates a sharp decline in the price of international telecommunications services over recent decades. Similar factors—the rise of ICTs and a relatively open regulatory stance—have made computer and information services increasingly tradable by cross-border means. By contrast, the case of personal, cultural, and recreational services is more difficult to explain, as one of the core activities of that sector—audiovisual services—remains highly protected in many markets. We believe there is perhaps an element of misreporting in this result, due to the possible confusion at the reporting stage between this sector and travel. However, this result requires further analysis in order to arrive at a better understanding of its roots.

The next group of services can be considered as exhibiting mid-level tradability: insurance services; government services; financial services; and construction services. It is perhaps surprising that insurance and finance do not appear with a higher rank in Table 4, but we believe this result may be due in part to the effects of the global financial crisis, which greatly reduced trade in these sectors in 2008 and 2009. In addition, there is again an issue of classification of flows: many back-office services in fact count as part of the other business services sector, rather than finance or insurance, even though they are intimately linked to these activities. In any event, we stress that our data cover Mode 1 only—not Mode 3, which is particularly important for finance and insurance. Even countries that are considered to be relatively open, like the United States, often place restrictions on Mode 1 trade in retail financial services. For instance, it is legal for a US citizen to hold a foreign bank account, subject to a declaration requirement for tax purposes. However, foreign banks are prohibited from advertising retail banking services in the US. Partly as a result of this policy, only a tiny share of the US population actually holds a foreign bank account. Measures like this one seriously limit the extent of Mode 1 trade in financial services, and undoubtedly result in substitution decisions by firms towards Mode 3, which is not captured by our data. Additional issues that might cause data problems for financial services that affect our results include the concentration of trade in a small number of hubs, the use of tax havens—which is

not motivated by comparative advantage—and the prevalence in some countries of confidential flows that may not be reflected in the official data.

Classification issues might also be relevant to the result for construction services, which is generally considered to be of very low tradability via Mode 1. It is probable that some ancillary construction services, such as engineering and architecture, have been recorded under this sector by some reporters, rather than as other business services. The result for government services also appears anomalous, and further investigation of the data in this area is merited.

The least tradable service in our data is transportation—a surprising result, given that trade in transportation services takes place on many occasions when there is an international exchange of goods. We would therefore expect transport to be a highly tradable activity. However, the role of goods trade in shaping the pattern of trade in transport services is so strong that our model arguably provides a poor fit for this sector, with the result that estimated probabilities are low. Indeed, given the potential problems with transportation and construction services—which have the two lowest scores in Table 4—we have re-estimated the model excluding each of those sectors, and have found our econometric results to be highly robust (Table 3, columns 4-5).

More generally, it is important to interpret the sectoral results with caution because of the significant possibility of cross-modal effects in services trade. It is possible for Mode 1 and 2 trade to be either a complement to or a substitute for trade in other modes, particularly Mode 3. We again stress that as our data consider only Modes 1 and 2 trade, we cannot draw any conclusions about the tradability of services via other modes, particularly Mode 3, or about the interrelationships between trade in different modes of supply for particular services sectors.

3.2.2 Analysis by Country

Tables 5 and 6 present tradability indices by country. The first table covers the exporter side, and the second covers the importer side. Due to the nature of the dataset, there is a small difference in

coverage between the two indices: the exporter index covers 91 countries, whereas the importer index covers 99.

The first point to note in relation to the importer and exporter indices is that they are highly correlated (rho = 0.939). This result is entirely expected, and follows from the fact that importing and exporting are closely associated activities: countries that are open in one direction tend over time to be open in the other direction as well.

Because of the strong correlation between the two indices, we focus in this section on the export side only (Table 5). The top five countries are (in order) Germany, the UK, the USA, France, and Italy. They are all closely bunched at the top end of the index, with rounded scores of at least 0.700. It is in line with expectations that services should be more tradable in the leading developed economies than elsewhere, as they have better developed institutions and ICT infrastructure, as well as, generally speaking, a less restrictive regulatory stance towards most parts of the services sector and cross-border trade in services. In addition, the services sector is very large in these countries, typically accounting for between two-thirds and three-quarters of all economic activity. Interestingly, the list of the top ten countries in terms of exporter tradability shows that although size matters—as suggested by the top five—it is not the only determinant of a country's index score and rank. For instance, the sixth ranked economy is Switzerland, and Austria, the Netherlands, and Belgium also figure in the top ten.

The top ranked developing country is China (ninth), which is perhaps surprising as it is more known globally as a goods exporter than a services exporter. In particular, it has not yet engaged in large scale exports in "new" sectors like other business services or computer services, although it does export in other sectors. Its index score perhaps indicates that it is now well placed to enter into this kind of trade. It is also important to remember that China has undergone significant regulatory reform in services following its WTO accession (Mattoo, 2004), with the result that services-related trade costs have fallen consistently and substantially, albeit from an initially high level (Miroudot et al., Forthcoming).

By comparison, India, which is known in these "new" sectors, ranks 28th; although surprising on the face of it, this result perhaps reflects the fact that India's services exports are concentrated in just a few areas, and it still suffers from highly restrictive regulations in many services sectors. Regulatory restrictiveness arguably adds to trade costs, and makes it difficult for firms to compete in the international marketplace.

3.3 External Validation

Although we have shown that our indices seem to pick up some important factors that enter intuitively into the idea of tradability, it is also important to subject them to external validation. If the indices are capturing the information we argue they capture, they should be correlated with important outcome and input indicators related to tradability at a conceptual level.

We deal with outcome indicators first. Clearly, more tradable services should be correlated with relatively higher shares of services exports and imports on a global level. Such is indeed the case. The exporter tradability index is correlated with export shares in our database with a coefficient of 0.693, which is 1% statistically significant. Both the sign and the significance of the correlation are in line with expectations. The correlation is even stronger in the case of the importer index: rho = 0.726, which is again 1% statistically significant (see Figure 1, with import shares converted to logarithms for ease of presentation). The strength of these correlations is indicative of two stylized facts: countries that score higher on our indices tend to trade more relative to those that score lower, but size does not explain everything that is included in the indices, particularly on the export side.

On the input side, we expect country-level tradability to be determined by a number of factors, based on the variables implicitly controlled for by the fixed effects in our regressions. (Figure 2 shows a set of illustrative correlations from among those discussed in this section.) One is the overall level of productivity, proxied by per capita GDP. More productive countries are expected to have more tradable services sectors, as their firms are better able to overcome the fixed cost hurdles associated with exporting to other countries. In addition, we expect market size—proxied by population—to matter for

tradability, because it determines the extent to which firms can take advantage of scale economies at home. In addition, we expect the country level factor endowment variables to influence tradability, because the latter is partly a function of comparative advantage forces. Finally, there should be an association between overall trade costs—averaging across all partner markets—and tradability, as well as policy and tradability: a more liberal policy stance should make services more tradable, as it reduces regulatory barriers facing importers and exporters.

To examine these factors, we proceed descriptively, rather than by a regression model, due to the small sample sizes involved. In particular, the relative lack of variation of many of the validation variables with respect to GDP per capita and population means that it is difficult to identify the effect of individual variables in a regression context. The descriptive approach is also in line with the fact that we are using these data for external validation purposes rather than positing a two stage model, which would require a completely different approach to estimation and testing in order to be robust.

Correlation coefficients with respect to our exporter tradability index and the three sets of input variables discussed above are in Table 7, and similar results for the importer tradability index are in Table 8. All but one of the variables have correlations with the expected signs, which are statistically significant (1%). Our first set of factors, GDP per capita and population, are both positively and significantly associated with exporter tradability. This result conforms to our prior that productivity and market size are important determinants of tradability.

Next, the three factor endowment variables—high-skill labor, non-ICT capital stock, and internet users per 100 population—also correlate positively and 1% significantly with tradability. This finding again makes sense in light of the assumed role of comparative advantage factors in generating trade. The institutional variable (quality of the legal system), which is closely related to comparative advantage in the services context, also has a positive and 1% statistically significant correlation with the tradability index, which is in line with our other findings.

The last four variables relate to trade costs and regulatory variables. The first one is the all-inclusive measure of policy- and non-policy-related trade costs due to Miroudot et al. (Forthcoming).[10] It displays a strongly negative and 1% statistically significant correlation with our exporter tradability index. The next two indicators cover a narrower range of trade costs, namely the restrictiveness of administrative regulations and domestic regulations as measured by the OECD's PMR Database. They correlate negatively with tradability, which is in line with expectations. In other words, a more restrictive regulatory environment makes it more difficult to export services. However, only one of the two variables—administrative regulation—has a statistically significant correlation coefficient. The final regulatory variable is the cost of starting a business, as measured by the World Bank's Doing Business project. Helpman et al. (2008) have shown that it can be used as a proxy for the fixed costs of market entry. As expected, we find that the entry cost data are negatively and 1% significantly correlated with the exporter tradability index.

Table 8 considers a reduced range of correlations for the importer tradability index. We exclude exporter-specific factors, such as endowments and institutions, which are not as relevant on the import side. Results are qualitatively identical in all cases. In addition, we examine the correlation between the importer tradability index and the World Bank's Services Trade Restrictiveness Index (Borchert et al., 2012a and 2012b), as an indicator of policy restrictions affecting foreign suppliers. We use the overall index value for Mode 1 trade. In line with expectations, the correlation coefficient is negative and 1% statistically significant: countries with more restrictive services import regimes tend to exhibit lower levels of tradability on the import side.

Based on the descriptive evidence presented in this section, we conclude that our indicators are largely associated in the expected way with important outcome and input measures related to the concept of

[10] See Miroudot et al. (Forthcoming) for a full explanation of their methodology and results. They rely on an inversion of the standard gravity model to infer model-based trade costs for services sectors. Trade costs in this definition include all factors that drive a wedge between export and import prices. International trade costs (between countries) are expressed relative to intranational trade costs (within countries), and are converted to ad valorem equivalents.

tradability. We are therefore confident that they pass these simple tests of external validation, and capture important features of the services trade landscape in a range of countries.

4 Policy Implications

What are the practical uses to which our data can be put? Consider the comparison between two countries, India and the Philippines, in the area of computer services. The former has a total probability of exporting computer services to the USA of 0.912, and the latter has 0.790. This difference in scores translates into a considerable difference in trade values: nearly $6 billion in 2009 versus only $232 million. What can the Philippines do to improve its trade performance in this area? The problem is unlikely to be one of geography: although India is slightly closer to the USA (using capital city distances), the difference is not large. It is tempting to think that human capital should be a priority, but the rate of tertiary completion is in fact considerably higher in our data for the Philippines than for India. Similarly, internet penetration is higher in the Philippines than in India. All of these factors suggest that the Philippines should have a greater probability of exporting to the US than India, but in fact, the reverse is true. Part of the answer lies in legal institutions, which are particularly important for services trade. India scores 5.8 on our legal institutions index, which is over 25% higher than the Philippines. As a first possibility, therefore, those interested in developing computer services exports in the Philippines could look at strengthening the rule of law and legal institutions more generally.

Our external validation exercise also provides some insights into why the Philippines has a lower exporter tradability score than India, which in turn negatively affects its export prospects to the USA in computer services. One obvious reason is the size of the domestic market, which is many times larger in India than in the Philippines. There is nothing the Philippines can do directly to remedy this problem, but regional integration offers an attractive alternative: building an integrated market within ASEAN, for example, as part of the ASEAN Economic Blueprint, should effectively provide a larger domestic market by including countries like Indonesia. A second possibility that could be investigated is the restrictiveness

of services policy settings in the Philippines in terms of domestic regulation—which affects exporters—rather than discriminatory measures, which are primarily aimed at potential exporters in other countries. The OECD's PMR indicators are only available for India, not the Philippines, so it is not feasible to compare scores on administrative regulation and domestic regulation. However, it is possible that at least in some areas, policy settings might be unduly restrictive in the Philippines, which would also negatively affect the exporter tradability index, and thus the probability of exporting computer services to the USA.

As this example shows, the policy implications of our data and findings are potentially important from the point of view of services trade and development. In addition to country-specific work based on our findings, our results suggest at least two general conclusions that might be of broader application. The first is that trade costs matter for the international tradability of services, which is both directly and indirectly affected by international integration policies. One direct finding flowing from our econometric study is that RTAs in services can increase the probability that two countries engage in trade. This finding sits well with previous work suggesting that RTAs lower trade costs in services, and indeed tend to do so in a way that introduces relatively little discrimination vis-à-vis excluded countries (Miroudot and Shepherd, 2013). In addition to RTAs as a second best, unilateral and multilateral liberalization can of course also play an important role in boosting services trade. It is important to stress, however, that it is not only regulations that discriminate against foreign firms that hold back services trade, but also non-discriminatory domestic regulations that are unduly restrictive. Regulatory reform to lower the costs of doing business is therefore an important part of promoting services exports, and the services economy more broadly, in the developing world.

Second, factor endowments and institutions also matter for trade in services. Of the variables included in our model, the rate of internet penetration—as a proxy for ICT capital—has a particularly strong effect on tradability. Given that we are dealing with pure cross-border trade in services, this finding makes sense: the internet is an important conduit for this kind of trade, and its development and

extension is an important way of increasing the contestability of services markets around the world. In addition to ICT capital, we also find that institutional capital—meaning the extent to which the rule of law is protected—is a very important determinant of the tradability of services. At a fundamental level, this finding probably flows from the fact that services need to bring together a complex set of inputs via contract in order to produce the final output, which can then be traded. This process is only possible in an environment in which the rule of law is well protected and, in particular, strong contract enforcement is available. Developing countries looking to expand their services exports could therefore also look carefully at ways in which their domestic governance institutions could be improved in order to facilitate that outcome.

Clearly, more detailed policy implications of our work need to be examined on a country-by-country basis. It will be important for analysts to drill down to a level of detail that cannot easily be covered in this paper, focusing on the determinants of trade in individual sectors for particular country pairs. In doing so, it will be instructive to include additional policy data relevant to specific sectors, such as the degree of market competition, the costs of network access in backbone services, and the role played by sectoral agreements with other countries in areas such as air transport services. Another approach that could be useful and complementary to the consideration of detailed policy variables is to track the evolution of the indices over time. We believe that ongoing research in these directions could yield significant insights into areas where developing countries may have unexploited potential either as services exporters or importers.

5 Conclusion

This paper has presented the first cross-country evidence on the tradability of services via Mode 1 (pure cross-border trade), and to a limited extent, Mode 2 (movement of the consumer). Whereas previous contributions to the services tradability literature focus on individual developed countries and use highly disaggregated production data to infer tradability based on the geographical dispersion of activity, we

take a different approach based on a well-established model of bilateral trade (Chor, 2010). The model incorporates trade costs, technology, and comparative advantage including institutions. The model fits the data very well, as in the previous literature. We use it to construct indices of exporter tradability, importer tradability, and sectoral tradability. Each index ranges between zero (non-tradable) and unity (highly tradable). In our approach, tradability is considered to be the average probability of observing trade for a particular country or sector: a higher score on an index indicates a higher probability of observing trade, and thus a higher level of tradability. Because our approach is based on trade data, rather than production data, we are able to produce tradability indices covering up to 99 countries in all regions of the world, and at a range of development levels. Although our findings are not comparable to those of previous work due to the different methodology adopted, they represent, we believe, a useful addition to knowledge in this area, and one that can potentially be of use to those working on services policy in the context of international development.

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Tables

Table 1: Data and sources.

Variable	Definition	Year	Source
$colony_{ij}$	Dummy variable equal to unity if countries i and j were once in a colonial relationship	NA	CEPII
$common\ official\ language_{ij}$	Dummy variable equal to unity for country pairs that share a common official language	NA	CEPII
$complexity_k$	Task complexity in sector k	1997	PSID survey
$contiguous_{ij}$	Dummy variable equal to unity for country pairs that share a common land border	NA	CEPII
$distance_{ij}$	Great circle distance between the main cities in countries i and j	NA	CEPII
$exports_{ijk}$	Dummy variable equal to unity if exports of services from country i to country j in sector k are greater than $1m	2009	Francois and Pindyuk (2011)
$Herfindahl_k$	Concentration index of intermediate input use in sector k, calculated as the sum of squared shares of use of each input (multiplied by -1)	1997	Bureau of Economic Analysis
$high-skill\ intensity_k$	Share of high-skill workers in total hours worked in sector k	2009	EU-KLEMS
$high-skill\ labor_i$	Percentage of country i's population with a tertiary education	2009	Barro and Lee (2012)
$ICT\ capital\ intensity_k$	Share of ICT-related capital used in sector k	2009	EUKLEMS
$internet\ users\ per\ 100\ people_i$	Internet users per 100 people in country i	2009	World Development Indicators
$legal_i$	Index of the quality of legal institutions and protection of private property rights in country i	2009	Gwartney and Lawson (2004); Fraser Institute
$non-ICT\ capital\ intensity_k$	Share of non-ICT-related capital used in sector k	2009	EU-KLEMS
$non-ICT\ capital\ stock_i$	Share of the non-ICT capital stock in the total capital stock in country i	2009	Conference Board; Groningen Center for Economic Growth
RTA_{ij}	Dummy variable equal to unity if countries i and j belong to the same regional trade agreement that covers services	2009	Authors; WTO.

Table 2: Summary statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
$colony_{ij}$	36003	0.036	0.187	0	1
$common\ official\ language_{ij}$	36003	0.067	0.251	0	1
$complexity_k$	37249	0.412	0.119	0.154	0.568
$contiguous_{ij}$	36003	0.044	0.206	0	1
$distance_{ij}$	36003	5827.712	4526.450	59.617	19586.180
$exports_{ijk}$	32375	0.466	0.499	0	1
$Herfindahl_k$	42864	0.079	0.140	0.026	0.548
$high-skill\ intensity_k$	37249	0.073	0.038	0.022	0.124
$high-skill\ labor_i$	34081	12.576	6.931	0.138	31.484
$ICT\ capital\ intensity_k$	37249	0.307	0.061	0.228	0.428
$internet\ users\ per\ 100\ people_i$	35978	55.334	24.345	0.220	92.181
$legal_i$	34730	6.624	1.382	2.000	8.800
$non-ICT\ capital\ intensity_k$	37249	0.399	0.075	0.291	0.573
$non-ICT\ capital\ stock_i$	34541	1542687.000	3059316.000	2953.020	22000000.000
RTA_{ij}	40656	0.249	0.432	0	1

Table 3: Estimation results.

	(1) Trade Costs	(2) Endowments	(3) Institutions	(4) No Transport	(5) No Construction
$\log(distance_{ij})$	-0.202***	-0.214***	-0.221***	-0.259***	-0.234***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$contiguous_{ij}$	0.026	-0.004	-0.003	0.078	-0.004
	(0.534)	(0.928)	(0.952)	(0.189)	(0.942)
$common\ official\ language_{ij}$	0.027	0.049	0.048	0.072*	0.049
	(0.331)	(0.120)	(0.129)	(0.052)	(0.163)
$colony_{ij}$	0.168***	0.135***	0.125***	0.130**	0.115**
	(0.000)	(0.004)	(0.010)	(0.038)	(0.026)
RTA_{ij}	0.132***	0.146***	0.142***	0.143***	0.156***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\log(high-skill\ labor_i)$ $*\log(high-skill\ intensity_k)$		0.020***	0.018**	0.017*	0.006
		(0.006)	(0.017)	(0.058)	(0.547)
$\log(non-ICT\ capital\ stock_i)$ $*\log(non-ICT\ capital\ intensity_k)$		0.041***	0.039***	0.028*	0.039***
		(0.001)	(0.002)	(0.055)	(0.003)
$\log(internet\ users\ per\ 100\ people_i)$ $*\log(ICT\ capital\ intensity_k)$		0.021	0.065**	0.065**	0.079***
		(0.407)	(0.018)	(0.041)	(0.006)
$legal_i * complexity_k$			0.115***	0.026	0.212***
			(0.000)	(0.359)	(0.000)
$legal_i * Herfindahl_k$			0.061***	0.099***	0.107***
			(0.000)	(0.000)	(0.000)
Observations	39879	32008	31524	28163	28140
Pseudo-R2	0.389	0.379	0.380	0.430	0.392

*Note: The dependent variable is exports in all cases. Estimation is by Logit with fixed effects by exporter, importer, and sector. Prob. values based on standard errors corrected for clustering by country pair are indicated in parentheses below the coefficient estimates. Coefficients are reported as marginal effects at the mean in all cases. Statistical significance is indicated as follows: * (10%), ** (5%), and *** (1%).*

Table 4: Sectoral International Services Tradability Index.

Rank	Sector	Index
1	Other business services	0.725
2	Travel	0.649
3	Personal, cultural, and recreational services	0.480
4	Communications services	0.442
5	Computer and information services	0.421
6	Insurance services	0.372
7	Government services	0.364
8	Financial services	0.348
9	Construction services	0.337
10	Transportation	0.187

Table 5: Exporter International Services Tradability Index.

Rank	Country	Index
1	DEU	0.840
2	GBR	0.837
3	USA	0.826
4	FRA	0.796
5	ITA	0.701
6	CHE	0.678
7	AUT	0.663
8	NLD	0.653
9	CHN	0.648
10	BEL	0.637
11	SWE	0.589
12	DNK	0.585
13	NOR	0.579
14	JPN	0.567
15	ARE	0.563
16	CAN	0.549
17	HKG	0.518
18	KOR	0.510
19	AUS	0.499
20	SGP	0.499
21	TUR	0.484
22	IRL	0.482
23	ESP	0.481
24	GRC	0.474
25	POL	0.462
26	RUS	0.455
27	HUN	0.454
28	IND	0.451
29	BRA	0.449
30	ISR	0.441
31	LUX	0.436
32	CZE	0.429
33	FIN	0.420
34	VNM	0.396
35	HRV	0.383
36	NZL	0.378
37	CYP	0.375
38	PRT	0.373
39	ROU	0.368
40	MYS	0.357
41	ZAF	0.353
42	SYR	0.350
43	BGR	0.348
44	KAZ	0.333
45	THA	0.326
46	IDN	0.322
47	CHL	0.308
48	ARG	0.304
49	SVK	0.297
50	SVN	0.295
51	EGY	0.286
52	KWT	0.286
53	BGD	0.286
54	LVA	0.274
55	MEX	0.268
56	UKR	0.266
57	MLT	0.258
58	EST	0.254
59	LTU	0.244
60	ARM	0.235
61	PHL	0.234
62	MDA	0.211
63	BHR	0.211
64	DOM	0.200
65	BRB	0.188
66	IRN	0.187
67	ISL	0.187
68	PAK	0.181
69	MAR	0.175
70	LKA	0.174
71	VEN	0.170
72	TUN	0.150
73	SEN	0.143
74	PER	0.143
75	DZA	0.133
76	JOR	0.130
77	ECU	0.125
78	JAM	0.125
79	UGA	0.125
80	MLI	0.111
81	KEN	0.105
82	TTO	0.083
83	COL	0.081
84	GTM	0.077
85	URY	0.075
86	ZWE	0.071
87	GHA	0.067
88	CRI	0.067
89	KGZ	0.057
90	ZMB	0.056
91	ALB	0.031

Table 6: Importer International Services Tradability Index.

Rank	Country	Index
1	GBR	0.812
2	DEU	0.812
3	USA	0.797
4	FRA	0.787
5	SAU	0.762
6	CHN	0.679
7	NLD	0.672
8	AUT	0.660
9	BEL	0.642
10	CAN	0.640
11	ITA	0.620
12	JPN	0.618
13	CHE	0.617
14	NOR	0.597
15	ARE	0.591
16	KOR	0.587
17	SWE	0.581
18	DNK	0.541
19	VNM	0.520
20	GRC	0.511
21	AUS	0.509
22	POL	0.503
23	MDA	0.500
24	RUS	0.497
25	ESP	0.490
26	HKG	0.484
27	IND	0.481
28	KAZ	0.480
29	BRA	0.480
30	SGP	0.478
31	TUR	0.454
32	IRL	0.446
33	HUN	0.443
34	ZAF	0.440
35	FIN	0.431
36	LUX	0.423
37	MEX	0.415
38	ROU	0.412
39	ARM	0.400
40	HRV	0.391
41	CZE	0.376
42	IDN	0.373
43	ISR	0.367
44	UKR	0.367
45	PHL	0.366
46	PRT	0.361
47	THA	0.336
48	NZL	0.322
49	MYS	0.321
50	PAK	0.316
51	SVK	0.308
52	BHR	0.294
53	ARG	0.293
54	LVA	0.292
55	CHL	0.292
56	CYP	0.269
57	SVN	0.265
58	EGY	0.257
59	DZA	0.250
60	SYR	0.250
61	BGR	0.249
62	LTU	0.225
63	PER	0.222
64	MMR	0.222
65	ISL	0.215
66	EST	0.215
67	KWT	0.208
68	IRN	0.205
69	KEN	0.200
70	JAM	0.200
71	MLT	0.196
72	VEN	0.191
73	QAT	0.190
74	MAR	0.190
75	SRB	0.185
76	MWI	0.167
77	GTM	0.167
78	BGD	0.158
79	BOL	0.154
80	CIV	0.154
81	UGA	0.154
82	LKA	0.150
83	ECU	0.143
84	BRB	0.143
85	CRI	0.143
86	KHM	0.142
87	TZA	0.133
88	TUN	0.133
89	URY	0.130
90	COD	0.111
91	JOR	0.100
92	MOZ	0.100
93	COL	0.099
94	TTO	0.091
95	SEN	0.077
96	GHA	0.077
97	DOM	0.071
98	KGZ	0.062
99	ALB	0.051

Table 7: Pairwise correlation coefficients with the exporter tradability index.

	Correlation Coefficient
$\log(GDPPC_i)$	0.680***
$\log(Pop_i)$	0.285***
$\log(high-skill\ labor_i)$	0.449***
$\log(non-ICT\ capital\ stock_i)$	0.697***
$\log(internet\ users\ per\ 100\ people_i)$	0.556***
$legal_i$	0.614***
$\log(trade\ costs_i)$	-0.738***
$\log(Domestic\ Regulation_i)$	-0.186
$\log(Administrative\ Regulation_i)$	-0.415***
$\log(Cost\ of\ Starting\ a\ Business_i)$	-0.455***

*Note: Per capita GDP and population are sourced from the World Development Indicators. Trade costs are sourced from Miroudot et al. (Forthcoming). Domestic regulation and administrative regulation are sourced from the OECD PMR Database. The cost of starting a business is sourced from the Doing Business database. Statistical significance is indicated as follows: * (10%), ** (5%), and *** (1%).*

Table 8: Pairwise correlation coefficients with the importer tradability index.

	Correlation Coefficient
$\log(GDPPC_j)$	0.585***
$\log(Pop_j)$	0.326***
$\log(trade\ costs_j)$	-0.689***
$\log(Domestic\ Regulation_j)$	-0.127
$\log(Administrative\ Regulation_j)$	-0.340**
$\log(Cost\ of\ Starting\ a\ Business_j)$	-0.429***
$\log(STRI_j)$	-0.294***

*Note: Per capita GDP and population are sourced from the World Development Indicators. Trade costs are sourced from Miroudot et al. (Forthcoming). Domestic regulation and administrative regulation are sourced from the OECD PMR Database. The cost of starting a business is sourced from the Doing Business database. The STRI is sourced from the World Bank Services Trade Restrictions Database, and covers Mode 1 trade in all relevant sectors. Statistical significance is indicated as follows: * (10%), ** (5%), and *** (1%).*

Figures

Figure 1: Correlation between import shares and the importer tradability index.

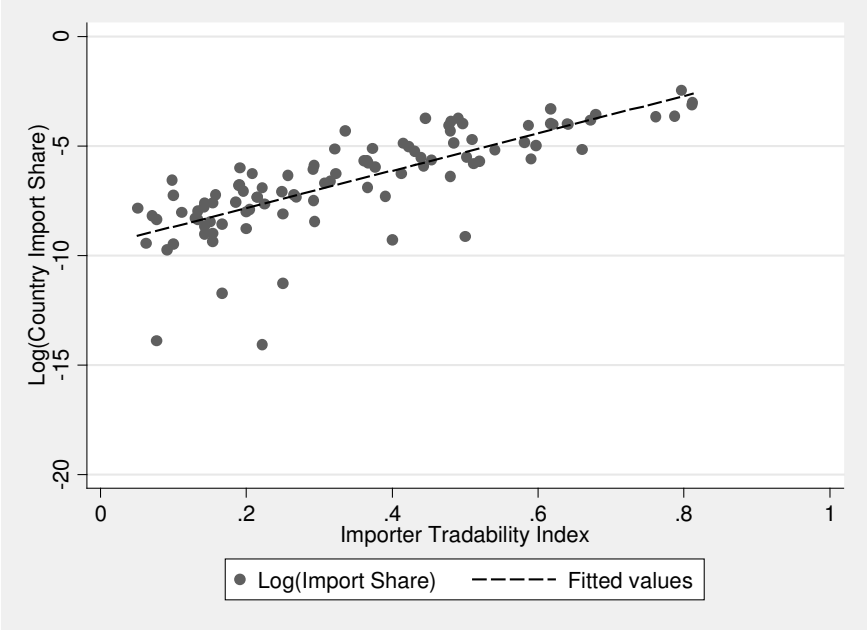

Figure 2: Illustrative correlations between the Exporter Tradability Index and external validation variables.