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Measuring and Understanding Trade in Service Tasks

Daniel Chiquiar, Martin Tobal and Renato Yslas

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Abstract

Improvements in Information and Communication Technologies (ICT) have had differential impacts on the costs of offshoring service tasks. As a result, services with stronger tradability characteristics are at a higher risk of being offshored. This has increased the need for coming up with proper measures of service tradability and to better understand the labor market implications of service offshoring. This paper reviews a literature that has proposed measures of service tradability, investigated the casual effects of service offshoring and developed theoretical models to rationalize the associated stylized facts. The review suggests that skill-intensity and tradability are key determinants of wage and employment effects. Nonetheless, the lack of widely accepted definitions and measures of tradability, the absence of high quality data on service trade flows and the difficulty of measuring import competition at higher disaggregation levels pose difficulties to attain further empirical progress. The theoretical literature must produce a new generation of models that could rationalize the stylized facts.

About the Authors

Daniel Chiquiar is the General Director of Banco de Mexico's Research Department (the country's central bank). He has previously worked as a Director of the Real Sector Analysis and the Macro-Financial Risk Analysis Units at the same central bank and as a manager of the Economic Policy department at the Ministry of Finance in Mexico. He holds a Ph.D. from the University of California, San Diego. His research covers a wide range of topics in different fields, ranging from macroeconomics and international trade to labor and development economics. He has made substantial contributions to understanding the nature of trade relationships between Mexico and the US, the economic implications of migration, regional convergence within Mexico and business cycle synchronization between the two countries, among several other topics. His work has been published in a wide range of journals, including the Journal of Political Economy, the Journal of International Trade and the Journal of Development Economics.

Martín Tobal works as a research economist at Banco de Mexico. Previously, he has worked as a financial analyst at the financial stability directorate at the same central bank and as a deputy manager of the macroeconomics research department at the Center for Latin-American Monetary Studies (CEMLA), in which he conducted a number of research projects about macro-financial performance in Latin America. He holds a Ph.D. from the University of California, San Diego. He has contributed to improve

knowledge in a wide range of topics in the fields of international trade and macroeconomics, including trade-in-tasks and services, the relationship between foreign financing and export survival, currency mismatches in the banking sector, as well as currency and banking crises.

Renato Yslas works as a financial economist at Banco de Mexico's financial stability directorate. He has previously worked as an economist at the research department of the Center for Latin-American Monetary Studies (CEMLA). He holds a master's degree in economics from Colegio de México (Colmex). His work has contributed to the literature of time series and, particularly, to better understanding the relationships between foreign exchange rate interventions and conventional monetary policies and the behavior of the exchange rate in Mexico. His research also covers different topics in international trade.

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1 INTRODUCTION

By spreading the use of technologies such as the Internet, cell phones and teleconferencing, the ICT (Information and Communication Technologies) revolution has facilitated the electronic delivery of services tasks. The implications have been a reduction in the costs of offshoring service tasks and a boom in service offshoring.

Offshoring costs have fallen for some tasks more than for others and, thus, certain workers have become particularly exposed to global competition. The effects of service task offshoring vary depending on their tradability. As a result, service tradability has gained a predominant role in shaping wage and employment effects.

The predominant role gained by tradability has led a recent literature to construct a wide range of tradability measures. However, as more carefully explained in the present review, this literature has been confronted with a major problem: the concept of service tradability is extremely hard to define, among other factors, because there is not an agreement on what characteristics of a service job make its output easier to offshore. In addressing this topic, the literature has proposed three potential determinants of service tradability. Levy and Murnane (2006) argue that tradability increases with the routines of a job; Blinder (2006; 2009) claims that tradability is stronger for services that do not require personal interaction and Garner (2004) holds that ICT enabled jobs tend to be tradable because their output can be sent over long distances at small costs.[1]

The role gained by tradability has also raised the question of whether traditional labor market distinctions between skill groups must be complemented with information on the tradability characteristics of labor tasks. The answer to this question depends on the nature of the correlation between skill-intensity and tradability: if these dimensions were perfectly correlated, the additional information would be redundant and there would not be a need for complementing traditional distinctions. Indeed, existing work has explored the sign and intensity of the correlation between skill-intensity and tradability. Through informal contributions, leading scholars argue that there are no reasons to believe that the correlation is strong (Krugman, 1996 and 2011; Grossman and Rossi-Hansberg, 2006; Baldwin, 2006 and Blinder, 2006 and 2009). Formal contributions show that the correlation could be positive but far from economically significant (Blinder, 2009; Jensen and Kletzer, 2010).

The new predominant role of service tradability has been more thoroughly investigated by Crinò (2010) and Liu and Trefler (2011) with sophisticated econometric methods. Crinò shows that employment is more likely to respond negatively to service offshoring in unskilled

[1] As shown in Section 2, these job characteristics have been used in the construction of tradability indexes. Depending on whether these indexes rely on personal judgement or on the number of characteristics considered, they can be classified over two dimensions: (i) subjective or objective and (ii) simple or compound.

occupations and occupations with stronger tradability characteristics, i.e., suggesting that, for these occupations, import competition effects overpower potential employment increasing effects.[2] Moreover, he finds that the probability of finding a negative employment response increases with tradability, even after controlling for educational attainment. Along similar lines, Liu and Trefler (2011) show that service offshoring increases occupational switching rates among unskilled workers and workers fulfilling routine tasks. That is, service offshoring seems to penalize unskilled workers and tradable tasks.

This body of evidence has confronted theorists with the need of developing models in which both skill-intensity and tradability play predominant roles. Motivated by these challenges, trade theory has recently made progress in developing frameworks that give tradability a predominant role without neglecting the traditional relevance of skill-intensity and skill groups (Grossman and Rossi-Hansberg, 2008; Tobal, 2012 and 2015). Nonetheless, there is still much room to gain understanding on the economic mechanisms that drive the empirical results.

The paper is structured as follows. Section 2 presents recent attempts to measure service tradability. Sections 3 reviews the evidence on the importance of skill-intensity and tradability in shaping wage and employment effects. Section 4 presents theoretical advances and Section 5 concludes.

2 Measuring tradability

2.1 Job characteristics and measures of tradability

As noted in the introduction, the concept of service tradability is elusive and hard to define. Whereas economists have traditionally defined goods as being more or less tradable, we are not used to defining services as being more or less costly to trade. After all, what characteristics of a service task make its output easier to be transported over long distances? Being aware of these challenges, a recent strand of literature has identified a number of job characteristics as being relevant in determining service tradability and, on the basis of these proposals, constructed a series of tradability indexes.

The precedent of this literature, as well as of the job characteristics first identified as being relevant, can be traced back to earlier works by labor economists. Autor et al. (2003), for instance, link the polarization of the U.S. wage distribution to the degree of routines of labor

[2] As carefully explained in Section 4, theoretical works have considered the existence of "productivity effects," through which service offshoring generates cost savings increasing the demand for domestic labor.

tasks.[3] They argue that a decline in the price of computers has spread the use of technology, inducing a substitution of routine tasks and, at the same time, raising the productivity of workers that undertake non-routine tasks.[4]

Levy and Murnane (2006) formally associate Autor et al.'s (2003) concept of routines with the notion of jobs tradability. They note that because routine activities can be expressed through a limited set of pre-established rules, they can be more easily explained without serious misunderstanding, they require less training and experience and they are easier to monitor. Based on this idea, Levy and Murnane argue that routine tasks are not only more likely to be substituted by computers, but they are also less costly to offshore. This association between routines and tradability has been subsequently used by the literature. For instance, as explained below, Crinò (2010) and Liu and Trefler (2011) use information on the routines of occupations to build indexes of tradability.

In addition to the degree of routines, the recent literature on service offshoring has identified a number of other job characteristics that could potentially determine the tradability of service tasks. Blinder (2006; 2009) refer to the need for face-to-face interaction as a relevant determinant of task tradability. According to him, services that demand a higher level of personal, face-to-face interaction, to which he refers to as "personally delivered" jobs, are less tradable given that either they cannot be delivered electronically or they can but only at significant costs, e.g. because dinners cannot be served through a wire, waiters must be at specific locations (restaurants) and supply "personally delivered" services. In contrast, he argues, "impersonally delivered" services do not require personal contact and can thus be undertaken at remote distances.[5]

Another characteristic identified as being a relevant determinant of tradability is the extent to which a job is enabled by ICT. Garner (2004) argues that the ICT revolution has triggered an impressive reduction in the costs of exchanging information so that, currently, information can be exchanged almost instantaneously at virtually no costs. In this context, jobs involving collection, manipulation and/or organization of information are easier to move because their output can be delivered at lower costs. Following this logic, Garner claims that ICT-intensive jobs are less costly to offshore.

[3] Polarization refers to the increasing trend in wage inequality in the upper tail of the skill distribution, and the slowdown or even reversal of such trend in the lower tail of the skill distribution. These patterns started to be observed in the U.S. wage distribution since the second half of the 1980s.

[4] In order to empirically test this hypothesis, Autor et al. (2003) constructed measures of the routine and non-routine task content of different occupations by using information from the Dictionary of Occupational Titles (DOT).

[5] In this sense, Blinder argues that "impersonal delivered" services have much in common with manufactured goods that can be put in a box to be exchanged in the international markets (Blinder, 2006).

2.2 INDEXES OF TRADABILITY

Recent contributions have formalized the concepts of tradability through the construction of tradability indexes. In the absence of data disaggregated at the task level, most of these indexes use occupational information. These measures exhibit differences that can be summarized in two points. First, some of them are based on information about the three occupational characteristics mentioned in the previous section, as well as on personal judgement regarding their relative importance; because they are based on personal judgment, these measures are frequently referred to as "subjective" indexes of tradability. On the other hand, measures not involving this personal judgment are termed "objective" indexes. Second, among the subjective measures, some indexes are based on a single occupational characteristic and others rely on multiple characteristics; these measures are respectively referred to as "simple indexes" and "compound indexes."

Two seminal simple, subjective indexes of tradability have been developed by Blinder (2006; 2009) and Liu and Trefler (2011). Blinder's contribution is based on the idea that, as noted above, services that demand face-to-face interaction tend to be non-tradable and must therefore be undertaken at specific locations. To construct his index, Blinder draws information about features of different occupations from the O*NET database and then, based on this information, uses personal judgment to classify service jobs into four groups:[6] jobs in which workers must be at a specific U.S. location are labeled "non-offshorable" and receive a rank number between 0 and 25;[7] jobs in which workers must be close to their work unit and this unit must be in the U.S. are classified as "hard-to-offshore" and receive a number between 26 and 50; jobs in which workers must be close to their work unit but this unit *does not need* to be in the U.S. are labeled "offshorable" and receive a number between 51 and 75 and, finally, jobs in which workers do not need to be either at a specific U.S. location or close to their work unit are classified as "highly offshorable" and receive a number between 76 and 100.

Another tradability measure that can be interpreted as a simple, subjective index of tradability refers to that developed by Liu and Trefler (2011). Using information contained in the O*NET database, they follow Autor et al. (2003) and define their measure of routines as the ratio of the relative importance of "repeating the same task" to the relative importance of "thinking creatively." Three reasons justify the interpretation of Liu and Trefler's measure of routines as a simple, subjective index of tradability. First, the degree of routines has been largely identified by the literature as a key determinant of service tradability. Second, even though Liu and Trefler do not explicitly refer to "tradability", they seek to understand the

[6] In this sense, it can be said that Blinder constructs a "subjective" index of tradability.

[7] Within the category of "non-offshorable" occupations, Blinder only assigns a rank number to those occupations that, according to his view, can be classified as tradable under at least some reasonable assumptions.

implications of service trade. Third, their measure is based on a personal judgement about which of the occupational characteristics contained in the O*NET database determine routines.

Other scholars have relied on more than one occupational characteristic to construct indexes of tradability. For instance, building on the works of Autor et al. (2003), Garner (2004) and Blinder (2006), Jensen and Kletzer (2010) and Crinò (2010) consider the three occupational characteristics mentioned in Section 1.A, i.e. routines, need for face-to-face interaction and technology intensity. Taking these characteristics in consideration, Jensen and Kletzer (2010) define five labor dimensions: i) the information content of a job; ii) whether the job is Internet-enabled; iii) the creative (non-routine) nature of the job; iv) its need for face-to-face interaction and v) whether it is attained physically to a particular location. They extract information from the O*NET database and, based on this information and personal judgement, they assign a rank number to each occupation over these five labor dimensions.[8] Subsequently, they construct their index by taking a weighted sum of the five rank numbers pertaining to each occupation.

Along similar lines, Crinò (2010) constructs his compound index of tradability by defining three labor dimensions: i) routines; ii) whether the job produces impersonal services, and iii) whether it is ICT-enabled.[9] Also in the manner of Jensen and Kletzer (2010), he assigns rank numbers to occupations over these three labor dimensions. Nonetheless, rather than simply using a weighted sum of rank numbers, Crinò follows Autor et al. (2003) and combines information on the three labor dimensions by using principal component analysis.

Motivated by the fact that subjective indexes rely on personal judgement regarding which occupational characteristics are relevant in determining tradability and how important they are, a different strand of literature has taken a more objective approach (Jensen and Kletzer, 2006; Kletzer, 2006; Jensen, 2011). This literature starts from the premise that the production of traded goods tends to be geographically concentrated, while the production of non-traded goods tends to be more evenly distributed within the U.S. Subsequently, the literature extends the intuition to the service sector, and use measures of geographic concentration to infer which services are more susceptible to be traded in international

[8] To rank occupations along the five dimensions, Jensen and Kletzer (2010) use information contained in the following categories of the O*NET database: i) for information content, they use "getting information", "processing information", "analyzing data or information", and "documenting or recording information"; ii) for Internet-enabled, they use "interacting with computers."; iii) for face to face interaction, they use "assisting or caring for others", "performing or working directly with the public", "establishing or maintaining interpersonal relationships"; iv) for non-routine nature, they use "making decisions or solving problems", and "thinking creatively" and v) for on-site nature, they use "inspecting equipment, structures or material". For instance, to measure whether a job is Internet-enabled, Jensen and Kletzer use two rating numbers reported for the variable "Interacting with computers" which reflect, respectively, how important it is for a job to interact with computers and how skillful one must be to carry out this interaction.

[9] Crinò employs the following O*NET categories: i) for routines, he uses "visual colour discrimination", "importance of repeating the same tasks", "getting information", "documenting/recording information" and "inspecting equipment, structures or materials"; ii) for impersonal services, he uses the frequency of "face-to-face interactions with individuals and groups", "perform for or work directly with the public", "deal with external customers" and "establishing and maintaining relationships" and iii) for ICT-enabled, he uses "interacting with computers".

markets. For instance, Jensen and Kletzer (2006) retrieve data from the 2000 Decennial Census of Population Public Use Micro Sample and construct locational Gini coefficients to proxy for domestic geographic concentration.[10] Using this measure, they identify which services are traded domestically and assume that these services are also more susceptible to be traded in international markets.[11]

Although objective indexes do not rely much on personal judgement and are thus less prone to manipulation, they present other shortcomings. In particular, given that these measures rank occupations in a pure mechanical way, they can generate results that are not compatible with common sense. For instance, as properly pointed out by Blinder (2009), Kletzer's index of tradability (Kletzer, 2006) ranks data entry keyers and telephone operators as virtually impossible to offshore. Nonetheless, common sense suggests that these occupations should be ranked at the top most tradable occupations.

In summary, measuring service tradability is not an easy task and may be far more challenging than measuring tradability for the case of goods. These difficulties arise from the fact that, among other things, it is not obvious what occupational characteristics are relevant in making a service activity more or less costly to trade. This, of course, leaves the doors wide open for personal judgement and, in the worst case scenario, for intended manipulation. At the same time, objective measures of tradability overcome these flaws but, on the other hand, may generate unreasonable results.

3 Does Tradability Really Matter?

3.1 Service Tradability: Relevance and Correlation with Skill Intensity

Workers undertaking the most tradable service tasks are now more exposed to global competition and, thus, their wages and employment are in principle at higher risk.[12] This, of course, raises the question of whether prospective work should extend past studies to account for this new predominant role of tradability. In particular, should traditional labor

[10] It may be possible that a service activity is concentrated at a given location regardless of its tradability characteristics. To control for this possibility, Jensen and Kletzer (2006) use the difference between a region´s share of industry employment and its share of industry demand when they construct their locational Gini coefficients.

[11] Specifically, they classify those service activities with a Gini coefficient lower than 0.1 as non-tradable and those with a Gini coefficient greater or equal to 0.1 as tradable.

[12] Regarding this point, note that tradability has been shown to be important in determining trade effects. There is a number of papers that, though not focusing explicitly on service offshoring, have provided evidence for this point. Ebenstein et al. (2014) show that U.S. workers who performed routine tasks tended to be the more negatively affected by offshoring and import competition over the period 1984-2002. Hummels et al. (2011) find that, conditional on skill type, Danish workers employed in routine task-intensive occupations suffered the larger drops in wages due to offshoring from 1995 to 2006. Along similar lines, Firpo et al. (2011) document that tradability explains an important part of the distributional wage changes observed in the US over the periods 1988-1990 and 2000-2002. Finally, using a sample of US multinationals for the period 2000-2006, Costinot et al. (2009) show that larger shares of intra-firm imports are negatively associated with the routine intensity of different sectors. They interpret this result as evidence that firms prefer to outsource routine activities rather than non-routine activities.

market classifications be complemented with information about the tradability characteristics of labor tasks?

Labor market distinctions in the field of international trade have been traditionally based on skill groups. Well-established theoretical results tend to be reinterpreted in terms of skilled and unskilled labor, e.g., the Stolper Samuelson theorem, and empirical work frequently distinguishes workers on the basis of educational attainment. In this environment, the question of whether there is a need for extending traditional labor market classifications boils down to the following point: are skill-intensity and tradability strongly correlated? If this were the case, and one could perfectly identify jobs with different tradability by their skill-intensity, complementing traditional labor market classifications with information on tradability would tend to be redundant.

Existing work has investigated the sign and intensity of the correlation between skill-intensity and tradability, mainly through the use of occupational data. Needless to say, a major issue in learning about this correlation has been the lack of a widely accepted measure of service tradability and of a tradability index which neither relies on personal judgment nor generates unreasonable results. Despite these difficulties, several scholars have made both informal and formal contributions to understanding the nature of the correlation between skill-intensity and tradability.

Regarding the informal contributions, a large number of scholars argue that tradability is key in determining wage and employment effects and that there are no reasons to believe that it is strongly correlated with skill-intensity (Krugman, 1996 and 2011; Grossman and Rossi-Hansberg, 2006; Baldwin, 2006 and Blinder, 2006 and 2009). Krugman (1996) claims that, in understanding labor market effects, the relevant distinction lies in the tradability of services because: (i) ICT-enabled jobs tend to be tradable;[13] and (ii) third-world countries will learn how to fulfill them, increasing their supply and reducing their reward. Furthermore, he holds that differences in the degree of routines, a widely used measure of service tradability, is responsible for the polarization of the U.S. wage distribution (see reference to Autor et al., 2003 in Section 1).[14]

Grossman and Rossi-Hansberg (2006) also claim that routines are important in shaping employment effects. Building on Autor et al. (2003), they classify tasks into five categories: expert thinking, complex communication, routine cognitive processes, routine manual labor and non-routine manual labor. They find that the share of U.S. jobs involving routine tasks has been falling rapidly since 1990. As for the correlation between skill-intensity and

[13] As noted in the previous section, the degree to which a job is enabled by ICT has been extensively referred to as a determinant of service tradability in the literature.

[14] Krugman (2011) also affirms that ICT improvements and software developments have reduced the demand for highly educated workers, such as lawyers, paralegals and engineers.

tradability, they emphasize that "*the tradability of a task does not correspond perfectly (or even very well) with the skill required to perform it.*"

Continuing with these ideas, Baldwin (2006) argues that tradability has become relevant in determining winners and losers from trade because: (i) the ICT revolution has taken global competition to the level of tasks and (ii) tasks differ in terms of tradability and, thus, exposure to global competition. In this context, he argues, the fact that some tradable tasks are skilled and others are not implies that the correlation between skill groups and winners and losers from trade has broken down. Blinder (2006) also emphasizes this lack of correlation through a comparison between security analysts and typists. According to him, while security analysis requires much higher levels of education, both service jobs are highly and, most importantly, almost equally tradable.

Blinder's contribution to understanding the correlation between skill-intensity and tradability is not limited to this example. In a formal contribution, he uses his index of tradability to estimate the rank correlation between tradability and educational attainment for a number of occupations in 2004 (Blinder, 2009). He finds a coefficient equal to 0.08, suggesting that the correlation is low and non-significant in economic terms. Further, he regresses wages against the number of schooling years required by an occupation and dummies indicating different degrees of tradability.[15] His results show that the dummy associated with the most tradable jobs is negative and statistically significant, and interprets this result as evidence that *actual offshorability* is important in shaping wage effects over and above skill-intensity.[16]

A second formal contribution to understanding the correlation between skill-intensity and tradability can be extracted from Jensen and Kletzer (2010).[17] Using their compound index of tradability based on the five labor dimensions referred to in Section 1, they estimate the rank correlation between tradability and educational attainment. They find a statistically significant coefficient equal to 0.306. Even though this suggests a stronger correlation than Blinder's results, the estimate is still far from being significant in economic terms and, most importantly, from the common presumption that unskilled labor-intensive jobs are easier to offshore, i.e., according to this presumption the estimated coefficient should be negative (Blinder, 2009).

[15] Blinder groups occupations according to their rank number of tradability into seven categories and indicates each category with a different dummy (see Section 1 for an explanation on how these numbers are assigned).

[16] As properly pointed out by Blinder, given that by 2004 only a small fraction of occupations had been offshored, the coefficient of the low and medium tradability dummies reflect the effects of potential offshorability while the coefficient of the high tradability index reflect the impact of actual offshorability. Blinder estimates that actual offshorability translates into a wage penalty equal to 14 percent.

[17] Using the tradability index of geographic concentration they construct in their paper of 2006, Jensen and Kletzer find that workers employed in tradable sectors tend to have higher levels of educational attainment. Nonetheless, this result cannot be perfectly matched with the discussion presented in this section because it is based on the tradability of the corresponding sector rather than on the tradability of the relevant occupations.

Apart from the contributions made by Blinder (2009) and Jensen and Kletzer (2010), there is a different strand of literature whose results could be interpreted as indirect evidence for a lack of correlation between skill-intensity and tradability. This strand does not focus on the correlation between the two labor dimensions; instead, it focuses on the impacts of service offshoring on wages and employment. However, as more thoroughly explained in the next subsection, these studies introduce skill-intensity and tradability measures as explanatory variables in the same equation and find that both are statistically significant. This, suggests that skill-intensity and tradability are not strongly correlated, at least to the point of generating multicollinearity concerns.

3.2 CAUSAL EFFECTS OF SERVICE OFFSHORING

Informal and formal contributions suggest that service tradability is key in determining trade impacts. In this context, it is not surprising that a young empirical literature has been recently using econometric methods to more carefully understand service offshoring effects. These econometric methods tend to be more sophisticated than those presented in the previous section and, in general, have been used to control for potential bias and identify causal effects.

In the process of identifying casual effects, scholars have been confronted with three important challenges. First, given that several economic shocks and unobservable occupational characteristics affect simultaneously service offshoring and labor market outcomes, their relationship is subject to severe endogeneity concerns (Liu and Trefler, 2011).[18] Furthermore, the fact that, as noted by Ebenstein et al. (2014), firms modify their offshoring choices in response to domestic labor market conditions implies that this relationship is also subject to important reverse causality concerns. Second, the intangible nature of services hampers the ability of institutions to keep track of international services flows. This reduces the quality of official statistics and generates measurement errors that complicate the identification of service offshoring effects. Third, even if high quality data were available, they would be broken down by sectors; thus, these data may provide useful sectoral information, but they may not be informative by themselves about the exposure to global competition faced by occupations or labor tasks.[19,20] These challenges and the

[18] Liu and Trefler (2011) note that demand and technological shocks affect service imports and labor market variables and, thus, not controlling for them leads to biased results. For instance, ICT improvements tend to increase service offshoring by reducing offshoring costs and, at the same time, raise worker's productivity and the demand for domestic labor.

[19] This flaw may be particularly important in estimating labor market effects given that global competition is currently being held at the task level and, thus, the effects of import competition tend to be better captured by using occupational data (Baldwin, 2006; Ebenstein et al., 2014).

[20] Similar problems emerge with firm-level data. Hummels et al. (2011), for instance, argue that inputs imports do not substitute for domestic labor in cases in which the inputs have not been produced within the boundaries of the firm. That is, an offshoring measure defined at the firm-level may not capture import competition effects.

relatively recent occurrence of the ICT revolution explain the scarcity of empirical studies investigating service offshoring effects.

Among these studies, a major contribution has been made by Crinò (2010). Using a panel dataset with information on more than one hundred occupations for the period 1997-2006, he explores the wage and employment impacts of service offshoring. He conceives service offshoring as a demand shifter and estimates the elasticity of occupational demands with respect to this shifter. His empirical approach proceeds in two steps. In the first stage, he estimates the relevant elasticity for each occupation.[21] The results show a higher concentration of positive elasticities among skilled occupations and of negative elasticities among unskilled occupations. Furthermore, occupations with negative elasticities tend to have stronger tradability characteristics. In the second step, he introduces his compound index of tradability and a measure of skill intensity into a probit model and estimates the effect of each labor dimension on the probability of finding a positive elasticity.[22] His outcomes show that this probability falls monotonically with tradability, even after controlling for skill intensity, and that both labor dimensions are statistically significant.

Liu and Trefler (2011) also provide evidence in favor of the relevance of tradability in determining the labor market implications of service offshoring. Combining matched data at the worker level extracted from the US current Population Survey (CPS) with Bureau of Economic Analysis (BEA) bilateral trade flows between the U.S. and other partners, they study the impacts of service imports from China and India on the U.S. labor market over the period 1996-2007.[23] Their findings show that service offshoring increases occupational switching rates among unskilled workers, suggesting that the ICT revolution has more strongly exposed these workers to global competition.[24] Furthermore, following Autor et al. (2003), they break up the sample into routine and non-routine occupations and find that service offshoring effects are more adverse for routine occupations than for non-routine occupations. However, when breaking up their sample by the educational levels, they do not find significant evidence for differential effects.[25] Finally, their results show that the impact of import services on occupational switching rates is gradual and, in several cases, involve transitions in and out of unemployment spells.

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[21] In order to measure service offshoring, Crinò follows Amiti and Wei (2005 and 2009) in extending the seminal measure of materials offshoring developed by Feenstra and Hanson (1996 and 1999) to the case of services. In particular, for each sector, he considers the share of total private services in total non-energy input purchases.

[22] Crinò's measure of skill-intensity is given by the average degree of schooling years required to perform the relevant job.

[23] Liu and Trefler (2011) study focuses on tradable services, which they identify by linking BEA´s import and export data to occupations. However, their results based on the breakdown between routine and non-routine occupations could be interpreted as evidence that, even among tradable services, some of them can be exchanged more easily.

[24] To measure service offshoring, Liu and Trefler (2011) use imports of 'other private services' from China and India, which incorporates mainly back office activities previously bounded to the location of the production process, e.g. business, professional, technical, financial and insurance services.

[25] They separate their sample between those with at least some high school and those with at least some college.

4 Theoretical Literature

Recent developments in the empirical literature have raised interesting challenges for theorists in the field of international trade. Trade theorists have traditionally been comfortable, and relatively at odds with evidence, by classifying labor into skill groups. Nonetheless, the already mentioned effects of the ICT revolution have confronted them with the need of giving jobs tradability a much more predominant role. Interestingly, most of the evidence suggests that this new, predominant role of tradability should not come at the expense of sacrificing the traditional importance of skill-intensity and skill groups. Indeed, most evidence suggests that both dimensions play relevant empirical roles.

These advances of the empirical literature imply, among other things, that traditional theoretical results may have to be reconsidered or reformulated. For instance, it may no longer be sufficient to distinguish winners and losers from trade solely according to their skill levels, i.e., as mentioned above, this distinction may arise, for example, from reinterpreting the traditional Stolper-Samuelson theorem in terms of skilled and unskilled labor. The ICT revolution has taken the world to a new globalization phase that requires the development of a new generation of theoretical models.

Indeed, theorists have responded to the stimulus created by the recent empirical literature. Although theory stands behind, important progress has been made and there seems to have been a tendency towards giving jobs tradability a much more predominant role in the determination of wage and employment effects. In an exercise of abstraction and simplification, it is possible to summarize the progress made by theory through these years by referring to three stages of development.

The first stage of development corresponds to a set of models that analyze the offshoring phenomenon from the perspective of standard theory and construct their arguments based on conventional skill groups (Markusen, 2005; Markusen and Strand, 2007). In the tradition of the Hecksher-Ohlin model, these frameworks explain the emergence of offshoring as the result of cross-country differences in relative factor endowments. In contrast with the standard version of the Hecksher-Ohlin model, on the other hand, these frameworks fragment the production process into small pieces (i.e., “activities” or “production stages”) with different skill-intensities.

These modelling characteristics are replicated in the two-good, two-factor, two-country framework developed by Markusen (2005). He conceptualizes the production process of the skilled-intensive good (“manufacturing”) in terms of a skilled-intensive activity and an unskilled-intensive one (“services”). For the case of a small, skill abundant country, he shows that this nation has a comparative advantage in the skill-intensive activity and offshores services. In a different paper, Markusen and Strand (2007) extend this framework to the case in which the production process of services can be itself fragmented into a skilled-intensive

production stage ("headquarters") and an unskilled-intensive one ("offices"). For the same case of a small, skill abundant country, they show that this nation specializes in "headquarters" and offshores "office activities."

The models pertaining to the second development stage also fragment production processes into "small pieces" and term them "production stages" or "labor tasks." In contrast with the models pertaining to the first development stage, these frameworks explain offshoring patterns based on the tradable and non-tradable nature of these small pieces. Motivated by the idea that some activities are more costly to offshore, this stream argues that firms will move abroad the most tradable tasks. In this sense, these models are consistent with the evidence that tradability has gained a predominant role in determining offshoring patterns, as well as wage and employment and effects.

The starting point in this second wave of offshoring models is perhaps the framework developed by Kohler (2004). This framework is one of the first to conceptualize the production process in terms of a continuum of production stages that differ in tradability. [26] These modeling tools are later used by Grossman and Rossi-Hansberg (2008) in their seminal contribution. They develop an offshoring model in which production is conceptualized in terms of a continuum of tasks differing in tradability and skill intensity. They identify three channels through which offshoring affects domestic wages. First, there is a "productivity effect," according to which offshoring generates cost savings that must be compensated with increases in domestic wages, i.e. so that the zero-profits conditions are restored. Second, there is a relative price effect that works in the context of large countries and whose intuition lies on the grounds of the standard Stolper-Samuelson theorem. For instance, offshoring of unskilled-intensive tasks increases the world supply of unskilled-intensive goods, reducing its relative price and raising the relative skilled wage. Finally, there is a "labor supply effect" that takes place with more factors than goods. This effect results from the reabsorption of workers who previously performed offshored tasks and, thus, reduce domestic wages.[27]

The third stage of development refers to models that take an in-between approach and highlight the tradable and non-tradable nature of labor tasks without neglecting the traditional relevance of skill-intensity and skill groups. In the sense that in these models both skill-intensity and tradability are important in determining wage and employment effects, they are consistent with the evidence presented in Section 3.

[26] Kohler (2004) develops a two-factor, two-sector H-O framework, where the production process of one of the industries is conceptualized in terms of a continuum of stages. These stages differ in their costs of fragmentizing them across countries. However, tradability across stages lines up completely with their factor-intensity; fragmentation costs increase (or at least do not fall) as production moves from labor-intensive stages to capital-intensive ones. In this sense, heterogeneous costs of fragmentation do not play an independent role of skill intensity in determining service offshoring patterns.

[27] One of the greatest contributions of Grossman and Rossi-Hansberg (2008) is to show that, due to the productivity effect, offshoring costs reductions and, more generally, offshoring can generate shared gains for all domestic factors and, in particular, both skilled and unskilled workers.

Among the frameworks pertaining to the third stage of development is the service offshoring setup developed by Tobal (2012; 2015).[28] In this setup, he considers two regions, two labor groups and two final goods sectors with different skill-intensities. Production processes are conceptualized in terms of labor tasks with different tradability and skill-intensities, and offshoring costs are modelled with an index that varies across the tasks in the manner of Grossman and Rossi-Hansberg (2008). In contrast to them, however, Tobal (2012; 2015) introduces trade costs in final goods and a putty-clay technology, according to which human capital is task specific. While the former assumption ensures that the skill-premium is lower in the small, skill-abundant country, the latter assumption implies that the supply of labor tasks are inelastic in the short run. In this framework, he shows the emergence of two wage effects. In the manner of Grossman and Rossi-Hansberg (2008), he shows the existence of a productivity effect that exerts upward pressure on domestic wages due to efficiency gains. He also identifies a foreign competition effect that exerts downward pressure on domestic wages. However, in contrast to Grossman and Rossi-Hansberg's labor supply effect (2008), the magnitude of this foreign competition impact is increasing in the tradability of labor tasks. Moreover, the fact that in the skill-abundant country the magnitude of this effect is greater for unskilled workers implies that, in Tobal's model, winners and losers from trade are classified not only according to their skill level but also according to the tradability of their tasks. That is, Tobal's model complements the traditional labor market distinction between skill groups with information about the tradability features of labor tasks.

5 Conclusion

Although the literature on service offshoring is still young, it has made progress in measuring service tradability and understanding service offshoring effects. Recent contributions have constructed a wide range of tradability indexes based on occupational characteristics. Using these indexes, the literature has shown that tradability has gained importance in shaping wage and employment effects. These results, along with the fact that the correlation between skill-intensity and tradability has been found to be weak, suggests that the traditional analysis based on skill groups must be complemented with information about the tradability features of tasks. The theoretical literature has made progress on this front and, indeed, a recent generation of models has given tradability a more important role without neglecting the traditional relevance of skill-intensity and skill groups.

[28] In the sense that Baldwin and Robert-Nicoud (2014) construct a general framework with Heckscher-Ohlin considerations and differences in the tradability of labor tasks, their model should also be included in this wave of theoretical models. Their results provide analogous versions of the traditional four Heckscher-Ohlin-Vanek H-O-V theorems (Heckscher-Ohlin-Vanek, factor price equalization, Stolper-Samuelson, and Rybczynski).

Notwithstanding these contributions, the lack of widely accepted measures and definitions of service tradability, the absence of high quality data on service trade flows and the difficulty of measuring import competition at the occupational level hampers the progress of the literature. Moreover, theory seems to be standing still behind the evidence provided by the empirical literature. In this sense, there is much work to be done in reaching consensus on service tradability measurement, in collecting higher quality data, in thinking about different ways of assessing the task-content of service trade flows and in developing new theoretical frameworks that describe different channels through which service tradability may have gained a predominant role.

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