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International Business Travel: An Engine of Innovation?

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ABSTRACT

While it is well known that managers prefer in-person meetings for negotiating deals and selling their products, face-to-face communication may be particularly important for the transfer of technology because technology is best explained and demonstrated in person. This paper studies the role of short-term cross-border labor movements for innovation by estimating the recent impact of U.S. business travel to foreign countries on their patenting rates. Business travel is shown to have a significant effect up and beyond technology transfer through the channels of international trade and foreign direct investment. On average, a 10% increase in business travel leads to an increase in patenting by about 0.3%. We show that the technological knowledge of each business traveler matters by estimating a higher impact for travelers that originate in U.S. states with substantial innovation, such as California. Moreover, the business traveler effect on innovation also varies across industries. This study provides initial evidence

1 Introduction

Throughout history the cross-borderfl

patenting on average by about 0.3%, and in the typical case business travel from the United States accounts for about 1% of the total di erence in patenting across countries. Moreover, we find evidence that the impact of inward business travel on patenting is increasing in the technological knowledge carried by each particular traveler.

While international trade in goods and foreign direct investment (FDI) have long been the subject of investigation, there is much less research on international trade in services, even though by now services trade is substantial in many countries. For example, services exports are now close to 40% of U.S. goods exports.[2] This paper sheds new light on the impact of international air travel. This provides new information for the gains from services liberalizations, both bilaterally (such as the Open Skies Agreement) and multilaterally among the members of the World Trade Organization.[3]

Monge-Naranjo 2009) so that international travel is crucial for knowledge di usion.

plus at a time when the literature is only emerging.[6]

The remainder of the paper is as follows. The next section gives an overview of the empirical analysis and also highlights important aspects of the estimation methods. Section 3 describes the data that will be used, with more details given in the Appendix. All empirical results are presented in section 4, while section 5 contains a concluding discussion of our findings.

2 An empirical model of innovation through cross-border movements

We are interested to estimate the impact of international business travel on the rate of innovation across countries and industries. Innovation is measured in terms of the countries' patents at the level of 37 industries. The industry dimension is important because industries vary greatly in terms of patenting activity. While patent data is available even by industry, information on business travel is much more scarce. This paper employs data on outward business travel of U.S. residents (who are predominantly U.S. citizens) to other countries.[7] The focus on one source country means that the spells of business travel are more comparable than if we had used data from multiple countries that might use di erent approaches in data collection. Moreover, we limit the analysis of patenting to patent applications in the United States, both to ensure a common quality standard across countries and because the United States is an important market for all of the countries in our sample.

[6] Productivity as it can typically be measured captures not only technical e ! ciency but also demand shocks and market power, factor market distortions, and product mix changes (Foster, Haltiwanger, and Syverson 2008, Hsieh and Klenow 2009, and Bernard, Redding, and Schott 2010, respectively). See Keller (2004) for more discussion on measures of technology and technology di usion.

[7] Thanks go to Jennifer Poole who shared the outcome of her NSF-funded data collection with us.

ensures that all inventions surpass the same quality standard, and moreover, patent protection in the United States will typically be important for major inventions given the importance of the U.S. market. This data comes from the custom data extracts of the USPTO database, which has information on country of residence for each of possibly several inventors per patent, original USPTO patent classification, as well as the application month and year.[9] In the case of ¯ ^ 1 inventors, we assign a fraction of 1]¯ to each inventors country of residence. Based on USPTO classification, patents are assigned to NBER 37 technological subcategories (or, industries).[10] A list of industries is provided in table A1 of the Appendix. The main dependent variable in the empirical analysis is the sum of these fractional patent counts aggregated by foreign country and industry for each quarter during the period 1993 to 2003.[11]

In addition, we employ the USPTO individual inventor database to separate out foreign patents that have a U.S. co-inventor. These patents are of particular interest because the traveler might in fact be the U.S. co-inventor on that patent. For this reason, we believe that the relationship between business travel and domestic innovation might be particularly strong for these patents. How frequent are patent applications that have a U.S. co-inventor? We find that on average about one in 60 of all foreign patent applications in the United States during the sample period had foreign and U.S. co-inventors.

It is well-known that a principal determinant of the rate of innovation is the country's R&D

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measures of innovation, namely a country's total patent applications in a particular year, both by residents of that country as well as by non-residents (source: World Intellectual Property Organization).[13] These variables control for innovative cycles in each country that are general in the sense that they are not specifically related to travel from the United States. In addition, including all patents on the right hand side controls for the patent family e ect, namely that a patent application in the U.S. reflects only the fact that a given technology has been invented and patented at home in the same period.

traveler variable, $b_{¤²µª}$, is defined as follows:

$$b_{¤²µª} = \sum_{´/s} \frac{p_{´²µ}}{g\,s\,p_{´²µ}}$$

(source: Penn World Tables, version 6.2). It is also important to control for other channels of international technology transfer, such as international trade and FDI (see Keller 2010). The regressions include U.S. exports to each of the sample countries, as well as the total sales of U.S. majority-owned multinational a ! liates in each of the sample countries.

Summary statistics of the data are presented in Table 1. The first two rows show some descriptive statistics on fractional patent counts by foreign inventors and joint U.S./foreign patent counts. There is a lot of variation in U.S. patenting by foreign countries and industries as evidenced by the standard deviation in both foreign U.S. patent counts as well as joint U.S. patent counts. A list of the 36 countries that are included in this analysis is given in Table A3 of the Appendix. The following four rows in Table 1 present (in natural logarithms) U.S. resident travel data for business, religious, and visitor purposes, along with data on travelers that are retired and homemakers.[14] As can be seen from the table, the number of travelers for the purpose of business and visitor are close in magnitude, while the number of observations for religious travel and retired and homemaker travel is much smaller.

We now turn to the empirical results.

4 Empirical results

We begin by introducing the estimation equation. It is given by

$$e\,[p_{¤²µa}|b_{¤²µa}[\,x_{¤²µa}[\,z_{¤²µa}] = \exp^{£} + \ln b_{¤²µa} + \,,\ln x_{¤²µa} + 6_{¤} + 6_{²} + 6_{µ} + 6_{a} + B_{¤²µa}^{¤} \qquad (3)$$

[14] In this analysis we focus on positive numbers of business travelers, as our analysis does not necessary apply to patenting in the case when there is no business travel.

where $p_{¤²µª}$, the expected patent counts of a country ¤ in the United States in quarter ² of year µ and industry ª is a function of $b_{¤²µª}$[the number of business travelers at that time between country ¤ and the U.S. (from equation 2), other determinants $x_{¤²µª}$ of country ¤'s patenting in the U.S. (such as R&D expenditures), country-, quarter-, year- and industry fixed e ects (the 6's), and an error term, $B_{¤²µª}$. In our data, the variance of patents exceeds its mean (overdispersion), and the negative binomial model is generally preferred to the Poisson model in our case.[15]

The initial results on the relation between innovation and U.S. business travel are shown in Table 2. In columns 1 to 5, the dependent variable is the foreign country's patent counts taken out at the U.S. patent o ! ce, while in column 6 the dependent variable is foreign patents that have U.S. coinventors. All regressions include country, year, quarter and industry fixed e ects. Robust standard errors which allow for clustering by country-year are reported in parentheses.[16] Column 1 shows that there is a strong correlation between patenting and travel from the United States, which is only slightly reduced with the inclusion of controls for size and level of development in column 2: the coe ! cient on business travel decreases from 0.056 to 0.053.

Next we include controls for domestic technology investments as well as international technology transfer. U.S. FDI and U.S. exports have a positive coe ! cient, although only FDI is significant. The inclusion of these variables lowers the business travel coe ! cient slightly. In column 4, we include R&D expenditures, which has a highly significant impact on patenting. With the inclusion of R&D expenditures, U.S. FDI becomes insignificant, while in contrast the

[15] We have also considered 'zero-inflated' negative binomial regressions, however, they do not lead to a major improvement in empirical fit.

[16] We cluster by country-year because some of the variables do not vary by quarter and by industry; for example, GDP per capita for a given year is employed for all four quarters of that year and all industries. In contrast, patents on the left and the business variable on the right-hand side vary by quarter and industry.

coe ! cient on business travel is largely unchanged.

Recall that the left-hand side variable is a country's industry-level patenting in the United States. In column 5 the patenting of the country in all countries of the world is added, where we distinguish resident from non-resident patenting. This controls for technology and other shocks that lead to changes in a country's overall patenting. We see that resident patenting is more

a ected by unobserved shocks, which would lead to biased estimates. In particular, we are concerned that e[b¤²µª[B¤²µª] ^ 0[because this would lead to an upward bias in the business travel coe ! cient. Our approach is to construct a control function variable, A¤²µª[such that when A¤²µª is included in the regression the correlation of business travel and the new regression error is zero.[18] The control function that we propose is the residual of a regression of business travel on visitor travel. Consider the following ordinary least-squares regression:

$$\ln b_{¤²µª} = -_{¤} + -_{²} + -_{µ} + -_{a} + -_{1} \ln v_{¤²µª} + -_{2} x_{¤²µª} + A_{¤²µª}[\qquad (4)$$

where v¤²µª is the number of visitor travelers between the U.S. and country ¤ in quarter ² of year µ and industry ª, where visitor travel is defined as travel intended to meet family and friends. The residual Â¤²µª of this regression will tend to be high when business travel is high relative to visitor travel, conditional on all other covariates. A new direct air connection between a particular U.S. state and a particular foreign country ¤, for example, will typically lead to an increase in both business and visitor travel. If, in addition, foreign country ¤ improves its business conditions by lowering corporate taxes, this will tend to increase business travel relative to visitor travel. But this would not constitute the exogeneous variation that is needed to estimate the causal impact of business travel on patenting, and it is important that the control function eliminates e ects like this. Identification comes from changes in business travel conditional on changes in profitability, technological capability, and other factors that are captured by shifts in the business-visitor traveler relationship. One requirement for this control function approach to

[18] Control function approaches have been widely applied in the estimation of productivity, perhaps starting with Olley and Pakes (1996); Blundell and Powell (2003) give an overview and provide general results on the control function approach.

are retired, the number of persons who travel for religious reasons, and the number of travelers

between business travel and innovation holds for high versus low patenting industries.[20] The results are shown in Table 5. Column 1 repeats for convenience the baseline estimates without the control function (from Table 4, column 1), while in columns 2 and 3 in addition to business travel an interaction of business travel with high patenting dummy (based on median or mean) is included. It is apparent that the impact of business travel on innovation is greater in high patenting industries: the coe ! cient on business travel in high patenting industries is around 0.3 compared to business travel overall 0.05 (column 1). It is somewhat of a puzzle that business travel has a negative impact in low-patenting industries, however, this may be due to correlation among the independent variables.

In columns 4 to 6, we show analogous results using the preferred control function approach.

In the basic specification in column 2, the coe ! cient on business travel is essentially zero as opposed to about 0.03 (Table 4). Specifi

that can be compared to the benefi

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