Social networks and trade of services: modeling interregional tourism flows with spatial and network autocorrelation effects

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Abstract

Recent literature on border effects has fostered research on informal barriers to trade and the role played by network dependencies. In relation to social networks, it has been shown that intensity of trade in goods is positively correlated with migration flows between pairs of countries/regions. In this study we investigate if such a relation also holds for interregional trade of services, focusing on the case of the Spanish intra and interregional monetary flows generated by the domestic tourism sector. With this aim, we develop a gravity model that captures spatial and network dependence attributable to demographic linkages between regions. The network linkage structure is derived using origin regions for the stock of immigrants living in each region. The results indicate that: the intensity of monetary flows generated by the domestic tourism sector depends positively on the gross value added of the Tourism sector; population and income levels of the regions of origin, and negatively on the travel distance between regions. Network direct effects, as well as indirect spatial or network spillover effects were also found to be positive and significant.

KEYWORDS: social networks, gravity models, trade of services, internal tourism, Bayesian spatial autoregressive regression model, spatial connectivity of origin-destination flows.

1 Introduction

In spite of decreases in transportation costs, recent literature on border effect shows how countries still engage more in internal trade than external trade with other countries (McCallum, 1995; Helliwell, 1996; Wolf, 2000; Evans, 2003; Chen, 2004; Okubo, 2004). In an effort to explain this, research has increasingly focused on informal barriers to trade. One such barrier is a lack of information about international trade and investment opportunities (Rauch and Casella,2003). Social and business networks are seen as possible channels to overcome such barriers and increase the volume of international trade (Portes and Rey, 2005). Evidence supporting such channels has been found for business groups operating across national borders (Belderbos and Sleuwaegen, 1998), immigrants (Gould, 1994), and long-settled ethnic minorities that maintain co-ethnic business societies.

This literature distinguishes two main mechanisms through which bilateral trade could be promoted by immigration. The first mechanism is related to 'idiosyncratic' preferences of immigrants or 'taste effects', where the positive impact of immigrants on trade intensity reflects tastes for goods from their countries of origin. The second mechanism is reduction of transaction costs or 'information effects', since immigration reduces transaction costs since migrants are familiar with preferences, social institutions, language and legal institutions of both countries, which reduces communication costs and cultural barriers. Moreover, communication between immigrants and those living in their country of origin is facilitated by social and business networks that is thought to be the explanation for higher levels of bilateral trade flows.

Motivated by this literature, we investigate whether similar results exists for regional trade in services. We focus on the special case of interregional trade flows of the tourism sector, where trade usually implies a cross-border movement of people. The motivation for this focus is threefold: first, it is well known that in all the developed countries, services account for the largest part of all economic activity; second, due to the lack of information on bilateral trade of services, it is difficult to find empirical work on quantification of border effects for services. Therefore, the relation between distance, the trade of services and the presence of informal barriers remains an open question. A third motivation is that due to data restrictions, most studies have focused on the link between international migration and international trade, not taking into consideration that the bulk of people and trade flows between regions within

countries.

In parallel with the positive relation between networks and trade in goods, it is reasonable to expect that social and business networks would also affect trade in services, and tourism flows in particular. Regarding business networks, tourism flows would be more intensive between countries that share common infrastructures and intermediaries (transportation networks, common tour-operators, etc.). In terms of social networks there are several mechanisms that could induce positive correlation between trade and the intensity of the demographic linkages. Our findings point to at least 2 direct and 4 indirect channels [1] throughout immigration could affect the destination choices of tourists.

Focusing on the link between tourism and migration at the international level, the network effects could be reduced by the limited number of foreign immigrants in a country, the third-world composition of the immigration structure, and the high cost of travel back to the home country. However, when the analysis focuses on the internal or interregional tourism flows, we might expect to see higher magnitudes of flows. For example, in the US during the single year of 2001, 2.8% or 7,778 million people moved between counties, and 1.3% or 3,715 million persons moved between states. Cumulative moves over the five year period from 1995 and 2000 involved 112 million people for the United States, of which 22 millions involved moves between states. This suggests an interstate migration rate for this period of 8.6%, with an inter-county migration rate of 24.8% (Perry and Schacher, 2003). Spain is a much smaller country, but with a strong tourist tradition, since Spain ranks 3rd in the World in terms of tourists inflows. In 2001, there were 552 million overnight stays by Spanish citizens within Spain, despite the fact that Spain has only 42 million citizens. In addition, mobility of Spanish citizens is such that only 16% of the population live in a region different from that in which they were born. An important distinction between interregional and international movement of citizens is that lodging expenses may be lowered by ownership of 'second residences' or the ability to 'share' accommodations with relatives and friends in the case of interregional flows of visitors, augmenting potential savings on 'transaction costs' induced by the presence of 'social networks' that would apply in the case of international tourism flows.

Despite these intuitively appealing reasons to believe that the potential for significant re-

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[1] Direct effects: The Home-Land-Attraction effect ('DHLA') and the Host-Region-Attraction effect ('DHRA'); Indirect effects: 2 indirect spatial effects and 2 indirect network effects.

lationships between tourist trade flows and stocks of immigrants in the interregional case is greater than for international tourism, the lack of information has limited the ability to explore interregional tourism flows. To our knowledge there have been no previous attempts to measure this type of relation for internal flows in Spain or worldwide.[2]

In this paper we study the relation between interregional trade flows of services linked to the tourism sector using a gravity model that relies on conventional distance measures thought to inhibit flows, plus spatial econometric methods for incorporating social network relationships between regions into the gravity model. The latter are based on use of the stock of interregional immigrants living in each region to form a spatial weight structure linking regions. This type of interregional dependence is contrasted with more conventional weight structures based on geographical proximity of the regions. We exploit recent estimates of the intra and interregional trade flows of tourism between the Spanish regions for the year 2001 (Llano and De la Mata, 2009a, 2009b), as well as efficient Bayesian econometric approaches based on Markov Chain Monte Carlo (MCMC) estimation methods.

We show that in the case of a simple gravity model, strong 'internal border effects' exist, and trade services in the tourism sector respond with a small negative but significant response to distance while controlling for intra-regional trade flows. More sophisticated models that introduce an increasing number of network effects tend to diminish the importance and significance played by geographical distance in the simpler models. These results are interpreted as an indication that domestic tourists express a preference for consumption of both intraregional and interregional services from regions with which they have strong migration linkages. Spatial econometric methods draw upon the concept of 'neighboring regions', where this is typically measured using geographical proximity. We broaden this concept to include regions that could be considered 'neighbors' based on common composition of residents, measured in terms of residents' regional migratory origins. The role played by this type of regional connectivity could be labeled 'network effects', since past migration flows in conjunction with social networks represent an alternative to conventional geographical proximity of regions.

An interesting finding is that after taking into account conventional geographical proximity and network connectivity of regions, the role played by distance between origin and destinations

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[2]There are some studies analyzing internal tourism flows, but they use input-output models (Eriksen and Ahmt, 2008), or time series approaches (Athanasopoulos and Hyndman, 2008), but not a gravity model with cross-sectional data or attention paid to network effects.

regions is no longer of statistical significance. This means that distance does not impede tourism flows after taking into account regions of origin and regions of residence. Tourists are just as likely to visit more distance as nearby regions, after controlling for the roles played by spatial and network connectivity to other regions.

In Section 2 we discuss origin- and destination-centric aspects as well as network influences on trade flows of services. Section 3 presents an empirical gravity model, detailing a series of increasingly complex specifications that control for spatial/geographical as well as network dependencies. Empirical results obtained from applying the model to intra- and inter-regional trade flows associated with tourism in Spain are presented and discussed in section 4.

2 Trade and social networks: background and definitions

2.1 Previous literature

An economic network has been defined as *a group of agents that pursue repeated, enduring, exchange relations with one another* (Podolny and Page, 1998). Based on this definition, several authors have analyzed the impact on bilateral trade between origin and destination regions of immigrant population from origin regions. As Rauch (2001) pointed out in his review, an immediate concern is that any positive impact of population immigration on trade may simply reflect immigrant taste for goods from their countries of origin, or a correlation of immigration with country of origin or destination characteristics that promote trade, for example geographic proximity. However, different authors have demonstrated that apart from these 'taste effects', there are also 'network effects' induced by the social linkages that immigrants maintain with their countries of origin. Such linkages may lead to important reductions in transaction cost resulting in increased bilateral trade flows.

Some authors have tried to quantify the relevance of social and business networks on trade in goods between countries. For example, Gould (1994), in an early article analyzed US trade with 47 other countries over the period from 1970 to 1986, arguing that immigration reduced information costs and or resistance due to border-effects. Head and Ries (1998) carried out a similar analysis of Canadian bilateral trade involving 136 countries for the period 1980 to 1992. Dunlevy and Hutchinson (1999, 2001) studied US imports and exports over the period from 1870 to 1910, finding that immigration affected both imports and exports. They argue that for

the case of imports 'taste effects' are larger than what they term 'information effects', which we label social network effects'. For exports they contend that 'information effects' are more important because this facilitates knowledge needed to promote trade opportunities between both countries. Similarly, Wagner et al. (2002) studied the effects of immigration on the international trade of Canadian provinces, and Rauch and Trindade (2002) studied how the presence of Chinese ethnics affect bilateral trade. In countries where a large presence of Chinese ethnics who maintained connections with their country of origin, as in southeast Asia, the effects on the bilateral trade were found to be greater. Digging deeper into the historical causes of the social networks induced by stocks of immigrants, Girma and Yu (2002) carried out an analysis using data on immigration and trade for the United Kingdom. They distinguished between migration from countries with historical relations to the Commonwealth versus countries with no such relation. White and Tadesse (2008) measured the effect of immigration on trade, using state-level US data, 75 countries, and a novel indicator of cultural distance. They too confirmed that immigrants tend to counteract the negative effect on trade arising from cultural distance. However, their results indicated that the influence of immigrants on trade was not large enough to overcome resistance to trade associated with information costs induced by cultural distance or separation.

Paradoxically, the role played by migration in determining patterns of trade flows should be more evident between regions within a single country than between countries, but literature examining this type of relation at the interregional level is very scarce. Helliwell (1999) analyzed the interregional and international trade of Canada and the US, finding that interregional migration played a minor role compared to that of international migration. The argument was that 'taste and information effects' are smaller between regions than between countries. More recently, Combes et al (2005) quantified the impact of social and business networks on the intensity of interregional trade between 94 French regions (departments). Using different gravity models, they verified that, despite of the traditional impediments to trade (distance and boundaries), networks facilitate bilateral trade, finding larger effects for business than social networks.

As already noted, most of these studies focus on trade of goods, without considering interregional trade of services and the role played by interregional migration flows. The magnitude of trade in services is much larger than goods in all OCDE countries[3].

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[3]For example, according to the Spanish National Accounts, more than 60% of the Spanish GDP is produced

2.2 Direct and indirect relations between tourism and immigration

For generality and simplicity, we describe concepts that relate to both international and interregional trade and the role of past migration flows embodied in stocks of immigrants from various origins. Although are ultimate focus is on 'regions', we use examples that apply to both cases. This approach might be more appealing to an international audience, despite the fact that our empirical application uses interregional data.

For our purposes, an immigrant is defined as an individual who was born in a different region ('region of origin') from his current region of residence ('host region'). Note also that, when considering interregional monetary flows of the Tourism sector, an 'exporting region' is the one producing the service, in our case the region receiving the tourists.

Focusing on the tourism sector, there are several channels that may lead to a positive relationship between the intensity of trade and the presence of social networks. We classify these channels in two groups to differentiate between relations affecting the trading regions (direct effects), or relations affecting neighbors of the trading regions (indirect effects).

For the immigrant group, we observed the following direct effects:

1. The destination choice of immigrants is conditioned by familiar ties with their regions of origin. Since tourists take advantage of vacations to visit their region of origin, they may own homes or have access to property in these regions. This should produce larger tourism exports from a host region to regions of origin for immigrants living in the host region. For example, Moroccans living in France tend to travel back to Morocco during vacations, so Morocco would account for larger tourism exports to France than would be expected from a model considering only characteristics of Moroccan tourists . We label this type of effect a *Direct-Home-Land-Attraction* (DHLA) effect.

2. Conversely, relatives and friends living in the region of origin may tend to visit immigrants in the host region, since these visits are made easier by access to information and less expensive dwelling options than other possible tourism destinations. For example, German tourists may choose Spain as destination if they share information and housing with expatriate Germans already settled in Spain. We label this the *Direct-Host-Region-Attraction* (DHRA) effect.

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by services, and more than 70% of the total output is consumed within the country

Apart from these two direct effects that would enhance tourism flows, there are additional channels of influence associated with social networks that could impact bilateral trade flows of the tourist sector in a more indirect manner. These channels are labeled indirect because the relation is not a bilateral one between two regions with a history of past immigrant flows. Rather, indirect channels relate to flows connecting the neighbors to exporting and importing regions under consideration. These indirect channels arise from what could be considered 'spatial and network' dependence effects. The existence of indirect channels of influence impact how we approach estimation of spatial interaction models (Bolduc et al, 1992; LeSage and Pace, 2008).

The basic motivation for indirect channels of influence is that the bilateral trade flows between regions i and j are not independent of flows to regions neighboring i, or those neighboring j. Moreover, the concept of 'neighboring region' could be defined from a geographic proximity or *spatial contiguity* perspective as in LeSage and Pace (2008), or more generally using proximity measured in terms of *population demographic composition*. We label these two types of proximity using the terms: *indirect spatial effects* and *indirect demographic effects* in our discussion.

These can be further delineated into two types of *indirect spatial effects*:

1. Those linked to the 'DHLA' effect, where immigrants living in a region may look for destinations that are near their region of origin. Although this 'spatial effect' could be justified by several complementary mechanisms, we focus on two linked to tourism decisions:

    (a) Due to the 'taste effect', immigrants from a specific region of origin may chose a destination region that is a spatial neighbor of the home-land region, since the probability of finding similar 'characteristics' in these neighboring regions is higher than other more distant regions For example, immigrants from Cuba living in Chicago may prefer Florida for vacations, which is the closest 'spatial and cultural neighbor' to Cuba within the US.

    (b) In addition, consistent with the notion of gravity that likely influenced past immigration flows, the probability of finding co-nationals (and therefore family and friendship ties) in the regions nearby the region of origin is higher than anywhere else. For example, since immigrants from Cuba tend to concentrate in Florida, any Cuban living in Chicago may prefer Florida for vacations, due to social networks with other co-nationals. These might provide a way to find better prices or even roommates for the

vacation stay.

2. Conversely, from the perspective of the 'DHRA' effect, the relatives of immigrants who are still living in the region of origin, may also look for destinations that are closer to an immigrant's host region rather than the host region itself. The mechanisms causing this type of indirect effect are linked to the 'DHRA', and are equivalent to those described for the 'DHLA' but with forces acting in the opposite direction.

For the case of *indirect demographic effects*, we can also delineate two types of these effects:

1. One type relates to historical patterns of emigration in a region. If emigrants have concentrated in a group of host regions, then 'demographic effects' are more likely to appear between these regions and the region of origin. However, 'demographic effects' could also appear between these 'host regions' themselves, throughout the presence of strong communities of co-nationals. In fact, a concept of 'demographic neighbors' could be easily defined depending on the similarity of the immigration structure of a group of host regions. This cross relation between a 'demographic neighbor region' s to j may introduce enhancing or competing effects for the direct positive relation between the tourist trade flows from region i to j and the stock of immigrants born in i living in j. This new indirect effect can be explained by different mechanisms. Using our example of Cubans, if the proportion of immigrants from Cuba in the US and Spain is similar, it is likely there are cross ties between Cubans living in both host-countries, and therefore, the US and Spain could be considered 'demographic neighbors' with regards to Cuban emigrants. Thus, the 'demographic effect' influencing bilateral trade flows of tourism between the US and Cuba could be associated (positively or negatively) to a parallel 'demographic effect' between the US and Spain. As noted earlier, immigration is influenced by gravity so 'demographic neighbors' could coincide with 'spatial neighbors'. However, alternative situations might also arise. For example, one might consider the Jewish Diaspora in general terms, and specifically after WWII when strong Jewish communities were organized in countries such as Israel, the US or Argentina, which are some distance from one another, but still today represent intense network ties and tourism relations.

2. A second type of situation could give rise to a 'demographic association' that could affect

the 'DHRA' influence. Relatives of immigrants who are still in the region of origin could decide to visit 'the demographic neighbors' of the host-region rather than the host-region itself. The mechanisms giving rise to this indirect effect are equivalent to the ones described above for the 'DHLA' effect, but with forces that act in the opposite direction.

Finally, we consider tourism destination preferences of non-immigrants, that is, people who live in their region of origin. It is important to highlight that immigrants could also affect 'tourism decisions' of other non-immigrants living in the host region. For example, if we think of the large number of immigrants who form families with natives in a region, it is easy to suppose there is an influence on immigrant tourism decisions arising from tastes and family ties that exert and influence on non-immigrants. For example, in the case of a 'mixed couple' (immigrant and non-immigrant) with two children, the decision to visit a relative in the home-land of one immigrant is conditioning travel decisions of three 'non-immigrants'. Moreover, relatives and friends of the immigrants who are still living in the origin region (but could interact regularly with them), could also spread their travel experiences and tastes among their co-nationals in the home-land. Although the diffusion of information and preferences would mainly take place within each region (the home-land and the host region), it could also be progressively diffuse to neighboring regions. In Combes et al. (2005), this effect is described as the main force driving the relation between the 'information effect' and the 'border effect' in the case of interregional trade of goods. In our case, this force is mixed and strengthened by the effects described above.

In conclusion, we have identified two direct effects that potentially could induce positive relations between bilateral trade of services in the tourism sector and the bilateral immigration stocks between any pair of regions i and j. Additionally, we have described four indirect forces affecting tourism decisions, which could lead to positive or negative dependence between trade flows of tourism between an origin and destination, with the trade flows from the same origin/destination and their corresponding 'spatial' (contiguous regions) and/or 'demographic neighbors' (regions with similar immigrant compositions). Furthermore, it could be assumed that all these influences could affect both immigrants and non-immigrant tourism decisions. The direct and indirect effects are summarized in Figure 1 and in Figure 2, together with the variables capturing them, which will be described in the next section.
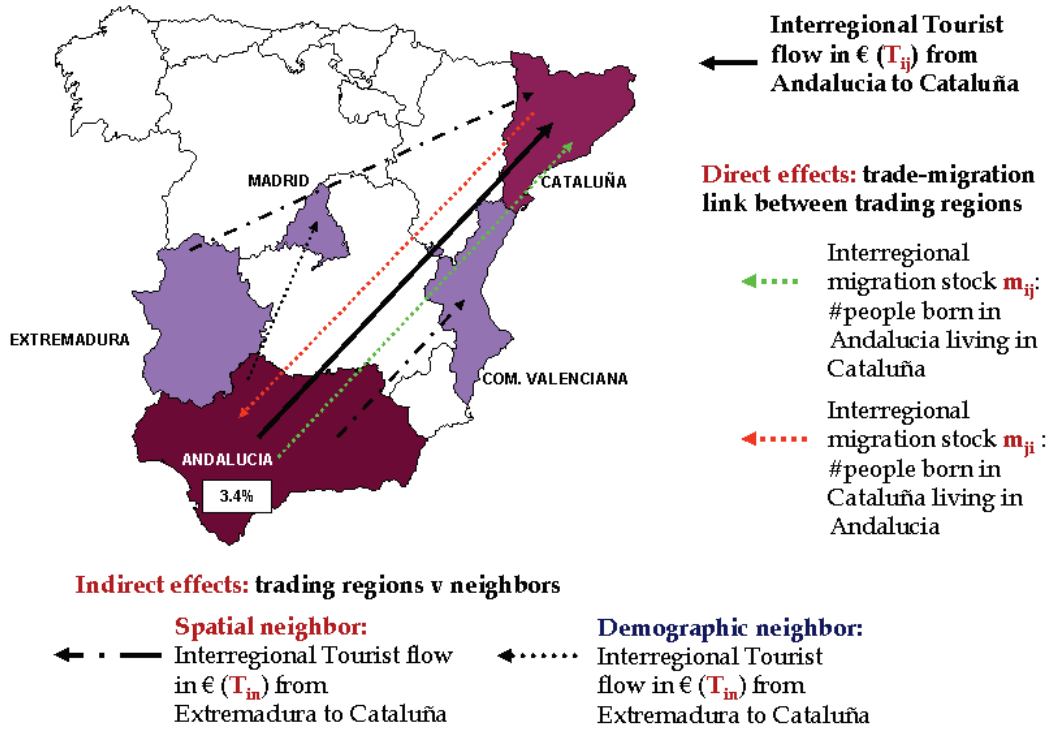
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Figure 1: Intuitive scheme showing the relation between tourist flows and migration stocks

3 The empirical model

In this section, we first discuss the concept of spatial and network autocorrelation effects as these relate to our spatial econometric model. A series of alternative model specifications of increasing sophistication are set forth. These allow us to engage in a model comparison exercise that examines the alternative model specifications. The spatial econometric models introduced to accommodate spatial and network dependence in the flows follow from work by LeSage and Pace (2008), LeSage and Fischer (2008) and Autant-Bernard and LeSage (2008).
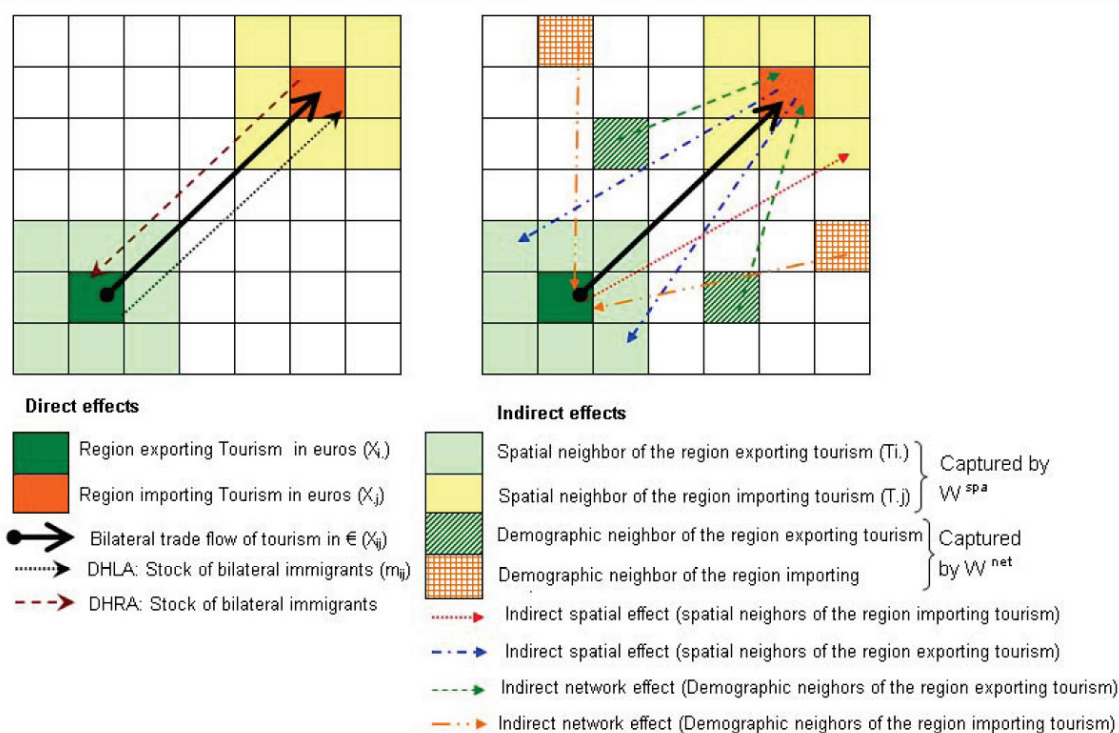
Figure 2: Scheme summarizing the spatial and network effects on tourism trade

3.1 Spatial and network autocorrelation effects affecting gravity model estimates

Black (1992) suggested that network and spatial autocorrelation may bias classical estimation procedures typically used for spatial interaction models. He suggested that "autocorrelation may (...) exist among random variables associated with the links of a network". Bolduc et al. (1992) suggested that classical gravity models do not consider the socio-economic and network variables adjacent to the bilateral origin-destination regions i and j, arguing these should also be incorporated in the relationship that attempts to explain flows (Y_{ij}) between these regions. He emphasized that omission of neighboring variable values gives rise to spatial autocorrelation in the regression errors. Sources of spatial autocorrelation among errors are model misspecification and omitted explanatory variables that capture effects related to the physical and economic characteristics (distances between zones, size of zones, lengths of frontiers between adjacent zones, etc.) of the region.

More recently, LeSage and Pace (2008) challenged the assumption that origin and destina-

tion (OD) flows in the classical gravity model contained in the dependent variable vector Y_{ij} exhibit no spatial dependence. They note that use of distance alone in a gravity model may be inadequate for modeling spatial dependence between observations. For the most part of socio-economic spatial interactions (migration, trade, commuting, etc.), there are several explanations for these effects. For example, neighboring origins and destinations may exhibit estimation errors of similar magnitude if underlying latent or unobserved forces are at work so that missing covariates exert a similar impact on neighboring observations. Agents located at neighboring regions may experience similar transport costs and profit opportunities when evaluating alternative nearby destinations. This similar positive/negative influence among neighbors could also be explained in terms of common factor endowments or complementary/competitive sectoral structures. For example, if natural factor endowments are key variables explaining patterns of trade specialization, neighboring regions with similar factor endowments may be affected in a similar way by demand and supply shocks. Since a large number of factor endowments are conditioned by space (similar natural resources and climate, joint transport infrastructures, etc.), it would be easy to find spatial autocorrelation in the sector specialization of production and trade of regions, when the spatial scale is fine enough.

In addition to these conventional economic and econometric motivations for dependence, as we have motivated in the previous sections, bilateral trade flows of service for the tourist sector could also be affected by at least four types of indirect effects. In the next section, we formally test an extended gravity model specification that accounts for spatial and network (demographic in our case) autocorrelation effects in interregional trade flows associated with tourism. The extended model subsumes models that exclude spatial and network dependence as special cases of the more elaborate model, and provides a simple empirical test for the presence of significant spatial and network dependence.

3.2   Introducing spatial and network effects in the gravity model

A conventional least-squares gravity model specification is shown in (1), where the bilateral flows (T_{ij}) between origin region i and destination region j are modeled as a function of a set of explanatory variables reflecting economic size of the two regions, and distance (d_{ij}) between the regions. T_{ij} denotes the monetary value in current euros of the exports of the tourist sector generated in region i and consumed in region j. The size of the origin region is proxied by gross

value added of the tourism sector in region i (gva_i), while the size of the destination region j is modeled as depending on population (pop_j) and per capita income (inc_j).

$$T_{ij} = \alpha \iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + \gamma d_{ij} + \varepsilon_{ij} \tag{1}$$

The next two specifications in (2) and (3) include two alternative ways of controlling for the different nature of intrarregional trade flows T_{ii}, which include expenses related to trips within each region as well as daily expenditures of residents on restaurants, coffee-shops, and pubs. The model described in (2) adds a dummy variable *ownreg* that takes a value 1 when trade is intrarregional, and 0 otherwise. Past studies interpret the coefficient associated with this dummy variable as an 'internal border effect' (McCallum, 1995; Helliwell, 1999; Wolf, 2000; Chen, 2004; Okubo, 2004; Combes et al, 2005). The coefficient β_4 is interpreted as the magnitude of increased of own-region tourism sector trade relative to other regions within the country (after controlling for size and bilateral distance).

$$T_{ij} = \alpha \iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + ownreg\beta_4 + \gamma d_{ij} + \varepsilon_{ij} \tag{2}$$

An alternative approach in (3) is that proposed by LeSage and Pace (2008), who create a separate set of explanatory variables to model intra- and inter-regional trade flows, those on the main diagonal of the flow matrix versus the off-diagonal. Regressors corresponding to the intrarregional flows are set to zero in the set of explanatory variables $X = (pop_j, inc_j)$ and used to form a new set of explanatory variables that we label $X_{iI} = (pop_{iI}, inc_{iI})$ for the ith observation. This prevents the large magnitudes typically associated with intraregional flows from entering the interregional flow model explanatory variables $X_i = (gva_i, pop_j, inc_j)$, and produces a separate set of explanatory variables to model variation in the intraregional flows ($T_{ii}, i = 1, \ldots, n$). Use of separate explanatory variables to explain variation in intrarregional commodity flows should downweight the impact of large intraregional flows on the main diagonal of the flow matrix, preventing them from exerting undue impact on the resulting estimates for β_1, β_2 and β_3, which are intended to explain interregional flow variation. Since the matrix X_I contains only n non-zero observations, we limit the number of explanatory variables used to explain variation in intrarregional flows. Specifically we rely on population (pop_{iI}) and the income (inc_{iI}) of the region for this purpose. This suggests we would expect to see more

intraregional flows (daily expenditures of the tourism sector) for regions with higher incomes and populations. Note that since interregional and intrarregional trade flows are now modeled separately, the border dummy is meaningless and was dropped from this model.

$$T_{ij} = \alpha\iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + X_{iI}\beta_I + \gamma d_{ij} + \varepsilon_{ij} \tag{3}$$

The next two models in (4) and (5) were used to account for the two direct effects that stocks of immigrants were argued to have on tourism flows. Regarding the direct effects, (4) includes the 'DHLA' effect by introducing the variable m_{ij} (Combes et al, 2005) that captures variation in flows attributable to the stock of immigrants from region i that are living in region j.

$$T_{ij} = \alpha\iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + m_{ij}\beta_4 + X_{iI}\beta_I + \gamma d_{ij} + \varepsilon_{ij} \tag{4}$$

Similarly, equation (5) includes the 'DHRA' effect by means of the variable m_{ji}, also considered by Combes et al. (2005). This variable captures variation in flows due to the stock of immigrants from region j living in region i.

$$T_{ij} = \alpha\iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + m_{ji}\beta_4 + X_{iI}\beta_I + \gamma d_{ij} + \varepsilon_{ij} \tag{5}$$

A related model in (6) includes both of these types of direct migration effects using variables m_{ij} and m_{ji}.

$$T_{ij} = \alpha\iota_N + gva_i\beta_1 + pop_j\beta_2 + inc_j\beta_3 + m_{ij}\beta_4 + m_{ji}\beta_5 + X_{iI}\beta_I + \gamma d_{ij} + \varepsilon_{ij} \tag{6}$$

The next set of spatial regression models rely on spatial lags of the dependent variable following the approach set forth in LeSage and Pace (2008). They also include all of the explanatory variables from the previous models, allowing these models to subsume the non-spatial regression models as special cases. A spatial lag of the dependent variable ($W^{spa}T$) is introduced in (7), where W^{spa} represents a spatial weight matrix of the form suggested by LeSage and Pace (2008) explained in the sequel, T is the $n^2 \times 1$ vector representing the $n \times n$ flows matrix transformed to a vector, ι_N is an $n^2 \times 1$ vector of ones, D is the $n \times n$ matrix of interregional distances transformed to an $n^2 \times 1$ vector, gva, pop, inc are $n^2 \times 1$ vectors containing the explanatory variables appropriate for each bilateral flow and ε is an $n^2 \times 1$ vector of normally distributed

constant variance disturbances.

$$T = \alpha\iota_N + \rho_1 W^{spa}T + gva\beta_1 + pop\beta_2 + inc\beta_3 + X_I\beta_I + \gamma D + \varepsilon \qquad (7)$$

In a typical cross-sectional model with n regions, where each region represents an observation, spatial regression models rely on an $n \times n$ non-negative weight matrix that describes the connectivity structure between the n regions. For example, $W_{ij} > 0$ if region i is contiguous to region j. By convention, $W_{ii} = 0$ to prevent an observation from being defined as a neighbor to itself, and the matrix W is typically standardized to have row sums of unity. In the case of origin and destination flows, where we are working with $N = n^2$ observations, LeSage and Pace (2008) suggest using $W^{spa} = W_j^{spa} + W_i^{spa}$, where $W_j^{spa} = I_n \otimes W$ represents an $N \times N$ spatial weight matrix that captures connectivity between regions viewed as destinations, and $W_i^{spa} = W \otimes I_n$ is another $N \times N$ spatial weight matrix that captures connectivity between origin regions.[4] For our model of monetary trade flows of the tourism sector with indirect spatial effects, we row-standardize the matrix W^{spa}, to form a *spatial lag* of the $N \times 1$ dependent variable vector containing the vectorized matrix of flows.

LeSage and Pace (2008) note that the spatial lag variable captures both 'destination' and 'origin' based spatial dependence relations using an average of flows from neighbors to each origin and destination region. Specifically, this means that flows from any origin to a particular destination region may exhibit dependence on flows from neighbors to this origin to the same destination, a situation labeled origin-based dependence by LeSage and Pace (2008). The spatial lag vector W^{spa} also captures destination-based dependence, which is a term used by LeSage and Pace (2008) to reflect dependence between tourism flows from a particular origin region to regions nearby the destination region.

The scalar parameter ρ denotes the strength of spatial dependence in flows, and it should be clear that when this parameters takes a value of zero the model in (7) simplifies to the independent regression model in (6). This allows us to carry out a simple empirical test for the statistical significance of spatial dependence in the flows.

We take a similar approach to produce a network dependence weight matrix, W^{net}, which captures network autocorrelation effects. As in the case of W^{spa}, the W^{net} matrix was formed as

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[4] We use the symbol $\otimes$ to denote a kronecker product.

a sum of two matrices that specify 'demographic neighbors' to the origin and destination regions, specifically $W^{net} = W_j^{net} + W_i^{net}$. The matrix $W_j^{net} = I_n \otimes W_m$, where W_m was constructed using stocks of migrants from each region living in each region, with details provided in the next section. Similarly, $W_i^{net} = W_m \otimes I_n$, and the matrix W^{net} was row-standardized. This allows us to create a model containing a network lag of the dependent variable shown in (8).

$$T = \alpha \iota_N + \rho_2 W^{net} T + gva\beta_1 + pop\beta_2 + inc\beta_3 + X_I \beta_I + \gamma D + \varepsilon \tag{8}$$

In the case of 'network autocorrelation', the 'tastes and information' could flow in both directions, which resulted in use of the two explanatory variables (m_{ij}, m_{ij}) to model direct effects. A rotated network weight matrix $W'^{net} = W_j'^{net} + W_i'^{net}$, can be used to capture the network indirect effects acting in the opposite direction. This matrix could be used to replace the spatial lag in (8).

Finally, the most sophisticated model is shown in (9), where a spatial lag as well as a network lag is included to account for the presence of both spatial and network dependence for origins and destinations. Following LeSage and Fischer (2008) and Autant-Bernard and LeSage (2008), we adjust the weight matrices to produce row-standardization across both of these, accomplished by scaling each matrix by 0.5.

$$T_{ij} = \alpha \iota_N + \rho_1 W^{spa} T_{ij} + \rho_2 W^{net} T_{ij} + gva_i \beta_1 + pop_j \beta_2 + inc_j \beta_3 + X_I \beta_I + \gamma d_{ij} + \varepsilon_{ij} \tag{9}$$

Of course the network dependence model in (8) as well as the combined network and spatial dependence model from (9) can be viewed as subsuming the simpler model specifications as a special case. This provides a simple test for the significance of the various types of dependence in our empirical application. We also note that in the presence of spatial or network dependence in flows, least-squares estimates are biased and inconsistent (LeSage and Pace, 2009).

4 An application to the Spanish domestic trade of the Tourist sector

4.1 The Data

As in most countries, there are no official data on monetary interregional trade flows associated with tourism in Spain. Our application takes advantage of recent estimates of intra and inter-regional trade flows fpr the 'Tourism sector' between the Spanish regions. The data represent the year 2001 (Llano and De la Mata, 2009a, 2009b), and were constructed as part of a larger research project (www.c-intereg.es). Schematically, the methodology used can be summarized in three steps:

1. The estimation of output for the 'Tourism sector' in each region consumed by Spanish citizens, that is to say, that not exported internationally;

2. The estimation, for each region, of the share of national absorption consumed by citizens living in each region (intrarregional trade), and in the remaining Spanish regions (total interregional trade);

3. Aggregate interregional trade for each region is split into bilateral flows. This last step is based on existing information regarding daily expenses of national travelers in the destination region (Familitur and Egatur surveys from the Spanish Institute of Tourist Studies, www.iet.es; Familitur, 2001; Egatur, 2004) and different origin and destination matrices (Familitur and Movilia surveys; Ministerio de Fomento, 2001; Familitur, 2001) that capture overnight displacements of Spanish residents, depending on the type of dwelling options at the destination. The estimation used different daily expenses for hotels, apartments and second residences, covering all possible trip motives (leisure, work, education, etc.). Conversely, the definition of the output and consumption of the tourist sector considered is restricted to the following three activities: hotels, apartments, restaurants, bars and travel agencies. Therefore, our data does not include expenses related to transportation, shopping or any other good or service bought during the stay. This fact avoids endogeneity problems between the interregional trade flows of the tourist services and the transport cost linked to the bilateral distance.

In summary, the estimates for the interregional monetary flows of the Tourist sector used the most accurate statistical sources available in Spain, obtaining figures that are constrained by the regional and national output of the sector (Spanish Instituto Nacional de Estadística, INE), the Balance of Payment (Bank of Spain) and the widest available sample of surveys on people movements within the country (Familitur, 2001; Ministerio de Fomento, 2001)

Regarding remaining variables, we used gross value added of the tourist sector, the population and per capita income level obtained from the Spanish Regional Accounts (INE). Similarly, the interregional migration matrices are obtained from the 2001 Spanish Census (INE), which offer information on the stock of people living in a region born other regions. The direct effects captured by the m_{ij} and the m_{ji} terms enter as two independent column vectors. In order to avoid collinearity problems between the pop_j and the intrarregional migration stock (number of people born in a region living in that region), the later is considered to be null ($m_{ii} = 0$).

The spatial weight matrices are built taking into account first order contiguity relations based on shared borders, with islands treated as having no adjacent regions. The social network weight matrix is built using a row standardized OD matrix of immigrants born in one region who are living in another, with diagonal elements set to zero values.[5]

Finally, the distance used was obtained from the Movilia survey 2001 (Ministerio de Fomento, 2001), which is the actual distance traveled by the Spanish residents in their displacements, both within and between regions. One of the most interesting features of this measure is that it includes not just interregional distance but also intrarregional. Thus, in the line of Head and Mayer (2010), we are able to escape from the a priori quantification of intrarregional distances assumed in other papers. Moreover, the distance used is an average of the actual distance traveled by each of the more than 500 million displacements estimated by the Movilia survey in 2001. These displacements cover all motives, so that the distance reported is not constrained by distance between capitals, which could be predominant for work trips, but not distances between tourist spots (beaches, skiing resorts, countryside, etc.) located in the periphery.

As an overview of internal tourism flows in Spain, Figure 3 shows the 2001 largest interregional monetary flows, as well as the distribution of the population and the location coefficient

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[5]Alternative specifications of the W^{net} matrix were explored based on percentages of the destination region population, or a binary matrix used in conjunction with a threshold (i.e. 5% of the population in the destination region). In the final analysis, since our trade flows are measured in levels we choose the current specification. This specification showed stronger results and avoids subjective decisions regarding a threshold level.
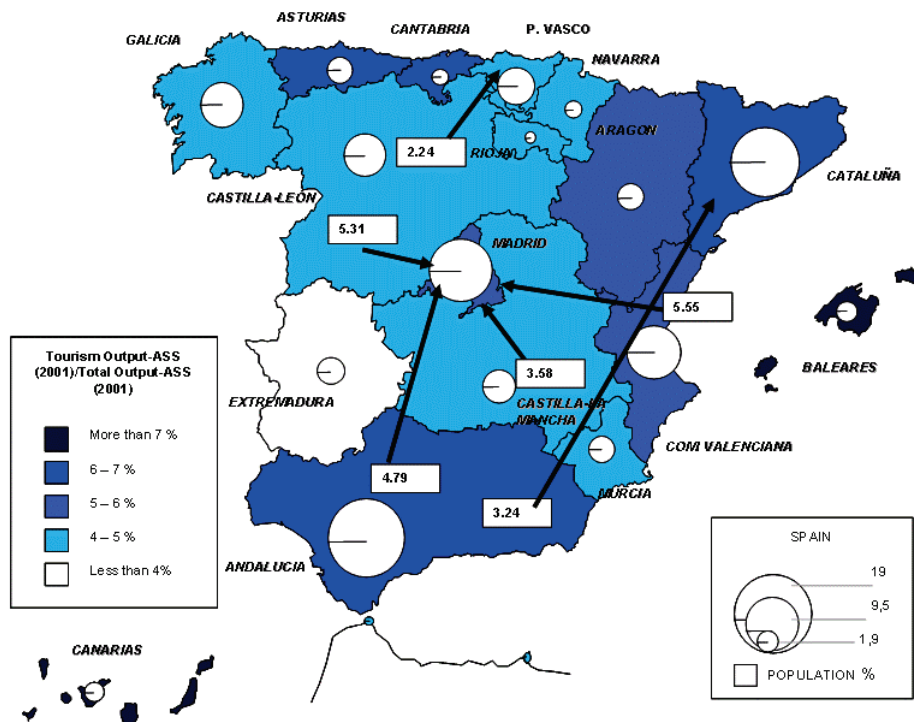
Figure 3: Main interregional flows (Euros) of the Spanish Tourist Sector in 2001 (Llano and De la Mata, 2009b)

for the tourism sector ($LC_{Region_i} = Regional\_Tourist\_GVA/National\_Tourist\_GVA$). Arrows in coastal origins of (Andalucia) to the inner destination region of (Madrid) show exports of the tourism sector (in current euros) from Andalucia to Madrid. These result from tourist travel from Madrid to Andalucia. From the figure, it is easy to see that the major exporting regions are located along the coast, with the largest importers located in the most populated high income regions. Note also that many of the large interregional flows are between distant regions. These may be explained by important social networks that have arisen as a result of historical bilateral migration flows (i.e., Andalucia to Cataluña).

19

Table 1: Description and source of the X variables

Variable	Abbreviation	Description	Source
[0.5ex] Income	inc_j	Per capita income by regions NUTS2.2001.	INE
Population	pop_j	Population by regions NUTS2. 2001.	INE
GVA	gva_i	Gross Value Added of Tourism sector. 2001.	INE
OD migration vectors	m_{ij},m_{ji}	Spanish Census. 2001.	INE
Distance	distance	Distance in Km between regions. 2001.	Movilia, 2001

4.2   Estimation results

We compare estimation results from the sequence of models beginning with non-spatial models that assume no spatial or network dependence. Additional model estimates not reported here were used to examine robustness with respect to outliers, carried out using non-spatial and spatial models described in LeSage and Pace (2009, Chapter 5). These models allows for non-constant variance scalars for each observation that are constructed using Bayesian priors and Markov Chain Monte Carlo estimation. Results reported here were found to be similar to those based on the robust estimation approaches that identify and downweight outliers.

The alternative model specifications were estimated using 17 NUTS 2 level Spanish regions, with two island regions Ceuta and Melilla excluded. This results in dependent and independent variable vectors having $N = 17 \times 17 = 289$ observations based on the period 2001. All the variables were logged transformed as is traditional when estimating gravity models.

Table 2, shows least-squares estimation results for six different model specifications that we have labeled $M1 to M6$ in the table. Model $M1$ in the first column of the table shows estimates for the simplest gravity model, which attempts to explain variation in the 289 bilateral tourism (Euro) flows between regions (T_{ij}) using gva_i, pop_j, inc_j and the distance d_{ij} as explanatory variables. The simplest model based on these four explanatory variables able to explain 54% of the variation in flows. All explanatory variables are highly significant, and have expected signs. For example, there are positive coefficients associated the measures of economic size of origin and destination regions involved in the bilateral flow, and a negative coefficient for distance between origin and destination regions. Given that the dependent and explanatory variables were log transformed, we can interpret the coefficient on income as an elasticity. The estimated income elasticity for tourism flows is greater than 1, an indication that tourism is a 'luxury good'.

Table 2: Ordinary Least Squares

Dependent variable: Interregional monetary flows of the Tourism sector. 2001.

	M1	M2	M3	M4	M5	M6
R-squared	0.544	0.647	0.653	0.672	0.693	0.697
Rbar-squared	0.538	0.640	0.645	0.664	0.685	0.688
$\hat{\sigma}^2$	2.661	2.070	2.041	1.932	1.811	1.793
Variable						
Constant	-29.779	-34.267	-35.470	-28.319	-38.057	-34.105
p_value	0.000	0.000	0.000	0.000	0.000	0.000
gva_i	1.100	1.017	1.063	0.901	0.559	0.551
p_value	0.000	0.000	0.000	0.000	0.000	0.000
pop_j	1.034	1,031	1.025	0.684	0.561	0.457
p_value	0.000	0.000	0.000	0.000	0.000	0.000
inc_j	1.722	2.004	1.999	1.540	2.914	2.552
p_value	0.000	0.000	0.000	0.000	0.000	0.000
m_{ij}				0.314		0.157
p_value				0.000		0.051
m_{ji}					0.536	0.459
p_value					0.000	0.000
log(Distance)	-1.342	-0.742	-0.748	-0.490	-0.215	-0.162
p_value	0.000	0,000	0.000	0.000	0.129	0.257
Ownreg		3.928				
p_value		0.000				
I_pop			1.402	1.269	1.290	1.239
p_value			0.000	0.000	0.000	0.000
I_income			3.480	2.805	3.699	3.330
p_value			0.000	0.000	0.000	0.000

Model $M2$ estimates shown in the second column includes the border effect dummy 'own-reg'. A comparison of the border coefficient estimate (3.928) with that obtained by Combes et al (2005) for interregional commodity flows in France (2.0 for a similar model specification), we would conclude that interregional trade in the Spanish Tourism sector exhibits a larger border effect than interprovincial commodity flows in France. This large border effect result is consistent with other empirical findings regarding border effects in Spain, for industries such as 'Chemical products' or 'Non-metallic minerals' (Requena and Llano, 2010; Ghemawhat et al, 2010). As discussed in (Llano and De la Mata, 2009b), a large border effect for the tourism sector likely arises from the importance of 'restaurants' within the tourism sector (more than the 50% of the output), which is heavily oriented towards intrarregional trade flows.[6] An interesting consequence of introducing the border dummy is that the negative coefficient on the distance variable decreases in absolute value from -1.342 to -0.742. As a robustness check, model $M3$ produced similar estimates when the border dummy variable in (2) is replaced by the X_I matrix as explained in the discussion surrounding equation (3).

Next, models $M4$, $M5$ separately include the two direct effects variables reflecting 'DHLA' (*Direct-Home-Land-Attraction*) influence using the variable m_{ij}, and 'DHRA' (*Direct-Home-Region-Attraction*) measured by m_{ji}. The coefficient estimates for these two variables point to a a positive (and significant) relation between bilateral immigration stocks and tourism flows. As in Combes et al. (2005), we can interpret this result as an indication of the presence of 'taste and information effects' that affect the (Euro) tourism flows in both directions. Model $M6$ includes both direct effects m_{ij} and m_{ji}. It is noteworthy that models $M5$ and $M6$ result in the distance variable becoming not significantly different from zero, and a reduction to around one-half in the coefficients on *gva* and *pop* relative to model $M3$ that does not include the 'DHLA' and 'DHRA' effects. The coefficient on *inc* shows a large increase in models $M5$ and $M6$, relative to model $M3$.

These results reinforce our hypothesis about a heterogenous impact of distance on tourism sector flows. We can interpret the lack of significance for distance as indicating that after controlling for situations where: tourists are not traveling within the region, or visiting their home-land, or visiting the host region with co-nationals already settled; distance does not pro-

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[6]This is partially a result of own-region holiday spending in restaurants and pubs which accounts for a large share of income spent relative to expenditures on hotels, travel-agencies, restaurants and similar businesses in other regions.

22

duce friction that reduces tourism flows to more distant regions. This result seems consistent with our casual observation regarding the tendency of population from high income, highly populated regions such as Madrid traveling to coastal regions for vacations. Addition of the control variables m_{ij} and m_{ji} for direct network effects lead to a higher $R^2 = 69\%$ than the simpler model specifications.

Estimation results for the spatial regression model specifications are shown in Table 3. These models were estimated using maximum likelihood methods (see LeSage and Pace (2009, Chapter 3). As opposed to the non-spatial least-squares estimates, these model estimates allow for the indirect or spatial spillover effects to neighboring regions as well as network spillover influences, both of which were motivated in the previous section. The non-spatial models restrict spatial and network spillover influences to be zero, since each bilateral flow is treated as independent of all other flows.

The first point to note is that the parameters ρ_1 and ρ_2 on the spatial and network lags of the dependent variable are statistically significant at the 95% level or above in all four of the spatial and network dependence model specifications $M7, M8, M9, M10$. In the absence of significant dependence of these types, the spatial and network models collapse back to the non-spatial and non-network models where bilateral tourism flows are independent of those to (and from) nearby spatial locations as well as network neighbors.[7]

The difference between the fully saturated models $M9$ and $M10$ (that include the full complement of explanatory variables) is use of the rotated version W'^{net} in model $M10$ in place of W^{net} for model $M9$. According to the likelihood function values, model $M10$ has the highest log-likelihood. We also see a slight improvement in fit for model $M10$ over the other models indicated by the higher R^2 and lower noise variance estimate, $\hat{\sigma}^2$.[8]

A second point regarding these results is that the coefficient estimates on the explanatory variables in these models are not interpretable in the same fashion as those from the non-spatial models, a point made in LeSage and Pace (2009, Chapter 8). However, the signs of the coefficient estimates reflect the correct direction of impact on flows that would arise from changes in the explanatory variables.[9]

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[7]For other applications relying on use of two different types of dependence lags, see LeSage and Fischer (2008) and Autant-Bernard and LeSage (2008).

[8]The R^2 was calculated using $\hat{y}'\hat{y}/y'y$, where $\hat{y} = (I_N - \rho_1 W^{spat} - \rho_2 W^{net})X\hat{\beta}$.

[9]The correct approach to calculating partial derivatives showing the impact of changes in the explanatory

Table 3: Spatial Autoregressive Model

Dependent variable: Interregional monetary flows of the Tourism sector. 2001.

	M7	M8	M9	M10
R-squared	0.713	0.725	0.726	0.729
$\hat{\sigma}^2$	1.646	1.579	1.570	1.551
log-likelihood	-890.747	-884.277	-883.243	-881.900
Variable				
Constant	-30.194	-37.312	-34.546	-33.254
p_value	0.000	0.000	0.000	0.000
gva_i	0.709	0.455	0.456	0.461
p_value	0.000	0.000	0.000	0.000
pop_j	0.585	0.488	0.419	0.387
p_value	0.000	0.000	0.000	0.001
inc_j	1.708	2.746	2.490	2.358
p_value	0.000	0.000	0.000	0.000
m_{ij}	0.223		0.110	0.140
p_value	0.001		0.143	0.061
m_{ji}		0.410	0.360	0.304
p_value		0.000	0.000	0.000
log(Distance)	-0.285	-0.098	-0.059	-0.048
p_value	0.017	0.455	0.659	0.717
I_pop	0.802	0.856	0.836	0.817
p_value	0.012	0.006	0.008	0.009
I_income	3.192	3.820	3.558	3.394
p_value	0.000	0.000	0.000	0.000
ρ_1	0.399	0.332	0.338	0.071
p_value	0.000	0.000	0.045	0.001
ρ_2	0.508	0.513	0.467	0.148
p_value	0.006	0.029	0.039	0.000

A final point is that distance is small and not statistically significantly different from zero in models $M8, M9, M10$. This appears to result from inclusion of the two direct effects variables, 'DHLA' (*Direct-Home-Land-Attraction*) m_{ij}, and 'DHRA' (*Direct-Home-Region-Attraction*) m_{ji}, not the spatial and network lags of the dependent variable.

5 Conclusions

In this study we consider whether interregional trade flows in tourism services exhibits spatial and/or social network dependence. Conventional empirical gravity models assume the magnitude of bilateral flows between regions are independent of flows to/from regions located nearby

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variables on the dependent variable in spatial gravity models is an unresolved issue.

in space, or flows to/from regions related through social/cultural/ethic network connections. Traditional empirical gravity model specifications have relied on bilateral distance in an effort to control for the role of location, while more recent work has introduced *Direct-Home-Land-Attraction* and *Direct-Home-Region-Attraction* variables in an effort to explore the influence of social/cultural/ethic network connections between regional flows. Empirical proxies for these variables rely on bilateral stocks of migrants living in origin and destination regions as a proxy for the strength of bilateral social/cultural/ethic network connections between regions (e.g., Combes et al. 2005).

We provide an extended empirical specification that relaxes the assumption of independence between bilateral flows which is inherent in any least-squares regression. Our argument is that bilateral flows between an origin region i and destination region j may exhibit dependence on: 1) flows to regions that are spatially near the origin and destination regions i and j (spatial dependence), and 2) flows to regions that are socially/culturally near the origin and destination regions i and j. A spatial weight matrix elaborated in the way suggested by LeSage and Pace (2008) was used to quantify the spatial structure of connectivity between regions involved in bilateral flows. A novel social network matrix was constructed using information on the origin and destinations of immigrant stocks in each of 17 Spanish regions.

Estimates from a set of nested models show evidence of statistically significant spatial and social network dependence in the bilateral flows of tourism dollars between regions. The significant social network dependence can be interpreted as an indication that tourists exhibit preferences for vacation destinations in or near their home-land regions, or destination regions in or near where co-nationals have settled heavily. Significant spatial dependence is an indication that tourists consider *intervening opportunities* taking the form of visits to regions nearby the origin of their vacation trip, as well as *competing destinations*, represented by regions nearby the vacation trip destination.

One finding of interest is that introduction of explanatory variables that control for *Direct-Home-Land-Attraction* and *Direct-Home-Region-Attraction* as well as spatial and network dependence (and the conventional measures of origin and destination economic size) result in a coefficient estimate for bilateral distance between origin and destination regions that is not statistically significant. This suggests that cultural/social as well as *intervening opportunities* and *competing destinations* considerations maybe exert an important enough influence on tourism

decisions to overcome the traditional resistance role played by distance that typically diminishes the magnitude of bilateral flows.

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