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The factor content of regional bilateral trade: The role of technology and demand

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ABSTRACT

The Heckscher–Ohlin–Vanek (HOV) model in its strict form has been strongly rejected by the data. Relaxing some assumptions of the standard HOV model is key to find improvements in its performance. We apply the Davis and Weinstein (2001) methodology to analyse the validity of the HOV model using regions rather than countries. Surprisingly, our results using data for 17 Spanish regions are similar to theirs with international data for OECD countries. Accounting for technological differences improves the predictive capacity of the factor proportions model and including trade costs and geography reduces significantly the missing trade problem. However, relaxing the assumption of factor price equalisation does not improve the performance of the HOV model in a regional setting.

1. Introduction

The Heckscher–Ohlin (HO) factor-proportion theory of comparative advantage has been used for almost a century by academics and policy makers to explain the determinants of trade flows, the impact of trade on factor remuneration within a country, and the consequences of factor mobility on regions' welfare (Helpman, 1999). According to the HO model, commodity trade flows between regions compensate the uneven geographic distribution of productive resources. Indeed, the basic insight of the HO model is that traded commodities are really bundles of factor services (capital, labour and land). The Heckscher–Ohlin–Vanek (HOV) theorem says that, under the assumptions of identical technology and identical and homothetic preferences, the net export of factor services will be the difference between a region's endowment and the endowment typical in the world for a region of that size (Vanek, 1968).

The strict version of the HOV model has been strongly rejected by data. Leontief (1953) and Maskus (1985) reported the *Leontief paradox* — that the USA, the most capital abundant country in the world was a net importer of capital services. Using a large number of countries and factors, Bowen, Leamer, and Sveikauskas (1987) found that the basic HOV model predicted the factor service trade as well as *flipping a coin*. Trefler (1995) documented the *mystery of missing trade* – that measured factor service trade is an order of magnitude smaller than that predicted based on national endowments – and the *endowment paradox* — that developing countries are revealed to be abundant in most production factors.

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The lack of correspondence between the theory in its strict version of the HOV model and the data has stimulated considerable research activity. Recent studies provide positive results for variants of the HOV model after adjusting the assumptions of the theoretical model, improving the data sets and developing more powerful and robust empirical tests.

Bowen et al. (1987) showed that the predictive capacity of the HOV model improved slightly after relaxing *ad hoc* the assumptions of identical technology and identical and homothetic preferences. Trefler (1993, 1995) also reported a significant improvement after measuring country differences in factor endowments in efficiency units rather than in physical units. Maskus and Webster (1999); Hakura (2001) and Trefler and Zhu (2010), with differing samples of countries, used country-specific input–output tables to calculate the factor content of net exports, reporting a good performance of the HOV model and confirming that the assumption of identical technology is not valid at international level. Davis and Weinstein (2001) [DW 2001 henceforth] made several contributions to the empirical HOV literature. First, they show how aggregation may systematically bias measured factor trade downward relative to the theoretically appropriate measure. Second, they recognize the crucial role played by the non-tradable sector in the HOV model. Finally, they incorporate trade frictions into the HOV model by using a gravity model. With all these departures from the simple HOV specifications, the "missing trade problem" almost disappears in a sample of 10 OECD countries.

A second line of research has employed the regions of a country as a more robust sample to test the HOV model in its original version. The use of regional data is preferable on three grounds. First, information at national level is more comparable than at international level. For example, regional-specific input–output tables employ a homogeneous methodology alleviating the serious problem of measurement error in technology that appears in international studies (Harrigan, 1997, 1999; DW, 2001). Second, some of the assumptions behind the HOV theorem, such as identical technology and preferences, factor price equalisation, and lack of trade barriers, are more likely to hold within a country than between countries. Davis, Weinstein, Bradford, and Shimpo (1997) and Requena, Artal, and Castillo (2008a) analysed the factor content of trade of the Japanese regions and Spanish regions, respectively and tested the importance of relaxing the assumptions of world factor price equalisation (FPE) and world identical and homothetic (IHP) preferences. For Japan, Davis et al. (1997) focused on the international trade of Japanese regions, and showed that by relaxing the world FPE assumption was enough to get an excellent performance of the HOV model. However, for our case, focusing on the interregional Spanish trade, a significant improvement emerged after relaxing both the world FPE and world IHP. Nevertheless, compared to DWBS (1997) for the case of the Japanese prefectures, we did not find an impressive improvement of the model's performance as they found in their paper.

Our paper investigates again the performance of the HOV model using interregional data, making three novel contributions. First, we use the *Intertio database*, a unique dataset which contains comparable input–output tables for each of the 17 Spanish regions as well as sector specific interregional trade flows in the year 1995 (Llano, 2004). In our previous research we used information from 14 individual regional TIOs and we had only information on aggregated trade flows.

Second, we use the 17 technology matrices to test for technological differences between regions so we are able to incorporate Hicks neutral technological differences into the standard HOV model. Moreover, we accommodate the standard HOV to allow for the presence of non-tradable sectors.

Third, we show the importance of taking into account economic geography as a determinant of trade flows before assessing the validity of the HOV model in a regional setting. The access to *bilateral* trade flows between Spanish regions allows us to incorporate a gravity model into the regional HOV framework to account for the role of transport barriers and physical distance as determinants of trade flows.

As a starting point and in line with our previous findings, the HOV model is strongly rejected by data, even after relaxing the two key HOV assumptions (world factor price equalisation and world identical and homothetic preferences). Therefore, there is extra room to further investigate other explanations. In this paper we explore two of them: technological differences and the role of geography.

The results show that Hicks-neutral technological differences do not play a major role in improving the performance of the HOV model at a regional level. However, after taking into account the existence of non-tradable sectors, the relative factor intensity is more affected by relative factor abundance in tradable good sectors than non tradable sectors. We observe that regions that are abundant in high educated labour tend to use more intensively this factor and less intensively the low educated labour in the production of traded goods. Incorporating this new feature into the HOV model improves significantly its performance.

Another important finding related to technology is the lack of evidence on the violation of factor price equalisation among regions, so a model of multiple diversification cones is rejected at a regional level in contrast to recent studies using international data. The last finding is that the presence of costs of trade alters significantly the HOV predicted level of trade flows between Spanish regions. Once we account for the role of distance on trade, the modified HOV model improves its performance again, and the mystery of missing trade remains but becomes 'a little bit less mysterious'.

So, in accordance to our findings, both technical differences and divergences in demand structure are necessary to successfully match the HOV theory with regional data. This result is quite striking and suggests that the modifications that DW (2001) implemented to improve the performance of the HOV model with data for 10 OECD countries are basically the same as those needed to improve the performance of the HOV model with data for the 17 Spanish regions. Additionally we show that technological differences among regions, though clearly exist, are of less extent than those among countries, as one will expect.

The rest of the paper is structured as follows. Section 2 describes the standard HOV equation and provides a parsimonious and plausible set of departures from the standard model. Section 3 presents the data and Section 4 the empirical results. Section 5 summarises the main findings of our investigation.