Is Spain a lumpy country? A dynamic analysis of the “lens condition”

Francisco Requena (Department of Applied Economics II, University of Valencia, Valencia, Spain) [Corresponding author]
Juana Castillo (Department of Applied Economics II, University of Valencia, Valencia, Spain)
Andrés Artal (Department of Economic Structure, Universidad Politécnica de Cartagena, Spain)

Abstract
We implement the “lens condition” of Deardoff [J. Inter. Econ. (1994), 36, 167-175] to investigate whether lumpiness, an excessively uneven geographic distribution of production factors, is large enough to allow for regional specialization of production at different factor prices. Using data from 50 Spanish provinces over the period 1964-2001, we show that Spain evolved from being a lumpy economy to a state where lumpiness no longer mattered.

Keywords: Heckscher-Ohlin, Factor price equalisation, Regional Integration

* Corresponding author
Dr. Francisco Requena Silvente
Dpto de Economía Aplicada II (Estructura Económica)
Edificio Departamental Oriental (4E06)
Facultad de Ciencias Económicas
University of Valencia
Avda del Tarongers s/n
46022, Valencia, Spain.
Tel. +34 (9) 63 828 353.
Fax. +34 (9) 62 828 354.
E-mail address: francisco.requena@uv.es

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Abstract
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1. Introduction
We implement the “lens condition” of Deardoff (1994) that compares regional endowments with sectoral factor inputs to investigate empirically whether the geographic distribution of production factors within Spain has ever been sufficiently uneven to allow regional specialization of production at different factor prices to occur. The novelty of the research is that we analyse changes in the regional and sectoral lenses over an extensive time horizon, 1964-2001, in order to understand whether lumpiness has become a real phenomenon. At the beginning the period we examine, Spain was engaged in a period of structural transformation from being an under-developed, predominantly agrarian economy, to an industrialised economy.¹ Our findings probe whether or not the lens condition is violated over differing phases in an economy’s transformation.

Since the work of Bowen et al. (1986), trade economists have tried to understand why the Heckscher-Ohlin-Vanek (HOV) model is such a poor predictor of the direction and volume of international trade flows. One explanation, confirmed empirically by Debaere and Demiroglu (2003) and Schott (2003), is that all countries are not able to produce the same set of goods using the same technology; therefore, factor price

¹ In 1964 33 percent of workers were employed in agriculture and 8 percent of workers were illiterate. In 2001, the percentages were reduced to 5 percent and 0.5 percent, respectively.
equalisation (FPE) due to trade of goods is not feasible due to the enormous dissimilarities in factor endowments between developed and under-developed countries.

Courant and Deardoff (1992, 1994) show that an excessively uneven distribution of production factors within a country can induce intra-national specialisation and different regional factor prices, what they called “lumpiness”, that is a sufficient reason for international trade. Debaere (2004) shows that such large differences in factor endowments did not occur across regions of UK and Japan in the eighties, supporting Davis et al. (1997) finding that the HOV model performs better using regional data rather than international data. In contrast to the predictions of Debaere and Demiroglu (2003) and Schott (2003) that under-developed economies are more likely to exhibit “lumpiness”, Debaere (2004) found no empirical support that the phenomena influenced trade using a single cross-section of Indian provincial data. However, Debaere cautionary pin his findings due to concerns about the quality of the data he employs.

In contrast, we find that Spain violated the lens condition during the mid-1960s but that factor endowments has become more uniformly distributed within Spain as she evolved into a developed economy. Our findings imply that: 1) Debaere (2004) was right to be cautious about the robustness of his findings for under-developed economies, and particular where underdeveloped economies undergo rapid substantial structural transformation; 2) researchers empirically testing the HOV model over lengthy time horizons should also provide empirical checks of the lens condition; 3) further research in order to posit a robust empirical relationship between economic development and whether integration of regional markets has developed sufficiently for ‘lumpiness’ not to be an issue of substantial importance in explaining trade flows would be fruitful.

2. The “lens condition” and the likelihood of factor price equalisation

Deardorff (1994) derives a condition for assessing the existence of factor price equality (FPE) across regions. This “lens condition” requires factor endowments to vary

\[ \text{See Demiroglu and Yun (1999), Xiang (2001), Qi (2003), Yun (2003) and Wong and Yun (2003) for alternative theoretical proofs and extensions. These extensions reveal that satisfaction of the lens condition is necessary but not sufficient for FPE in settings with more than two factors. Thus, while violation of the lens condition may be useful for ruling out FPE, a lack of violation does not indicate support for FPE.} \]
less across regions than factor input intensities vary across goods. Deardorff demonstrates that FPE is impossible if the set points (i.e., lens) defined by regional factor abundances passes outside the set of points defined by goods’ input intensities.

The (polyhedral) lenses are constructed as follows. For a pair of production factors, say capital and labour, we obtain the national endowment box using their endowments. With information on the regional and sectoral distribution of factors within a country, \( \begin{bmatrix} K_{rs}, L_{rs} \end{bmatrix}, \begin{bmatrix} K_r, L_r \end{bmatrix} \) and \( \begin{bmatrix} K_s, L_s \end{bmatrix} \) can be defined as the regions’ endowment vectors and the sectoral vectors, respectively, where each element is obtained as follows: 

\[
K_r = \sum_{rs} K_{rs}, \quad K_s = \sum_{rs} K_{rs}, \quad L_r = \sum_{rs} L_{rs} \quad \text{and} \quad L_s = \sum_{rs} L_{rs}. 
\]

For the regional (sectoral) lens, we rank the regional endowment (sectoral) vector by the capital/labour ratio and concatenate the resulting vector, in increasing and decreasing order of their capital/labour ratio from the origin of the national endowment box.\(^3\)

For two production factors, the “lens condition” states that regions produce the same goods and have equal factor prices if and only if the regional lens lies inside the sectoral lens.\(^4\) When the regional endowment lens extends outside of the factor-use lens, factor price equalisation does not hold. Moreover, as shown by Deardoff (1994) for the \( n \)-goods case, it is not enough that the endowments are inside the same diversification cone. In addition, they must be far enough inside it to be able to produce those goods demanded by the rest of regions.

In this paper, we investigate how the regional lens and sectoral lens evolved over time in order to answer whether, when, and why the “lens condition” is violated.\(^5\) The use of a long time horizon allows us to follow the changes in the distribution of resources across regions (whether the regional endowment lens expands or contracts) and in the factor usage across sectors (again, whether the sectoral lenses expand or

\[^3\] Although we know the stock of land varies across provinces, it is not possible to construct a lens condition for any pair of factors that includes land because of the lack of knowledge about the sectoral land use.

\[^4\] Courant and Deardoff (1994) show that regional factor immobility is not necessary for lumpiness and that specialization and unequal factor prices can coexist with interregional factor mobility in the presence of non-traded goods, consumption amenities and production amenities.

\[^5\] Debaere and Demiroglu (2003) and Debaere (2004) used data for one year to implement the “lens condition”.

contract). As a complement to the visual inspection of the lens condition, we perform various calculations. First we check whether the lens condition is violated using the “distance” measure proposed by Debaere and Demiroglu (2003). The measure is defined as
\[
\min_x \{1 - \frac{d(x,r(x))}{d(x,s(x))}\}
\]
where \(d(x,r(x))\) is the distance from a point \(x\) in the diagonal of the endowment box and the point that is perpendicular to \(x\) in the regional lens; and \(d(x,s(x))\) is the distance from a point \(x\) in the diagonal of the endowment box and the point that is perpendicular to \(x\) in the sectoral lens. A positive value indicates that the lens condition is satisfied and a negative value indicates a violation.\(^6\) Second we measure the area of both lenses and their difference year by year. If the endowment lens lie inside of the sectoral lens and the area difference increases over time, lumpiness is not an issue within the country and the likelihood of factor price equalisation increases over time.

3. Data and results

The dataset contains information about three production factors (stock of capital, low educated labour and high educated labour) for six economic activities (agriculture, energy and water, industry, constructions, market services and non-market services) and 50 Spanish provinces (NUTS III) over the period 1964-2001.\(^7\) The dataset is publicly available on internet through the webpage of the Instituto Valenciano de Investigaciones Económicas (IVIE), www.ivie.es. These data allow us to implement a strict “lumpiness” test for Spain for two reasons. First, the level of aggregation is adequate. Debaere and Demiroglu (2003) show that higher levels of regional disaggregation induce to the violation of the lens condition for a given sectoral lens and less sectoral dissagregation make a violation of the lens condition more likely for a given regional lens. Second, the time dimension has not being explored in the literature and prior research suggests that the change in level of economic development may provides evidence of changes in the

\(^6\) The properties of this measure are discussed in Debaere and Demiroglu (2003, pp. 117-118).

\(^7\) The stock of capital is only available until 1998. Low educated workers are those with completed primary studies or less. High educated workers are those with completed secondary and tertiary studies.
intra-regional distribution of resources, in either of the two lenses, such that the likelihood of “lumpiness” increases or decreases over time.

The results are illustrated in Figure 1 (high educated labour vs. capital), Figure 2 (low educated labour vs. capital) and Figure 3 (low-educated labour vs. high-educated labour), which illustrate the evolution of the lens condition for four specific years: 1964, 1975, 1990 and 1998 (2001 in Figure 3). As the endowments are normalised with the total factor supplies, the sides of the endowment box add up to 1. As it can be seen, the regional endowment lens lie inside the sectoral lens in all years except 1964, revealing that there is more variation in the factor inputs than in the regional factor supplies. The fact that the lenses touch each other in 1964 indicates that lumpiness was likely to support sustainable factor reward differences across provinces in the early years of the Spanish industrialisation. Over time the regional endowment lens became more flat, while the sectoral lens expanded, reducing the likelihood of lumpiness.\(^8\)

Table 1 presents the distance measure, the lens areas and the area differences for selected years. The negative sign of the distance measure in two of the three boxes (high educated labour vs. capital and low vs. high educated labour) confirms that lenses touched each other in 1964 (and until 1970). Afterwards the likelihood of lumpiness gets lower as the area of the distance measure is always positive, the area of the sectoral lens increases (i.e. more factor use variation across activities) and the area of the regional lens decreases (i.e. more uniform distribution of endowments across provinces). Note also that the factor use across activities changes faster than reallocation of factors across provinces, being that the major force behind the lack of lumpiness in Spain after 1970, once the industrialisation process is consolidated.

4. Conclusions

\(^8\) We have also another dataset with information on the stock capital, high educated labour and low educated labour for 21 sectors and 17 regions (NUTS II) for the year 2001 (1998 for stock capital). The labour series are calculated using Regional Accounts (number of total workers by region/sector) and Labour Force Survey (percentage of each type of worker by region/sector). The lens condition is overwhelming satisfied using these alternative dataset, confirming that lumpiness is not a phenomenon in Spain in the new century. These results are available on request.
Using the lens condition of Deardoff (1994), we examine the evolution of the regional and sectoral lenses for Spain over the period 1964-2001 in order to evaluate whether the uneven geographic distribution of endowments was a sufficient condition for complete production specialization across their provinces at different factor prices. We found that the lens condition was violated in the second half of the sixties, when Spain was an under-developed economy. Afterwards the shape of the lenses has evolved in such way that lumpiness cannot explain any sustainable price differences across regions anymore. Our results support the predictions of Debaere and Demiroglu (2003) and Schott (2003) that lumpiness can be a phenomenon in developing countries.

References


Table 1: Measures

<table>
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<tr>
<th>Year</th>
<th>Measure</th>
<th>Sectoral lens</th>
<th>Regional lens</th>
<th>Difference lens areas</th>
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<tbody>
<tr>
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<td>0.2145</td>
<td>0.2235</td>
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<td>0.1960</td>
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<tr>
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<table>
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<th>Regional lens</th>
<th>Difference lens areas</th>
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<tr>
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<th>Regional lens</th>
<th>Difference lens areas</th>
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<tbody>
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<td>0.1467</td>
<td>0.3214</td>
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</table>

Note: (*) Additional years included in calculations.
Figure 1: The regional and sectoral lens for Spain. Two factors: high educated labour vs. capital. 6 sectors (triangles) and 50 provinces (circles). Period: 1964-1998.

Figure 2: The regional and sectoral lens for Spain. Two factors: low educated labour vs. capital. 6 sectors (triangles) and 50 provinces (circles). Period: 1964-1998.
Figure 3: The regional and sectoral lens for Spain. Two factors: low educated labour vs. high educated labour. 6 sectors (triangles) and 50 provinces (circles). Period: 1964-2001.