

AN APPROACH TO THE GRAVITY MODEL:

COMMERCIAL RELATIONS BETWEEN SPAIN AND RUSSIA

This study pretends to enhance the practical skills acquired during these weeks. I wanted to focus my effort on elaborating a versatile econometric model which will be able to forecast the trading between Spain and Russia with a minimum confidence interval of 75%.

Since all kind of analysis on the past, current and future relationships between our countries were done by the ICEX¹ and the models exposed by the Dr Ulrike Grote became so interesting for me, I decided to apply one of them: the Gravity model!

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Introduction: motivation and basis

The gravity model is a simple model developed, in 1962, by the Dutch economist Jan Tinbergen (the first Nobel laureate in Economics) and used in international economics to forecast (or extract) issues regarding the trading between two countries. In this case: SPAIN and RUSSIA.

This model is expressed, as seen in class, in the following way: $T_{ij} = A \cdot Y_i \cdot Y_j / D_{ij}$

Where: T_{ij} is the value of trade between country i and j ; Y_i and Y_j are the GDP for country i and j (respectively); D_{ij} is the distance between both countries and A is a constant term.

However, this model would need some other variables, to reduce the error term (ϵ) to its minimum expression¹. Nevertheless, these dummy variables², such as: shared border, colonial link, common language, common language, regional trade agreement, volume of reciprocal immigration, etc. have no significant effect on these regressions (almost all variables were nearly 0).

Core I: applying the model

Our main objective is being able to forecast future trade trends of Spain and Russia by developing the Gravity model. For this it is necessary to obtain reliable information, expressed in the same currency and with equivalent time series. We will base it from 2000 until nowadays.

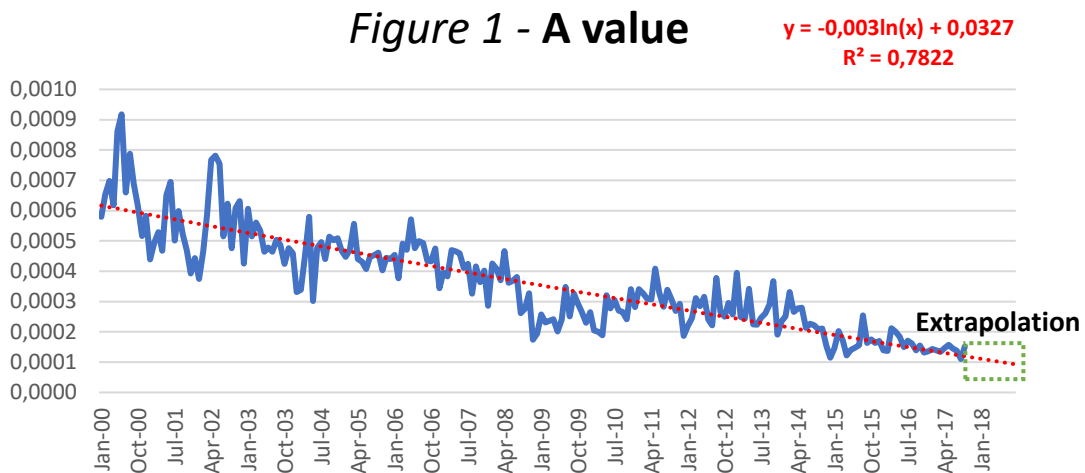
Thus, ESTACOM³ⁱⁱ database (available on ICEX main website) is our main source of information for trading relationships between Spain and Russia. Even though, for monthly GDP amounts it is necessary to adapt it from DATOSMACROⁱⁱⁱ database. While the distance between Spain and Russia is a simple average between the seven most common routes used.

¹ Instituto Español de Comercio Exterior: <https://www.icex.es>

² They show the effects of cultural, historical and sociological influence of one country over the other.

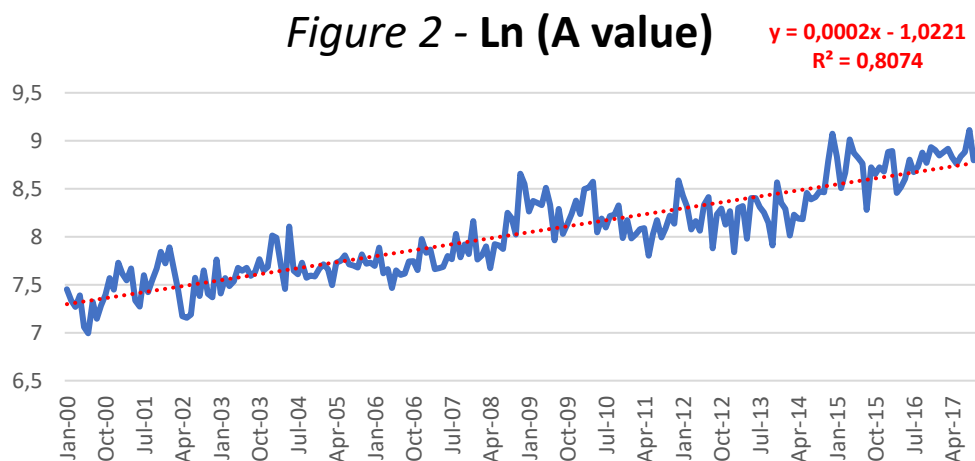
³ ESTADÍSTICAS ESPAÑOLAS DE COMERCIO EXTERIOR: Spanish Tax Agency database regarding trading.

At this point, the necessary is to solve the equation and find A value for each bundle:



Some implications can be obtained from this model:

- A value** is not stable over time, but it follows a logarithmic function which explains, roughly, the 78.22% (according to R^2) of whole trading between both countries.
- GDP, exports and imports are subjected to same risks: market, country, political, sociographic, etc. therefore, all trends move forward in the same way with the only exception of the exchange rate⁴, even though it is indirectly included.
- The most common dummy variables needed for this kind of regressions have, relatively, few impact on the outcome of the regression (such as: the Russian or Spanish community in the other country or the knowledge of the language).



By smoothing the A value with absolute value of its Napierian logarithms⁵ we obtain an increasing function for A value, that is not as predicted by the model, but it will play a role in the further model.

⁴ **J-curve** effect suggests that a decrease in the exchange rate leads to an immediately decrease in imports, but to a progressively increase in exports. Affecting the GDP in two different shocks.

⁵ Thanks to the properties of the logarithms that: $-\ln(1/x) = \ln(x)$

Core II: developing the model

Alternatively, to the traditional Gravity model there is the possibility to develop a linear model based on a STATA regression using the same data which can forecast the evolution of the trading (T_{ij}) with historical data, while the only requirements are:

- R^2 over 0.75, meaning that the model explains, at least, the 75% of T_{ij} (forecasted).
- $P > |t|$ (P value) is not above 0.05
- Monetary amounts are expressed in million euros and distance in kilometres.

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. reg Tij_4 Yi Yj_D A_1
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| Source | SS | df | MS | | | |
|----------|------------|-----|------------|-----------------|--------|--|
| Model | 11690332.9 | 3 | 3896777.63 | Number of obs = | 210 | |
| Residual | 3835497.59 | 206 | 18618.9204 | F(3, 206) = | 209.29 | |
| | | | | Prob > F = | 0.0000 | |
| | | | | R-squared = | 0.7530 | |
| | | | | Adj R-squared = | 0.7494 | |
| Total | 15525830.5 | 209 | 74286.2702 | Root MSE = | 136.45 | |

| Tij_4 | Coef. | Std. Err. | t | P> t | [95% Conf. Interval] | |
|-------|-----------|-----------|--------|-------|----------------------|-----------|
| Yi | .0088496 | .0014398 | 6.15 | 0.000 | .006011 | .0116882 |
| Yj_D | 22.88259 | 1.528285 | 14.97 | 0.000 | 19.8695 | 25.89567 |
| A_1 | -405.2323 | 31.28821 | -12.95 | 0.000 | -466.9185 | -343.5461 |
| _cons | 2588.206 | 206.184 | 12.55 | 0.000 | 2181.705 | 2994.708 |

| T_{ij} | A_1 | A_2 | Y_i | Y_j/D | k | R^2 | Observations |
|-----------|-----------|-----------|-----------|----------|-----------|--------|-----------------------------|
| T_{ij1} | -609.3084 | - | 0.0132571 | 23.96029 | 3,847.837 | 96.89% | Only used to test the model |
| T_{ij2} | -448.4206 | - | 0.009785 | 22.70945 | 2,864.365 | 77.25% | $\rho = 0,97204$ |
| T_{ij3} | -420.4763 | - | 0.0089400 | 23.12491 | 2,698.566 | 76.54% | $\rho = 0,96489$ |
| T_{ij4} | -405.2323 | - | 0.0088496 | 22.88259 | 2,588.206 | 75.30% | $\rho = 0,96094$ |
| T_{ij5} | -139.5240 | -280.0231 | 0.0093615 | 22.90198 | 2,568.057 | 74.55% | $R^2 > 0.75$ – only shown |
| T_{ij6} | -179.4403 | -196.8701 | 0.0085097 | 22.45426 | 2,388.860 | 70.37% | $R^2 > 0.75$ – only shown |

Regression 1 and Table 1 – STATA models

Summarizing, we can conclude that models (as seen in Figure 3) follow the same trends and keep a low mean squared error (MSE), while correlation (ρ) is above 0.96 and R^2 above 0.75.

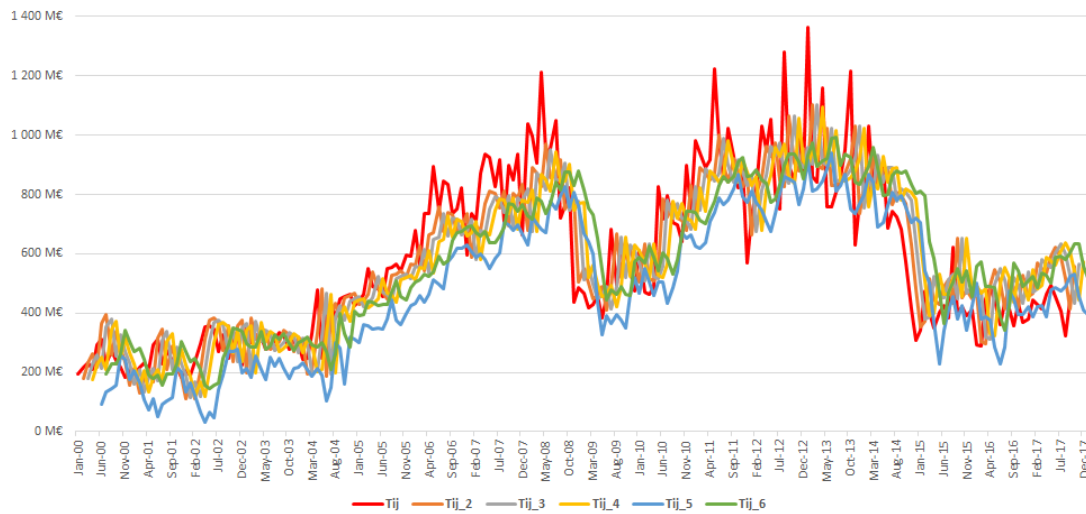
There is a clearly period: 2004-2008 and 2010-2013 when Russia traded more than the expected. This could be because of economic expansion (before the Great Recession) and the internal devaluation done by Spain (afterwards).

The increase in oil prices (between 2010-2012) benefit Russia mostly, therefore it would be better to split imports and exports, even though Spain has been always a deficit-trade partner.

All in all, to sum up the effects and see the future trends of the trading between Spain and Russia we must base our analysis in the previous results and, clearly, models have a medium-

acceptable approach to the reality: since no one is able to forecast future trade in the mid-run nor with a very high confidence.

Figure 3 - Models together

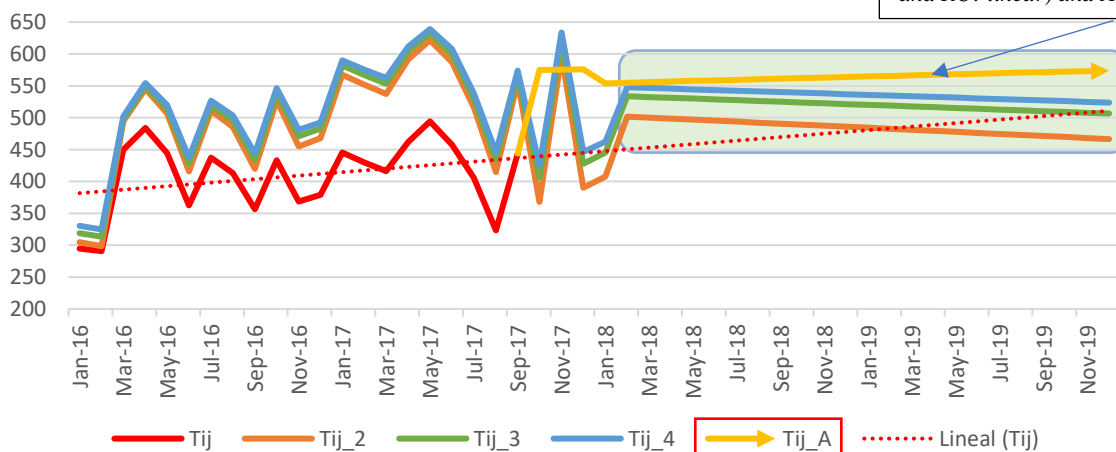


Analysis: current situation and forecast

In 2015, the Spanish Minister of Foreign Affairs, *Alfonso Dastis Quecedo*, was ready to re-enhance trade relations with Russia, nevertheless, the possible interference of support of the Russian Government to the Catalan Independentist movement has freeze bilateral relationships.

The models forecast a stagnation in trade (see Figure 4 - Forecasted trends), nevertheless, due to the adverse political circumstances (such as the recent *Skripal* case^{iv}, EU embargo and some other electoral issues^v) trade is being undervalued: not because of economic reasons, but political. Even though, it seems that trends are not clear, but future T_{ij} would be around 450-550 million euros (monthly) most likely in the short/mid-run.

Figure 4 - Forecasted trends



Pure Gravity model, it follows the same path as T_{ij} and it is just a result of the extrapolation of: GDP (SP: potential and RU: linear) and A (logarithmic).

Meanwhile, in the second semester of 2018 Spain has arranged a round regarding the “*Acuerdo de Cooperación Económica e Industrial*^{vi}” which involves: investment, space race, energy,

transport and tourism. After all, this is a crucial agreement that may help to the increase in commerce between both countries, since trading has drastically decrease, thanks to the EU embargo, according to las ICEX report^{vii}, about a 45.3% in accumulated terms.

By the moment, the main aim of the Spanish Government is to re-launch, mainly, industrial products which decreased during the crisis and the post-embargo in 2016: mechanics (-20%), ceramics (-19%), plastics (-32%), pharmaceutical products (-41%), etc. That is why this future agreement is taken as crucial for both sides.

Russia has increased its imports over olive oil (+21% in 2016), soft drinks (+22%) and vehicles (+54%); being the last the fastest grown. This is one of the keys that motivate the Spanish Government (as well as Spanish firms) to have positive perspectives over Russian imports of Spanish goods (because they increased by 21.4%) during 2017, although the embargo still on and Spanish imports of Russian goods are composed by a 78% of combustible.

Conclusions: forecast and implications

All in all, while developed models are giving the impression that we are on the way of stagnation of bilateral trading, official perspectives seem too pleasant. It should be considered, also, the fact that Russia is fasting increasing its agriculture production (one of the most important tranches of Spanish exports) what could lead to a cooling of trading between both nations.

Spain is interested in diversifying its global trade portfolio, as well as Russia, that may lead to a reallocation of exports, from the Spanish, side towards: cloth, industrial items and vehicles.

Nevertheless, there is nothing clear but a clear intervention in the political sphere that, if it is solved in the next Spanish-Russian round it could lead to an increase in trade, as it is hoped, which may lead to the efficient allocation of resources and an increase in global welfare.

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ⁱ **Cipollina**, M. and **Salvatici** L., *AGRODEP Technical Note TN-05: Hands-on gravity estimation with STATA* (Ver. 2). AGRODEP, April 2013. UNITED STATES OF AMERICA: Washington DC.

ⁱⁱ **ESTACOM** – Database available on: <http://estacom.icex.es/estacom/desglose.html#>

ⁱⁱⁱ **DATOSMACRO**: <https://www.datosmacro.com/> *Expansión's* macroeconomic database (collects official data)

^{iv} **ABC** – *Spain expels two Russian diplomats for Skripal case*: http://www.abc.es/internacional/abci-espana-ex-pulsara-diplomaticos-rusos-respuesta-ataque-quimico-salisbury-201803261753_noticia.html 26.03.2018

^v **ECD** – *The Minster of foreign affairs quarrel the Spanish ambassador in Moscow because of his declarations about "free and clean elections"*: https://www.elconfidencialdigital.com/politica/ministro-atencion-embajador-Moscu-elecciones_0_3115488443.html 22.03.2018

^{vi} **ICEX** – Bilateral agreements: <https://www.icex.es/icex/es/navegacion-principal/todos-nuestros-servicios/informacion-de-mercados/paises/navegacion-principal/el-pais/relaciones-bilaterales/index.html?idPais=RU#3>

^{vii} **ICEX** – *Estudio económico y comercial. Rusia 2017*: <https://www.icex.es/icex/es/navegacion-principal/todos-nuestros-servicios/informacion-de-mercados/paises/navegacion-principal/el-mercado/estudios-infor-mes/DOC2017773495.html?idPais=RU>