sciendo

PRODUCTION ENGINEERING ARCHIVES 2022, 28(1), 40-49

PRODUCTION ENGINEERING ARCHIVES

ISSN 2353-5156 (print)
ISSN 2353-7779 (online)

Exist since 4th quarter 2013
Available online at https://pea-journal.eu

Statistical analysis of road freight transport in Catalonia

Adrienn Boldizsar[1,2]

[1] Budapest University of Technology and Economics, H-1111 Budapest, Muegyetem 3, Hungary
[2] John von Neumann University, H-6000 Kecskemet, Izsaki 10, Hungary
Correspondence: boldizsar.adrienn@edu.bme.hu

Article history
Received 23.03.2021
Accepted 28.12.2021
Available online 07.02.2022

Keywords
Catalonia
indicators
freight transport
correlation
economic

Abstract
This article describes the links between economic level, investment in Research & development (R&D), and Catalan freight transport between 2006 and 2016. Catalonia is the second most populous area in Spain, northeast of the Iberian Peninsula, whose economy ranks second among the Autonomous Communities, surpassed only by the Community of Madrid, to speak of a significant economic and social region. The study sought to answer the question of what economic contexts exist in the region regarding freight transport. To do all this, it uses mathematical-statistical tools to explore the relationships between real data sets, which were calculated using seven indicators. The analyses suggest a positive increase in the volume of imports and exports of goods in the region. The same is true for GDP per capita. It came as a surprise that virtually no positive correlations existed between R&D and any other indicators. In analysing the indicators, we found that the current economy was pushed back by the 2008 world economic change, similarly to international trends. At the same time, there has been rapid growth since 2010, especially in exports. This also means that Spain, particularly the Catalan region, has serious trade relations, which affect the region's economic development and the freight transport industry.

DOI: 10.30657/pea.2022.28.05 JEL: L62, M11

1. Introduction

The aim of the present research is to assist in a similar regional analysis of other countries, thereby supporting a country's macro-strategic planning in the context of the economy and road freight transport. Logistics processes, including freight transport, have grown into one of the dominant industries of the present age, the impact of which on our daily lives has become even more noticeable in the context of a pandemic. At the same time, it is a less researched part of the social and economic impact of the life of individual countries and regions. In the context of the present study, we sought to answer the question of the relationship between economic, R&D and transport indicators in the Catalan region.

The null hypothesis of the research, the answer was sought to see if there was a relationship between the seven selected indicators. As a starting point, it can be deduced that the connection between the economy and land transport of goods must be high since road transport is one of the bases for exchanging goods. This study also investigates the relationships between R&D and economic activity. The R&D investments would give their fruits in the coming years, and if there are not very significant discoveries, they would not be significant. The study's data is provided by the Institut d'Estudis Regionals i Metropolitans de Barcelona (IERMB). The research framework is shown in Fig. 1.

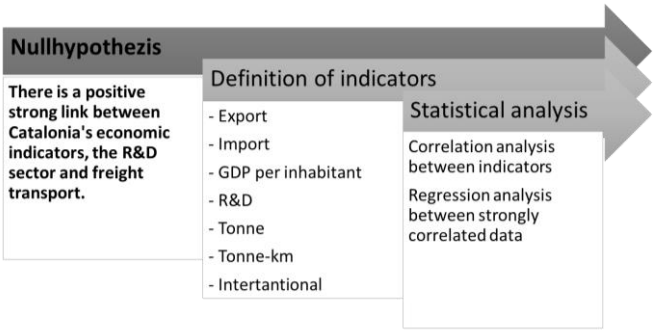

Fig. 1. Research framework

All of this study is expected to show the long-term consequences of freight transport in the region of Catalonia if current processes continue. By drawing the correct conclusions, similar analyses can even help decision-making at the strategic level in the long run.

2. Literature review

The development of sustainable transport and freight transport systems has become one of the main drivers of transport policy measures. In addition to the environmental impact, one of its fundamental pillars is the economic impact, which is a key element of the entire energy sector (Deja et al., 2021). Most research considers it an indispensable fact that the economic impact of road freight needs is constantly increasing, and this is also true for social and environmental impacts, all in Spain (Alesis et al., 2014) and, within this, Catalan region (Aza et al., 2010).

Freight transport and its economic relationship provide the basis for several international studies, particularly the impact of the 2008 global crisis. A study support verification that the indicator of tonne-km produced is meaningful for the economy in Greece (Moschovou, 2017). At a micro level, significant mathematical relations were established between the road tonne-km and the (Gross Domestic Product) GDP for both national and international means of transport showed a straightforward linear association. The overall conclusion is that road freight transport has shown a marked sensitivity and relation to the economy and its fluctuations, and this relation is one of the dramatic drops in the transported tonne-km, much higher than the respective drops in national GDPs. Also, it would appear that the tonne-km is the most appropriate indicator to express the road freight transport output at the country level. Economic indicators can be widely used to analyse other transport-related contexts, even at the regional level (Szabó et al., 2021).

Another study covers the relation between transports and economic activity in Belgium (Meersman and Nazemzadeh, 2017). The contribution of transport infrastructure to economic activity: The case of Belgium. Supports the relationship between these indicators. Belgium's GDP per capita is positively impacted by traditional indicators such as the openness of the Belgian economy, the rate of investment as a whole, technological change and the length of the motorways, the rail network, and the investments in port infrastructure.

There is a study about the EU transportation, Road freight transportation in a period of economic instability: A panel data study in four EU Mediterranean countries. (Moschovou and Giannopoulos, 2021) It can find their conclusions supporting the relation of both indicators. The type of data used and was able to produce statistically significant results connecting the road freight transport performance (mainly in terms of total road freight tonne-km) with the GDP per capita, the share of exports to EU28 member countries (as related to total exports), and the index of the production in the manufacturing sector. For example, the first work based on a cross country analysis of 17 developed countries (including Greece, Italy, Spain, and Portugal) for 1989 estimated elasticity of road freight tonne-km in respect to GDP of 1.017, indicating an almost linear type of relation between the growth of freight with the economy (Bennathan et al., 1992; Nedeliakova et al., 2021).

Numerous studies deal with the impact of the R&D sector on individual industries but focus on R&D and freight transport, possibly including road freight transport, which is less studied, especially in the transport sector as a whole (Lambertini et al., 2001). An international study in the South African region found a similar finding that the relationship between transport and R&D is not included in the national research plan. However, mutual development of the two areas is essential (Rust et al., 2008). When designing road systems, it is impossible to go without parameters that quantify socio-economic impacts, which presupposes a complex technical-economic approach. Defining social costs helps to re-evaluate the performance of the road sector so that in addition to the needs of road users, the effects of traffic on society can even be taken into account in traffic management (Sipos et al., 2012; Mészáros et al., 2012).

Following a review of the literature in the third chapter describes the research methodology and applied mathematical-statistical tools. The fourth chapter shows the results. The fifth chapter has the conclusion.

3. Experimental

3.1. Indicators

An indicator is neither an action, the name of the measurement, nor the instrument used to find the measurement data. It can be defined as data or information that serves to know or assess the characteristics and intensity of an event. The indicator is always a numerical scale that will allow us to orientate and evaluate the behaviour of the activities set for each objective. To develop the study, good indicators are needed to help analyse and determine the economy's performance, freight transport, and R&D (Table 1).

Table 1. Summary of the indicators (Own editing)

Indicators	Abridgement	Interpretation
Indicators of the economic level		
Exports	E1	Exporting is defined as selling products and services in foreign countries sourced or made in the home country (In Catalonia).
Imports	E2	Importing refers to buying goods and services from foreign sources and bringing them back into the home country (In Catalonia).
GDP per inhabitant	E3	It is defined as the total value of goods and services produced within a country's borders in a specific period.
Indicator of the inversion in R+D		
Research & Development	G1	R&D investments contribute directly to the accumulation of knowledge, lead to new products or production processes and contribute to productivity improvement.
Indicators of the road freight transport		
International trade	T1	The number of international road freight transport operations.
Tons transported	T2	International tons transported.
Tonne-km produced	T3	International tonne-km transported

The data used is based on seven indicators of Catalonia between 2006 and 2016.

3.2. Applied tools of the research

Statistics can be defined as the science of collecting, organising, processing, analysing, and interpreting data to deduce the characteristics of a target group or population. This study used descriptive statistics, which uses numerical and graphical techniques to describe and analyse a set of data (Albareda and Morera, 2020; Moreno, 2006; Zenaida, 2012). To examine the relation between two variables, it is essential to know whether they are related or not and the degree of association and how they are related. In statistics, these questions can be answered with the help of two techniques.

Correlation quantifies how closely related two variables are, while linear regression generates an equation (model) that allows the value of one to be predicted from the other based on the relationship between the two variables. Both tools help us to deepen the analysis of the relationships between variables. One last differential definition: correlation measures the degree of association, and regression helps us know how they are related (Table 2).

Table 2. Summary of the formulas (Own editing)

Applied tool	Formula	Interpretation
Correlation	$S_{xy} = \left[\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})\right]\frac{1}{N}$ S_{xy}=Covariance between variables x and y $\bar{x}$=Arithmetic median of variable x $\bar{y}$=Arithmetic median of variable y x_i= value associated with the modality i y_i= value associated with the modality i N=Number of observations of the total set	The correlation studies the degree of association between the components of statistical variables, and its objective is to construct coefficients that determine whether or not there is covariation. Covariation is a value indicating the joint degree of variation of two random variables concerning their means.
Coefficient of determination	$R^2 = \frac{S'^2_{Y^*}}{S^2_{rY}}$ R^2=Coefficient of determination $S^2_{rY^*}$= variance of the theoretical model S^2_{rY}= variance of the accurate model	The coefficient of determination is a reasonable coefficient to measure the quality of the fit; it measures the proportion of the total variance explained by the model.
Regression	$y_i = a + bX + e_i$ y_i = dependent variable X = independent variable a = regression constant b =regression coefficient e_i= error	The regression is concerned with determining (if possible) the dependency structure that best expresses the type of relation between the components. It tries to obtain a functional connection.

In the first half of the analysis, the presentation of the selected indicators for the period between 2006 and 2016 was prepared, with which we want to establish the second half of our study. The second part follows the result of the relationships between the indicators. Subsequently, a regression analysis of the indicator pairs with the most robust relationship was performed, further examining the inherent relationships of the correlations.

4. Results and discussion

4.1. Analysis of indicators

An individual study of the indicators will be conducted by observing their evolution and relating it to historical events in the region (Fig. 2).

Using the first year of the study, 2006, as a variation point to have a clear vision of the evolution, it can be seen that the impact of the crisis on exports reached the critical point in 2009, but it has been snowballing and in 2011 surpassing pre-crisis values. Between 2012 and 2013, there was a second recession. Due to the crisis, financial rescues were made with large amounts of money that, together with the solid generalised fall in tax revenues, caused austerity policies, implying substantial social cuts and an increase in widespread poverty. Economic imports started to decline in 2008 due to the crisis, reaching their lowest value of the study in 2009, declined due to the second recession during 2012 and 2013, and rose to values similar to, but not higher than, pre-crisis levels. Compared with exports, it can be seen that these grow at a higher percentage but remain behind imports that grow at higher rates, generating an imbalance. Imports are one of the critical points in the growth pattern of Catalonia and Spain in recent years.

GDP per inhabitant is an indicator used to study the economy; it is positively related to the quality of life. The graph shows that it started to decrease in 2008, arriving at the lowest point in 2011 and not improving until 2014 and arriving in similar values in 2016. Catalonia is a municipality of Spain, and Spain was one of the countries more affected by the crisis; through pressure and imposed policies by their lender organisations. The austerity measures had severe economic impacts such as reduced economic activity, pensions, and wages with a corresponding cut in the citizens' spending power, increasing unemployment rates. The crisis combined with the second recession had a much more long-term effect on this indicator, demonstrating the significant impact of the crisis on the population.

In R&D per inhabitant, a decrease in investment can be observed, but not following a direct trend as in the previous indicators, since from 2007 to 2008 when the other indicators begin to decrease or reduce growth, the most significant increase occurs 9 %. Due to the crisis, investment fell until it reached a minimum in 2013 and finally did not recover its maximum values in 2016. A fact to highlight the indicator is that it is the only one with a value as equal or superior to the values of 2006; this is due to the importance that the countries know of the excellent R&D for the future to compete.

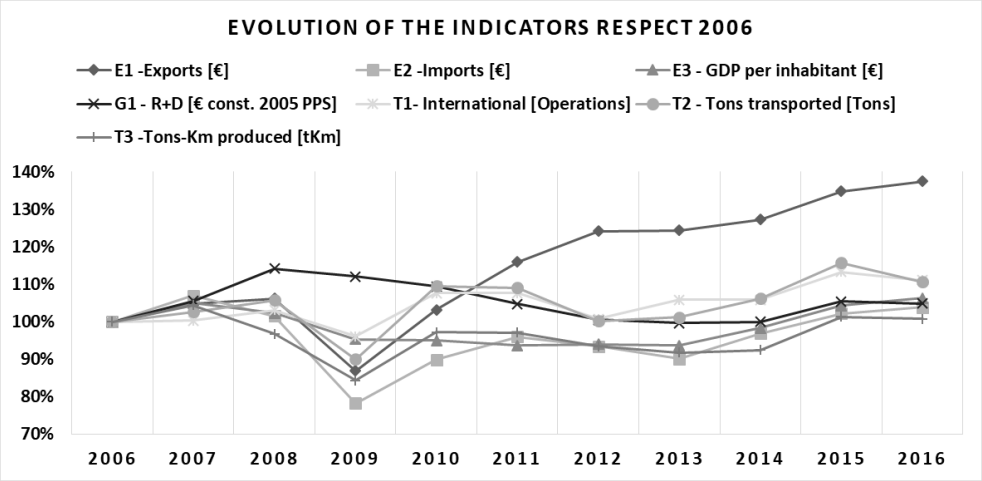

Fig. 2. Evolution of the indicators from 2006

As shown in the time graph, all indicators follow a similar evolution except for E1 and G1. The E1 indicator, International economy exportations, suffers a critical point in 2009 as the rest of the indicators (except G1), but quickly starts to rise to reach very high incriminations as a percentage compared to the rest, demonstrating the growing importance of exports in the Catalan economy. On the other hand, indicator G1 begins to suffer the blow of the crisis in 2008 and suffers a slight but constant fall without reaching its maximum values at the end of the study, demonstrating how badly the population has suffered from crisis and how difficult it is to recover compared to the other indicators. To understand well what happened in the two critical points, 2008 and 2012, will be resumed.

International transport responds to the needs of foreign trade and is affected by changes in it. It suffered less from the crisis than domestic transport, this is due to a greater internationalisation of transport activity, and the trend in the world is towards greater competition and concentration in international transport and logistics markets. International freight transport reached its lowest point in the study in 2009. However, the following year came values were even higher than before the crisis due to the internalisation, remaining constant the next year and then suffering the austerity policies in 2012 until recovering in 2015. Tons transported reached its lowest point in the study in 2009, but the following year it came values even higher than before the crisis due to the internalisation, remaining constant the next year and then suffering the austerity policies in 2012 until recovering in 2015. It has a very similar evolution compared to the T1 indicator. Tonne-Km produced reached its lowest point in the study in 2009, but the following year it came values even higher than before the crisis due to the internalisation, remaining constant the next year and then suffering the austerity policies in 2012 until recovering in 2015. The three freight transport indicators are very similar, operations, tonnage transported, and the ratio of kilometres travelled to cargo transported have similar trends.

4.2. The relationship between the indicators

The coefficients of correlation values vary between -1 and 1. The further the value is away from the zero coefficient, the greater the linear relationship between the variables. In the extreme case of coefficients 1 or -1, we will have maximum relation. The sign tells us the behaviour between the indicators. Can be direct (positive, when one variable grows the other) or inverse (negative, when one variable increases, the further decreases). If the coefficient is 0, it just means that the variables have no linear relation, but they can have a different type of relationship. Official classification:

- $0 \leq r < |0.3| \rightarrow$ low relation,
- $|0.3| \leq r < |0.7| \rightarrow$ medium relation,
- $|0.7| \leq r < |1| \rightarrow$ high relation.

The correlation between the indicators is shown in Tables 3/a and 3/b.

Table 3/a. Classification of correlations (Own editing)

	E1 - Exports [€]	E2 - Imports [€]	E3 - GDP per inhabitant [€]	G1 - R+D [€ const. 2005 PPS]
E1 - Exports	1	0.447	0.262	-0.508
E2 - Imports	0.447	1	0.782	-0.183
E3 - GDP per inhabitan	0.262	0.782	1	0.170
G1 - R+D	-0.508	-0.183	0.170	1
T1 - International	0.777	0.397	0.288	-0.129
T2 - Tons transported	0.670	0.615	0.413	-0.046
T3 - Tonne-km produc	0.302	0.903	0.692	-0.118

Table 3/b. Classification of correlations (Own editing)

	T1 - International [Operations]	T2 - Tons transported [Tonne]	T3 - Tonne-km produced [Tonne-km]
E1 - Exports	0.777	0.670	0.302
E2 - Imports	0.397	0.615	0.903
E3 - GDP per inhabitant	0.288	0.413	0.692
G1 - R+D	-0.129	-0.046	-0.118
T1 - International	1	0.925	0.441
T2 - Tons transported	0.925	1	0.661
T3 - Tonne-km produced	0.441	0.661	1

The strengths of the relationships between the indicators were also shown in the two tables using the colours. According to this, green indicates a strong relationship, yellow indicates a neutral connection, and red suggests weak associations in the tables.

The study is searching for the relation between the different indicators. To achieve this has been studied the degree of covariation or common variation between pairs of indicators. According to the analysis done, the indicators are related to each other; they are not independent. The next step is to find out how they are related.

4.3. Study of the highest relations

This section will compare the high relations of the indicator that have given a ratio higher than 0.7 and the medium ties with a different ratio higher than 0.5. Comparing these two indicators considers just the transport of goods by land by heavy vehicles (Fig. 3/a.). Comparing the indicators T2, Tons-Km produced, and T3, Tons transported Catalonia's international freight transports (Fig. 3/b.).

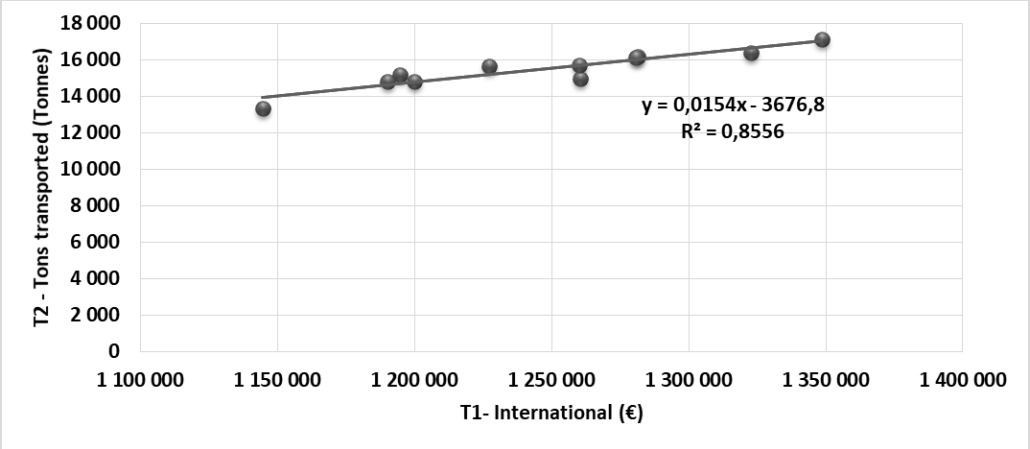

Fig. 3/a. Comparison between indicators T1 and T2

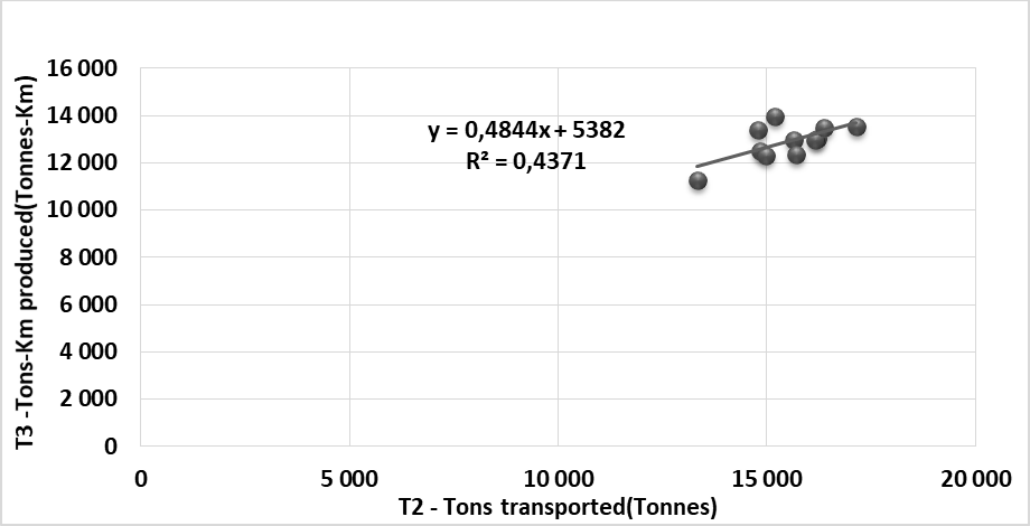

Fig. 3/b. Comparison between indicators T2 and T3

The relation between the international transports and the tons transported is the highest in this study, and this is because the number of international transports operations has an increased connection with the tons transported. The ratio between the indicators is not exact, but it is very high with a determination coefficient of 0.8556, very close to 1. An excellent positive relationship between these two indicators is proven.

If it can be seen at the previous comparison of the indicators T1 and T2 (this last being much higher), suggest that the importance of the operations carried out, which is directly related to the km carried out, is much higher than the relation with the tons. Looking at the value of "a" when the Tons transported are zero (x=0), the Tonne-km produced has a value of 5382 Tonnes-Km, a tremendous value considering the quantities. It means that for the indicator T3, the Km done has more weight than the exports. The slope is positive, and the increase of one unit of T2 has a rise of 48.44 % of the indicator T3 units, which is a good relationship that indicates the connection of the evolution of both indicators. The value of the determination coefficient is 0.4371, not too reliable, but the comparison can give us some valuable perceptions.

The differences are apparent; export is based on trade carried out internationally out of Catalonia by land, sea, and air (Fig. 4/a.). Figure 4/b shows the relationship between the indicator of the international tons transported and the economic exportation, both in Catalonia.

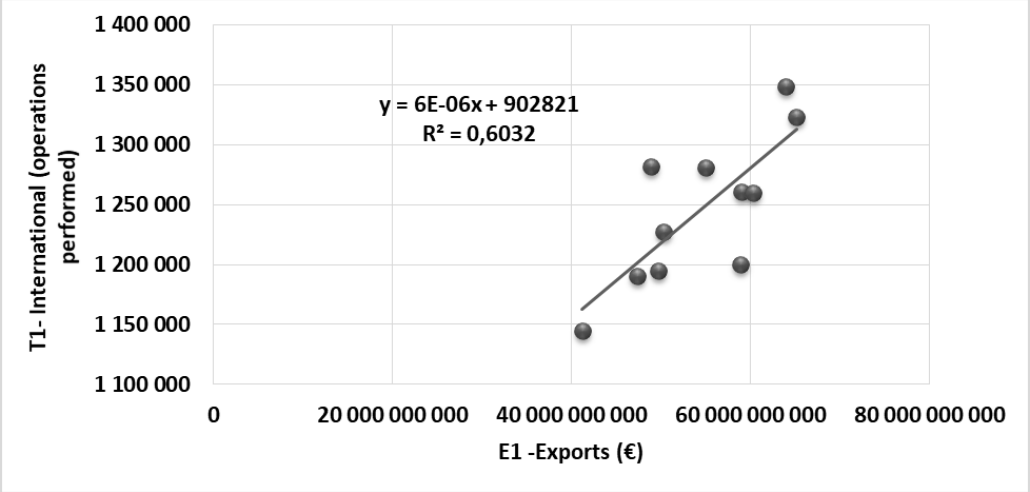

Fig. 4/a. Comparison between indicators E1 and T1

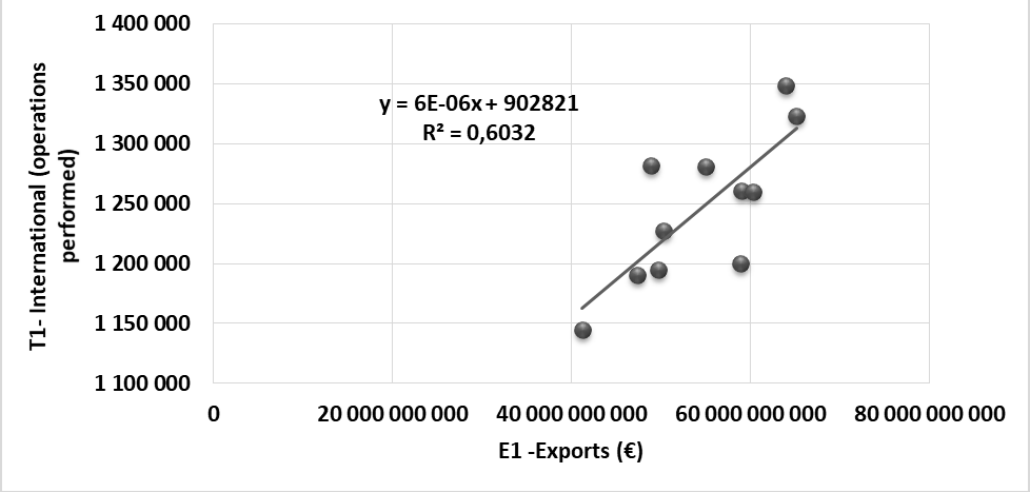

Fig. 4/b. Comparison between indicators E1 and T2

The transport of goods is only by land but includes imports as well. Observing the linear trend equation indicates that imports continue to significantly weigh the international freight transport operations with a zero value of exports. As in the previous cases, the slope is positive, but with a value very close to 0, the results are affected by the considerable difference of importance, but it can be said that both have a positive relation. To backup this not very exact relation, it has a value of the determination coefficient of 0.6032. The difference, as explained in the previous relations, is that exports are based on all trade carried out internationally out of Catalonia by land, sea, and air, and on the other hand, the tons transported internationally is only considered the freight transports by land, including the imports as well. As in the previous cases, the slope is positive, but with a value very close to 0, the results are affected by the considerable difference of values, but

we can say that both have a positive relation. The value of the determination coefficient is 0.4794, not too reliable, but the comparison can give us some valuable perceptions.

The graph (Fig. 5/a.) compares the international trade imports with the tonne-km ratio transported internationally. The relation between E2 Importations of the global economy and indicator T2 of the Tons transports (Fig. 5/b.), the imports are based on all trade carried out internationally out of Catalonia by land, sea, and air.

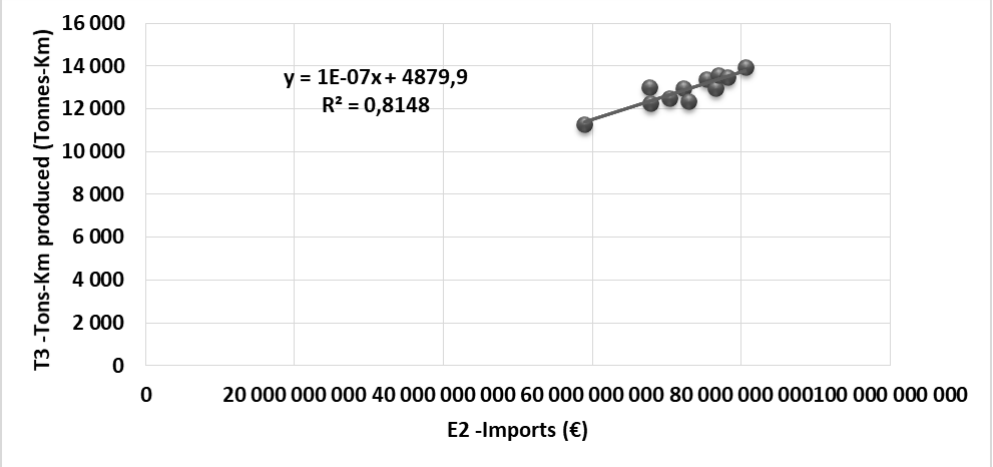

Fig. 5/a. Comparison between indicators E2 and T3

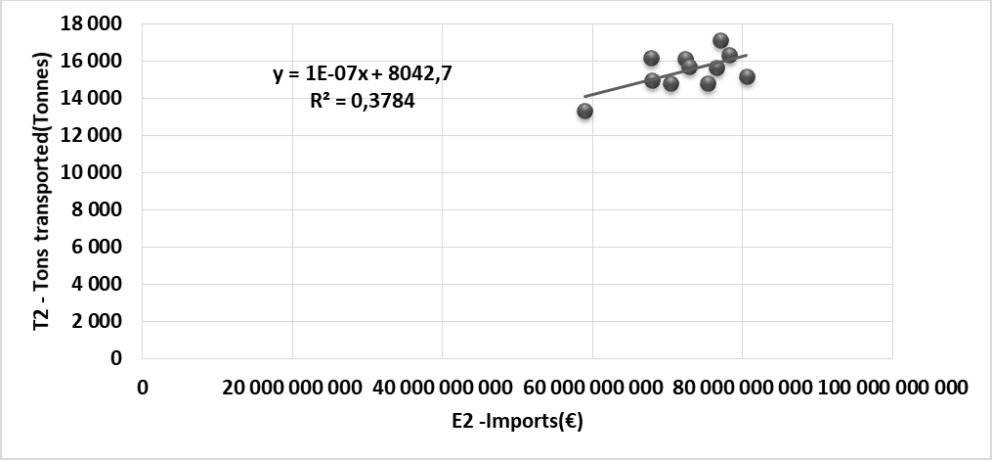

Fig. 5/b. Comparison between indicators E2 and T2 T3

While the indicator T3 considers the tonne-km produced by goods transported internationally, indicator E2 considers all imports by any transport, whether by sea, land, or air. Looking at the slope, it is a positive slope, but very close to zero, this is caused by the considerable difference of the values, but we can state that when economic imports increase, the tonnes-km produced increase. These two indicators are highly correlated with a coefficient of determination of 0.8148. It is giving a good sign of the connection between the economy and transport.

On the other hand, the tons transported internationally only considered the freight transports by land, including the imports. This is caused by the fact that land transport, even without substances, still has a significant weight on exports. The value of the determination coefficient is 0.3784, not too reliable, but the comparison can give us some valuable perceptions.

In Figure 6/a, the two indicators are related to the economy, and figure 6/b is compared the GDP per habitant and the Tonne-km produced. Indicator E2 with realised imports and indicator E3 with GDP per inhabitant, a relation exists. However, the financial crisis affected the long-term and slower recovery in the E3 indicator. GDP per inhabitant has a large share of weight that is not directly related to imports. Looking at the slope, it can be said that it is positive, but with a value very close to 0, as the comparison done before the results are affected for the considerable difference of values, but we can say that both have a positive relation. The coefficient of determination is in line with the reasoning with a non-high value of 0.6109. While indicator T3 considers the tonne-km produced by goods transported internationally, indicator E3 is related to the quality of life. Both of them have a similar evolution, but T3 is more rapidly affected by the changes like the crisis of 2008 or the second recession of 2012, and the E3 is more constant. With the positive slope, when the indicator E3 increases

one unit, the T3 indicator increases 35.1%, meaning that both have a positive relationship and increasing in similar proportions if their quantities are considered. The value of the determination coefficient is 0.4794, and this implies that the trend line is not entirely reliable, as it is most reliable when its coefficient of determination (R^2 value) is set to 1 or close to 1, but it provides us with information that can be considered for the study.

Figure 7 shows the first relation that the indicator G1 of R&D is included in the study and a reverse link with the E1 indicator, the economic exportations.

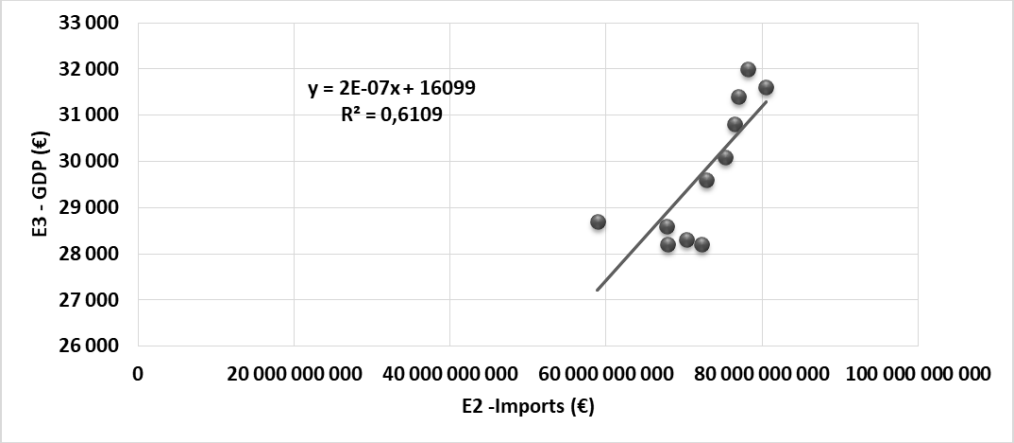

Fig. 6/a. Comparison between indicators E2 and E3

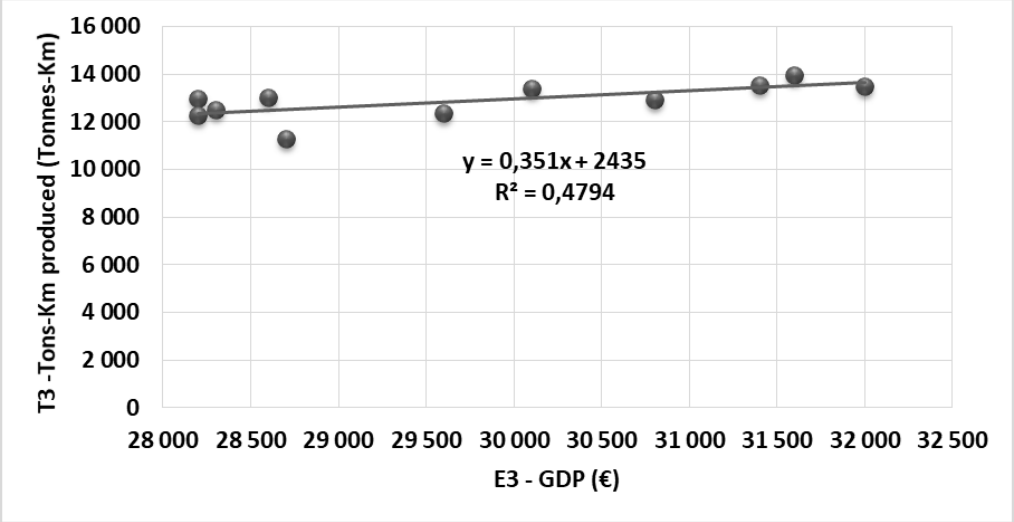

Fig. 6/b. Comparison between indicators E3 and T3

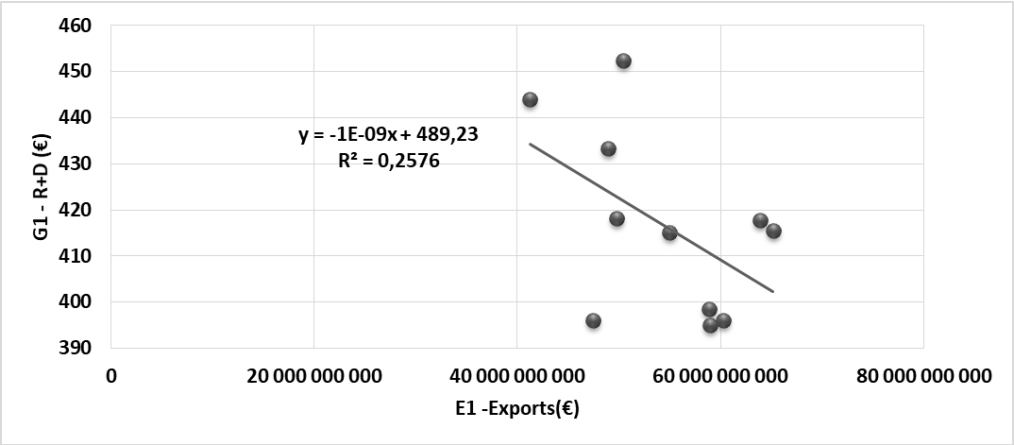

Fig. 7. Comparison between indicators E1 and G1

Here there is a reverse relation between two variables in which, as the independent variable increases, the dependent variable decreases. This relation is because R&D investment is more lightly impacted by the crisis but has a much longer-lasting effect. While investment continues to fall, the export economy quickly recovers, creating this reverse effect. Looking at the slope, it is a negative slope, but very close to zero, this is caused by the considerable difference of the values, but we can state that economic exports increase the R&D investment decrease in this study. The value of the determination coefficient is 0.2576, not reliable at all. As seen in the evolution, this relation between the indicators is caused for the crisis and its effects, not actual proof of a link.

5. Summary and conclusion

This paper analysed statistical tools the principal correlations between indicators based on the economy, freight transport by land, and research and development (R & R & R&D). The study was conducted between 2006 and 2016 in Catalonia, Spain (NUTS 2), as the impact of the 2008 crisis was mapped. Since the economic crisis in Spain in 2007, Catalonia suffered a severe setback in its economy, producing negative figures in the annual growth rate of GDP per inhabitant for the first time. Since 2013, the trend has been positive, showing a yearly GDP per inhabitant growth rate. As can be seen, transportation and economic exportation and importation rapidly grew after 2009, but the GDP per inhabitant and R+D needed more years to recover due to the crisis that burst and affected these indicators much more. It can also see the worst year for most of the indicators was 2009, and all the indicators show in 2016 significantly better values; the crisis and the second recession are in the past. Exports suffered a drop in 2009 due to the crisis but continue their progressive growth. Imports sustained a fall in 2008 and 2009 and recovered more slowly than exports, and in 2016 the imports had values lower than pre-crisis data. If we compare exports with imports, exports grow more than if it is talking with percentages, import has more importance in Catalonia.

The results obtained show significant relations with economic growth and freight transport. Most of the values are understandable. Catalonia is a technologically advanced country with infrastructures developed and has a great location between Spain and France. It means that it has an excellent commercial situation. Catalonia, as all Europe suffered the Crisis of 2008 and the second recession of 2012, both dates in the study period. It affected hard in the economy and transports and the recuperation especially in south European countries like Spain, the recovery was hard needing the help of the European Union. About the R&D, we find no visible relation in the data with the other indicators, only an inverse relationship with exports. It is happened due to the effects of the crisis and recession and the country's investments. Comparison with other regions at the NUTS2 level in Spain could provide further research potential, providing a picture of the situation of the regions and helping to support strategic policy decisions, including transport policy. Carrying out the same analysis may be interesting for the current Covid 19 pandemic situation, for which a similar result can be expected as in a few years after 2008. The main issue is the extent of relapse, which may be less than during the period studied in the present study.

As a limitation of the research, the period between 2006 and 2016 was analysed in the time-series study. One of the main reasons for this is that at the NUTS2 regional level, these data were available in the Spanish database at the beginning of the research. On the other hand, when defining the investigation, the answer was sought to the impact of the crisis of 2008 and how each indicator behaved in the following years. In the long run, extending the time horizon means further research potential. Another limitation is that the research only covers the Catalan region. It could be interesting to compare with other NUTS2 regions in Spain regarding whether the evolution of the same indicators shows similarities.

Similar research is provided to assist in analysing other countries at the regional level, thereby supporting the macro-level strategic planning of a given country in the context of the economy and road freight transport.

Acknowledgement

Authors is grateful for the support of BSc Erasmus student Mr. Cristòfol Urtusol Ferran from Budapest University of Technology and Economics.

Reference

Albareda, M., Morera, M.R., 2020. Anàlisi Multivariable Estadística Aplicada a l'Organització Industrial (Multivariate Analysis Applied to Industrial Organisation) (ESEIAAT, UPC).

Aliases, A., Jose Manuel, Vassallo, J.M., Guzmán, A.F., 2014. Road freight transport decoupling: A comparative analysis between the United Kingdom and Spain. Transport Policy, 32, 186-193, DOI: 10.1016/j.tranpol.2014.01.013

Aza, R., Baños, J., Arbués, P.G., Llorca, M., 2010. Road freight transport demand in Spain: a panel data model. 12th WCTR, July 11-15, 2010 – Lisbon, Portugal, https://www.wctrs-society.com/wp-content/uploads/abstracts/lisbon/selected/02749.pdf (Last downloaded: 08.05.2021).

Bennathan, E., Fraser, J., Thompson, L.S., 1992. What determines the demand for freight transport? 998, World Bank Publications, https://www.rhd.gov.bd/Documents/ExternalPublications/WorldBank/ TransSectPub /contents/documents/B31.pdf (Last downloaded: 10.05.2021).

Deja, A., Ulewicz, R., Kyrychenko, Y., 2021. Analysis and assessment of environmental threats in maritime transport. Transportation Research Procedia, 55, 1073-1080, DOI: 10.1016/j.trpro.2021.07.078

Lambertini, L., Mantovani, A., Rossini, G., 2001. R&D in transport and communication in a Cournot duopoly. Bologna: Dipartimento di Scienze economiche DSE. Quaderni - Working Paper DSE 401(12), DOI: 10.6092/unibo/amsacta/4900.

Meersman, H., Nazemzadeh, M., 2017. The contribution of transport infrastructure to economic activity: The case of Belgium. Case Studies on Transport Policy, 5(2), 316-324.

Mészáros, F., Markovits-Somogyi, R., Bokor, Z., 2012. Modelling and multicriteria optimisation of road traffic flow considering social and economic aspects. Logi - Scientific Journal On Transport And Logistics, 3(1), 70-82.

Moreno, M.J.G., 2006. Apuntes de Estadística Descriptiva, (Descriptive Statistics Notes) (E.T.S.A). http://www2.ulpgc.es/hege/almacen/download/38/38759/estad_2006.pdf (Last downloaded: 23.05.2021).

Moschovou, T.P., 2017. Freight transport impacts from the economic crisis in Greece, Transport policy, 57, 51-58.

Moschovou, T.P., Giannopoulos, A.G., 2021. Road freight transportation in a period of economic instability: A panel data study in four EU Mediterranean countries. Research in Transportation Business & Management, 100622.

Nedeliakova, E., Hudakova, M., Masar, M., Lizbetinova, L., Stasiak-Betlejewska, R., Šulko, P., 2020. Sustainability of railway undertaking services with lean philosophy in risk management–Case study. Sustainability, 12(13), 5298.

Rust, F., Van Wyk, L., Ittmann, H. W., Kistan, K., 2008. The role of R&D in transport infrastructure in South Africa. SATC 2008, https://repository.up.ac.za/bitstream/handle/2263/7532/rust_role.pdf?sequence=1 (Last downloaded: 03.06.2021).

Sipos, T., 2017. Spatial Statistical Analysis of the Traffic Accidents. Periodica Polytechnica Transportation Engineering, 45(2), 101-105. DOI: 10.3311/PPtr.9895

Sipos, T., Mészáros, F., Bokor, Z., 2012. Determination of road transport sotial cost. In Hungarian: A közúti közlekedés társadalmi költségeinek meghatározása] Scientific Review of Transportation, In Hungarian: Közlekedéstudományi Szemle, 62(3), 31-35.

Szabó, Z., Török, Á., Sipos, T. 2021. Order of the Cities: Usage as a Transportation Economic Parameter. Periodica Polytechnica Transportation Engineering, 49(2), 164-169, DOI: 10.3311/PPtr.13786

Zenaida, H.M., 2012. Methods of data analysis: notes. In Spanish: Métodos De Análisis De Datos: Apuntes, Universidad de la Rioja, España: Servicio de Publicaciones. Determinar el impacto de mejora significativo de un sistema de información web en el proceso trazabilidad de productos de ferretería en Lima.

加泰罗尼亚公路货运统计分析

關鍵詞
加泰罗尼亚
指标
货运
相关性
经济的

摘要
本文描述了 2006 年至 2016 年间经济水平、研发（R&D）投资和加泰罗尼亚货运之间的联系。社区，仅次于马德里社区，是一个重要的经济和社会区域。该研究试图回答该地区在货运方面存在哪些经济背景的问题。为此，它使用数理统计工具来探索真实数据集之间的关系，这些数据集是使用七个指标计算得出的。分析表明，该地区的货物进出口量出现正增长。人均 GDP 也是如此。令人惊讶的是，研发与任何其他指标之间几乎不存在正相关。在分析指标时，我们发现当前经济受到 2008 年世界经济变化的影响，与国际趋势类似。同时，自 2010 年以来出现了快速增长，尤其是出口。这也意味着西班牙，尤其是加泰罗尼亚地区，有着严重的贸易关系，影响了该地区的经济发展和货运业。