

Innovation Success in the European Union: Aggregate Demand Analysis

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Abstract: In the current period of uncertainty in the European Union, innovation is becoming a key factor for maintaining not only economic stability but also competitiveness in the globalised environment. Following the financial crisis that hit Europe, aggregate demand indicators slowly started to stabilise, mostly reaching their peak in 2019. However, in the following year, due to the pandemic crisis, these indicators fell again, posing a new challenge for researchers around the world. This study examines the relationship between macroeconomic indicators of aggregate demand and innovation performance in 25 EU countries. Using data for the period 2013-2021 as input for the regression analysis, the research identifies firm investment and exports as important innovation support factors and highlights their key role. On the other hand, the research shows that household consumption and imports are barriers to innovation. Somewhat surprisingly, government spending on goods and services does not have a significant impact on innovation success, underlining the need to rethink government investment policies. This finding highlights the need for a more thorough analysis of the effectiveness of state investment in innovation and possible adjustments to state policies to maximise the promotion of innovation activities in the state. The study also highlights the importance of comprehensive strategies that promote investment and exports, while emphasising the removal of barriers to innovation in the form of household consumption and imports.

Keywords: Innovation success, Aggregate demand, Investment, Export, Import

1. Introduction

Innovation is an important driver of both national and regional development (Xu et al, 20-23). The link between economic growth and innovation remains an interesting concept for researchers and is frequently explored in the literature (Pece et al, 2015; Kijek, 2019). Currently, the world is entering the fourth industrial revolution (Schwab, 2017), which is characterised by new technological transformations in different fields. The ever-evolving artificial intelligence or new practices in the healthcare and financial sectors are just the tip of the iceberg of the transformation of the contemporary world. It is these changes and transformations that can be seen as the result of the much discussed and needed innovations (Malik, 2023).

Technological innovation not only supports economic growth, but also plays a key role in strengthening regional competitiveness (Pece et al, 2015; Zeboite et al, 2019; Szopik-Depczyńska et al, 2020). Thus, a region's ability to adapt to new technologies and implement them effectively becomes a critical factor for its success in the global economic space. For these very reasons, it is now imperative to properly measure and monitor innovation success within a region. The Global Innovation Index (GII) can be a useful tool for identifying and measuring the overall innovation success of countries. In this way, it can help individual economies to better monitor the innovation environment within a country, which can be seen as an important step towards enhancing overall growth in a global context (Jankowska et al, 2017; Yu et al, 2022).

Innovation is not only an important driver of growth for a region, but it is also an important source of competitive advantage for a region (Prokop et al, 2021). An evolutionary approach to technological change points to the fact that innovation is the result of interactions between individuals, firms and organisations in a specific socio-economic and institutional context (Iammarino et al, 2009; d'Agostino and Scarlato, 2013). In this context, it is therefore particularly important to measure innovation and discuss the outcomes associated with it. At the expert level, there are numerous discussions on the determinants that promote or, on the contrary, reduce the success of innovation in a region. Given the evolutionary approach to technological change mentioned above, in this paper we focus on the different actors of innovation success within a region. Thus, the aim of this paper is to use a regression model to test the influence of households, firms, government and other countries, as expressed by the determinants of aggregate demand - consumption, investment, government spending, exports and imports - on the innovation success of the 25 countries of the European Union, expressed as a Global Innovation Index score.

The paper is structured as follows: Section 2 presents recent findings from the known literature and hypothesis development, Section 3 briefly describes the methodology and data we used, Section 4 presents the results of our research, which are then discussed in more detail in Section 5. Section 6 presents conclusions, including theoretical and practical implications, limitations of the research, and suggestions for future research.

2. Literature Review and Hypothesis Development

Since the middle of the twentieth century, many schools of thought have considered innovation to be an important determinant of productivity. Following the pioneering work of Romer (1986) and Lucas (1988) on the endogenous growth model, there have been subsequent large-scale studies showing that innovation is an important driver of long-term economic growth and that innovation also increases the international competitiveness of regions (Prokop et al, 2021; Alekseeva et al, 2022; Tadevosyan, 2023). Innovation activities are an essential factor in the competitiveness of virtually any economic entity (Alekseeva et al, 2022; Wahyudi et al, 2023). As mentioned above, according to the evolutionary approach to technological change, the basic actors of innovation are individuals, firms and organisations.

The impact of individuals, expressed in this case as household consumption, on the innovation success of regions has been studied several times in the past. A positive relationship between household consumption and regional innovation can be observed, where higher levels of household consumption can lead to increased incentives for innovation and overall technological progress. Similarly, innovation can affect household consumption in a number of ways. For example, it can lead to the development of new products and services, which can fundamentally affect consumption patterns and preferences and subsequently affect overall consumption in the economy (d'Agostino and Scarlato, 2013; Schot, 2018). As household consumption is also closely linked to savings, the impact of savings on the innovation success of regions can also be examined. Empirical evidence shows that household savings have a positive impact on innovation success, especially in poorer emerging economies. In contrast, richer countries often have extensive innovation networks that do not depend on household savings to finance and subsequently implement innovation projects (Aghion et al., 2016). Based on these findings, we therefore put forward a first hypothesis:

H1: Household consumption has a positive impact on the innovation success of the region.

According to the evolutionary approach to technological change, the second actor of innovation is firms. In this case, firms are proxied by their private investment as a component of aggregate demand. There are several papers on the positive impact of private investment by firms on the innovation success of regions. Research has shown that firms' investment, especially investment through venture capital, can significantly boost regional innovation as well as the creation of new firms (Dyer et al, 2016; Fu, 2008). This finding is further supported by the positive impact of foreign direct investment (FDI) on regional innovation success, with the strength of this effect depending on the absorptive capacity and innovative complementary activities in the region (Fu, 2008). Hintosh et al. (2020) add that FDI has a positive impact and contributes significantly to the innovation performance of regions, but only if it is FDI from domestic firms. Dorzhieva and Kirillova (2019) then provide an opposing view of investment, emphasising that financial investment alone is not synonymous with innovation. On the contrary, they argue that strategic reorganisation and rationalisation of productive resources through competitive priorities is more important and can also lead to innovation in various fields, ultimately increasing both the competitiveness and economic growth of a country. Based on these findings, we therefore put forward a second hypothesis:

H2: Private investment by firms has a positive impact on the innovation success of the region.

The third actor in the region's innovation success is the state, represented in this paper by government spending on the purchase of goods and services. Different governments support innovation activity in the region in both the public and private sectors through different economic policy instruments (Avellar, 2011; Kijek, 2019). Public funding stimulates innovation activity in a region, but does not significantly increase innovation activity (Kokot-Święta and Krawczyk, 2020). The level of public funding can also influence the adoption of new innovative practices, and the system of such funding is particularly important (Salmi, 2012). According to Salmi (2012), lower levels of public funding facilitate innovative practices. On the other hand, if we look at the most effective tool for stimulating innovation activities in the private sector - public procurement - we can find a rather significant positive impact of public procurement on innovation activities in the region (Kijek, 2019). Higher public spending in the form of public procurement also motivates companies to engage in innovative activities, which in turn increases the innovation success rate of a given region (Kijek, 2019). Based on these findings, we therefore present a third hypothesis:

H3: Public spending has a positive impact on the innovation success of a region.

The final innovation actor in our paper is foreignness, expressed as the size of each country's exports and imports. If only exports are considered, expert studies show that they have a significant impact on innovation activity, especially for firms operating in the region (Ebling and Janz, 1999; Fassio, 2018). However, it is important

to note that this impact varies significantly depending on the destination of the exports (Fassio, 2018). Aghion et al (2018) further add that while export shocks increase innovation incentives for all firms, independent of other factors, they can also indirectly reduce profits for firms with lower productivity. This claim is also supported by Cai et al (2020), who show, using the case of Chinese firms, that firms' export participation significantly increases the probability of innovation, with the effect of export market size being important. Based on these findings, we present a fourth hypothesis:

H4: Exports have a positive impact on the innovation success of the region.

On the other side of the external market are imports, for which academic publications also show a positive relationship between import-related activities and the innovation performance of the region. Blind (2004) and Bertschek (1995) in their studies have shown a clear positive relationship between imports and innovation using the services sector as an example. These claims are further extended by Chen et al. (2017), who present the finding that imports stimulate innovation mainly through knowledge spillovers from foreign firms, using the example of Chinese firms. A similar result is then presented by Montégu et al (2021), who confirm, using the example of Chilean firms, that import activity has a positive effect on promoting not only technological areas but also non-technological innovation in the region. The authors also agree that imports through the high-income channel have a much greater impact on innovation in the region than imports through the low-income channel (Chen et al, 2017; Montégu et al, 2021). Based on these findings, we therefore present our final hypothesis:

H5: Imports have a positive impact on the innovation success of the region.

Based on the findings from a comprehensive literature search of factors that influence innovation success and the formulated hypotheses, we present a conceptual model for our study (see Figure 1).

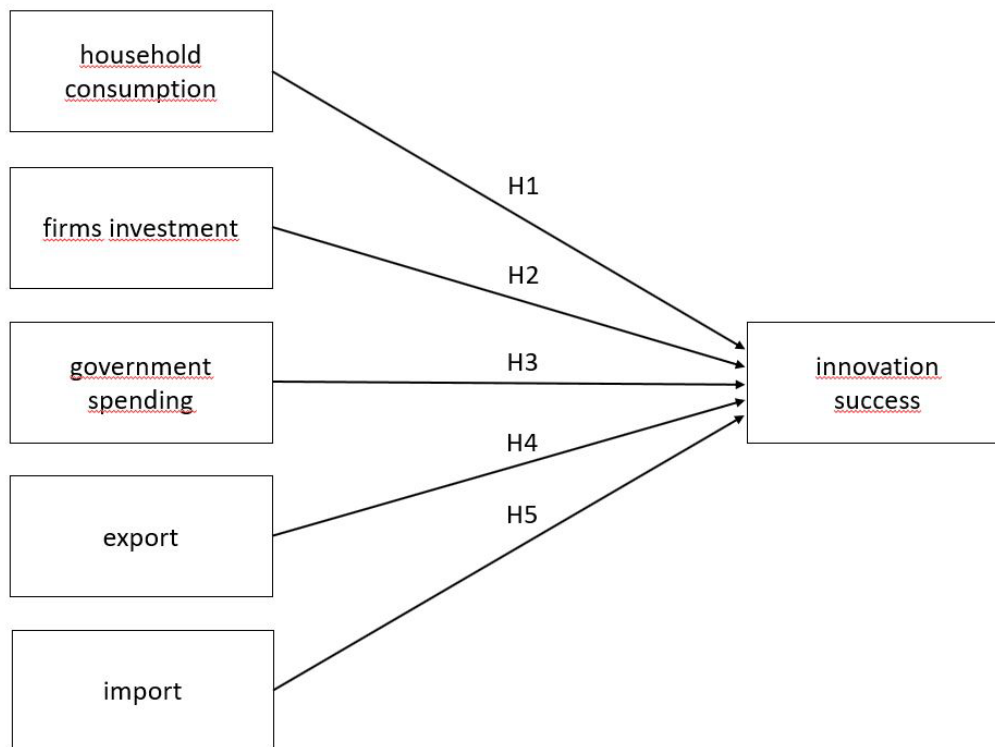


Figure 1: Research framework

3. Data and Methodology

To create the linear regression model that was chosen as appropriate for our analysis, we collected data from 25 European countries. We obtained these data from the OECD and Eurostat databases for the period 2013 to 2021, thus focusing exclusively on the period between the financial crisis and the pandemic crisis with spillovers to the pandemic crisis. The result was a panel dataset that includes 225 observations over 9 calendar years. The countries included are Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France,

Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

To quantify innovation success as a dependent variable, we used a widely accepted international indicator, the Global Innovation Index (GII). The independent variables in our model then represent the individual components of aggregate demand - household consumption (HSC), firms' investment (INV), government spending (GOV), exports (EXP) and imports (IMP). Finally, we supplement our model with a control variable very closely related to innovation – R&D expenditures (R&D). A more detailed overview of the individual variables, including their use in thematically similar studies, is given in the following table (see Table 1).

Table 1: Overview of Variables

Type	Variable	Description	Unit	Source	References
Dependent		Score of Global Innovation Index	Score (0-100)	GII	Rehman et al (2020)
Independent	HSC	Household Consumption	%GDP	Eurostat	d'Agostino and Scarlato (2013); Schot (2018)
	INV	Firms Investment	%change, previous period	OECD	Dyer et al (2016); Fu (2008)
	GOV	Government Spending	Thousands of US dollars/capita	OECD	Salmi (2012); Kokot-Stępień and Krawczyk (2020)
	EXP	Export	%GDP	OECD	Fassio (2018); Cai et al (2020)
	IMP	Import	%GDP	OECD	Chen et al (2017); Montégu et al (2021)
Control	R&D	R&D Expenditures	%GDP	Eurostat	Rehman et al (2020)

Before fitting the regression model, we first normalised the data using the min-max method. This ensured that all variables had the same range and were comparable. We then constructed a linear regression model that allowed us to analyse the relationship between dependent (GII) and independent (HSC, INV, GOV, EXP, IMP) variables. On the basis of the results, we can assess how these factors have an impact on the success of innovation in each country.

The coefficient of determination was also an integral part of our calculation. This allows us to assess how well our regression model fits the real data. A higher value of the coefficient of determination indicates a better fit of the linear regression model to our collected data. For a more detailed description of linear regression, see, e.g., Montgomery et al (2021).

All calculations in this study were performed in Gretl software.

4. Results

Several interesting findings emerge from the results of our linear regression model (see Table 2). The validity of these findings is further enhanced by the coefficient of determination, which reaches a value of 0.710. This means that up to 71% of the variability in the original data is explained by our model. The relevance of our analysis is further underlined by the 99% significance of our chosen control variable (R&D).

Table 2: Regression Analysis Results

Independent	Coeff. Estimate	Std. Error	t-value	p-value	
CONST	0,392	0,081	4,831	2,56E-06	***

Independent	Coeff. Estimate	Std. Error	t-value	p-value	
EXP	1,836	0,426	4,313	2,44E-05	***
IMP	-1,584	0,409	-3,876	0,0001	***
INV	0,255	0,119	2,149	0,0327	**
GOV	-0,136	0,095	-1,436	0,1523	
HSC	-0,475	0,080	-5,900	1,37E-08	***
R&D	0,611	0,050	12,28	1,05E-26	***
R-squared 0.710					

According to the results of the regression model, we first reject hypothesis H1 about the positive effect of household consumption on innovation success. On the other hand, there is evidence at the 99% level that household consumption has a negative effect on innovation success in the selected countries. On the contrary, hypothesis H2 confirms the positive effect of business investment on innovation success, but at the 95% level of significance. With regard to government expenditure, we cannot reject hypothesis H3 of a positive effect on innovation success, as this relationship is not statistically significant. Finally, the different impact on innovation success is illustrated by exports and imports - in both cases these variables are significant at the 99% significance level, but only exports have a positive impact on innovation success. Therefore, we confirm hypothesis H4 and reject hypothesis H5 regarding the positive effect of imports on innovation success.

5. Discussion

The following conclusions are possible about the research hypotheses identified in this study. Hypothesis H1 had to be rejected because in the regression model household consumption showed a negative effect on regional innovation success, which contradicts the claim of d'Agostino and Scarlato (2013) who argue that higher levels of household consumption can have a positive effect on regional innovation. The negative effect in our case can be explained, for example, by the fact that households in European regions often focus more on short-term consumption to satisfy their immediate needs. This in turn may lead regional firms to focus more on short-term products that are already on the market, leaving no room for innovation and research that could bring longer-term benefits to the region. Households may also have limited financial resources to devote to innovative services and products. This can lead to some limitation of the region's capacity to innovate.

We accept hypothesis H2 at the 95% significance level, which can still be considered a significant effect, confirming the positive impact of private investment on the innovation success of the region. This result confirms and complements the findings of Dyer et al. (2016) and Fu (2008), who also agree that private investment by firms has a positive impact on regional innovation. Given the private investment by domestic firms, this result is also consistent with the finding of Hintosh et al (2020), who highlight the positive impact of investment mainly by domestic firms on the innovation success of the region. However, our result is not consistent with Dorzhieva and Kirillov (2019). They find that investment should not be confused with the concept of innovation. However, it is important to point out the similarity between these two aspects of the economy, as our study mainly investigates the impact of private investment by firms and does not try to directly substitute innovation with private investment by firms.

Another aspect of aggregate demand included in hypothesis 3 is government expenditure on the purchase of goods and services, which was found to be insignificant in our regression model, so hypothesis H3 has to be rejected. This result contradicts the results of Avellar (2011) and Kijek (2019), who argue in their studies that public spending is a crucial tool of economic policy to influence innovation in a region. Our result also contradicts the finding of Salmi (2012), according to which the level of public expenditure facilitates innovation practices within a region. However, it is important to note that the model we examined only includes public expenditure on the purchase of goods and services, and thus does not include the total public sector or total public expenditure, which includes science and research expenditure, which was included as a control variable in our model.

Hypotheses H4 and H5 then included the foreign segment, represented in our model by the export and import variables. In the case of exports, we accept hypothesis H4, as exports have a positive parameter at the 99% significance level. This result is not surprising and confirms the claim of Ebling and Janz (1999), Fassio (2018) and Cai et al. (2020) that exports do indeed have a significant impact on innovation activity in a region through firms operating in that region. On the other hand, our results force us to reject hypothesis H5. Imports are significant at the 99% significance level, but with a negative parameter, which means that imports have a negative effect on a region's innovation performance. This result contradicts the findings of Bertschek (1995), Blind (2004), Chen et al. (2017) and Montégu et al (2017), who reported in their studies that imports are positively related to regional innovation. The difference between our results and those of other authors can mainly be explained by the nature of the countries studied. Most countries in the European Union are innovation performers, which means that they are often the carriers of their own innovativeness, which may explain why imports are not an important aspect of their innovative success.

6. Conclusion

From the results of our study, we can conclude that there is a strong relationship between aggregate demand indicators and the innovation success of regions. The implications of our findings are twofold. First, they show the importance of aggregate demand indicators as one of the key determinants of regional innovation success and suggest that policy makers should prioritise aggregate demand stimulation strategies with the clear objective of fostering innovation ecosystems. Second, the observed negative impact of government spending on the purchase of goods and services and the negative impact of imports calls for a critical rethinking of established policy approaches to fostering innovation. Government spending has traditionally been seen as a catalyst for economic growth and regional innovation. However, our findings suggest a somewhat different reality, where indiscriminate or inefficient spending may be hindering rather than facilitating innovation in the regions. Moreover, the negative impact of imports highlights the challenges posed by global economic dynamics. While international trade can facilitate knowledge transfer, it also exposes domestic industry to increased competition from abroad, which can undermine new incentives to innovate. Policymakers therefore need to strike a delicate balance between promoting open markets and protecting domestic innovation capabilities. In light of these implications, policymakers should rigorously assess and recalibrate their spending priorities to ensure that government spending is aligned with innovation objectives and complements rather than hinders private sector innovation initiatives. In addition, there is an urgent need for targeted policies to mitigate the negative impact of imports on domestic innovation ecosystems, such as strategic trade policies, investment in skills development and support for technology adaptation and diffusion.

Our analysis also introduces the positive effect of exports and private investment by firms, as well as a control variable in the form of R&D expenditure. Policy makers should therefore favour policies that promote exports, encourage private investment in innovation and strengthen R&D efforts to create an enabling environment for innovation at the regional level. These results suggest that aggregate demand indicators are one of the most important triggers of a region's innovation success.

Our research also has some limitations. Our research focused on the period 2013-2021, so it would be useful for future research to also cover 2022 and 2023, when the full impact of the current crises and challenges that have shaken the whole of Europe will be felt. Another limitation is the inclusion of the full range of EU countries in our model. For future research, it would be useful to categorise countries according to their innovation performance, for example, as our research included countries that can be considered innovation leaders, but also countries that struggle with low innovation performance. Such a categorisation could therefore yield further interesting results.

Future research should not only focus on aggregate demand indicators, but also include other indicators that are closely related to aggregate demand. For example, extending the model to include labour market indicators could provide insights into innovation success from another perspective - human capital in the labour market.

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