

On the role of innovation and market structure on trade performance: is Schumpeter right?

Kore Guei

University of Johannesburg, Johannesburg, South Africa

Innovation and
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Abstract

Purpose – The goal of the paper is to examine the dynamics between innovation, market structure and trade performance. Firstly, the author first investigates the effects of innovation on trade performance. Secondly, the author then examines how market structure affect trade by classifying industries based on their innovation intensity.

Design/methodology/approach – The author uses a detailed level data set of eight OECD countries in a panel of 17 industries from the STAN and ANBERD Database. The author employs both a pooled regression and a two-stage quantile regression analysis. The author first investigates the effects of innovation at the aggregate level, and then the author assesses the effects at the disaggregated or firm level.

Findings – The author finds that at the aggregate level, innovation and market size have a positive and significant effect on competitiveness in most of the specifications. However, innovation is negatively associated with trade performance in the case of bilateral trade between Spain and the Netherlands. Also, the sectoral analysis provides evidence that the innovation-trade nexus depends on technological classification. The author shows that: (1) the effect of innovation activity on trade performance economic performance is lower for the high technology and high concentration (HTHC) market compared to the low technology (LT) market; (2) the impact of innovation on economic performance is ambiguous for firms in the high technology and low concentration (HTLC) market.

Research limitations/implications – Although the database provides a rich data set on industrial data, it fails to provide innovation output such as patent data which may underestimate the innovation activities of firms that do not have a separate R&D records. In the current context of subdued economic growth these research results have important policy implications. Firstly, the positive impact of innovation on trade performance strengthens its role for sustainable development. The negative coefficient on innovation is an indication that research intensity in some cases has not been able to create a new demand capable to boost economic performance.

Practical implications – The market classification analysis provides new evidence that innovation in the LT market has the potential to enhance competition. Secondly, market size supports industries that are competing in the international market. Policy makers must therefore put in place incentives to encourage firms to grow in size if they want to remain globally competitive.

Social implications – Sustainable development can be supported through investment in research and development in the low technology sector.

Originality/value – The study is the first as far as the author knows, to examine the impact of innovation on bilateral trade performance using industry level data from OECD countries. Secondly, the author complements the existing literature by examining how innovation activities (classified as high technological intensive or low technological intensive) affect trade performance.

Keywords Trade, Innovation, Trade performance

Paper type Research paper

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1. Introduction

There is the need for policy makers to understand the mechanisms through which innovation policy can support higher GDP growth especially for the post COVID-19 pandemic period. In that context, the EU leaders have proposed a budget of over US\$ 180 billion for the period 2021–2027 (European Commission, 2020). They stress that spending on innovation and research can enhance productivity. One of the goals of this fund is to create a financing instrument that can support job creation and build a more social and inclusive society.

Despite the needed resources to recover from the coronavirus, some are against this recovery plan. This has sparked a debate on how best the funds need to be allocated to recover from the pandemic and fuel economic growth. The question that arises is how effective innovation policies can ensure a sustainable recovery. Understanding the factors that influence trade performance can provide policy makers new knowledge on how economic growth and standard of living can be sustained.

In early literature, the role of innovation on economic growth has been emphasized on endogenous growth models (Grossman and Helpman, 1991; Romer, 1990). Much of the empirical literature on how technology affects trade documents that innovation is an important determinant of trade performance. For instance, Eaton and Kortum (1996) examine the role of innovation and the diffusion of technology among a panel of OECD countries. They find that technological knowledge contributes to more than half of productivity growth for all the countries examined except the United States. Their study also shows that innovation in Germany, the United States and Japan spur more than half of the growth in OECD countries.

Phelps (2013) argues that prosperity in many advanced economies occurred as a result of widespread technological invention. This translated into a higher standard of living, wealth accumulation and better jobs for people. In the same context, Peters *et al.* (2018) highlight the important role of innovation in contributing to higher productivity in service enterprises. Overall, the empirical literature indicates that technology is an important determinant of trade performance.

Scarpetta and Tressel (2002) examined the impact of innovation activity on multi-factor productivity. They find that productivity convergence across OECD countries is stronger in the services sector compared to the manufacturing sector. They also provide evidence that there is a feeble convergence in productivity in the high-tech industries. Crespi *et al.* (2014) in their work investigate and compare the determinants of innovation and labor productivity at the firm level in Latin America. They show that innovation activity leads to improvement in the production process.

Although several studies have examined the importance of technology spillover on trade, none of them has given attention to the link between bilateral trade performance and market structure. It has been documented that industries characterized by high research and development outlays such as the electronics sector tend to grow faster than other industries (Fagerberg, 1997). It is important to understand the role of innovation, market structure and trade performance especially with the stagnant growth countries are experiencing.

One of the most important components of global market entry is exporting. It enables market efficiency and flexibility. With the competitive nature of the business environment, exporting has become an essential tool for industries' growth (Golovko and Valentini, 2011). However, there has been no satisfactory theoretical explanation on how success in the export market is determined. It is important to understand the role of innovation, market structure on trade performance especially with the stagnant growth countries are experiencing.

The author expects technology to have different effects on trade depending on each country relative investment in research and development and patents. Also, technological spillover through export varies if countries export or import products with different quality in the same or different industries. Hence in this paper, we study the link between market structure and innovation empirically.

For the modeling analysis, the econometric approach is based on a production function that allows for innovation and market size. The model the author employs resembles that of Sanyal (2004) in which he assesses how relative innovation and factor endowment affects export performance in 10 intra-OECD countries.

Empirical studies on market structure classification have identified three types of market according to the degree of market concentration and the innovation's returns. For example, when the revenue from innovation is moderate, the amount of investment devoted to it will be small. This setting indicates low-tech industries (LT) (see Scarpetta and Tressel, 2002). It represents a market in which firms compete aggressively on price which is approximately equal to the marginal cost.

However, if the revenue from innovation is large, firms will spend large amount in innovation to increase the production process. In such case, the market may react differently, leading to different or one trajectory. When firms embark on different trajectories (product differentiation), it implies that there will always be a demand for a new product and an increasing number of producers. Such industry is referred to as the high-tech low concentration (HTLC) market. In such market each firm has some monopoly power which is reduced because of free entries of new firms. If high revenues from innovation can be obtained through one trajectory, such market is referred as the high-tech high concentration (HTHC) market in which few firms control the market.

Hence the study first contributes to the literature by providing a complete understanding of the effects of innovation on trade performance at the country level. The second objective of the paper is to examine the innovation and trade performance nexus by grouping industries according to their market classification. Also, few studies have examined the relationship between bilateral trade performance and innovation across firms. This is crucial for labor productivity and also for sustainable development in the current context of the world economy.

In determining bilateral trade performance, the author uses the ratio of exports between two countries, namely country m to country n over exports from country n to country m in a sector s . The author adds other important determinants of trade flow such as market size and labor cost identified in the general equilibrium model of trade to capture factor endowment and productivity, respectively. The inclusion of these variables has been supported in the literature (see Egger and Pfaffermayr, 2005; Grossman *et al.*, 2006) for a detailed review.

The paper attempts to address two main issues between innovation and trade performance. First, the author investigates the relationship between innovation and trade performance across countries. Generally, studies in the literature have either focused on one or several countries. Because countries have different characteristics in terms of natural endowment and national policies, the author investigates trade performance for each bilateral trade setting. The second issue is related to the differences in innovation intensity across sectors. Therefore, the author argues that it is necessary to group each sector based on their R&D intensity and evaluate their impact on trade. This helps to understand whether industries classified as HTLC, HTHC or LC play an important role in influencing trade performance.

The remainder of the paper is organized as follow: The next section presents evidence on technology innovation and market structure. Section 3 discusses the analytical framework of the model. Section 4 describes the data set and the econometric approach used in the analysis. Section 5 presents the results. Section 6 summarizes the findings and concludes.

2. Literature review

2.1 Innovation and trade performance

Early empirical studies on trade performance have incorporated innovation as an independent variable in their model. In the Hecksher–Ohlin model of trade, relative factors

determine the pattern of trade. The early work of [Fagerberg \(1997\)](#) shows that technological competitiveness measured by R&D and patents expenditures have a significant effect on the exports of OECD countries. Any factors that boost export demand can also increase growth. The nexus between trade and growth has been examined by research that emphasizes the role of R&D, returns to scale and learning for growth. The work of [Lucas \(1988\)](#) considers significant differences for technological progress which is captured by learning. He shows that countries that specialize in high technology industries tend to benefit from higher growth than those that do not. This approach suggests that the capacity to specialize toward more technological intensive industries is an important factor for trade performance.

[Grossman and Helpman \(1991\)](#) reached a similar conclusion by highlighting the importance of R&D and its spillover effect on trade and economic growth. They show that countries with a large domestic market that spend a large share of their resources to R&D will be more likely to grow faster and specialize in high technological industries.

Since then, a large body of literature has studied the implications of technological adoption and its impact on firms' productivity (see [Scarpetta and Tressel, 2002](#); [Griffith et al., 2004](#); [Cainelli et al., 2006](#); [Crespi et al., 2014](#); [Busom and Vélez-Ospina, 2017](#)).

The concern over the years has been the interaction between market structure and the specialization patterns of countries with the aim to understand the driving factors behind a country's trade performance. [Madsen \(2008\)](#) examines the ability of innovation and product variety to explain manufacturing exports. He finds that innovation does not influence total exports from OECD countries but only influences relative performance among countries.

In a study on manufacturing firms in Korea, [Hahn and Choi \(2017\)](#) investigate the bi-directional effect of innovation and export performance. They find that innovation activities influence positively exports and vice-versa. They identify the interactivity between firms and external agents to be one of the possible reasons for this effect.

Recent research on the innovation-trade performance relationship suggests technological innovation is crucial factor in the exporting activities of firms ([Azar and Ciabuschi, 2017](#)). This study strengthens the idea that innovation enables firms to gain competitive advantage in the global markets.

Similarly, [Wadho and Chaudhry \(2018\)](#) suggest that export is positively related to innovation performance. The study reveals that manufacturing firms that export to developed countries tend to participate more in innovation activities. They also show that firms that devote substantial investment in innovation are more productive than those with less investment.

[Tavassoli \(2018\)](#) assesses the impact of innovation on exports' behavior of Swedish firms. He shows that innovation output has a positive relationship with firms' exports. This finding is robust whether or not the model includes the firm's specific characteristic such as size, productivity and physical capital.

Further, the introduction of a new product may require new marketing strategies. [Lee et al., \(2019\)](#) reveal that the relationship between new products and the performance of firms rises with marketing innovation. This implies that technological and marketing innovations can strengthen each other, thereby improving firms' performance. On this basis, the author proposes the following hypothesis:

H1. There is a positive relationship between innovation and trade performance.

2.2 Innovation and market structure in OECD countries

Before turning to the empirical analysis, this section shows the innovation patterns and market structure in a sample of OECD countries. Innovation is a significant factor for product differentiation as it introduces new features and enables firms to achieve higher product quality. [Schumpeter and Opie \(1961\)](#) argued that innovation activities led individuals to

accumulate private properties and consumer preferences cannot cause economic changes. Consumers play a passive role in the economic development process which led him to the conclusion that innovation is the reason for economic change. Hence, innovations are necessary for economic growth. Although there is an extensive literature that has examined the impacts of market structure on economic activity, a definite conclusion has been difficult to establish.

Other studies (Aghion *et al.*, 2005; Gilbert, 2006; Piekkola and Rahko, 2020) challenged Schumpeter’s theory that monopoly power is more conducive to innovation. Aghion *et al.*, (2014) for instance find that firms that have lower level of competition have a lower incentive to invest in research and development. The author attempts to reconcile these two views by examining the time series evidence of technology in a different market.

Figure 1 below shows the average spending on technology in eight OECD countries over the period 2009–2016. The author chose this period for comparative purposes and present the amount devoted to technology for nine different industries based on market classification. In Figure 1, the HTLC market which is represented by pharmaceutical products, machinery and equipment and computer and electronic products has the highest investment in technology. The HTHC market represented by motor vehicles, electrical equipment and chemical products devotes on average US\$ 800 million. The LT market represented by wood and paper products, rubber and plastic products and food and beverages spends the least on technology.

Another interesting feature the graph reveals is that high concentration industries (monopoly or oligopoly) devote more resources to research and development. This is in line with Schumpeter’s view on competitive firms and innovation. The author also observes a rapid increase in innovation activities in most of the industries during the last decade especially in machinery and equipment, and motor vehicles which are highly intensive research activities. Computer and electronic equipment industry on the other hand, display a declining pattern. In this study, the author attempts to examine empirically the impact of innovative activities in high concentration industries by comparing the role of innovation in different market structure.

The author expects the coefficient on innovation to have a positive sign. This is because investment in R&D allows bringing in new products in an industry and enhances the quality of the existing ones, thereby improving economic performance (Crespi *et al.*, 2015). If the level of spending on machines grows over time, and the performance of machines are more efficient

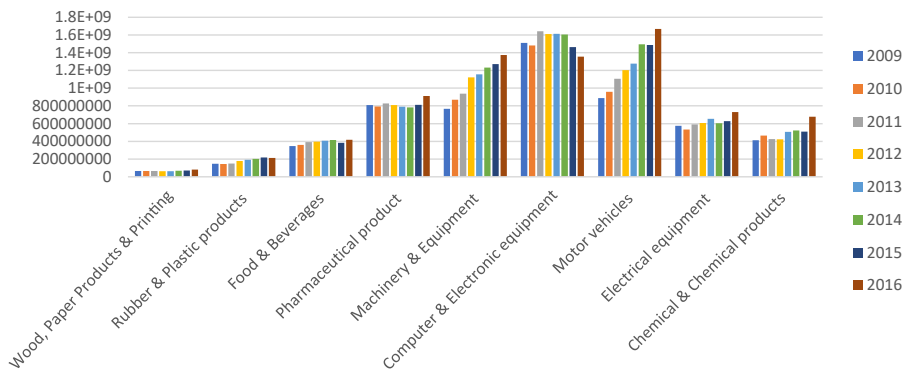


Figure 1. Investment on research and development by industries

Note(s): The following countries are included in the figure: France, Germany, Italy, Austria, Spain, Netherland, United Kingdom, Finland

than labor employed, then capital stock is expected to increase bilateral trade. Assuming this dynamic is the same for all industries, it has the potential to improve competitiveness in the economy. Capital stock and trade performance are expected to be positively associated. The author also expects a positive nexus between apparent consumption and trade performance. The author follows the convergence hypothesis of (Markusen, 2002) which suggests that a large market size tend to increase the performance of economic activity. A higher labor cost or compensation in the parent market constitutes a barrier to exports in the host market. However, a significant value added supports bilateral trade. Because labor cost can either exceed or be inferior to value added depending on a firm' ability to make profit; the author considers the sign of labor input to be ambiguous.

3. Empirical framework

The interest of this paper is based on the relationship between innovation, trade and market structure. Although the link between innovation and trade seems evident, it is difficult to demonstrate. Innovation can be related to trade in the sense that it enables to improve the distribution channel and to access new markets.

The goal of this paper is to understand how relative innovation and resource endowments impact trade performance. The modeling estimation starts with the factors that can impact economic or trade performance in a group of Z countries ($i = 1, \dots, Z$) and J industries ($j = 1, \dots, J$). Trade performance in a country is influenced by technological factors and resource endowments. The author also assumes that production in each industry j and country i at a time t takes the following form:

$$Y_{ijt} = F_j A_{ijt} (K_{ijt}, L_{ijt}) \quad (1)$$

where K stands for physical capital, L is labor and A denotes technical efficiency or technology that changes across each industry, country and the time period.

Hence the production function can be re-written as a Cobb–Douglas production function:

$$Y_{ijt}/L_{ijt} = (Y_{ijt}/L_{ijt})^\alpha A_{ijt} \quad (2)$$

The author then estimates a log-linear regression of the Cobb–Douglas function:

$$y_{ijt} = k_{ijt} + a_{ijt} \quad (3)$$

International competitiveness is defined as the ability to sell goods in the international market in the presence of other competitors. Bilateral export has been used in the literature to measure competitiveness. It is defined as the ratio of exports from country m to country n over exports from country n to country m in an industry s . The subscript m refers to the parent country, n is the bilateral partner or the host country and s represents the NACE industry.

$$y_{mns}/y_{nms} = f[(k_{ms}/k_{ms}), (a_{ms}/a_{ms}), (l_{ms}/l_{ms})] + u_{ts} \quad (4)$$

Following the model of Sanyal (2004), the dependent variables (y) represent trade performance which is defined as bilateral trade, (k) which stands for capital stock, captures the capital stock to the number of persons employed in a sector s , (a) is the innovation intensity variable which measures R&D expenditure in a sector s , (l) captures labor input which is defined as labor compensation over value added in a sector s . The author augments the modeling specification by including apparent consumption at an industry level which represents market size in the analysis. Siedschlag and Zhang (2015) have stressed the importance of size in determining productivity. Market size is an important determinant of intra-firm exports (Markusen and Keith, 2002; Egger and Pfaffermayr, 2005).

$$y_{mns}/y_{nms} = f[(k_{ms}/k_{ns}), (a_{ms}/a_{ns}), (l_{ms}/l_{ns}) + (a_{cms}/a_{cns})] + u_{ts} \quad (5) \text{ Innovation and market structure}$$

The log-linear model takes the following form:

$$\ln(y_{mns}/y_{nms}) = \beta_0 + \beta_1 \ln(k_{ms}/k_{ns}) + \beta_2 \ln(a_{ms}/a_{ns}) + \beta_3 \ln(l_{ms}/l_{ns}) + \beta_4 \ln(a_{cms}/a_{cns}) + u_{ts} \quad (6)$$

The literature identifies three main aspects that characterize the market environment of industries. The first element corresponds to the entry barriers such as economies of scale due to technological opportunity. The second issue is related to sunk costs which constitute another barrier to entry. Lastly, products can be differentiated horizontally when consumers are able to attach a value to it.

The author then follows the market classification of (Scarpetta and Tressel, 2002) and identifies three types of industries. For the LT industries, The author includes basic metal and fabricated metal products, coke and refined petroleum products, food products, textile and wearing apparel, wood and paper product and printing, building of ships and boats. Also, the author groups pharmaceutical products and pharmaceutical preparations, audiovisual and broadcasting activities, computer and electronic products, machinery and equipment, manufacturing and telecommunication in the HTLC industry. The author considers chemicals and chemical products, electrical and optical equipment, motor vehicle trailers and semi-trailers, and transport equipment in the analysis of the HTHC industry. Following this reasoning, the regression equation for the market structure becomes:

$$\ln(T_{mns}/T_{nms}) = \beta_0 + \beta_1 \ln(k_{ms}/k_{ns}) + \beta_2 \ln(a_{ms}/a_{ns}) + \beta_3 \ln(l_{ms}/l_{ns}) + \beta_4 \ln(a_{cms}/a_{cns}) + u_{ts} \quad (7)$$

where (T_{mns}/T_{nms}) represent bilateral exports based on market classification as discussed above. Thus, the analytical framework allows us to investigate further the role of diverse patterns of innovation on trade.

4. The data set and methodology

4.1 The data

The sample consists of 17 industries in the manufacturing and business services sector in eight OECD countries over the period 2000–2017. The countries included in the analysis are: France, Germany, Italy, Austria, Spain, Netherland, United Kingdom and Finland. Thus, a total of 1,360 observations in the analysis is obtained. The author attempts to capture the largest possible data for the empirical analysis. However, for the innovation indicator (the main variable) the latest period available from the database starts from the year 2000. The time span covered was chosen mainly because of the availability of innovation data which is proxy as R&D. The raw data from several sources is obtained. The author obtains capital stock, number of employed, labor compensation and value added from the OECD Stan database 2020. Data on R&D by industry is taken from the ANBERD database. The author calculates labor input by dividing labor compensation over value added. Market size for each industry (parent and host) is proxied as apparent consumption. The calculation of the latter is given as gross output minus imports plus exports for each year. Imports and exports flow are extracted from the OECD bilateral trade database. Table A3 in Appendix section provides the definition for the measurement variables.

4.2 Econometric methodology

The goal is to estimate equations (6) and (7) on a pool annual time series for each bilateral setting. Before proceeding with the econometric estimation, the author first checks the

presence of heteroskedasticity in the data. The author considers the following bilateral setting: France–Germany, Italy–Austria, Spain–the Netherlands, the United Kingdom–Finland. The author also employs robust standard error to deal with potential heteroskedasticity in the model. The stationarity of the data is then examined through the implementation of a unit root test. A panel unit root test which shows that the series are stationary is conducted. These findings suggest that we can safely investigate the role of technology on economic performance. The author considers France, Italy, Spain and the United Kingdom to be the parent countries while Germany, Austria, the Netherlands and Finland are the host countries.

Also, the author removed outliers in the sample by focusing on data that departs away from the mean to minimize the risk of a bias estimation. Thus, the author excludes industries with innovation growth rate that are more than five standard deviations away from the mean value in each bilateral trade.

Although the full sample covers the period 2000–2017, the starting period for each country-pair is restricted by the availability of R&D data as noted in the section above. The author obtains a strongly balanced panel data for all the specifications which allows us to make a fair assessment of the effects of innovation activity on export performance. The author first presents the results of baseline regression by using a pooled OLS estimation and a quantile regression to obtain consistent parameters. The literature has well documented the use of pooled OLS in quantitative studies to study the effects of institutional determinants of trade performance and macroeconomic policies. Thus, the intercept terms are restricted to be the same for each country-pair. The coefficients were initially permitted to change across countries. However, the estimated results appear to be insignificant for all the explanatory variables. One possible explanation can be related to the changing patterns of unobserved parameters, which can have an effect on bilateral trade over time and may lead to a biased estimate in the case of fixed-effects model.

The quantile regression model allows estimating the difference between the elasticities of trade performance in each bilateral pair. The author investigates the possible innovation–trade performance nexus using three quantiles ($\theta = 0.25, 0.50, 0.75$). The regression results for the quantile ($\theta = 0.25$) do not lead efficient estimates. Hence, the author reports the 0.50, 0.75 quantile regression only. The quantile regression is used as a sensitivity test because of its ability to consider unobserved heterogeneity in the data. The next section reports the results (see [Table 1](#)).

5. Estimation results

The author now tests the empirical hypothesis that innovation activity does contribute to a higher trade performance. [Table 2](#) reports the results of estimating [equation \(6\)](#). Even though the data shows a rise in capital stock over time, the log value for capital stock is significantly positive only for column 3. In the remaining specifications cases however, the coefficients are significantly negative. These results appear to be in contradiction with the *a priori* expectation. This calls into question the idea that increasing the investment in capital stock automatically improves the trade performance. The coefficients on apparent consumption are positive and significant at the 1% level for all the estimations. This suggests that market size has a positive effect on trade performance. In other words, the larger the size of a sector, the better its ability to trade. This is in accordance with the literature that finds a positive relationship between firms' size and exports' performance ([Nazar and Saleem, 2009](#)). Turning into the labor input coefficients, The author finds a positive and significant relationship in column 1 and 3. Labors are paid based on the value they contribute to the firms. The author also observes a rising trend in value added. These results indicate that workers contribute positively to the advancement of firms.

Authors	Sample	Methodology	Model	Main results
Barrère et al. (2022)	Uruguayan Manufacturing Firms (2010–2015)	The relation between innovation and export for a firm located in a developing country to the destination (developed or developing country)	Probit regression model	Innovation precedes exports when the export market is a developing country Firms are not able to adapt with both innovation and export strategies when the export market is a developed country
Aghion et al. (2018)	French Manufacturing firms (1994–2012)	Exporters vs. non-exporters	Linear OLS specification	A shock in export demand has a positive impact on innovation in high productivity firms whereas it might negatively impact innovation in low productivity ones
Caldera (2010)	Spain, 1990–2000	Exporters vs. non-exporters	Probit model	Innovation and productivity enhances the probability of exporting
Becker and Egger (2013)	Germany 1994–2004	Exporters vs. non-exporters	Matching techniques	Product innovation increases the propensity to export
Sanyal (2004)	OECD countries, 1980–1998	Bilateral exports	Linear OLS specification	Innovation influences bilateral trade. The effect is higher in the high-technology sectors

Table 1. Empirical studies on the link between innovation, exports and market structure

	(1)	(2)	(3)	(4)
Log (innovation)	0.064*** (0.017)	0.257*** (0.076)	−0.601*** (0.148)	0.468** (0.228)
Log (apparent consumption)	0.090*** (0.017)	0.677*** (0.093)	1.027*** (0.144)	2.346*** (0.360)
Log (capital stock)	−0.088*** (0.029)	−0.481*** (0.118)	0.363** (0.138)	−1.259*** (0.370)
Log (labor input)	0.135*** (0.030)	0.198 (0.217)	0.869*** (0.239)	−0.578 (0.708)
Observations	165	216	130	104
Group	France–Germany	Italy–Austria	Spain– the Netherlands	The United Kingdom–Finland
R-squared	0.330	0.345	0.385	0.525

Table 2. Pooled OLS estimates (the dependent variable is trade performance)

Note(s): * denotes significant at 10% level; ** significant at 5% level; *** significant at 1% level. Numbers in parentheses indicate robust standard errors

For the variable of interest, the coefficients are significant and positive for column 1, 2, 4 and only negative for column 3. The positive coefficients imply that innovation activity has a positive effect on trade performance. The results from column 3 contrast with the hypothesis testing. This finding however should be cautiously examined because R&D in the pair (Spain-Netherlands) has been declining over time. This trend can be a possible reason for the negative association between innovation and bilateral trade.

Table 3 reports the results using a quantile regression model. Several studies in the empirical literature have used IV regressions or OLS, which assume parameter homogeneity. This may lead to a false conclusion if there is heterogeneity in the data under analysis. Put it differently, a positive effect of innovation on growth found in a bilateral trade may vary in other country-pairs because of different data patterns. Therefore, the author employs a two-stage quantile method to improve the traditional technique. The author presents the results using two quantiles ($\theta = 0.50, 0.75$). One of the important findings is that altering the conditional distribution only significantly affects the sign of the capital stock coefficient for the United Kingdom–Finland bilateral trade. There are no significant changes in the coefficients of the variable of interest (innovation), which only reduces with a higher quantile. The results are similar to the work of (Mohnen and Hall, 2013) which show that innovation leads to better productivity performance. The coefficient on labor input becomes negative and significant in the case of Italy–Austria. This implies a low contribution which can be attributed to the reduction in value added. With regards to apparent consumption, there is positive and significant effect at the 1% level for the 75th quantile of distribution for each country-pair. The results show that on average a 1% increase in economic size leads to (0.2%–1.5%) increase in bilateral exports. Overall, the sensitivity test supports the findings that innovation activity does not always contribute to increase in export performance.

Technological intensity is an important factor of international competitiveness and productivity. However, there are also considerable differences in terms of investment on R&D across industries and sometimes within the same industries. It may be misleading to conclude that all firms commit the same amount on their innovation. The paper attempts to provide evidence on how different market structure affect economic performance. Hence there is the need to further investigate if technological concentration plays a role in influencing trade performance. Table 4 shows the results of estimating equation (7). Different market conditions lead to high or low returns to innovations. This context allows us to examine the effects of market structure on trade performance. For comparative purposes the author considers 14 industries in each sub-group under investigation. The author also aligns the time period (2009–2016) for the analysis in order to evaluate whether high-tech or low-tech industries have different effects on competitiveness. For each bilateral pair France–Germany, Italy–Austria, Spain–Netherlands and the United Kingdom–Finland, the author includes the following industries: (1) For the LT market the author considers Food, Wood, Rubber; Food, Wood, Rubber; Basic metal, Food, Wood, Rubber; Basic Metal, Food, Wood, Rubber. (2) For the HTLC market the author considers Pharmaceutical, Computer; Machinery, Manufacturing; Pharmaceutical, Computer, Machinery, Manufacturing; Pharmaceutical, Computer, Machinery, Pharmaceutical, Computer, machinery. (3) For the HTHC market the author considers Chemical, Electrical, Motor, Transport; Chemical, Electrical, Motor, Transport; Chemical, Electrical, Motor; Chemical Electrical Motor, respectively.

Looking at the results from Table 4, only the innovation coefficients on the LT and HTHC regressions are significant. The author observes a non-significant value on innovation for the HTLC regression, which is consistent with the work of (Cainelli *et al.*, 2006). This is an intriguing result, hence the author tries to replace some the industries initially used to re-examine the innovation-trade performance nexus for this particular market. The author substitutes machinery industry by manufacturing one. The results are provided in Appendix section. The estimated effect of innovation on trade performance is negative and significant (see Table A2). The results provide two reasoning for the HTLC market: (1) innovation investment does not enhance bilateral exports; (2) innovation worsens exports performance. One possible reason for these findings is that firms in this market have reached their production possibilities frontiers. Hence any increase in research becomes either irrelevant or put a downward pressure on the sector's economic growth. Since firms invest large amount on R&D projects, which are considered to be fixed costs in the firms' balance sheet, the rate of

	(1)	(2)	(3)	(4)
Log (innovation)	0.50 -1.488 (3.878)	0.75 0.166*** (0.043)	0.50 0.161*** (0.022)	0.75 0.012 (0.025)
Log (labor input)	-7.402 (17.563)	0.214*** (0.049)	0.203*** (0.044)	0.3*** (0.032)
Log (capital stock)	2.915 (6.797)	-0.290*** (0.075)	-0.736*** (0.060)	0.3*** (0.032)
Log (labor input)	4.790 (9.933)	0.286*** (0.080)	-1.387*** (0.080)	-0.386*** (0.046)
Observations	165	165	130	104
Group	France-Germany	Italy-Austria	Spain-Netherlands	The United Kingdom-Finland
Note(s):	* denotes significant at 10% level, ** significant at 5% level, *** significant at 1% level			

Table 3.
Two-stage quantile
regressions (dependent
variable is trade
performance)

Table 4.
Innovation and the
market structure

	Log (trade performance) LT	Log (trade performance) HTLC	Log (trade performance) HTHC
Log (innovation)	0.596*** (0.179)	0.148 (0.149)	0.138*** (0.035)
Log (apparent consumption)	0.512*** (0.238)	0.481*** (0.106)	0.227*** (0.033)
Log (capital stock)	1.879*** (0.306)	0.265** (0.120)	0.244*** (0.050)
Log (labor input)	0.308 (0.384)	-0.113 (0.220)	-0.406** (0.192)
Observations	112	112	112
R-squared	0.438	0.546	0.789

Note(s): * denotes significant at 10% level; ** significant at 5% level; *** significant at 1% level. HTHC, HTLC and LT stand respectively for High-Technology High Concentration, High-Technology Low Concentration and Low-Technology industries

returns or the firms' sales must be high enough to compensate for these costs. If this is not the case, it will limit the firms' ability to grow and remain competitive.

In the high concentration market, a 1% increase in innovation causes a 0.13% rise in exports. This finding supports the common argument that concentrated market structure compliments technological development, with a higher GDP and a higher welfare. In the low technology market, the innovation coefficient is the highest highlighting the potential these low-tech industries can play in the pursuit of sustainable development.

With regards to apparent consumption and capital stock, the coefficients on these variables are positive and significant for all the estimations. This confirms the hypothesis that firm size and capital stock improve economic performance. Also, the coefficient on labor input is only significant in the high concentration market. Even though in the LT and HTLC market, the coefficients are positive and negative, they are not significant. These findings support the hypothesis that labor input has an ambiguous effect on economic performance.

An interesting aspect of the study is the investigation of the dynamics between innovation, market structure and trade performance. The paper highlights the importance of innovation in the LT and HTLC market. A 1% increase in innovation in the LT industry leads to a 0.59% rise in trade performance. This suggests that industries that are not highly R&D intensive contributes strongly to exports growth. The LT industry is a fast-growing sector that offers a high level of market opportunity.

6. Conclusion

The paper aims to provide an understanding on the links between innovation, market structure and trade performance. Separating industries based on their level of innovation will help to understand if a particular market has a stronger potential for exports' growth.

In order to classify industries, the author adopts a two-way classification method where industries are grouped based on innovation's profitability and the degree of market concentration. The econometric analyses show the crucial role of innovation in enhancing trade performance at the aggregate level. On one hand, innovation and trade performance are positively associated in three of the specifications. On the other hand, innovation influences trade performance negatively in the case of the country-pair (Spain–the Netherland). The empirical evidence for the OECD countries used also reveal that market size has a positive and significant effect on bilateral exports. Conversely, the sign of capital stock and labor input are ambiguous.

Regarding market structure, innovation activities improve trade performance in the LT and HTHC market. The results indicate that for the period under study, innovation activities have a higher impact on trade performance in the LT market. Innovation activities in the

HTLC market however are unclear. These findings do not support Schumpeter's theory of innovation that only firms that have market power can support the costs of innovation.

In the current context of subdue economic growth these research results have important policy implications. Firstly, the positive impact of innovation on trade performance strengthens its role for exports' growth. The negative coefficient on innovation should be examined cautiously because innovation investment has been declining in the country-pair (Spain–the Netherland). The market classification analysis provides new evidence that innovation in the LT market has the potential to enhance trade. Policy makers must also support and encourage firms' growth since they contribute to a country's export growth.

Another interesting aspect of the study is the investigation of the dynamics between innovation, market structure and trade performance. The paper highlights the importance of innovation in the LT and HTLC market. A 1% increase in innovation in the LT industry leads to a 0.59% rise in trade performance. The managerial implication is that industries that are not highly R&D intensive contributes strongly to exports' growth.

One of the limitations of this study is that it uses spending on research and development to capture innovation. However, some industries rely more on R&D activities for developing process innovations. Using only this indicator can produce some measurement errors, because it does not capture innovation output. Thus, it underestimates the innovation activities of firms that do not have a separate R&D records.

Although innovation influences trade, the various lockdown measures and restrictions in different sectors have led countries to re-examine their innovation investment activities. Future study could examine the impact of COVID-19 on innovation and its implications on trade. This would complement the understanding of the relationship between innovation and trade while at the same time provides a more robust framework for policy analysis in times of economic shocks.

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Further reading

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Corresponding author

Kore Guei can be contacted at: marcqueik@gmail.com

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Industry name	ISIC code (rev. 3)	Market structure
Food products, beverages and Tobacco	15–16	LT
Basic metal and fabricated metal	27–28	LT
Textile, wearing apparel, leather and related products	17–19	LT
Wood, paper product and printing	20–22	LT
Coke refined petroleum products	23	LT
Basic pharmaceutical products and pharmaceutical preparations	2,423	HTHC
Rubber and plastic products	25	LT
Building of ships and boat	351	LT
Manufacturing c	36	HTLC
Machinery and equipment n.e.c	29–33	HTLC
Audiovisual and broadcasting activities	32	HTLC
Computer, electronic and optical equipment	30–33	HTLC
Communication	32	HTLC
Chemical and chemical products	24	HTHC
Motor vehicles, trailers and semi-trailers	34	HTHC
Electrical equipment	31	HTHC
Transport equipment – air spacecraft and related machinery	34–35	HTHC

Note(s): HTHC, HTLC and LT stand respectively for High-Technology High Concentration, High-Technology Low Concentration and Low-Technology industries

Table A1.
Industries considered
in the sample

	Log (trade performance) LT	Log (trade performance) HTLC	Log (trade performance) HTHC
Log (innovation)	0.596*** (0.179)	–0.554*** (0.114)	0.138*** (0.035)
Log (apparent consumption)	0.512*** (0.238)	0.764*** (0.079)	0.227*** (0.033)
Log (capital stock)	1.879*** (0.306)	0.357*** (0.085)	0.244*** (0.050)
Log (labor input)	0.308 (0.384)	0.244 (0.156)	–0.406** (0.192)
Observations	112	112	112
R-squared	0.438	0.671	0.789

Note(s): * denotes significant at 10% level; ** significant at 5% level; *** significant at 1% level

Table A2.
Innovation and the
market structure

Variables	Definition
Innovation	It measures R&D expenditures undertaken by business enterprises
Apparent consumption	It is defined as gross production minus exports plus imports in each year. It captures market size for each industry
Capital stock	It represents capital stock to the number of persons employed in a sector
Labor input	It measures labor compensation divided by value added

Table A3.
Variable description