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Macroeconomic factors, liquidity issues and research and development investments: empirical evidence from the EU pharmaceutical industry

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Abstract
In recent decades, the business landscape is influenced by corruption, a pervasive phenomenon, faced by all countries, irrespective of their stage of development. The pharmaceutical industry is recognized as a "fertile ground" for corrupt practices. The paper aims to investigate the impact of corruption, economic freedom, and gross domestic product (GDP) growth on research and development (R&D) investment using a dataset of European Union (EU) pharmaceutical companies from 2011 to 2019. It also investigates the moderating effect of liquidity issues on the relationship between corruption and R&D investment. The study employs a quantitative approach using fixed effects models. Results show that corruption has a negative influence on pharmaceutical firms' decision to undertake R&D activities, while economic freedom and GDP growth have a positive and significant impact on R&D investment. The findings are especially important given the deleterious effects of corruption and may be useful for both managers and policy-makers.

Keywords: R&D, corruption, liquidity issues, pharmaceutical industry

Introduction

Innovation is crucial for the pharmaceutical industry. At the heart of innovative activities lie research and development (R&D) investments. An unfavourable institutional environment may lead to inappropriate behaviour regarding R&D investment decisions, particularly in the case of pharmaceutical companies which have a high level of control over the R&D activity. In recent decades, R&D behaviour and its determinants have represented a concern of economists. The institutional theory is considered more adequate for explaining the significant trends of R&D expenditures than other firm-level theories (Alam et al., 2019). Institutions are considered a "heart determinant" of investment in general (Hashi & Stojcic,

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2013). Wang (2010) stated that the extent of R&D investments can be more easily explained by institutional factors.

Pattit et al. (2012) also noticed that R&D activities may be better explained by institutional factors. Using a panel of Korean pharmaceutical firms, Sung (2019) shows that firm-level innovation is affected by government policies. As previous studies show, innovation is encouraged by better developed financial markets (Hsu et al., 2014), frequently associated with economic freedom (Hafer, 2013). At the same time, Alam et al. (2019) demonstrated that in emerging markets, political instability and corruption adversely influence a firm's R&D investment, while strong laws and regulation of the country and effective government have a significant positive effect. Several researchers (Brown, 2013; Martinez et al., 2017) argue that corruption is developed on account of a weak legal framework. De Rosa et al. (2010) see corruption as a negative institutional factor that depresses R&D investment through increased transaction costs and uncertainty. Nevertheless, Alam et al. (2019) considered these studies insufficient to clarify the effect of institutional factors on R&D investment. According to official statistics, the health sector is a top investor in R&D (European Commission, 2020).

Corruption in the pharmaceutical sector has a detrimental effect on the population's level of health. An IMF (International Monetary Fund) study (Gupta et al., 2000) concludes that countries with high incidences of corruption are associated with higher Infant Mortality Rates. These results are borne out by a recent study (Dincer & Teoman, 2019) that finds a strong association between corruption and infant mortality.

Ultimately, pharmaceutical companies are profit-maximizing and corrupt practices are more common than one would expect. Two of the most popular pharmaceutical companies, especially in the context of the Covid-19 pandemic, Pfizer Inc and Johnson & Johnson, were charged with violations of the "Foreign Corrupt Practices Act" (FCPA). Their employees were accused of bribing doctors to "reward" them for prescribing or ordering the firm's products (Peltier-Rivest, 2017).

Motivated by the importance of the institutional factors in R&D activity and the scant empirical evidence on EU pharmaceutical companies, this study seeks to contribute to the literature by showing empirical evidence on the significant effect of corruption, economic freedom, and gross domestic product (GDP) growth on the R&D behaviour of pharmaceutical firms. At the same time, the study can complete the extant literature on R&D investment by improving the understanding of the importance of the institutional setting. It is concluded that corruption, economic freedom and GDP growth play a major role in explaining the R&D behaviour of European pharmaceutical companies and the unfavourable impact of corruption on the R&D activity is more evident when companies encounter liquidity issues. The empirical results of this study can be of interest to both academics and practitioners as they may turn out useful in inspiring anti-corruption policies and stimulate a collective effort of mitigating the effects of this conundrum.

The article is structured as follows. A theoretical discussion regarding the link between R&D investment, corruption, economic freedom and GDP growth rate is presented in the next section. The research methodology is described in Section 3, Section 4 presents the results and robustness checks, while the last section concludes the study.

1. Literature review and hypotheses development

1.1. An institutional theory perspective on R&D investment

According to institutional theory, a country's investments are facilitated by its institutional frameworks as they provide incentives and support and create a stable business environment, decreasing risks and uncertainty. Waarden (2001) stated that institutional quality generates effects on R&D investment. Wang et al. (2015) consider that institutions can have a significant influence on firms' innovative activities. This influence can be realized through regulations, laws, and policies. Laeven (2003) stated that stronger institutional frameworks can improve knowledge accumulation in a country, prompting innovation in general.

North (1990) associated institutional quality with economic and political governance, as well as societal interactions. He stated that low-quality institutional settings hinder society to collect productivity gains from innovation, technologies or the specialized division of labour and hence they fail to achieve economic growth. In this regard, their development trajectories can be modified by promoting principles aimed at combating corruption, developing human capital and promoting freedom (economic, political or religious) (Lee & Kim, 2009).

According to Wu et al. (2016), "Better institutional environment may stimulate R&D activity by providing enhanced collaborative capacity to the firms". Bringing several arguments, Alam et al. (2019), emphasize the importance of institutional factors for innovative activities. R&D investments are risky, bear fruit in the long run and can be affected by agency problems. Choi et al. (2014) document that high-quality institutional factors contribute to the reduction of agency problems, thereby leading to increased R&D investments. The high quality of institutional factors facilitates access to resources, is likely to attract foreign investments (Bénassy-Quéré et al., 2007), increases the transparency of information (Hillier et al., 2011), and facilitates the access of firms to external finance (La Porta et al., 1997).

1.2. Corruption and R&D expenditures in the pharma industry

The quality of the institutional environment can be affected by corruption. Widely known as a major deterrent to economic growth (Chen et al., 2022), corruption can have a corrosive impact on health outcomes (Dincer & Teoman, 2019). The pharmaceutical industry is prone to corruption for a number of reasons. The commercialization of medicines is lucrative, thereby creating a favourable context for embezzlement and misuse of power (Zirojević, 2020). Patients are often in a vulnerable position as their health comes first. Therefore, consumer price sensitivity tends to be lower as compared to other industries. Generally speaking, patients are less likely to discontinue treatment than are consumers to give up other types of products. Although the elasticity of medicines is influenced by the availability of substitutes and their prices, previous literature (Landsman et al., 2005; Yeung et al., 2016) shows that the demand for pharmaceutical products is relatively inelastic, especially for high-value drugs. The high degree of asymmetry of information in the pharmaceutical industry and the large number of actors (medical suppliers, pharmaceutical companies, health care providers, payers and policy-makers) hinder the detection of conflicts of interest and smooth the path for different forms of corruption such as collusion, favouritism/nepotism, extortion, and fraud (Hussmann, 2010).

Although there are universally accepted forms of corruption (pharmaceutical drug counterfeiting, misuse of funds, sham contracts with doctors, bribery, illegal promotion), one has to bear in mind that there is a fine line between gifts, socially accepted favours and informal payments or bribes (Deliversky, 2016; Martinez et al., 2017; Stepurko et al., 2017).

Within this context, the pharmaceutical industry represents a good setting to scrutinize the impact of corruption on R&D decisions. The development of a drug portfolio is not possible without R&D activities. The pharmaceutical industry spends on R&D to find the cure to different diseases or to develop generic drugs and to stay competitive in a highly dynamic market (Nandy, 2022). It is widely acknowledged as the industry with the highest R&D intensity in the manufacturing sector (Mahajan, 2020). As far as these activities are concerned, Sismondo (2021) draws attention to the "ghost-management" of medical research. In other words, the medical literature is often biased because drug trials are funded, designed, and written up by pharmaceutical companies. As Egharevba and Atkinson (2016) emphasise, clinical trials are the mainstay in process of authorizing medicines. Apparently, the industry-sponsored trials are conducted by independent researchers, but previous literature (Martinez et al., 2017; Sismondo, 2021) suggests that it is very likely that pharmaceutical companies silently control them. In this context, it comes as no surprise that the treatment schemes prescribed by physicians are often viewed with scepticism (Marmat et al., 2020). Unethical practices of the industry adversely influence the trust of consumers (Stepurko et al., 2017).

1.3. Hypotheses development

The pharmaceutical sector is vulnerable to corruption. Investments in innovative activities are discouraged by the low level of institutional trust caused by corruption (Anokhin & Schulze, 2009). International business literature recognizes that corruption shapes and affects the firms' behaviour (Rodriguez et al., 2005) and foreign direct investment (Hannafey, 2003). According to Daude and Stein (2007), a high level of corruption causes managers and investors to engage in acts of bribery to obtain licenses and permits, which translates into increases in the cost of the investment. Through these increased costs, corruption depresses the development of new products, services, and technology. Furthermore, a high level of corruption is associated with more uncertainty and less profitable investments, thereby making investors less motivated by such costly investments like R&D. Corruption also hinders entrepreneurship, productivity, and investment in R&D (Anokhin & Schulze, 2009). Moreover, a high level of corruption generates an increase in information asymmetries and the cost of doing business.

As this phenomenon remains a major problem that makes the actors of the pharmaceutical sector be distracted from promoting the well-being of the population, health, and innovation in the healthcare sector (Lexchin, 2019), the following hypothesis is formulated:

H1: Corruption negatively influences R&D investment.

Economic freedom refers to all the rights of individuals, including labour and property rights. Nordin (2014) defines economic freedom from three points of view based on individuals, government, and the economy. Individuals have the right to choose where to live and work, their own properties and can control their productivity. The concept of freedom on government view refers to the transparency, visibility and openness of the decision-making process and the removal of discrimination. As for the economic view, every individual or firm has an equal chance of success because free and open competition permits an appropriate allocation of resources for consumption and production, and the power of economic decision-making is widespread. Countries with a high level of economic freedom accept diversity and promote creativity which encourages innovation.

Widely considered one of the main factors that generate economic prosperity, economic freedom influences the effectiveness and efficiency of resource use. There is a set of studies that shows that nations with a high level of economic freedom have evolved economically (Dawson, 1998; Easton & Walker, 1997; Hanson, 2000; Weede & Kamph, 2002). In a report conducted by McQuillan and Murphy (2009), it is stated that higher economic freedom encourages, especially in developing countries, both income growth and production growth. Depken and Sonara (2005) infer that the growth of trade flows is strongly correlated with a high level of economic freedom. Using Latin America as a research setting, Calvo and Robles (2003) show that a high level of economic freedom from the host country is conducive to increased foreign direct investment inflows. At the same time, researchers (Calvo & Robles, 2003; Pourshahabi et al., 2011) note that economic growth from the host country promotes FDI and economic freedom fosters economic growth (Nordin, 2014). Berggren (2003) shows that economic freedom has a complex character, as some components (in particular, the use of property rights, business freedom) of the economic freedom index cause economic growth, while other components (monetary freedom, government integrity, investment freedom, financial freedom, and trade freedom) come as a result of economic growth.

Turning to the pharmaceutical industry, whose products are designed to protect the health of individuals, economic freedom presupposes that patients' access to safe and effective treatments should take precedence over profit (Kreiner, 1995). Moreover, the profit obtained from the development of new drugs gives pharmaceutical companies the economic freedom to choose what drugs to develop (Hole et al., 2000). Economic freedom is also correlated with patent protection in the pharmaceutical industry (Qian, 2007) which stimulates innovation (Haley & Haley, 2011). Therefore, the following hypothesis is proposed:

H2: Economic Freedom has a positive effect on R&D investment.

R&D investment and income growth mutually interact (Wang, 2010). On the one hand, Coe & Helpman (1995) stated that a high level of productivity is created by R&D outcome and spillover mechanism, and this leads to higher revenue growth. A high level of GDP growth rate makes firms consider that there are possibilities for greater use of existing production capacity, increased sales and rising profits. This is confirmed by the acceleration principle which shows that the GDP growth rate rates influence the variation in R&D investment (Schmookler, 1966). The effort involved in the R&D activity materializes in a diversified portfolio and superior quality products, which generates high returns. This increases productivity, value added, and further ensures income growth (Nordin, 2014).

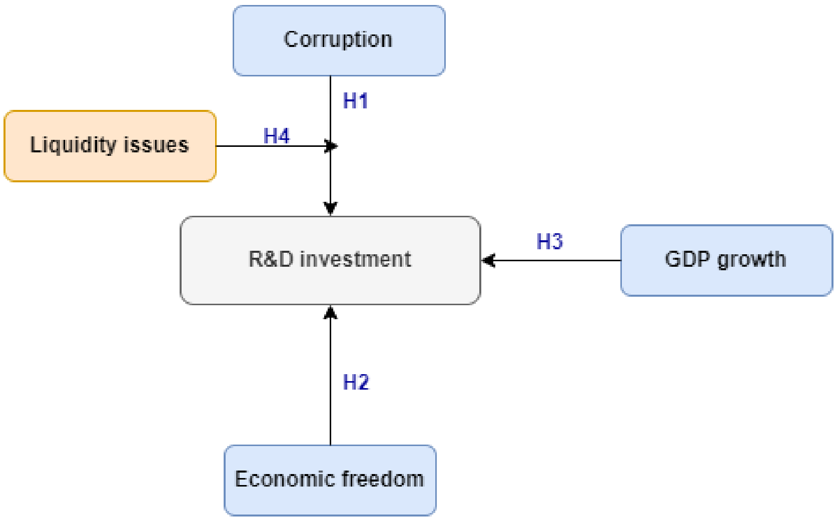
On the other hand, Markusen (1986) confirmed that R&D-intensive products are more sought after by high-income consumers. Researchers have found a direct relationship between GDP growth rate and R&D investment. Cheung (2014) demonstrated that the higher its per capita real GDP, the more innovative a state is. Alam et al. (2019) observed that in developed markets GDP growth rate is correlated with the firms' R&D expenditure. The global pharmaceutical industry is changing landscape and moving towards mergers and acquisitions, contract manufacturing and R&D activities. In this case, the impact of GDP growth rate is paramount (Vaidya et al., 2018). Tran (2021) assumed that a high GDP growth rate indirectly favours R&D projects by providing companies with lower costs of external financing. A high level of GDP growth rate is expected to increase interest in innovation and technological progress in the pharmaceutical industry. Thus, following Wang (2010) who remarked that R&D investment can be stimulated by GDP growth rate, the following hypothesis is proposed:

H3: Gross domestic product (GDP) growth has a positive effect on R&D investment.

The level of investments is affected by the firms' financial status (Alam et. al., 2019). External financing, and in particular debt, is considered inadequate for financing R&D investments (Hall, 1992). Obtaining funding for R&D activities can be hampered by a series of barriers, like uncertainty, risk and the absence of collateral that characterizes R&D projects (Hall & Lerner, 2010). R&D expenditures of multinational and domestic corporates are positively influenced by cash flows (Bae

& Noh, 2011). According to Rafferty and Fund (2005), R&D projects are stimulated by cash flow increases. Results show that R&D projects are sustained by the success of new medicines that generate large cash flows. Firms' internal funds are considered the most important sources of R&D investment funding (Czarnitzki & Hottenrott, 2011). At the same time, companies are reluctant to use external funds to finance R&D projects in order to avoid revealing sensitive information regarding their R&D projects (Bhattacharya & Ritter, 1983). Thus, besides government funding, internal financial resources represent the safest source of financing. Himmelberg and Petersen (1994) estimate that R&D decisions depend on the constant trend of increasing cash flow. If there are no prospects for increasing cash flow, managers are reluctant to R&D investments (Brown et al. 2012; Krammer, 2015; Sasaki, 2016). However, the permanent character of the increase in the cash flow determines the firms' managers to be more willing to carry out R&D activities.

Figure 1. Conceptual framework



Source: Authors' representation

According to Hubbard (1998), the firms' decisions to invest are affected by capital market imperfections. These arise as a result of the asymmetric information and agency problems between investors and management (Myers & Majluf, 1984). The firms can obtain certain public contracts in exchange for paying bribes (Liu et al., 2017). An agency problem may easily occur when corporate cash is used by managers for paying bribes, without shareholders' knowledge (Tran, 2019). Consequently, the firms' cash flow sensitivity increases. At the same time, firms may be more tempted to engage in corruption if they face certain liquidity issues. In light of these findings, it is expected that the relationship between corruption and R&D investment is influenced by liquidity issues:

H4: Liquidity issues moderate the relationship between corruption and R&D investment.

Figure 1 exhibits the conceptual framework of the research.

2. Research methodology

2.1. Sample and variables

The paper scrutinises the influence of corruption (captured through a composite indicator retrieved from the World Bank database), index of economic freedom (IEF), and gross domestic product (GDP) growth on R&D investment of pharmaceutical manufacturing firms listed in the European Union[1]. Furthermore, it is empirically assessed the moderating effect of liquidity issues on the corruption-R&D investment nexus. Firm-level variables are retrieved from ORBIS. Only those companies that reported R&D expenditures for at least 3 consecutive years were considered. Several observations were deleted due to a lack of data for the variables of interest. Following the use of the two filters, the final sample consists of 118 companies. The analysis is conducted on unbalanced panel data with 749 firm-year observations and spans 9 years (2011-2019).

The study uses R&D expenditures as a dependent variable. Consonant with earlier research (Chen et al., 2016; Lee & Hwang, 2003), R&D investment is quantified using the natural logarithm of R&D expenditures. The log transformation facilitates discussions and enables findings comparability.

The main independent variable is corruption. Corruption in all forms is more likely to occur in an environment characterised by uncertainty, divergent interests, and information gaps between pharmaceutical companies (insiders) and customers (outsiders) as emphasised by Global Corruption Report 2006 (Transparency International, 2006). Wang (2010) also assumed corruption as an explanatory variable of R&D investment. Secondary data concerning corruption are retrieved from the World Bank database. Therefore, corruption is quantified using a composite indicator, constructed using a plethora of individual variables that reflect the misuse of power (irregular payments, frequency of bribery, corruption in different sectors, etc). This aggregate indicator is computed using the unobserved components model (UCM) and it is based on a multitude of different data sources (such as survey institutions, think tanks, organizations and private companies) (Alam et al., 2019).

[1] More specifically, our study analyses companies from Austria, Bulgaria, Croatia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain and Sweden.

As explanatory variables, the models also include the index of economic freedom and GDP growth rate. The index of economic freedom (IEF) shows the extent to which the factors of production can move freely in a given economy. Data on the index of economic freedom comes from the World Heritage Foundation (WHF) database. According to WHF, the aggregate index is computed as the simple average of the following sub-indicators: “Property rights, Freedom from corruption, Fiscal Freedom, Government Spending, Business Freedom, Labor Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, and Financial Freedom”. A country’s economic health is proxied by GDP growth rate, a country-level variable extracted from the World Bank database.

An indicator named liquidity issues was constructed, a dummy variable that takes value 1 if the company encounters liquidity issues and 0 otherwise. It is considered that a company faces liquidity issues if the liquidity ratio is less than 1 (Abusalah & Ng, 2012). Data regarding liquidity ratio, also known as quick ratio, is retrieved from the ORBIS database.

In addition, the models include control variables, three firm-specific factors, commonly known as good predictors of corporate innovative activity, namely: return on assets, the number of employees, which serves as a proxy for firm size, and leverage. Scott (1995) and Oliver (1997) inferred that R&D behaviour may be determined by both external and internal factors. The paper considers the above-mentioned factors to minimize the omitted variable bias. Table 1 summarizes the main information about the variables included in the models.

Table 1. Independent variables

Independent/ Control variables	Symbol	Description	Data source
Corruption	Corruption	measures perceptions of the extent to which public power is exercised for private gain	World Bank, WGI
Index of Economic Freedom	IEF	quantifies the impact of liberty and free markets around the globe	Heritage Foundation
GDP growth rate	GDPG	expresses the economic growth of a nation	World Bank
Liquidity issues	LqI	equals 1 if the firm faces liquidity issues, and 0 otherwise	ORBIS
Return on assets	ROA	(profit before tax / total assets) * 100	ORBIS
Leverage	LEV	(non-current liabilities + current liabilities) /total assets	ORBIS
Firm size	LnEMPL	number of employees	ORBIS

Source: Authors’ representation

2.2. Empirical models

Panel data analysis is based on two fixed effects models, consistent with the results of the Hausman test. The study adds cross-section fixed effects, a widely employed approach by studies that investigate the drivers of investment decisions (Sun et al., 2019). R&D expenditures are seen as a function of several macroeconomic factors and internal factors:

$$LnR\&D = \beta0 + \beta1Corruption + \beta2IEF + \beta3GDPG + \beta4ROA + \beta5LEV + \beta6LnEMPL \quad (1)$$

$$LnR\&D = \beta0 + \beta1Corruption + \beta2IEF + \beta3GDPG + \beta4Corruption \times LqI + \beta5ROA + \beta6LEV + \beta7LnEMPL \quad (2)$$

Equation (1) represents the basic model and allows the exploration of the influence of corruption, IEF, and GDP growth rate on the R&D activity of pharmaceutical companies, while equation (2) allows scrutinising the moderating role of liquidity issues on the impact of corruption on R&D investment. Data analysis is performed using EViews.

3. Results

3.1. Descriptive statistics and correlation

The main indicators of descriptive statistics are presented in Table 2. The average value of R&D expenditures is 116,968 € and the standard deviation is 587.180 €. It can be inferred that pharmaceutical companies invest considerable amounts in R&D projects. Official statistics regarding the R&D landscape point out that the pharmaceutical industry is one of the top investors in R&D, right after ICT producers, owning together almost 43.5% of R&D investment in 2019 (European Commission, 2020). The average value of the corruption index is equal to 1.5417 and the standard deviation is 0.6749. The range is between -0.2673 (for Bulgaria) and 2.4049 (for Denmark). This indicates that Bulgaria suffers from a lack of control of corruption, while Denmark enjoys a strong control of corruption. As far as economic freedom is concerned, the mean value of IEF is 70.4727 which suggests that, overall, UE countries are mostly economically free. The minimum value (53.2) corresponds to Greece which indicates a mostly unfree economy, and the maximum value (80.90) corresponds to Ireland which implies that its economy is one of the freest in 2020. On average, 22,94% of the sampled companies encounter liquidity issues. The average GDP growth rate is 1.7622% and the standard deviation is relatively high (3.1278), which suggests that the countries in the sample have GDP growth rate rates that are not clustered around the mean. It is observed that the companies in the sample have, on average, negative ROA (-14.8748), which is not necessarily a sign of low efficiency of assets. Typically, firms that invest heavily in assets are associated with lower ROA due to the time-lagged impact on profit. The sampled companies are large, with an average number of employees of 3650.8. Debt-to-assets ratio (leverage) mean value (0.4571) shows that, overall, the companies are not in a risky position.

To ensure there are no suspicions of multicollinearity, the matrix of correlation and the variance inflation factors (VIF) are computed and displayed in Table 1. The values of correlation coefficients are low and all the VIF values are below the reference value of 10, introduced by Kennedy (2008) and Hair et al. (2010), respectively 5, proposed by Studenmund (2016). Additionally, the condition number was examined and the results (less than 100) (Montgomery et al., 2001) confirm that the issue of multicollinearity does not arise in this study.

Table 2. Descriptive statistics and correlation

	Mean	*Median*	*Std. Dev.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*VIF*
1.lnRD	9.7061	9.6748	2.2743	1								
2. Corruption	1.5417	1.5834	0.6749	0.09**	1							1.02
3. IEF	70.4727	72.000	5.5192	0.13***	0.65***	1						1.04
4. GDPG	1.7622	1.7929	3.1278	0.10***	0.06	0.36***	1					1.01
5. LqI	0.2294	0.0000	0.4206	0.04	-0.07*	-0.02	-0.03	1				1.10
6. ROA	-14.9748	-7.3350	29.134	0.34***	-0.07**	0.10**	0.02	0.07**	1			1.05
7. LEV	0.4572	0.3878	0.4352	-0.01	-0.11***	-0.05	0.00	0.39***	-0.15***	1		1.16
8. lnEMPL	4.8490	4.4308	2.6750	0.75***	-0.08**	0.08***	0.06*	0.21***	0.62***	0.09**	1	1.03

Notes: *significant to 10%; **significant to 5%; and ***significant to 1%.
Source: Authors' representation

3.2. Regression results

As previously mentioned, this paper scrutinises the impact of some of the potential institutional determinants on research and development (R&D) investment of pharmaceutical manufacturing companies listed in the European Union.

As it can be seen from Table 1, corruption adversely affects the R&D behaviour of European pharmaceutical companies. This result is congruent with the prediction and supports the institutional-based view and the "sanding-the-wheels" hypothesis. More specifically, an increase in corruption is associated with around 0.7321% fall in companies' R&D expenditure, other factors being fixed. It is evident that R&D activity is sensitive to malfeasance, bribery, irregular payments, and embezzlement. These practices have a detrimental effect on resource allocation and undermine the company's growth (Bukari & Anaman, 2021). The literature also postulates that corruption exacerbates the costs (Ivanovic-Djukic et al., 2019; Nguyen et al., 2016). Therefore, the high cost of obtaining licenses or loans acts as a deterrent to a firm's decision to undertake R&D activities (Sena et al., 2018). The paper corroborates the findings by Alam et al. (2019) who analysed 663 firms from emerging markets and concluded that corruption harms R&D activity, as it leads to higher investment costs and hinders foreign investments. Using a longitudinal dataset of 48 U.S. states and two measures of corruption, Dincer (2019) also demonstrates that corruption decelerates innovation. The inverse relationship between corruption and innovation is also empirically evidenced by other analyses (Lee et al., 2020; Mahagaonkar, 2008).

Concerning the second hypothesis, table 3 clearly shows that the index of economic freedom has a positive impact on R&D investment, consonant with conventional wisdom. Economic freedom is widely recognized as a catalyst for economic development (Rapsikevicius et al., 2021). The report of McQuillan & Murphy (2009) lists many benefits of greater economic freedom, inter alia, increased investments, and more innovation. The view that economic freedom enhances innovation is also shared by other scholars. Using panel data of 5809 companies, spanning 22 years, Zhu & Zhu (2017) provide evidence that economic freedom is a key driver of corporate innovation. Similarly, Erkan (2015) finds a positive association between innovation and IEF and emphasizes the importance of economic freedom in devising policy recommendations. Asandului et al. (2016) find a positive correlation between IEF and GDP per capita and between IEF and social progress index.

Table 3. Regression results for R&D as a function of corruption and other explanatory variables

	Model 1	Model 2
Corruption	-0.7321**	-0.7284**
IEF	0.0429**	0.0453**
GDPg	0.0154*	0.0162**
ROA	-0.0081***	-0.0080***
LEV	-0.6273***	-0.5358***
lnEMpl	0.7952***	0.7952***
Corruption*LqI		-0.1079**
Constant term	3.3241**	3.1262**
Obs.	749	749
R^2	0.946137	0.946644
Adj. R^2	0.935536	0.936041

Notes: *significant to 10%; **significant to 5%; and ***significant to 1%.
Source: Authors' representation

The hypothesised direct relationship between GDP growth rate and R&D investment is supported by the empirical analysis. A rise in GDP growth rate leads to increased R&D investments. The result is hardly surprising and merely confirms that firms have the confidence to invest more when economic growth is strong. Galindo & Méndez (2014) demonstrate that the direction of causality runs both ways as economic growth positively influences innovation and vice-versa. Hypothesis 3 is thus supported.

Table 3 also conveys the results of the regression analysis examining the moderating effect of liquidity issues on the corruption - R&D investment relationship. The findings highlight that liquidity issues moderate the influence of corruption on R&D activity (β=-0.1079). In other words, the adverse effect of corruption on the R&D activity of the manufacturing pharmaceutical industry is more pronounced when firms deal with liquidity issues. One possible explanation found in the literature is that debt is not suitable for financing R&D activities (Ughetto, 2008; Xu & Yano, 2017), and internal equity should be employed instead. It is concluded that corruption and economic freedom play a relevant role in explaining the R&D behaviour of pharmaceutical companies.

3.3. Robustness checks

Several additional tests are performed to check the robustness of the results. To reinforce the results, the sample is further divided into subsamples based on the median of the variables GDP growth rate and government effectiveness. Sub-sample analysis running the abovementioned specifications is performed (equation 1 and equation 2). The use of alternative sub-samples in running supplementary analyses to ensure the generalizability of the findings is a recommended practice (Hair et al., 2010). The country-level variable ‘government effectiveness’ was retrieved from the World Bank database and refers to the competency and the capacity of the government. Third robustness test considers an additional variable (*i.e.* EC - enforcing contracts) that measures the time and cost for resolving a commercial dispute through a local first-instance court, and the quality of judicial processes index. The results presented in Tables 4-6 lend strong support to the baseline findings and the hypotheses. There are no noteworthy changes in the values or statistical significance of the coefficients. The results are quite robust.

As a final exercise, we performed an analysis to eliminate endogeneity concerns. The independent variables, suspected to be endogenous, were tested. First, independent variables were regressed. The resulting residuals and Wald Test were used to ensure that there are no problems of endogeneity.

Table 4. Robustness checks

	High GDPg		Low GDPg	
	Model 1	**Model 2**	**Model 1**	**Model 1**
Corruption	-0.3916	-0.3100	-0.7891*	-0.8112*
IEF	0.0672***	0.0629***	0.0437*	0.0519**
GDPg	-0.0105*	-0.0098**	0.0243	0.0247
ROA	-0.0027	-0.0080***	-0.0062***	-0.0064***
LEV	-0.1332	-0.5358***	-0.7855***	-0.6870***
lnEMpl	0.4188***	0.4490***	0.7421***	0.7530***
Corruption*LqI		-0.0851		-0.1380**
Constant term	3.2978*	3.1262**	3.6737**	3.0669*

Obs.	178	749	274	274
R^2	0.9876	0.9878	0.9854	0.9858
Adj. R^2	0.9778	0.9779	0.9771	0.9775

Notes: *significant to 10%; **significant to 5%; and ***significant to 1%.
Source: Authors' representation

Table 5. Robustness checks

	High GE		Low GE	
	Model 1	**Model 2**	**Model 1**	**Model 1**
Corruption	0.1480	0.1784	-1.0192**	-0.9699**
IEF	0.0539**	0.0638**	0.0438***	0.0441*
GDPg	0.0135**	0.0138**	0.0438***	0.0439***
ROA	-0.0038**	-0.0043**	-0.0080***	-0.0080***
LEV	-0.3197***	-0.1609	-0.5542*	-0.5203**
lnEMpl	0,.010***	0.7188***	0.8288***	0.8232***
Corruption*LqI		-0.1302**		-0.0887
Constant term	1.4432	0.5125	2.8236	2.8761
Obs.	251	251	201	201
R^2	0.9837	0.9844	0.9735	0.9736
Adj. R^2	0.9784	0.9792	0.9616	0.9615

Notes: *significant to 10%; **significant to 5%; and ***significant to 1%.
Source: Authors' representation

Table 6. Regression results for R&D as a function of corruption and other explanatory variables

	Model 1	Model 2
Corruption	-0.5892**	-0.6019**
IEF	0.0358*	0.0381**
GDPg	0.0265**	0.0264**
ROA	-0.0078***	-0.0077***
LEV	-0.6566***	-0.5872***
lnEMpl	0.7652***	0.7702***
Corruption*LqI		-0.0795*
EC	0.0062***	0.0058***
Constant term	3.5582***	3.3967**
Obs.	746	746
R^2	0.947527	0.947797
Adj. R^2	0.937151	0.937373

Notes: *significant to 10%; **significant to 5%; and ***significant to 1%.
Source: Authors' representation

Conclusions

To bring the paper to a close, the main points are summarised here: corruption, economic freedom and GDP growth rate play a meaningful role in explaining the R&D behaviour of European pharmaceutical companies and the adverse effect of corruption on the R&D activity is more evident when firms encounter liquidity issues.

Corruption in the pharmaceutical sector is a fervent topic. Raising awareness about this issue by studying the nexus between corruption and R&D behaviour of pharmaceutical manufacturing companies is a paramount step in developing effective policies to address this issue and stimulate a collective effort of mitigating the effects of this nefarious phenomenon. Understanding corruption and its consequences are not solely of academic importance but are also relevant in designing anti-corruption policies. The results yield important implications for managers and policy-makers and may be of interest to both civil society and scholars concerned with the issue of corruption in the pharmaceutical industry and the determinants of R&D activity. By providing anecdotal evidence on the impact of corruption and economic freedom on R&D, the study can contribute additional pieces to the knowledge of factors susceptible to influence R&D expenditures. Most importantly, the paper emphasizes the moderating role of liquidity issues corruption - R&D investment relationship. It is recommended that pharmaceutical firms take notice of the corruption phenomenon in all its forms owing to its deleterious effect on R&D activity and take several measures such as adopting new technologies throughout the pharmaceutical value chain to raise transparency and establishing a management oriented towards promoting anti-corruption principles. It is paramount that all actors from the health sector understand that patients are more important than profits. The problem of corruption exacerbates when firms face liquidity issues. Therefore, managers may take into account to access a flexible line of credit or negotiate favourable credit terms with their suppliers, as needed. Governments are expected to create a climate conducive to R&D investment through fiscal facilities and discourage corrupt practices through unequivocally enforced regulations and severe sanctions.

The research has some limitations due to the lack of firm-level evidence regarding corruption, a relatively small-time span of analysis, and the inclusion of all EU countries, disregarding the development level. Notwithstanding that the results are related to the EU context, they could have international relevance as well. The shortcomings of this paper offer opportunities for future research. Therefore, it would be useful to include firm-level data regarding corruption, extend the period of analysis, conduct the same study on different industries and develop the analysis by investigating different subsamples such as euro area and non-euro area states.

References

Abusalah, E., & Ng, M. (2012). Using Altman'S Model and Current Ratio Assess The Financial Status of Companies Quoted in the Malaysian Stock Exchange. *International Journal of Scientific and Research Publications*, *2*(7), 1-11.

Alam, A., Uddin, M., & Yazdifar, H. (2019). Institutional determinants of R&D investment: Evidence from emerging markets. *Technological Forecasting and Social Change*, *138*, 34-44. https://doi.org/10.1016/j.techfore.2018.08.007

Anokhin, S., & Schulze, W.S. (2009). Entrepreneurship, innovation, and corruption. *J. Bus. Ventur*, *24*(5), 465-476. https://doi.org/10.1016/j.jbusvent.2008.06.001

Asandului, L., Iacobuta, A., & Cautisanu, C. (2016). Modelling Economic Growth Based on Economic Freedom and Social Progress. *European Journal of Sustainable Development*, *5*(3), 229-238. https://doi.org/10.14207/ejsd.2016.v5n3p229

Bae, S.C. & Noh, S. (2011). Multinational Corporations versus Domestic Corporations: A Comparative Study of R&D Investment Activities. *Journal of Multinational Financial Management*, *11*, 89-104. https://doi.org/10.1016/S1042-444X(00)00044-X

Bénassy-Quéré, A., Coupet, M., & Mayer, T. (2007). Institutional determinants of foreign direct investment. *World Econ*. *30*(5), 764-782. https://doi.org/10.1111/j.1467-9701.2007.01022.x

Berggren, N. (2003). The Benefit of Economic Freedom: A Survey. *Independent Review*, *8*(2), 193-211. https://www.jstor.org/stable/24562685

Bhattacharya, S., & Ritter, J. R. (1983). Innovation and communication: Signalling with partial disclosure. *Review of Economic Studies*, *50*(2), 331-346. https://doi.org/10.2307/2297419

Brown, A. (2013). Understanding pharmaceutical research manipulation in the context of accounting manipulation. *Journal of Law, Medicine and Ethics*, *41*(3), 611-619. https://doi.org/10.1111/jlme.12070

Brown, J.R., Martinsson, G., Petersen, B.C. (2012). Do financing constraints matter for R&D. *European Economic Review*, *56*(8), 1512-1529. https://doi.org/10.1016/j.euroecorev.2012.07.007

Bukari, C., & Anaman, E. A. (2021). Corruption and firm innovation: a grease or sand in the wheels of commerce? Evidence from lower-middle and upper-middle income economies. *Eurasian Business Review*, *11*, 267-302. https://doi.org/10.1007/s40821-020-00164-8

Calvo, M. B, & Robles, B. S. (2003). Foreign Direct Investment, Economic Freedom, and Growth: New Evidence from Latin America. *European Journal of Political Economy*, *19*(3), 529-545. https://doi.org/10.1016/S0176-2680(03)00011-9

Chen, J., Leung, W. S., & Evans, K. P. (2016). Are employee-friendly workplaces conducive to innovation? *Journal of Corporate Finance*, *40*, 61-79. https://doi.org/10.1016/j.jcorpfin.2016.07.011

Chen, Z., Zhou, M., & Ma, C. (2022). Anti-corruption and corporate environmental responsibility: Evidence from China's anti-corruption campaign. *Global Envinronmental Change*, *72*, 102-449. https://doi.org/10.1016/j.gloenvcha.2021.102449

Cheung, O. L. (2014). Impact of innovative environment on economic growth: An examination of state per capita GDP and personal income. *Journal of Business & Economics Research*, *12*(3), 257-270. https://doi.org/10.19030/jber.v12i3.8730

Choi, Y.R., Yoshikawa, T., Zahra, S.A., & Han, B.H. (2014). Market-oriented institutional change and R&D investments: do business groups enhance advantage? *Journal of World Business*, *49*(4), 466-475. https://doi.org/10.1016/j.jwb.2013.10.002

Coe, D. & Helpman, E. (1995). International R&D spillovers. *European Economic Review*, *39*(5), 859-887. https://doi.org/10.1016/0014-2921(94)00100-E

Czarnitzki, D., & Hottenrott, H. (2011). R&D investment and financing constraints of small and medium-sized firms. *Small Business Economics*, *36*(1), 65-83. https://doi.org/10.1007/s11187-009-9189-3

Daude, C., Stein, E. (2007). The quality of institutions and foreign direct investment. *Economics & Politics*, *19*, 317-344. https://doi.org/10.1111/j.1468-0343.2007.00318.x

Dawson, J. W. (1998). Institutions, Investments and growth: New cross country and panel data evidence. *Economic Inquiry*, *36*, 603-619. https://doi.org/10.1111/j.1465-7295.1998.tb01739.x

De Rosa, D., Gooroochurn, N., & Görg, H. (2010). *Corruption and Productivity: Firm-Level Evidence from the Beeps Survey, World Bank Policy Research Working Paper No. 5348.* The World Bank. https://doi.org/10.1596/1813-9450-5348

Deliversky, J. (2016). How Does Corruption Affects Healthcare Sector in Bulgaria. *Journal of IMAB - Annual Proceeding (Scientific Papers)*, *22*(1), 1088-1090. http://dx.doi.org/10.5272/jimab.2016221.1088

Depken C. A. & Sonara. R. J. (2005). The asymmetric effects of economic freedom on International Trade Flows. *Journal Economic Literature*, *4*(2), 141-155. http://dx.doi.org/10.5272/jimab.2016221.1088

Dincer, O. (2019). Does corruption slow down innovation? Evidence from a cointegrated panel of U.S. states. *European Journal of Political Economy*, *56*, 1-10. https://ijbe.fcu.edu.tw/assets/ijbe/past_issue/No.04-2/pdf/vol_4-2-4.pdf

Dincer, O., & Teoman, O. (2019). Does corruption kill? Evidence from half a century infant mortality data. *Social Science and Medicine*, *232*, 332-339. https://doi.org/10.1016/j.socscimed.2019.05.017

Easton, Steven T., & Micheal A. Walker. (1997). Income, Growth and Economic Freedom. *American Economic Review*, *87*(2), 328-332. https://www.jstor.org/stable/2950940?origin=JSTOR-pdf

Egharevba, E., & Atkinson, J. (2016). The role of corruption and unethical behaviour in precluding the placement of industry sponsored clinical trials in sub-Saharan Africa:

Stakeholder views. *Contemporary Clinical Trials Communications*, *3*, 102-110. https://doi.org/10.1016/j.conctc.2016.04.009

Erkan, M. K. (2015). Economic Freedom and Innovation. *International Journal of Science and Research*, *4*(7), 1806-1809.

Galindo, M. Á., & Méndez, M. T. (2014). Entrepreneurship, economic growth, and innovation: Are feedback effects at work? *Journal of Business Research*, *67*(5), 825-829. https://doi.org/10.1016/j.jbusres.2013.11.052

European Commission, Joint Research Centre, Grassano, N., Hernández, H., Tübke, A.et al. (2020). *The 2020 EU industrial R&D investment scoreboard*. Publications Office of the European Union, 2020. https://data.europa.eu/doi/10.2760/203793

Gupta, S., Davoodi, H., & Tiongson, E. (2000). Corruption and the Provision of Health Care and Education Services. *IMF Working Papers*, *2000*(116). https://doi.org/10.5089/9781451853926.001

Hafer, R. W. (2013). Economic freedom and financial development: International evidence. *Cato Journal*, *33*, 111-126. http://www.cato.org/sites/cato.org/files/serials/f ... /2013/1/cj33n1-6.pdf

Hair, J. F. J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th ed.). Pearson Prentice Hall.

Haley, G. T., & Haley, U. C. V. (2011). The effects of patent-law changes on innovation: The case of India's pharmaceutical industry. *Technological Forecasting and Social* Change, *79*(4), 607-619. https://doi.org/10.1016/j.techfore.2011.05.012

Hall, B. H. (1992). Investment and Research and Development at the Firm Level: Does the Source of Financing Matter? *Working Paper 4096*. National Bureau of Economic Research. https://doi.org:10.3386/w4096

Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the economics of innovation* (pp. 111-112). Elsevier. https://doi.org/10.1016/S0169-7218(10)01014-2

Hannafey, F.T. (2003). Entrepreneurship and ethics: a literature review. *Journal of Business Ethics*, *46*, 99-110. https://doi.org/10.1023/A:1025054220365

Hanson, J.R. (2000). Prosperity and Economic Freedom. *The Independent Review*, *4*(4), 525-531. http://www.jstor.org/stable/24562580

Hashi, I., & Stojcic, N. (2013). The impact of innovation activities on firm performance using a multi-stage model: evidence from the community innovation survey. *Research Policy*, *42*(2), 353-366. https://doi.org/10.1016/j.respol.2012.09.011

Hillier, D., Pintado, J., De Queiroz, V., & De La Torre, C. (2011). The impact of country-level corporate governance on research and development. *Journal of International Business Studies*, *42*, 76-98. https://doi.org/10.1057/jibs.2010.46

Himmelberg, C., & Petersen, B. (1994). R&D and internal finance: A panel study of small firms in high-tech industries. *Review of Economics and Statistics*, *76*, 38-51. https://EconPapers.repec.org/RePEc:fip:fedhma:91-25

Hole, O., P., Wintherá, F., E., & Straume, B. (2000). Clinical research: the influence of the pharmaceutical industry. *European journal of clinical pharmacology*, *56*, 851-853. https://doi.org/10.1007/s002280000238

Hsu, P., Tian, X., & Xu, Y. (2014). Financial development and innovation: Cross-country evidence, *Journal of Financial Economics*, *112*(1), 1639-1649. https://doi.org/10.1016/j.jfineco.2013.12.002

Hubbard, R. G. (1998). Capital-market imperfections and investment. *Journal of Economic Literature*, *36*(1), 193-225. https://doi.org/10.3386/w5996

Hussmann, K. (2010). *How to note: Addressing Corruption in the Pharmaceutical Industry*. A DFID practice paper. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/67659/How-to-Note-corruption-health.pdf

International Transparency. (2006). *Global corruption Report*. https://doi.org/10.5860/choice.42-2452

Ivanovic-Djukic, M., Lepojevic, V., Stefanovic, S., Stel, A. van, & Ateljevic, J. (2019). Corruption as an Obstacle for Starting a New Business in Serbia. *International Review of Entrepreneurship*, *17*(1), 37-58. https://www.researchgate.net/publication/334749242

Kennedy, P. (2008). *A guide to ECONOMETRICS* (6th ed.). Blackwell Publishing.

Krammer, S. M. S. (2015). Do good institutions enhance the effect of technological spillovers on productivity? Comparative evidence from developed and transition economies. *Technological Forecasting and Social Change*, *94*, 133-154. https://doi.org/10.1016/j.techfore.2014.09.002

Kreiner, A. (1995) The Ethics of the Pharmaceutical Industry and the Need for a Dual Market System, The *Journal of Medical Humanities*, *16*(1), 55-67. https://doi.org/10.1007/BF02276820

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1997). Legal determinants of external finance. *The Journal of Finance*, *52*(3), 1131-1150. https://doi.org/10.1111/j.1540-6261.1997.tb02727.x

Laeven, L. (2003). Does financial liberalisation reduce financing constraints? *Financial Management*, 5-34. https://doi.org/10.2307/3666202

Landsman, P. B., Yu, W., Liu, X. F., Teutsch, S. M., & Berger, M. L. (2005). Impact of 3-tier pharmacy benefit design and increased consumer cost-sharing on drug utilization. *American Journal of Managed Care*, *11*(10), 621-628. https://pubmed.ncbi.nlm.nih.gov/16232003/

Lee, C. C., Wang, C. W., & Ho, S. J. (2020). Country governance, corruption, and the likelihood of firms' innovation. *Economic Modelling*, *92*, 326-338. https://doi.org/10.1016/j.econmod.2020.01.013

Lee, K., & Kim, B.Y. (2009). Both institutions and policies matter but differently fo different income groups of countries: determinants of long-run economic growth revisited. *World Development*, *37*(3), 533-549. https://doi.org/10.1016/j.worlddev.2008.07.004

Lee, M. H., & Hwang, I. J. (2003). Determinants of corporate R&D investment: An empirical study comparing Korea's IT industry with its non-IT industry. *ETRI Journal*, *25*(4), 258-265. https://doi.org/10.4218/etrij.03.0101.0401

Lexchin, J., Kohler, J., & Gagnon, M.A. (2019). Combating Corruption in the Pharmaceutical Arena. Indian Journal of Medical Ethics, *3*(3), 234. https://doi.org/10.20529/IJME.2018.022

Liu, Z., Liu, X., Hong, Y., Brockner, J., Tam, K. & Li, Y. (2017). Is individual bribery or organizational bribery more intolerable in China (versus in the United 114 States)? Advancing theory on the perception of corrupt acts. *Organizational Behavior and Human Decision Processes*, *143*, 111-128. https://doi.org/10.1016/j.obhdp.2016.12.002

Mahagaonkar, P. (2008). Corruption and innovation: a grease or sand relationship? *Jena Economic Research* Papers, No. 2008,017. http://hdl.handle.net/10419/25713

Mahajan, V. (2020). Is productivity of Indian pharmaceutical industry affected with the introduction of product patent act? *Indian Growth and Development Review*, *13*(1), 227-258. https://doi.org/10.1108/IGDR-11-2018-0116

Markusen, J., (1986). Explaining the volume of trade: an eclectic approach. *American Economic Review*, *76*, 1002-1011. http://www.jstor.org/stable/1816465

Marmat, G., Jain, P., & Mishra, P. N. (2020). Understanding ethical/unethical behavior in pharmaceutical companies: a literature review. International. *Journal of Pharmaceutical and Healthcare Marketing*, *14*(3), 367-394. https://doi.org/10.1108/IJPHM-03-2018-0016

Martinez, M. G., Kohler, J. C., & McAlister, H. (2017). Corruption in the pharmaceutical sector. In M. S. Aßländer & S. Hudson (Eds.), *The Handbook of Business and Corruption* (pp. 329-361). Bingley: Emerald Publishing Limited.

McQuillan, L. J., & Murphy, R. P. (2009). The Sizzle of Economic Freedom. Pacific Research Institute. https://cdn.mises.org/Sizzle of Economic Freedom.pdf

Montgomery, D. C., Peck, E. A. & Vining, G. G. (2001). *Introduction to linear regression analysis* (3rd ed.). Wiley.

Myers, S., & Majluf, N. (1984). Corporate financing and investment decisions when firms have information that investors do not. *Journal of Financial Economics*, *13*, 187-221. https://doi.org/10.1016/0304-405X(84)90023-0

Nandy, M. (2022). Impact of R&D activities on the financial performance: empirical evidence from Indian pharmaceutical companies. *International Journal of Pharmaceutical and Healthcare Marketing*, *16*(2), 182-203. https://doi.org/10.1108/IJPHM-08-2020-0067

Nguyen, N. A., Doan, Q. H., Nguyen, N. M., & Tran-Nam, B. (2016). The impact of petty corruption on firm innovation in Vietnam. *Crime, Law and Social Change*, *65*(4-5), 377-394. https://doi.org/10.1007/s10611-016-9610-1

Nordin, N. N., & Nordin, N. H., (2014). Economic Freedom and Research and Development (R&D): Study based on different income level on developing countries, *First International Conference on Economics and Banking*, 399-410. https://doi.org/10.2991/iceb-15.2015.56

North, D.C, (1990). *Institutions, Institutional Change, and Economic Performance*. Harvard University Press.

Oliver, C. (1997). Sustainable competitive advantage: combining institutional and resource-based views. *Strategic Management Journal*, *18*(9), 697-713. https://doi.org/10.1002/(SICI)1097-0266(199710)18:9%3C697::AID-SMJ909%3E3.0.CO;2-C

Pattit, J.M., Raj, S.P., & Wilemon, D. (2012). An institutional theory investigation of US technology development trends since the mid-19thcentury. *Res. Policy*, *41*(2), 306-318. https://doi.org/10.1016/j.respol.2011.10.008

Peltier-Rivest, D. (2017). The prevention and detection of corruption in pharmaceutical companies. *Pharmaceuticals Policy and Law*, *19*(1-2), 17-31. https://doi.org/10.3233/PPL-170451

Pourshahabi. F., Mahmoudinia. D., & Soderjani.E. S. (2011). FDI, Human Capital, Economic Freedom and Growth in OECD Countries. *Research Journal of Internatıonal Studıes*, *19*(1), 71-81.

Qian, Y. (2007). Do national patent laws stimulate domestic innovation in a global patenting environment? A cross-country analysis of pharmaceutical patent protection, 1978-2002. *The Review of Economics and Statistics*, *89*(3), 436-453. https://doi.org/10.1162/rest.89.3.436

Rafferty, M. & Fund, M. (2005). Asymmetric Effects of The Business Cycle on Firm-Financed R&D. *Economics of Innovation and New Technology*, *17*(5), 497-510. https://doi.org/10.1080/10438590701407232

Rapsikevicius, J., Bruneckiene, J., Lukauskas, M., & Mikalonis, S. (2021). The impact of economic freedom on economic and environmental performance: evidence from European countries. *Sustainability*, *13*(4), 1-20. https://doi.org/10.3390/su13042380

Rodriguez, P., Uhlenbruck, K., & Eden, L. (2005). Government corruption and the entry strategies of multinationals. *Academy of management review*, *30*(2), 383-396. https://doi.org/10.5465/amr.2005.16387894

Sasaki, T. (2016). Financial cash flows and research and development investment. *Pacific-Basin Finance Journal*, *39*, 1-15. https://doi.org/10.1016/j.pacfin.2016.05.002

Schmookler, J. (1966). *Invention and Economic Growth*. Harvard University Press.

Scott, W. (1995). *Institutions and Organizations.* Sage Publications.

Sena, V., Duygun, M., Lubrano, G., Marra, M., & Shaban, M. (2018). Board independence, corruption and innovation. Some evidence on UK subsidiaries. *Journal of Corporate Finance*, *50*, 22-43. https://doi.org/10.1016/j.jcorpfin.2017.12.028

Sismondo, S. (2021). Epistemic Corruption, the Pharmaceutical Industry, and the Body of Medical Science. *Frontiers in Research Metrics and Analytics*, *6*, 614013. https://doi.org/10.3389/frma.2021.614013

Stepurko, T., Pavlova, M., & Groot, W. (2017). Informal Payments in Health Care. In M. S. Aßländer & S. Hudson (Eds.), *The Handbook of Business and Corruption* (pp. 305-327). Bingley: Emerald Publishing Limited.

Studenmund, A. H. (2016). *Using econometrics: A practical guide*. Pearson.

Sun, X., Lee, S. H., & Phan, P. H. (2019). Family firm R&D investments in the 2007-2009 Great Recession. *Journal of Family Business Strategy*, *10*(4), 1-9. https://doi.org/10.1016/j.jfbs.2018.02.004

Sung, B. (2019). Do Government Subsidies Promote Firm-Level Innovation? Evidence From the Korean Renewable Energy Technology Industry. *Energy Policy*, *132*, 1333-1344. https://doi.org/10.1016/j.enpol.2019.03.009

Tran, Q. T. (2019). Corruption, agency costs and dividend policy: international evidence. *The Quarterly Review of Economics and Finance*, *76*, 325-334. https://doi.org/10.1016/j.qref.2019.09.010

Ughetto, E. (2007). Does internal finance matter for R & D? New evidence from a panel of Italian firms. Cambridge Journal of Economics, *32*(6), 907-925. https://doi.org/10.1093/cje/ben015

Vaidya, M., Garg, S., Singh, C., Mahajan, M. M. (2018). Changing Dimensions of Drug Patents of Indian Pharmaceutical Industry. *Journal of Intellectual Property Rights*, *23*, 111-118. http://nopr.niscpr.res.in/handle/123456789/45332

Waarden, F.V. (2001). Institutions and innovation: the legal environment of innovating firm. *Organization Studies*, *22*(5), 765-795. https://doi.org/10.1177/0170840601225002

Wang, C. (2010). Determinants of R&D Investment: The Extreme-Bounds-Analysis approach applied to 26 OECD countries. *Research Policy*, *39*, 103-116. https://doi.org/10.1016/j.respol.2009.11.010

Wang, C., Yi, J., Kafouros, M., & Yan, Y. (2015). Under what institutional conditions do business groups enhance innovation performance? *Journal of Business Research*, *68*(3), 694-702. https://doi.org/10.1016/j.jbusres.2014.08.002

Weede, E., & Kampf, S. (2002). The Impact of Intelligence and Institutional Improvement on Economic growth. *Kyklos*, *55*(3), 361-380. https://doi.org/10.1111/1467-6435.00191

Wu, J., Wang, C., Hong, J., Piperopoulos, P., & Zhuo, S. (2016). Internationalization and innovation performance of emerging market enterprises: the role of host-country institutional development. *Journal of World Business*, *51*(2), 251-263. https://doi.org/10.1016/j.jwb.2015.09.002

Xu, G., & Yano, G. (2017). How does anti-corruption affect corporate innovation? Evidence from recent anti-corruption efforts in China, *Journal of Comparative Economics*, *45*, 498-519. https://doi.org/10.1016/j.jce.2016.10.001

Yeung, K., Basu, A., Hansen, R. N., & Sullivan, S. D. (2018). Price elasticities of pharmaceuticals in a value based-formulary setting. *Health Economics*, *27*(11), 1788-1804. https://doi.org/10.1002/hec.3801

Zhu, H., & Zhu, S. X. (2017). Corporate innovation and economic freedom: Cross-country comparisons. *Quarterly Review of Economics and Finance*, *63*, 50-65. https://doi.org/10.1016/j.qref.2016.04.003

Zirojević, M. (2020). Corruption and pharmaceuticals: a special relationship. In J. Kostić & A. Stevanović (Eds.), *The role of society in the figth against corruption* (pp. 195-207). Institut za uporedno pravo. http://ricl.iup.rs/id/eprint/627