Impact of formal and informal institutional constraints on innovation: firm-level evidence from Tunisia

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Impact of formal and informal institutional constraints on innovation: firm-level evidence from Tunisia

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Abstract

Using data from the 2020 World Bank Enterprise Survey in Tunisia, we analyze the joint impact of formal and informal institutional constraints on the types of firms' innovation. Moreover, we were interested in estimating the effect of the interaction between the two institutional constraints on the types of innovation. The main results of the econometric analysis show that the government system constraints have a positive and statistically significant effect on the likelihood of being an imitator. Furthermore, we show that the legal system constraints have a negative effect on the likelihood of being an innovator, but a positive effect on the probability of being an innovation pretender. We find a significant negative direct effect of commercial bribery on firm innovation. Moreover, the results show that the positive (negative) effect of the constraints from the government system (of the constraints from the legal system) on the probability of innovation will be alleviated by commercial bribery.

Keywords Innovation. Formal Institutions. Informal Institutions. Tunisian firms

JEL Classification O12. O3. D73. E2

Introduction

Innovation is a process by which firms introduce new ideas, new products and services in order to satisfy the consumers' needs and demands. This process is considered, on the one hand, as a fundamental factor for the survival of firms (Zhang et al., 2018; Cefis, and Marsili, 2011). On the other hand, it is considered as a key driver of economic growth of any country in the long term (Romer, 1994; Cameron, 1996; Rosenberg, 2004; Lederman, 2010). The production of innovation is influenced by several factors (Crepsi, 2004). Past research on this topic showed that high quality institutions, low level of corruption, protection of property rights, and low level of bureaucracy are seen as crucial factors for growth, job creation, improved productivity and for innovation. Many developing countries encourage firms to innovate through, for example, foreign direct investment. Yet, countries in transition, in particular, need a significant level of innovation to stimulate economic growth. However, companies in these countries face various barriers, notably institutional constraints. These constraints impede firms' business operations, especially innovation activities.

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The works dealing with the relationship between the institutional constraints and innovation have been largely studied in the literature. Most focused on analyzing this relationship from a macroeconomic level (Wei,1999; Zhao et al., 2003; Dirienzo and Das, 2014). Others focused on the microeconomic level (Nguyen et al., 2016; Beltrán 2015; Rodríguez and Zhang, 2020). From this literature, much attention was paid to the role of formal institutions which include tax administration, tax rates, business license and custom obstacles (Zhu et al., 2012; Rodriguez and Cataldo, 2015; Goedhuys et al., 2016; Barassa et al, 2017). However, little attention was given to informal institutions that include obstacles posed by bribe, political instability, and informal financing (Nguyen et al., 2016; Nguyen, 2020, Weng et al., 2021). Their empirical results are divergent. Some find that informal behaviors facilitate most types of innovation. Inversely, others find that informal practices are major obstacles to innovation. Although the aforementioned studies point to the existence of constraints that slow down and inhibit innovation in developed countries, they nevertheless give little attention to these constraints in transition economies.

Tunisia, our case study, is considered as an economy in transition. It has taken its steps in the democratic, economic and social transition since the 2011 revolution. But, during the democratic transition, Tunisia experienced an unexpected economic situation which is characterized by slow growth, a high unemployment rate, a drop in investments, etc. These critical circumstances were accompanied by political turbulence, the multiplicity of sit-ins and strikes, as well as the emergence of bad practices, such as smuggling and terrorism across the country. This has had an impact on the country's economic and social stability.

In order to accelerate growth and maintain economic and social stability, the Tunisian government announced the *strategic plan for economic and social development* in 2016 based on various structural reforms.[2] Among these reforms, we can mention fighting corruption, improving the business climate, enhancing the competitiveness of companies by focusing on innovation and promoting the transition to a knowledge-based economy. These reforms aim to enhance the country's attractiveness in terms of foreign direct investment and encourage companies to invest more in innovation activities. To strengthen the links within the Tunisian innovation system, the innovation ecosystem is still emerging. In accordance with *the strategic plan for economic and social development*, the reforms will be oriented towards the establishment of a national innovation system. This system is based on the development of competition centers and technology parks. This approach is part of a policy aimed at facilitating the creation and development of innovative activities on the basis of exchanges and cooperation between companies, research centers and training organizations. The evolution of the activities of the technological poles and the dynamics developed through the creation of the clusters make it possible to stimulate technological innovation. Moreover, the Tunisian government pursued an active industrial strategy to promote innovation and export growth. This strategy aims to provide direct subsidies and tax breaks to start-ups in order to fill the innovation gap in the market. According to the *national research and innovation program*, between 2011 and 2018, the premiums reached 12 MD to finance 54 projects. 60% of the amounts released enabled the support structures to strengthen their infrastructure and acquire scientific equipment. Due to this program, 9 patents have been filed, 10 prototypes produced and 3 start-ups created in several sectors. [3]

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[2] See, www.oecd.org/fr/sites/mena/competitivite/État-avancement-réformes-Tunisie-Compact-FR.pdf

[3] For more details, See *Voluntary National Report On the Implementation of the Rural Development Goals (ODD 2019)*, available on

However, despite several studies on the innovation topic, there is still limited empirical evidence about the importance of the institutional environment on innovation for developing countries in transition, Tunisia in particular. The scope of this paper is twofold. First, we analyze directly the impact of both formal and informal institutional constraints on the types of innovation. Second, we examine the impact of the interaction between informal and formal constraints on the types of innovation for Tunisian firms. Following Weng et al., (2021), we classify firms into three types of innovators according to the combination of their innovation input and output.

To address this issue, we organize our paper as follows. Section 2 presents a theoretical analysis and research hypothesis. Section 3 contains a description of the data set, the variables used in the empirical analysis and the econometric model. Section 4 analyzes the main results. Section 5 is devoted to conclusions, implications and future research.

Theoretical Analysis and Research Hypothesis

The concern of a firm is to produce new products or services that meet consumers' expectations and therefore develop competitive advantages in the market. To do this, the firm must make considerable efforts in R&D in order to achieve this concern. This situation is linked to several factors such as the institutional environment that includes the social, political, and legal systems of the environment where a firm is embedded (Scott and Meyer, 1994). The instability of institutions in a country can constitute constraints to economic developments, investments and innovation in particular, and can slow down its process. We distinguish two forms of institutional constraints: formal and informal institutional constraints. Formal institutions are represented by rules of law, courts and bureaucracies. These institutions are set up through official channels to control the business activities. For this type of institutions, the sanctions are formal and usually occur in writing (Horak and Restel, 2016). Conversely, informal institutions are unwritten cultural and normative rules (North, 1990). They are built, shared and applied outside of official channels. These include informal networks, close relationships with governments to fill the void revealed by formal institutions, payment of bribes, etc.

The link between formal institutions and innovation

The question relating to the institutional environment has been widely studied in the literature. In particular, studies analyzing the relationship between innovation and formal institutional constraints (Barasa et al., 2017; Laursen et al., 2012; Goedhuys et al., 2016). Some works have focused on either the regional or national side of institutions. At the regional level, Laursen et al., (2012) show that a regional environment affects firms' ability to introduce new products. Rodriguez and Cataldo (2015) analyze how the quality of government at the regional level affects innovation performance in the European regions. The authors measure the quality of government through control of corruption, rule of law, government effectiveness and government accountability. Through this study, they find a strong link between the quality of government and the capacity of regions to innovate. Inefficient and corrupt government measures represent a major obstacle to the capacity for innovation. In the same context, Barasa et al., (2017) study the regional aspect of the institutional environment on innovation. The authors show that the regional environment influences firms' capacity to transform their resources into innovation. At the national level, Tebaldi et Elmslie (2013) examine the link between innovation and institutional environment. Using cross-country data, the authors show that institutional arrangements explain variations in the number of patents between countries.

According to Varsakelis (2006), political institutions have a significant effect on a country's ability to enforce an effective patent protection framework and therefore on innovation.

Other works have focused on studying the relationship between the institutional environment and innovation at the firm-level. More precisely, we note the studies dealing with the impact of formal institutional constraints on innovation. Theses constraints incorporate tax burdens, low efficiency in administrative approval, and government corruption. Rodriguez and Min (2020) analyze the extent to which institutional quality affects innovation probability and intensity of Chinese firms. They show that poor institutional quality is a major constraint to innovation. Using firm-level data from Tunisia and Egypt, Goedhuys et al., (2016) reveal that corruption negatively influences a firm's innovator likelihood. In the Tunisian context and using firm-level data from the World Bank Enterprise Survey, Sdiri and Ayadi (2022) demonstrate that Tunisian firms consider corruption as a major obstacle to their operations, notably innovation activities. Recently, Weng et al., (2021) studied the impact of both formal and informal institutions on firms' innovation. The authors indicate that the perceived constraints of the government system increase firms' innovator likelihood rather than its non-innovator likelihood.
Following Weng et al., (2021), we examine three main aspects of government systems that influence the innovation. These aspects are taxation or tax burdens (tax rates and tax administration), administrative permits and corruption. These aspects include the efficiency, transparency and accountability of government systems.

According to the literature, the good quality of institutions and infrastructure encourage companies to make considerable efforts in terms of innovation. Is this always the case? We aim through this work to answer the question by posing the following hypothesis:

> ***Hypothesis 1a:*** *Constraints from the governmental system are positively associated with the likelihood of being imitators.*

> ***Hypothesis 1b****: Constraints from the governmental system are positively associated with the likelihood of being innovators.*

The legal system is seen as another important aspect of formal institutions. It guarantees the performance of contracts, provides protection of property rights, helps build transactional confidence and maintains financial stability (Weng et al., 2021). Transparency, fairness and efficiency of the courts are essential for business development and therefore for innovation (Rodriguez and Cataldo, 2015). Firms perceive that the legal system can be a major obstacle to their innovation activities by rendering unfair court decisions. For example, weak protection of intellectual property rights facilitates counterfeiting and piracy, reduces the potential for technology transfer, limits the formation of knowledge markets and therefore discourages companies from investing in innovation (OECD, 2010). Based on the above discussion, we propose the following hypothesis:

> ***Hypothesis 2a:*** *Constraints from the legal system are negatively associated with the likelihood of being imitators.*

> ***Hypothesis 2b****: Constraints from the legal system are positively associated with the likelihood of being an innovation pretender.*

> ***Hypothesis 2c:*** *Constraints from the legal system are negatively associated with the likelihood of being innovators.*

Since innovation is very expensive, firms need to finance their projects. However, most of these firms find financing to be a barrier due to lack of access to finance in the credit market. Recent

empirical studies have shown that access to finance is the most constraining obstacle to innovation. This means that the lack of formal finance significantly reduces a firm's likelihood to engage in innovation activity. Ayalew and Xianzhi (2019) show that financial constraints negatively affect the likelihood of having product innovation and process innovation. In the case of Turkey, Keravanci and Kayaôglu (2020) show that obtaining government subsidies is a factor that affects SME innovation. In light of what has been discussed previously, the hypothesis about the lack of formal finance can be formulated as follows:

> ***Hypothesis 3:*** *Lack of formal finance is negatively associated with types of innovation.*

The link between informal institutions and innovation

While formal resources are fundamental, it has recently been shown that there are other informal factors that can significantly limit firms' innovative behavior. In this paper, we focus on two factors: commercial bribery and lack of informal finance.

The literature dealing with the subject of bribe payments has two points of view: the "sanding-the-wheels" and the "greasing-the-wheels" viewpoints. The first view means that bribery is an obstacle to firms' innovation. For instance, Weng et al., (2021) show that prevalence of bribery makes firms more likely to be non-innovators than innovators. Poddar and Singh (2020) find that corruption, measured by bribery payment, has a negative impact on the likelihood of innovations. The second view means that bribery can help to accelerate a firm's innovation activities. Using level-firm data from Vietnamese firms, Nguyen et al., (2016) showed that informal payments encourage innovation. These authors revealed that, in the short run, bribery facilitates innovation. They interpret innovation as a short-run objective. In addition, Sharma and Mitra (2015) show that bribery allows companies to overcome political obstacles and bureaucratic complexity, in order to accelerate their innovation activities. We therefore formulate our hypothesis as follows.

> ***Hypothesis 4a:*** *Commercial bribery is negatively associated with the likelihood of being imitators.*
> ***Hypothesis 4b:*** *Commercial bribery is negatively associated with the likelihood of being an innovation pretender.*
> ***Hypothesis 4c:*** *Commercial bribery is negatively associated with the likelihood of being innovator.*

According to Weng et al., (2021), the lack of informal financing reduces companies' financial resources to invest in innovation activities. Instead of doing original innovation, companies are only able to imitate other products or do not engage in innovation. We thus propose our hypothesis as follows:

> ***Hypothesis 5*** *Lack of informal finance is negatively associated with the likelihood of being innovator.*

The joint effect of formal and informal institutions on firm innovation

As mentioned above, there is a large literature on the subject of innovation. Some analyze separately the impact of formal and informal institutional quality on innovation. However, few studies focus on the joint effect of the formal and informal institutional environment on innovation. North (1990) mentioned that formal and informal institutions operate as a cluster of characteristics that commonly occur together. Saka et al., (2020) explore how formal and informal institutions and internal firm resources complementarily interact to facilitate firm innovation. In the same line, Doh et al., (2017) examine the role of interaction between formal

and informal institutions and innovation. In line with Weng et al., (2021), we analyze the influence of the interplay of formal and informal constraints on the likelihood of innovation. Therefore, the following hypothesis was introduced in order to examine the impact of the interaction between formal and informal institutions on the likelihood of innovation.

> **Hypothesis 6a:** *Commercial bribery lessens the impact of governmental system constraints on the types of innovation.*

> **Hypothesis 6b:** *Commercial bribery attenuates the impact of legal system constraints on the types of innovation.*

> **Hypothesis 6c:** *Commercial bribery attenuates the impact of lack of formal finance constraints on the types of innovation.*

> **Hypothesis 7:** *Lack of informal finance attenuates the impact of formal institutions' constraints on the types of innovation.*

Figure 1 below summarizes our hypotheses.
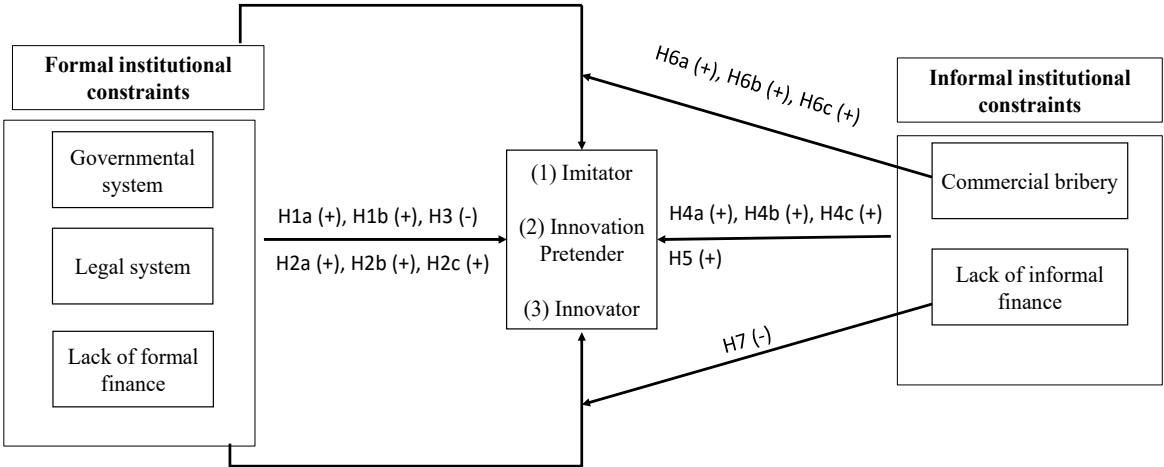
Figure 1: Conceptual model: formal and informal institutional constraints and innovation link

The Empirical Model

Data source

To test the relationship between both formal and informal institutions and firms' innovation behavior, we used the Enterprise Survey data carried out by the World Bank in 2020. The data were collected in partnership with the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB). The World Bank Enterprise Survey (hereafter WBES) is carried on firm-level surveys to a representative sample of firms. To warrant the representativeness of the sample, the WBES data are collected through a stratified random sampling by using the industry, region of establishment location, and establishment size.[4]

The questionnaire used for the survey offers a wide range of data. Apart from general information on the firm's characteristics, the questionnaire includes several sections such as

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[4] For more details, see http://www.enterprisesurveys.org/Methodology/

access to finance, competition, labor, formal institutions, informal institutions, innovation, etc. In this paper, we have dropped the missing responses as well as the "Do not know" and "Does Not Apply" responses from the dataset. Due to the missing values for variables, the sample size is reduced to a total of 241 Tunisian firms.

Definition of Variables

In order to analyze the joint effect of institutional constraints on the types of innovation, we describe in what follows the key variables and their measures.

Dependent Variables

Innovation. The dependent variable of interest is *innovation*. Innovation has been measured in different ways depending on the study context. In this paper, we rely on a measure adopted by Weng et al., (2021). Innovations are classified into three types according to the combination of their innovation input and output. We take R&D activities and the introduction of a new products or services to represent innovation input and output respectively. The three indicators are binary. First, we consider *Imitators* the firms that introduce new products or services but do not invest in R&D activities. This variable takes 1 if new products or services dummy is 1 and 0 if R&D dummy is 0. Second, *Innovation pretenders* are firms that invest in R&D but have not yet produced any new products or services. It takes 1 if R&D dummy is 1 and new products or services dummy is 0. Third, *Innovators* are firms that both invest in R&D activities and introduce new products or services. It takes 1 if R&D dummy is 1 and new product or services dummy is 1.

Independent Variables

In what follows, we detail the explanatory interest variables that are relative to formal and informal institutional constraints.

The constraints from the governmental system. We measure *the barriers from the governmental system* by the average of the sum of firms' perception of government tax rate, government tax administration, government permits and government corruption. These items are ordered according to a 5-point scale ranging from 0 to 4: (0) no obstacle, (1) a minor obstacle, (2) a moderate obstacle, (3) a major obstacle, or (4) a very severe obstacle.

The constraints from the legal system. In this paper, we rely on a measure adopted by Weng et al., (2021). This variable responds to the question: To what degree are courts an obstacle to the current operations of this establishment? The answers to this question are ordered according to a 5-point scale ranging from 0 to 4: (0) no obstacle, (1) a minor obstacle, (2) a moderate obstacle, (3) a major obstacle, or (4) a very severe obstacle.

Lack of formal finance. Ayyagari et al., (2011) show that in developing countries, external financing of SME investments is positively linked to innovation. In fact, access to external finance facilitates the accumulation of capital necessary for the development of new products, processes or organizational models. Barasa et al., (2017) measure external financing as the percentage of working capital obtained from external sources. In this paper, we use a dummy variable that takes a value of 1 if the firm does not benefit from formal funding in order to purchase working capital or fixed assets and 0 otherwise.

Commercial bribery. Various indicators are used in order to operationalize the bribe. According to the world bank data, Beltrán (2015) use the percentage of total annual sales paid in bribes. She is based on the question: *'We've heard that establishments are sometimes required to make gifts or informal payments to public officials to "get things done" with regard to customs, taxes, licenses, regulations, services etc. On average, what percent of total annual sales, or estimated total annual value, do establishments like this one pay in informal payments or gifts to public officials for this purpose?'*. Unlike governmental corruption, which is imposed by the government, commercial bribery stems from the extortion of private actors (Weng et al., 2021). In this paper, we adopt the same measure used by Weng et al., (2021). This variable is binary. It takes 1 if the firm is asked to give gifts or informal payments in order to obtain electricity, water, telephone connection, building permits and 0 otherwise.

Lack of informal finance. In addition to formal external financing, which includes banks and non-banking financial institutions, companies resort to other informal financing resources in order to finance their investment projects. According to Nguyen and Canh (2021), the informal finance *"is defined as small, unsecured and short-in-maturity funding capital sourced from (1) private moneylender(s), (2) the relatives and friends of the business owners and (3) other enterprises"*. These resources may also incorporate purchases on credit from suppliers and advances from customers and other sources (Barasa et al., 2017). In line with Weng et al., (2021), we use a dummy variable that takes a value of 1 if the firm does not benefit from informal funding in order to purchase working capital or fixed assets and 0 otherwise.
Control Variables

Property loss. This indicator is captured by the answer to the question: To what degree are crime, theft and disorder an obstacle to the current operations of this establishment? The crime obstacle is ordered according to a 5-point scale ranging from 0 to 4: (0) no obstacle, (1) a minor obstacle, (2) a moderate obstacle, (3) a major obstacle, or (4) a very severe obstacle.

Skilled worker percentage. It is described by the ratio of skilled production workers to the firm's total number of workers.

Licensed technology. This variable is captured to find out whether firms use technology licensed from foreign-owned companies in their operations. We use a dummy variable that takes 1 where a firm uses technology licensed from a foreign-owned company and 0 otherwise.

Firm age. Firm age is important for innovation. It is argued that older firms are less innovative than younger firms (Ayyagari et al., 2012). We include a control variable or firm age, which is determined by the year when the establishment began its operations. More precisely, this measure indicates the number of years during which the firm has been acting in the market until the year of the survey (2020).

Top manager's experience. It is measured by the years of experience the firms' top manager has in the sector.

Firm size. Previous studies have found a relationship between firm size and innovation (Ayyagari et al., 2012). In fact, larger and medium firms innovate more than small firms. In this study, we control for the size which represents the number of full-time permanent employees in 2020: the firms are small (with less than 20 employees), medium (with 20 to 99 employees) and large (with 100 or more employees).

Competition. Following Weng et al., (2021) and Jaworski and Kohli (1993) in measuring the competition dummy variable by comparing the number of competitors' similar products to

measure the competition intensity. This variable takes 1 if firm responds 'too many to count' competitors and 0 if the number of competitors is countable.

We include in this paper dummies variables in order to control for industry sector ranging from food industry to recycling industry.

Model Specification and Estimation

In order to analyze the joint effect of formal and informal institutions' constraints on types of innovation in Tunisia, we estimate three models. The first model (Model 1) regressed the dependent variables including control variables. The second and third models (Model 2 and Model 3) added the interaction effects of commercial bribery and lack of informal finance to Model 1 respectively. Since the dependent variables are binary in nature, discrete choice estimation methods were used. More precisely, we adopt probit model with robust standard error.

Estimation Results

Descriptive Statistics

Table 1 presents each variable's means and standard deviations. The table also provides statistical tests based on each coefficient's variance inflation factor (hereafter VIF). According to Neter et al., (1996), the values of the individual VIF are greater than 10 and the values of average VIF are greater than 6 indicating, hence, a multicollinearity problem. In our context, we notice that the mean VIF is about 1.58 and the VIF of each variable is inferior to 10. According to this result, it is proven that there is no multicollinearity problem between the explanatory variables used in these models. To check the singularity condition of the correlation matrix, we have calculated its determinant. We find that this determinant is equal to 0.063 > 0.00001, which ensures that our variables are not perfectly correlated (Table 1 below).

Regression Results

The results of the probit model with robust standard error are shown in Tables 2, 3, and 4. Table 2 reports the regression results of Model 1. Table 3 shows the regression results of Model 2 with the interaction effect of the *commercial bribery* variable, while table 4 reveals the results of Model 3 with the interaction effects of the *lack of informal finance* variable. The results show a strong global significance of all the models (Model 1, Model 2 and Model 3). This is verified by the Wald test. The latter indicates that the null hypotheses stipulating that the coefficients are simultaneously equal to zero are strongly rejected ((prob > chi2) =0.000).

Column 1 of Table 2 presents the regression results exploring the relation between *constraints from government system* and imitator (first innovation type). As expected, the estimated coefficient of the variable *constraints from governmental system* is positive and statistically significant at 5%. This means that one unit increase in *constraints from governmental system* variable, on average, increases the likelihood of being *imitator* by 4.41%. (Model 1a, dy/dx=0.041). These results apply mainly to the Tunisian context. Due to the country's economic and political instability, some Tunisian companies cannot cover their R&D expenses and therefore have an interest in resorting to imitation. Thus, H1a is supported but H1c is not.

Table 2 shows results of the influence of the second formal constraint. First, we find that the coefficient of the independent variable *constraint from the legal system* is negative and statistically significant as expected. Marginal effects analyses reveal that *constraint from the*

legal system has a strong negative effect on the likelihood of being an *imitator* (Model 1a, dy/dx= -0.0623).

Second, we show that the coefficient associated with the variable *constraint from the legal system* is equal to -0.312 (Model 1c). This means that this variable is negative and statistically significant at 1%. A one unit increase in *constraint from the legal system*, on average, decreases the likelihood of being innovator by 5.98% (Model 1c, $\beta = -0.312, dy/dx = -0.0598$). This result can be justified by the fact that during the survey period, Tunisia experienced several governmental changes. These changes come with issues of theft, crime, disorder as well as random strikes. This results in a major disruption of the functioning of the institutions, particularly the courts. The effectiveness of these institutions in controlling industrial property rights is therefore weakened. This can slow down the innovation process of potentially innovative companies. Finally, the results of the econometric analysis show that the likelihood of being an *innovation pretender* is positively affected by the variable *constraint from the legal system*. This result indicates that a one-unit increase in "*constraint from the legal system*", on average, increases the likelihood of being an *innovation pretender* by 3.3% (Model 1b, $\beta = 0.406, dy/dx = 0.0330$). This may be due to the fact that the innovation resulting from the firms' R&D projects is not yet launched in the market to face these institutions. Thus, H2 (H2a, H2b, and H2c) is supported. Regarding the third formal constraint, we do not find a significant effect of *lack of formal finance* on each type of innovation (Model 1). This may be due to the fact that firms need finance to finance investment in R&D activities. Thus, H3 is not supported.

Regarding informal constraints, the results indicate that *commercial bribery* negatively affects the likelihood of being an *imitator* (Model 1a). The coefficient of *commercial bribery* is negative and very significant, indicating that a one unit increase in bribes paid by firms results in a decrease in the probability of imitating by 11.5%. This result indicates that the *commercial bribery* is negatively correlated with imitation. Given that corruption is an informal behavior, corrupt officials can cheat in some cases. In this case, the payment of bribes is no longer guaranteed. This may be because the company does not have enough information about the corrupt officer. These bribes are therefore not always beneficial due to the dishonesty of some officers. Similarly, we find that *commercial bribery* is negatively correlated with the likelihood of being an *innovation pretender*. A one unit increase in bribes paid by firms results in a decrease in the likelihood of being an *innovation pretender* by 10.4%. We do not find a significant effect of *commercial bribery* on the likelihood of being innovator. Thus, H4a and H4b are supported but H4c is not.

Table 1: Descriptive statistics and pairwise correlations

Variables	Mean	Std. Dev.	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Constraints from governmental system	2.047	1.115	2.53	1											
(2) Constraints from legal system	1.421	1.409	2.91	0.715	1										
(3) Lack of formal finance	0.444	0.498	1.15	-0.026	0.120	1									
(4) Commercial bribery	0.846	0.362	1.09	-0.094	-0.091	0.128	1								
(5) Lack of informal finance	0.477	0.501	1.35	0.088	0.288	0.233	-0.029	1							
(6) Property loss	1.714	1.299	2.20	0.66	0.641	-0.047	-0.066	0.019	1						
(7) Skilled worker	0.273	0.323	1.80	0.43	0.512	0.136	0.034	0.249	0.435	1					
(8) Subsidiary	0.228	0.421	1.15	0.22	0.215	-0.088	-0.097	0.094	0.196	0.237	1				
(9) Firm age	22.191	14.413	1.22	-0.090	-0.009	-0.033	0.059	0.203	-0.091	-0.013	0.144	1			
(10) Top manager's experience	25.934	10.658	1.17	-0.073	-0.053	0.012	-0.095	0.116	-0.105	-0.055	0.087	0.300	1		
(11) Competition	0.369	0.484	1.23	-0.18	-0.057	0.008	-0.031	0.130	-0.163	-0.305	-0.068	0.053	0.086	1	
(12) Licensed technology	0.166	0.373	1.11	0.073	0.074	0.095	-0.119	0.177	0.038	0.119	0.129	0.051	-0.014	0.121	1
Mean VIF			**1.58**						**Det= 0.06299452**						

As for the last indicator which measures informal constraints, the econometric results show that the variable *lack of informal finance* has a negative and statistically significant effect at 10% on the probability of innovating (Model 1c, $\beta = -0.540, dy/dx = -0.104$). The greater the lack of informal financing, the lower the likelihood of innovating. This means that the *lack of informal financing* reduces the firm's internal resources and, consequently, it becomes unable to cover the strong expenses of the innovation activities. Thus, H5 is supported.

Table 3 shows that the interaction coefficient of the two variables *constraints from the governmental system* and *commercial bribery* is negative and statistically significant for all models (Models 2a, 2b, and 2c). On average, one unit increase in *constraints of the government system* for firms that have committed commercial bribes decreases the firm's likelihood of being an *imitator* by 17% (Model 3a, $dy/dx = -0.170$), the likelihood of being an *innovation pretender* of 19.8% (Model 2b, $dy/dx = -0.198$) and the likelihood of being an *innovator* of 18.9% (Model 2c, $\frac{dy}{dx} = -0.189$). Thus, H6a is supported. Furthermore, marginal effects analyses reveal that the interaction between variables *constraints from the legal system* and *commercial bribery* is negative (Models 2e and 2f). For these models, we notice that the interaction effect is significant (Model 2e, $dy/dx = -0.142$, Model 2f, $dy/dx = -0.103$). This means that, on average, one unit increase in *constraints from the legal system* for firms that have committed commercial bribes lessens the likelihood of being an *innovation pretender* of 14.2% and the likelihood of being an *innovator* of 10.3%. Thus, H6b is supported. However, the interaction term of *lack of formal finance* and *commercial bribery* is not significantly related to type of innovation (Models 2g, 2h, and 2i). Thus, H6c is not supported. As shown in Table 4, the interaction term of *lack of informal finance* and *constraints from the governmental system* is not significantly related to the type of innovation (Models 3a, 3b, and 3c). Further, we show no significant effect of the interaction between *lack of informal finance* with *constraints from the legal system* (Models 3d, 3e, and 3f). Finally, our econometric results show that the parameter associated with the interaction between *lack of informal finance* and *lack of formal finance* is negative and not significant (Models 3g, 3h, and 3i). Thus, H7 is not supported.

Robustness Check

In order to check the overall robustness of our empirical results, we used logistic regression to re-estimate models M1, M2, and M3. The results of the logistic regression and the odds ratios are shown in Tables 5, 6, and 7 in appendix. The models' overall significance is satisfied. Indeed, the Wald test indicates that the null hypothesis indicating that the coefficients are simultaneously null is rejected (Prob > Chi2 = 0.00). The results obtained from the logistic regression model are broadly consistent with the estimates from the probit model. This indicates that our results are robust.

The literature reveals that the innovation of the firm can influence inversely its corruption behavior. This latter can be subject to potential endogeneity and therefore inferences become biased (Beltrán, 2016; Ngyyen et al., 2016; Rodríguez and Cataldo, 2014). One way to solve this problem is to apply instrumental variables. Some studies use industry location averages of bribes as an instrument of corruption (Beltrán, 2016; Ngyyen et al., 2016). In this paper, following this literature and to check the endogeneity problem of *commercial bribery* (which can be a source of endogeneity), we use industry-location averages of *commercial bribery* as an instrument. We test the relevance of the instrument, using a likelihood ratio (LR) chi2 test to check whether the instrument used is strongly correlated with the endogenous variable (Bound et al., 1995). The LR chi2=29.98 is greater than 10 (Prob > Wald Chi2= 0.0002 is less than 5%), confirming that the instrument is strongly correlated

with the *commercial bribery* variable.[5] Then, we apply a Smith-Blundell exogeneity test for probit regression. For Model 1, we verify that the Smith-Blundell test statistic for exogeneity is equal to 0.8267807 and the p-value is 0.3632. For Model 2, the Smith-Blundell test statistic is 2.008284 and the p-value is 0.1564. For Model 3, the Smith-Blundell test statistic is 2.322425 and the p-value is 0.1275. These p-values do not reject the null hypothesis that all explanatory variables are exogenous at all levels of significance. Moreover, in line with Davidson and Mackinnon (1993), the Durbin-Wu-Hausman endogeneity test turns out to be non-significant for all the models at 5%. Thus, these tests indicate the absence of the endogeneity problem in our case.[6]

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[5] According to Semadeni et al., (2014), a common rule-of-thumb in linear instrumental variable regression is an *F-statistic* greater than 10. Since our variable is binary, we relied on the Likelihood Ratio Chi-Square for the joint significance of the variables.

[6] The estimation results from the instrumental variable method are available upon request.

Table 2: Effect of formal and informal institutional constraints on types of innovation

Model 1 (Probit model)	(1a)		(1b)		(1c)	
	Imitation		Innovation Pretender		Innovation	
Variables	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx
Constraints from government system	**0.324****	**0.0441****	0.262	0.0213	0.0272	0.00521
	(0.154)	(0.0218)	(0.248)	(0.0208)	(0.157)	(0.0301)
Constraints from the legal system	**-0.457*****	**-0.0623*****	**0.406****	**0.0330****	**-0.312****	**-0.0598****
	(0.138)	(0.0199)	(0.180)	(0.0138)	(0.144)	(0.0267)
Lack of formal finance	0.0564	0.00768	0.205	0.0167	-0.170	-0.0325
	(0.280)	(0.0381)	(0.413)	(0.0338)	(0.256)	(0.0491)
Commercial bribery	**-0.843*****	**-0.115*****	**-1.272****	**-0.104****	-0.316	-0.0606
	(0.312)	(0.0433)	(0.509)	(0.0404)	(0.311)	(0.0606)
Lack of informal finance	-0.113	-0.0153	0.287	0.0234	**-0.540***	**-0.104***
	(0.308)	(0.0422)	(0.540)	(0.0435)	(0.297)	(0.0545)
Property loss	-0.0200	-0.00273	**-0.680*****	**-0.0554*****	-0.0438	-0.00840
	(0.173)	(0.0236)	(0.226)	(0.0199)	(0.160)	(0.0305)
Skilled worker	-0.175	-0.0239	0.394	0.0321	-0.745	-0.143
	(0.502)	(0.0682)	(1.242)	(0.102)	(0.527)	(0.102)
Subsidiary	0.272	0.0370	**-3.191*****	**-0.260*****	**0.561****	**0.108****
	(0.287)	(0.0389)	(0.739)	(0.0732)	(0.266)	(0.0505)
Firm age	0.00576	0.000785	0.0175	0.00142	-0.00206	-0.000395
	(0.00850)	(0.00114)	(0.0165)	(0.00129)	(0.00864)	(0.00166)
Top manager's experience	-0.00204	-0.000278	**-0.0406****	**-0.00331****	0.0103	0.00198
	(0.0103)	(0.00140)	(0.0177)	(0.00151)	(0.00956)	(0.00186)
Competition	0.397	0.0541	**-0.806***	**-0.0657***	**0.806*****	**0.155*****
	(0.267)	(0.0364)	(0.417)	(0.0383)	(0.251)	(0.0425)
Licensed technology	-0.211	-0.0287	**1.230*****	**0.100*****	**0.557****	**0.107****
	(0.321)	(0.0449)	(0.451)	(0.0353)	(0.272)	(0.0483)

Table 2: Continued

Model 1 (Probit model)	(1a) Imitation		(1b) Innovation Pretender		(1c) Innovation	
	Coef	dy/dx	Coef	dy/dx	Coef	dy/dx
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
_cons	0.201		1.022		-1.149**	
	(0.933)		(0.997)		(0.544)	
N	219	219	159	159	217	217
Wald chi2	37.02		43.01		44.82	
Prob > chi2	0.0033		0.0002		0.0001	
Pseudo R2	0.1767		0.4432		0.2817	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Interaction effects of formal constraints and commercial bribery

Model 2 (Probit model)	(2a) Imitation	(2b) Innovation Pretender	(2c) Innovation	(2d) Imitation	(2e) Innovation Pretender	(2f) Innovation	(2g) Imitation	(2h) Innovation Pretender	(2i) Innovation
Variables	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Constraints from government system	**0.0557****	**0.0446****	0.0208	**0.0443****	0.0155	0.00685	**0.0435****	0.0259	0.00482
	(0.0227)	(0.0227)	(0.0309)	(0.0218)	(0.0191)	(0.0309)	(0.0219)	(0.0219)	(0.0302)
Constraints from the legal system	**-0.0680*****	**0.0391****	**-0.0625****	**-0.0646*****	**0.0844*****	**-0.0635****	**-0.0631*****	**0.0302****	**-0.0603****
	(0.0225)	(0.0152)	(0.0283)	(0.0217)	(0.0179)	(0.0293)	(0.0201)	(0.0137)	(0.0270)
Lack of formal finance	0.0114	0.00984	-0.0257	0.0104	0.0215	-0.0197	0.00914	0.0181	-0.0318
	(0.0380)	(0.0320)	(0.0491)	(0.0384)	(0.0323)	(0.0488)	(0.0388)	(0.0338)	(0.0482)
Commercial bribery	**-0.139****	**-0.177*****	-0.0428	**-0.142***	**-0.136*****	-0.0326	**-0.164****	**-0.124***	-0.0719
	(0.0649)	(0.0458)	(0.0613)	(0.0729)	(0.0252)	(0.0616)	(0.0763)	(0.0663)	(0.0727)
Lack of informal finance	-0.0189	0.0270	**-0.115****	-0.0158	0.0127	**-0.113****	-0.0134	0.0122	**-0.101***
	(0.0420)	(0.0441)	(0.0527)	(0.0428)	(0.0408)	(0.0533)	(0.0416)	(0.0429)	(0.0532)
Property loss	-0.00598	**-0.0650*****	-0.0139	-0.00253	**-0.0555*****	-0.00649	-0.00177	**-0.0596*****	-0.00745
	(0.0234)	(0.0223)	(0.0302)	(0.0243)	(0.0200)	(0.0313)	(0.0237)	(0.0197)	(0.0305)
Skilled worker	-0.0453	0.0278	-0.199*	-0.0336	0.0383	-0.197	-0.0182	0.0476	-0.137
	(0.0806)	(0.0950)	(0.119)	(0.0778)	(0.0948)	(0.122)	(0.0696)	(0.103)	(0.103)
Subsidiary	0.0317	**-0.403*****	0.0988**	0.0383	**-0.739*****	**0.113****	0.0384	**-0.256*****	**0.109****
	(0.0396)	(0.112)	(0.0500)	(0.0395)	(0.199)	(0.0505)	(0.0381)	(0.0708)	(0.0493)
Firm age	0.000775	0.000849	-0.000418	0.000885	0.00112	0.0000923	0.000821	0.00205	-0.000354
	(0.00120)	(0.00138)	(0.00181)	(0.00119)	(0.00124)	(0.00170)	(0.00115)	(0.00134)	(0.00166)
Top manager's experience	-0.00106	**-0.00376*****	0.000627	-0.000473	**-0.00363*****	0.00153	-0.000274	**-0.00407*****	0.00202
	(0.00142)	(0.00135)	(0.00187)	(0.00137)	(0.00130)	(0.00180)	(0.00140)	(0.00144)	(0.00184)
Competition	0.0545	**-0.103****	0.154***	0.0569	**-0.0908****	0.162***	0.0586	**-0.0748***	0.161***
	(0.0369)	(0.0426)	(0.0419)	(0.0369)	(0.0410)	(0.0413)	(0.0361)	(0.0383)	(0.0442)
Licensed technology	-0.0230	**0.114*****	0.112**	-0.0248	**0.118*****	0.118**	-0.0277	**0.102*****	0.110**
	(0.0439)	(0.0330)	(0.0491)	(0.0447)	(0.0337)	(0.0493)	(0.0453)	(0.0334)	(0.0491)

Table 3: Continued

Model 2 (Probit model)	(2a) Imitation	(2b) Innovation Pretender	(2c) Innovation	(2d) Imitation	(2e) Innovation Pretender	(2f) Innovation	(2g) Imitation	(2h) Innovation Pretender	(2i) Innovation
Variables	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Constraints from government system* Commercial bribery	**-0.170***	**-0.198***	**-0.189***						
	(0.076)	(0.038)	(0.08)						
Constraints from the legal system* Commercial bribery				0.024	**-0.142*****	**-0.103***			
				(0.06)	(0.05)	(0.06)			
Lack of formal finance* Commercial bribery							-0.07	0.13	-0.06
							(0.15)	(0.12)	(0.15)
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	219	159	217	219	159	217	219	159	217
Wald chi2	35.97	40.70	53.58	39.45	384.13	57.03	38.13	54.44	45.40
Prob > chi2	0.0071	0.0006	0.0000	0.0025	0.0000	0.0000	0.0037	0.0000	0.0002
Pseudo R2	0.1923	0.4882	0.3110	0.1809	0.5103	0.3028	0.1780	0.4518	0.2830

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Interaction effects of formal constraints and Lack of informal finance

Model 3 (Probit model)	(3a) Imitation	(3b) Innovation Pretender	(3c) Innovation	(3d) Imitation	(3e) Innovation Pretender	(3f) Innovation	(3g) Imitation	(3h) Innovation Pretender	(3i) Innovation
Variables	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Constraints from government system	**0.0463**[**]	0.0238	0.00754	**0.0461**[**]	0.0215	0.00973	**0.0437**[**]	0.0246	0.00592
	(0.0221)	(0.0225)	(0.0306)	(0.0225)	(0.0214)	(0.0295)	(0.0213)	(0.0203)	(0.0298)
Constraints from the legal system	**-0.0604***[***]	**0.0310**[**]	**-0.0585**[**]	**-0.0602***[***]	**0.0329**[**]	**-0.0576**[**]	**-0.0634***[***]	**0.0303**[**]	**-0.0617**[**]
	(0.0194)	(0.0143)	(0.0265)	(0.0195)	(0.0141)	(0.0263)	(0.0197)	(0.0132)	(0.0263)
Lack of formal finance	0.00630	0.0169	-0.0323	0.00690	0.0166	-0.0362	0.0112	0.0153	-0.0299
	(0.0377)	(0.0337)	(0.0489)	(0.0381)	(0.0337)	(0.0477)	(0.0402)	(0.0342)	(0.0494)
Commercial bribery	**-0.118***[***]	**-0.107***[***]	-0.0661	**-0.115***[***]	**-0.104**[**]	-0.0658	**-0.111***[***]	**-0.104**[**]	-0.0548
	(0.0428)	(0.0393)	(0.0587)	(0.0431)	(0.0404)	(0.0581)	(0.0425)	(0.0410)	(0.0593)
Lack of informal finance	-0.0157	0.0202	**-0.102**[**]	-0.00991	0.0235	**-0.0953**[*]	-0.0134	0.0286	**-0.0988**[*]
	(0.0409)	(0.0453)	(0.0517)	(0.0430)	(0.0440)	(0.0525)	(0.0415)	(0.0436)	(0.0514)
Property loss	-0.000823	**-0.0546***[***]	-0.00591	-0.000433	**-0.0553***[***]	-0.00858	-0.00197	**-0.0528***[***]	-0.00779
	(0.0233)	(0.0196)	(0.0297)	(0.0227)	(0.0200)	(0.0302)	(0.0236)	(0.0180)	(0.0307)
Skilled worker	-0.0165	0.0368	-0.129	-0.0237	0.0321	-0.142	-0.0205	0.0247	-0.139
	(0.0674)	(0.0988)	(0.0970)	(0.0664)	(0.102)	(0.101)	(0.0678)	(0.0966)	(0.104)
Subsidiary	0.0414	**-0.251***[***]	**0.114**[**]	0.0416	**-0.260***[***]	**0.116**[**]	0.0359	**-0.262***[***]	**0.105**[**]
	(0.0388)	(0.0761)	(0.0499)	(0.0390)	(0.0773)	(0.0494)	(0.0384)	(0.0748)	(0.0495)
Firm age	0.000864	0.00142	-0.000232	0.0416	**-0.260***[***]	**0.116**[**]	0.000761	0.00109	-0.000431
	(0.00110)	(0.00132)	(0.00165)	(0.0390)	(0.0773)	(0.0494)	(0.00115)	(0.00136)	(0.00169)
Top manager's experience	-0.000264	**-0.00328**[**]	0.00197	-0.000292	**-0.00331**[**]	0.00182	-0.000174	**-0.00330**[**]	0.00210
	(0.00141)	(0.00154)	(0.00186)	(0.00140)	(0.00149)	(0.00188)	(0.00140)	(0.00152)	(0.00186)
Competition	0.0526	**-0.0704**[*]	**0.152***[***]	0.0532	**-0.0658**[*]	**0.152***[***]	0.0543	-0.0613	**0.155***[***]
	(0.0362)	(0.0385)	(0.0425)	(0.0364)	(0.0394)	(0.0423)	(0.0362)	(0.0382)	(0.0424)
Licensed technology	-0.0256	**0.104***[***]	**0.110**[**]	-0.0297	**0.101***[***]	**0.106**[**]	-0.0281	**0.105***[***]	**0.110**[**]
	(0.0451)	(0.0353)	(0.0496)	(0.0458)	(0.0364)	(0.0490)	(0.0449)	(0.0358)	(0.0481)

Table 4: Continued

Model 3 (Probit model)	(3a) Imitation	(3b) Innovation Pretender	(3c) Innovation	(3d) Imitation	(3e) Innovation Pretender	(3f) Innovation	(3g) Imitation	(3h) Innovation Pretender	(3i) Innovation
Variables	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
Constraints from government system* Lack of informal finance	-0.04	-0.01	-0.03						
	(0.04)	(0.03)	(0.05)						
Constraints from the legal system*Lack of informal finance				-0.017	0.006	-0.02			
				(0.04)	(0.03)	(0.04)			
Lack of formal finance* Lack of informal finance							-0.04	-0.04	-0.03
							(0.07)	(0.06)	(0.08)
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	219	159	217	219	159	217	219	159	217
Wald chi2	35.88	42.63	44.33	35.67	42.93	44.27	37.56	42.01	45.56
Prob > chi2	0.0073	0.0003	0.0003	0.0078	0.0003	0.0003	0.0044	0.0004	0.0002
Pseudo R2	0.1811	0.4463	0.2846	0.1808	0.4432	0.2864	0.1785	0.4471	0.2827

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusions, Implications, and Future Research

This paper aims to analyze the joint impact of formal and informal institutional constraints on the innovation of the Tunisian firms. In this paper, we distinguish between three types of innovation: imitator, innovation pretender, and innovator. To test our hypotheses, we use the world bank enterprise survey conducted in 2020. Regarding the formal institutions, we show that *constraint from government system* is positively related to the likelihood of being an *imitator*. We relate this result to the fact that institutional constraints, even the strongest ones, may remain ineffective because innovative firms are more likely to attribute a higher trust scale to these constraints. Therefore, certain niches or opportunities will be left in the hand of potential imitators. In addition, we show that *constraint from the legal system* is inversely related with the likelihood of being an imitator and an innovator, but it positively affects the likelihood of being an *innovation pretender*. This result can be linked to the fact that Tunisia has gone through difficult times characterized by the multiplicity of sit-ins and strikes in all areas. The country's economic and political instability has affected companies' ability to innovate. Tunisian firms are increasingly concerned about protecting their innovation output. With respect to informal institutions, we find that *commercial bribery* negatively affects firms' likelihood of being an *imitator* and an *innovation pretender*. Informal gifts or payments can also threaten the success of any innovation project. This result can be related to the fact that if the firm's business environment is characterized by corrupt behavior, there will be no trustful contracts between concerned parts. Therefore, corruption can hinder any innovation. In order to mitigate the harmful effect of commercial bribery on innovation, any government should take certain measures.

Our article adds to the debates on the relationship between formal and informal institutions on innovation by generating some results whose interpretation deserves the attention of Tunisian policy makers. The main results obtained in our paper have interesting policy implications. In the first place, when the government plans to set barriers to deter imitation, it should simultaneously raise the awareness of innovating firms' managers regarding these probable imitation intentions. Secondly, in order to mitigate the informal gift or payment, Tunisian policy makers are advised to put in place a digital system that handles the filing of innovation files. This procedure can, in a way, reduce the waiting time and thus companies can get rid of bribes. Third, we advise Tunisian policy makers to ensure political stability in order to give confidence to local and foreign investors. To do this, radical changes in the legal, fiscal, financial, industrial and agricultural systems should be undertaken. Success in creating honesty and trust in business environments reduces corruption. The main reason is that in these environments, companies collaborate and exchange more knowledge and implement a more efficient decentralized management system. These factors promote innovation. Fourthly, government should encourage firms to invest in the R&D activities by giving them subsidies. Also, it is advisable to speed up the procedures for granting loans to SMEs. This can limit the resort to the informal financing. Finally, despite the establishment since 2014 of an anti-corruption agency in Tunisia, l'*Instance de la Bonne Gouvernance et de la Lutte Contre la Corruption* (IBGLCC), the problem of corruption still persists. Therefore, we advise Tunisian policymakers to strengthen the capacity of the anti-corruption agency by hiring qualified and specialized workforce and to increase control procedures.

Although our study provides important results regarding the impact of the joint effect of formal and informal institutions on innovation, it can be extended in several ways. First, in this paper, we have relied particularly on data carried out by the World Bank in 2020 on the Tunisian context. The results of our analysis might not be generalizable to other countries. Second, due to limitations in the currently available data, we used a binary variable in order to measure commercial bribery. Third, due to the nature of the cross-sectional data collected, we investigated the static effect of the formal and informal institutions and firms' innovation behavior. Fourth, we used in our analysis only data relating to the year 2020.

In light of these limitations, the following research perspectives are suggested. First, we propose to extend the analysis to a multi-country context in order to make comparisons. Second, it might also be interesting to use other measures of commercial bribery such as the amount paid in bribes to be able to generalize the results. Third, analyzing the relationship between innovation and formal and informal constraints by using an unbalanced panel dataset for 2013-2020 could be an important topic to address in future research. Finally, the availability of panel data could allow researchers to study the causal effect of commercial corruption on innovation in different regions.

Appendix

See Tables 5, 6, and 7

Table 5: Effect of formal and informal institutional constraints on types of innovation (logit model)

Model 1' (Logit model)	(1a)'		(1b)'		(1c)'	
	Imitation		*Innovation Pretender*		*Innovation*	
Variables	Coef	Odds ratio	Coef	Odds ratio	Coef	Odds ratio
Constraints from government system	**0.586****	**1.798****	0.587	1.799	1.070	1.070
	(0.293)	(0.527)	(0.627)	(1.129)	(0.314)	(0.314)
Constraints from the legal system	**-0.876*****	**0.416*****	**0.782****	**2.187****	**0.550****	**0.550****
	(0.310)	(0.129)	(0.349)	(0.764)	(0.167)	(0.167)
Lack of formal finance	0.181	1.199	0.357	1.428	0.750	0.750
	(0.641)	(0.768)	(0.786)	(1.123)	(0.378)	(0.378)
Commercial bribery	**-1.536****	**0.215****	**-2.342*****	**0.0962*****	0.653	0.653
	(0.621)	(0.134)	(0.903)	(0.0868)	(0.379)	(0.379)
Lack of informal finance	-0.155	0.857	0.755	2.128	**0.354***	**0.354***
	(0.678)	(0.581)	(1.596)	(3.396)	(0.203)	(0.203)
Property loss	-0.00775	0.992	**-1.244****	**0.288****	0.860	0.860
	(0.377)	(0.374)	(0.505)	(0.146)	(0.305)	(0.305)
Skilled worker	-0.515	0.597	0.231	1.260	0.232	0.232
	(1.197)	(0.715)	(4.023)	(5.067)	(0.272)	(0.272)
Subsidiary	0.498	1.645	**-5.824*****	**0.00296*****	**2.573***	**2.573***
	(0.579)	(0.952)	(1.424)	(0.00421)	(1.259)	(1.259)
Firm age	0.0141	1.014	0.0360	1.037	0.997	0.997
	(0.0164)	(0.0166)	(0.0308)	(0.0320)	(0.0171)	(0.0171)
Top manager's experience	-0.00698	0.993	**-0.0735***	**0.929***	1.015	1.015
	(0.0198)	(0.0197)	(0.0404)	(0.0376)	(0.0171)	(0.0171)
Competition	0.775	2.170	-1.310	0.270	**4.549*****	**4.549*****
	(0.559)	(1.212)	(0.815)	(0.220)	(2.163)	(2.163)
Licensed technology	-0.231	0.794	**2.294****	**9.919****	**2.929****	**2.929****
	(0.656)	(0.521)	(0.987)	(9.793)	(1.483)	(1.483)
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
_cons	0.2716	1.312	1.263	3.534		
	(1.460)	(1.916)	(1.897)	(6.703)		

Table 5 : Continued

Model 1' (Logit model)	(1a)'	(1b)'	(1c)'
	Imitation	Innovation Pretender	Innovation
N	219	159	217
Wald chi2	35.90	42.84	37.71
Prob > chi2	0.0047	0.0002	0.0017
Pseudo R2	0.1767	0.4435	0.2937

Standard errors in parentheses, $^{*} p < 0.10$, $^{**} p < 0.05$, $^{***} p < 0.01$

Table 6: Interaction effects of formal constraints and commercial bribery (logit model)

Model 2' (logit)	(2a)'	(2b)'	(2c)'	(2d)'	(2e)'	(2f)'	(2g)'	(2h)'	(2i)'
			Innovation			Innovation	Imitation	Innovation	Innovation
	Imitation	Innovation Pretender		Imitation	Innovation Pretender			Pretender	
Variables	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio
Constraints from government system	**4.582****	**32.32*****	**4.155***	**1.780****	1.741	1.108	**1.765***	2.032	1.070
	(2.905)	(38.94)	(3.391)	(0.514)	(1.222)	(0.342)	(0.515)	(1.279)	(0.315)
Constraints from the legal system	**0.370*****	**2.660****	**0.527***	0.551	**1775954.1*****	1.054	**0.409*****	**2.056****	**0.548***
	(0.136)	(1.066)	(0.174)	(0.232)	(2284258.9)	(0.533)	(0.130)	(0.723)	(0.170)
Lack of formal finance	1.231	1.108	0.772	1.235	1.513	0.829	2.025	0.280	1.599
	(0.773)	(0.939)	(0.410)	(0.779)	(1.293)	(0.427)	(2.045)	(0.429)	(1.793)
Commercial bribery	0.857	2.568	0.331*	0.878	1.898	0.346*	0.875	1.498	0.358*
	(0.584)	(5.077)	(0.190)	(0.610)	(3.580)	(0.204)	(0.589)	(2.346)	(0.205)
Lack of informal finance	0.981	0.204**	0.843	1.022	0.245**	0.907	1.013	0.251***	0.862
	(0.370)	(0.127)	(0.312)	(0.409)	(0.139)	(0.349)	(0.386)	(0.133)	(0.311)
Property loss	0.430	1.072	0.154	0.485	1.208	0.157	0.668	2.145	0.251
	(0.622)	(5.045)	(0.193)	(0.688)	(5.850)	(0.208)	(0.816)	(8.651)	(0.298)
Skilled worker	1.600	0.0000674***	2.659*	1.692	2.73e-14***	2.821**	1.669	0.00310***	2.611**
	(0.932)	(0.000155)	(1.341)	(0.977)	(8.69e-14)	(1.396)	(0.939)	(0.00425)	(1.228)
Subsidiary	1.014	1.026	0.997	1.016	1.034	1.002	1.015	1.054	0.998
	(0.0179)	(0.0373)	(0.0194)	(0.0176)	(0.0364)	(0.0177)	(0.0171)	(0.0357)	(0.0173)
Firm age	0.981	0.912**	1.003	0.990	0.910**	1.011	0.993	0.912***	1.015
	(0.0210)	(0.0410)	(0.0182)	(0.0194)	(0.0398)	(0.0171)	(0.0196)	(0.0307)	(0.0168)
Top manager's experience	2.182	0.0867**	4.649***	2.219	0.105**	4.802***	2.350	0.210**	4.997***
	(1.241)	(0.0899)	(2.258)	(1.233)	(0.108)	(2.210)	(1.309)	(0.159)	(2.535)
Competition	0.813	17.46**	2.970**	0.828	22.57**	3.071**	0.809	10.59***	3.034**
	(0.538)	(21.03)	(1.577)	(0.539)	(30.50)	(1.570)	(0.539)	(9.371)	(1.562)

Table 6: Continued

Model 2' (logit)	(2a)' Imitation	(2b)' Innovation Pretender	(2c)' Innovation	(2d)' Imitation	(2e)' Innovation Pretender	(2f)' Innovation	(2g)' Imitation	(2h)' Innovation Pretender	(2i)' Innovation
Variables	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio
Licensed technology	0.217**	0.0765**	0.620	0.168**	194.0***	0.469	0.264*	0.0422***	0.845
	(0.137)	(0.0798)	(0.355)	(0.118)	(220.1)	(0.285)	(0.184)	(0.0471)	(0.519)
Constraints from government system* Commercial bribery	0.336	**0.0473*****	**0.223***						
	(0.229)	(0.0527)	(0.182)						
Constraints from the legal system* Commercial bribery				0.619	**0.00000116*****	0.398			
				(0.363)	(0.00000152)	(0.253)			
Lack of formal finance* Commercial bribery							0.482	9.712	0.396
							(0.545)	(19.33)	(0.489)
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
_cons	4.464	42.98**	0.176	0.358	0.0116**	0.0404***	0.978	8.244	0.0887**
	(6.801)	(78.42)	(0.203)	(0.561)	(0.0236)	(0.0456)	(1.487)	(15.33)	(0.0935)
N	219	159	217	219	159	217	219	159	217
Wald chi2	33.55	35.77	48.10	34.75	380.34	51.01	37.14	52.76	37.91
Prob > chi2	0.0143	0.0031	0.0001	0.0102	0.0000	0.0000	0.0050	0.0000	0.0025
Pseudo R2	0.1913	0.4907	0.3137	0.1821	0.5123	0.3080	0.1790	0.4528	0.2964

Standard errors in parentheses, $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Interaction effects of formal constraints and Lack of informal finance (logit model)

Model 3' (Logit model)	(3a)' Imitation	(3b)' Innovation Pretender	(3c)' Innovation	(3d)' Imitation	(3e)' Innovation Pretender	(3f)' Innovation	(3g)' Imitation	(3h)' Innovation Pretender	(3i)' Innovation
Variables	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio	Odds ratio
Constraints from government system	**2.184****	3.008	1.280	**1.862****	1.916	1.113	**1.801****	1.887	1.078
	(0.812)	(3.567)	(0.466)	(0.585)	(1.467)	(0.319)	(0.527)	(1.111)	(0.312)
Constraints from the legal system	**0.425*****	**2.060****	**0.551***	**0.501****	**2.394***	0.680	**0.411*****	**2.072****	**0.543****
	(0.128)	(0.692)	(0.168)	(0.168)	(1.264)	(0.209)	(0.124)	(0.735)	(0.162)
Lack of formal finance	1.200	1.373	0.760	1.234	1.384	0.743	1.638	2.598	0.913
	(0.768)	(1.087)	(0.379)	(0.814)	(1.099)	(0.365)	(1.270)	(3.532)	(0.547)
Commercial bribery	**0.204*****	**0.0833****	0.606	**0.220****	**0.0962****	0.616	**0.230****	**0.0930****	0.690
	(0.126)	(0.0818)	(0.340)	(0.138)	(0.0880)	(0.349)	(0.140)	(0.0877)	(0.390)
Lack of informal finance	0.797	2.367	**0.279***	0.650	2.299	0.222	1.142	3.750	0.440
	(0.559)	(4.347)	(0.194)	(0.555)	(4.080)	(0.220)	(0.822)	(4.708)	(0.253)
Property loss	1.004	**0.292****	0.866	1.005	**0.291****	0.838	1.005	**0.300*****	0.864
	(0.375)	(0.142)	(0.307)	(0.365)	(0.140)	(0.296)	(0.380)	(0.138)	(0.307)
Skilled worker	0.672	1.296	0.283	0.603	1.165	0.229	0.648	1.219	0.249
	(0.786)	(5.226)	(0.315)	(0.689)	(4.819)	(0.267)	(0.782)	(4.833)	(0.298)
Subsidiary	1.756	**0.00370*****	**2.717****	1.781	**0.00327*****	**2.761****	1.605	**0.00274*****	**2.493***
	(1.023)	(0.00553)	(1.304)	(1.037)	(0.00481)	(1.319)	(0.908)	(0.00410)	(1.186)
Firm age	1.015	1.035	1.000	1.013	1.035	0.999	1.015	1.029	0.997
	(0.0162)	(0.0315)	(0.0173)	(0.0166)	(0.0304)	(0.0170)	(0.0178)	(0.0346)	(0.0176)
Top manager's experience	0.993	**0.928***	1.013	0.992	**0.927***	1.011	0.995	**0.930***	1.017
	(0.0204)	(0.0415)	(0.0176)	(0.0200)	(0.0420)	(0.0173)	(0.0197)	(0.0374)	(0.0173)
Competition	2.198	**0.229***	**4.429*****	2.186	0.257	**4.434*****	2.165	0.300	**4.577*****
	(1.253)	(0.198)	(2.103)	(1.248)	(0.224)	(2.075)	(1.189)	(0.266)	(2.186)
Licensed technology	0.822	**12.04****	**3.029****	0.765	**10.81****	**2.752****	0.790	**10.83****	**3.016****
	(0.547)	(14.14)	(1.572)	(0.517)	(12.56)	(1.379)	(0.519)	(10.14)	(1.534)
Constraints from government system* Lack of informal finance	0.602	0.517	0.602						
	(0.358)	(0.439)	(0.352)						
Constraints from the legal system*Lack of informal finance				0.616	0.811	0.478			
				(0.441)	(0.536)	(0.411)			
Lack of formal finance* Lack of informal finance							0.433	0.358	0.575
							(0.527)	(0.642)	(0.543)

Table 7: Continued

Model 3' (Logit model)	(3a)' Imitation	(3b)' Innovation Pretender	(3c)' Innovation	(3d)' Imitation	(3e)' Innovation Pretender	(3f)' Innovation	(3g)' Imitation	(3h)' Innovation Pretender	(3i)' Innovation
_cons	5.826	14.25	0.126*	0.481	10.63	0.0630**	1.155	3.079	0.103**
	(8.978)	(25.58)	(0.144)	(0.760)	(18.04)	(0.0719)	(1.729)	(5.798)	(0.108)
Firm size dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	219	159	217	219	159	2017	219	159	217
Wald chi2	34.34	39.80	37.16	33.34	40.99	37.51	36.42	42.67	38.43
Prob > chi2	0.0114	0.0008	0.0032	0.0152	0.0006	0.0029	0.0062	0.0003	0.0021
Pseudo R2	0.1818	0.4499	0.2990	0.1825	0.4446	0.3043	0.1803	0.4467	0.2952

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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