# Does innovation foster or mitigate the corruption obstacle? Firm-level evidence from Tunisia

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# Does innovation foster or mitigate the corruption obstacle? Firm-level evidence from Tunisia

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**Abstract**

The aim of this paper is to analyze the extent to which Tunisian firms regard corruption as a major obstacle to their product and process innovation. Using firm-level data from the World Bank Enterprise Survey conducted in 2013, we empirically test how innovation accentuates or mitigates the corruption obstacle. We show that innovation has a negative and statistically significant effect on the corruption obstacle. Besides, we prove that competition and the obstacle to corruption are negatively related. This result teaches that the Tunisian firms face a rent-shifting corruption.

**Key words:** Innovation, Corruption obstacle, Rent-shifting.

**JEL classification:** L80, O31, O32, D73.

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# 1 Introduction

Several theoretical and empirical studies have been carried on innovation. Some frameworks focused on the relationship between innovation and economic performance (Crépon et al., 1998; Mairesse and Mohnen, 2003; Roper and Dundas, 1998; Cainelli et al., 2006; Mansury et al. 2008). Other works analyzed the determinants of innovation and the role of external linkages while introducing external control factors such as size and age of the firm (Duguet, 2006; Raymond and St-Pierre, 2010). Innovation has also been the topic of some Tunisian papers. Indeed, Kriaa and Karray (2010) analyzed the link between R&D investment and innovation of Tunisian firms. They showed that firms invest in R&D not only to innovate but also to improve their ability to assimilate and exploit the existing technological knowledge. Furthermore, innovation can be influenced by other relevant features. For instance, Sdiri and Ayadi (2014) show that internationalization increases firms' innovation profitability. This result may embody the fact that the access to external knowledge can determine the innovation performance of service firms.

Despite the abundance of literature on innovation, the analysis of the relationships between innovation and corruption remains a major and noteworthy issue. Empirical studies on this relationship are rather limited for developing countries, Tunisia, in particular. Therefore, it is necessary to empirically investigate the hypothesis that corruption can hamper Tunisian firms' innovation.

The definition of corruption is ambiguous. Some scholars regard it as a good contributor to the economic growth and performance (Leff, 1964). Other scholars link corruption to the worst way by which political and public decision makers govern the country's affairs; corruption has then tendency to harm the well-being of nations. Under a corrupted system, the wealth of the nation has been, typically, in the hand of a limited number of corruptors who handle and manage institutions to their best interests.

Corruption has always been among the most important concepts that economists and practitioners have debated for decades. The majority of them have been interested in analyzing its causes and consequences. They have also provided some policy considerations and solutions to this hidden and no-controllable practice. The major questions they should address are: how to reduce and/or avoid corruption? What are the tools to battle corruption? Does cooperation with the existing corruptors inhibit the advent of other ones? The negative consequences of corruption can be perceived at the micro and macro levels. At the micro-level, corruption contributes to reduce firms' competitiveness and limit their market power. For instance, Alexeev and Song (2013) evaluate the impact of corruption on the product market competition. Corruption strengthens also the informal economy that, in turn, undermines the public-private relationships. At the macro-level, corruption is a factor of economic recession. It decreases the GDP per-capita (exogenous economic growth), lowers the economic development (endogenous economic growth), intensifies social instability, implies higher unemployment and inflation rates, etc. Corruption may also inhibit the foreign direct investors. Castro and Nunes (2013) studied corruption impact on FDI inflows. They showed that countries with lower corruption benefitted from greater FDI entries.

In spite of the fact that public and private decision-makers have always tended to mitigate the corruption magnitude via undertaking innovation investments, corruption remains an obstacle and/or a big problem for them. Actually, the corruption obstacle-innovation relationship is a new topic. Wong (2015) has investigated the extent to which innovation alters the growing shape of corruption. He shows that when a firm decides to innovate, it considers corruption as a major obstacle to innovation decision.

It is well-observed that the intensity of corruption is sufficiently large in the developing and/or emerging countries. This is linked to the weak social, economic and political infrastructures in these countries. For instance, according to the enterprise survey realized by the World Bank in 2013, 54.78% of Egyptian companies identify corruption as a major or serious problem; and 45.18% of Moroccan firms consider corruption as a severe constraint. Tunisia suffers also from corruption. In 2015 and according to the Corruption Perceptions Index of Transparency International, Tunisia is ranked 76$^{\text{th}}$ among 168 countries and territories in terms of corruption [1]. The Tunisian GDP decreases by 2% because of corruption. Global Financial Integrity has assessed that Tunisia has lost 1.2 billion dollars every year between 2000 and 2008. This is caused by bribes, subordination and falsification of the criminal activities. [2] This corruption is notably related to the corrupted political systems that have governed Tunisia before the 2011-revolution and during the democratic transition. The economic infrastructures and the education systems are deteriorated. Furthermore, the wealth distribution is distinctly oriented to the coastal regions where resident and foreign capitalists are willing to invest. It is also important to mention that corruption has attracted corrupt foreign investors who cooperate with the resident ones.

Corruption is a major obstacle to the Tunisian business firms' activities, including innovation. Tunisian companies continue to increase their R&D to lower their marginal production costs (achieving economies of scale) and therefore they could capture more competitive advantages in the final market (market power). These companies also provide more efforts in order to improve the quality of their products and thus increase the range of the varieties on the market. Thus, they see corruption as a constraint that could hamper the activities related to innovation. This constraint could be either enhanced or attenuated by investments in innovation.

*The scope of this paper is then to analyze the extent to which Tunisian firms regard corruption as a major obstacle to their innovative activities. In other words, we examine how undertaking innovation accentuates or mitigates the corruption obstacle. We distinguish between product and process innovation.*

The paper is organized as follows. Section 2 presents a brief literature review on the relationship between innovation and corruption. Section 3 contains a description of the data set and the variables used in the empirical analysis. Section 4 sets out the econometric model. Section 5 analyzes the main results. Section 6 is a conclusion.

1. For more details, see http://www.transparency.org/cpi2015
2. World Bank (2014): "The unfinished revolution : bringing opportunity, good jobs and greater wealth to all Tunisians". Rapport Nº 86179-TN, p117

## 2 Innovation and corruption: literature review

In this section, we present the main works that concentrated on corruption. The latter is ascribed numerous definitions. For instance, Transparency International defines it as "*the abuse of entrusted power for private gain. It can be classified as grand, petty and political, depending on the amounts of money lost and the sector where it occurs*".[3] The World Bank regards it as "*the single greatest obstacle to economic and social development. It undermines development by distorting the role of law and weakening the institutional foundation on which economic growth depends*". Corruption has several forms, such as bribery, extortion, fraud, falsification and informal practices.

Even if corruption is not a new phenomenon, it has taken a wide attention from the academic research during the last decade. Some studies discussed the relationship between corruption and economic growth. The results of these studies were divergent. For instance, Mauro (1995) and Wei (2000) showed that corruption constitutes an obstacle for the economy because it hampers the economic growth. However, Barreto (2001) determined a positive relationship between corruption and GDP per capita growth. Lau et al. (2015) indicated that corruption greases the wheels of economic growth of countries in the European and Central Asia (ECA). Other frameworks analyzed the effect of corruption on the Foreign Direct Investment. Castro and Nunes (2013) investigated the impact of corruption on FDI inflows. Using 73 countries during the period 1998-2008, they suggested that the FDI inflows are greater in countries where corruption is lower. They also noted that corruption control can be an important strategy to enhance the FDI inflows. In addition, some other scholars such as Alexeev and Song (2010) analyzed the correlation between competition and corruption. They deduced that fierce competition is associated with higher corruption.

According to the above literature, it is argued that corruption, whatever its forms, has harmful effects on business operations. For instance, it reduces employment, hinders the entry of FDI, reduces firms' competitiveness and creates inequality. But what about the relationship between innovation and corruption? Indeed, many empirical studies have analyzed this relationship. Lau et al. (2015) analyzed the determinants of product innovations. They proved that corruption promotes innovative capabilities of countries in ECA region. Using World Bank Enterprise Survey on Indian firms, Waldemar (2012) tested the impact of corruption, measured as a bribes tax, on product innovation. He found that corruption reduces the probability to innovate. Mahagaonkar (2010) ascertained that corruption has a positive effect on marketing innovation and a negative effect on product innovation and organization innovation. Nguyen and Jaramillo (2014) argued that the firms' return on innovation is lower in countries with low level of institutional quality. They explained this result by the fact that bad institutional environments discourage firms to innovate. In the same context, Wong (2015) was interested in analyzing the incidence of corruption on innovation decision. This author concluded that corruption is a bigger obstacle when a firm decides to enter the innovation process.

3. For more details, see https://www.transparency.org.

# 3 Data and variables measure

## 3.1 Data

To test how innovation fosters the corruption obstacle, we used the enterprise survey data carried out by the World Bank in 2013. This data base is carried on firm-level using a representative sample of the manufacturing and service firms. The World Bank Enterprise Survey (hereafter WBES) data are collected through a stratified random sampling by using the industry, region of establishment location and establishment size. [4] Indeed, the survey covers small (5 to 19 employees), medium (20 to 99 employees) and large (more than 99 employees) firms from manufacturing (food, garments, and other manufacturing) and services sectors (retail and other services) located in five Tunisian regions (Tunis, Sfax, Northeast, South Coast/West and Interior). [5]

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 access to finance, competition, capacity, labor, performance, corruption, innovation and the business environment. The dataset consists of 592 Tunisian enterprises. In this paper, we have dropped the missing responses as well as the "Don't know " and "Does Not" responses from the dataset. This has led to cross section data of 2013 that included only 536 firms in Tunisia.

## 3.2 Variables measure

**Corruption Obstacle** Prior empirical studies have used different indicators in order to measure corruption. Ades and Ditella (1999) measured corruption by subjective indicators that are related to the whole country. Barasa et al. (2014) adopted a composite measure of firm-level perceptions of governance of the institutional quality at the regional level. This measure is constructed by using factor analysis so as to synthesize information about the perceptions of corruption, rules of law and regulatory quality. In this paper, we rely on a measure adopted by Wong (2015). This variable is the answer to the question: To what degree is corruption 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.

**Innovation** The majority of the previous studies that have focused on the innovation topic measured innovation by the number of patents or the percentage of new product sales (Mairesse and Mohnen, 2003). In this paper, we use two indicators of innovation. The first one is a dummy variable equal to 1 if the establishment has introduced new or significantly improved products or services and 0 otherwise. The second one is another dummy variable that takes the value 1 if the firm has introduced any new or significantly

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

5. Northeast (Ariana, Ben Arous, Bizerte, Manouba, and Nabeul), South Coast/West (Sousse, Monastir, Mahdia, Gabes, Medenine) and the Interior (Beja, Gafsa, Jendouba, Kairouan, Kasserine, Kebili, Kef, Sidi Bouzid, Siliana, Tataouine, and Tozeur)

improved methods of manufacturing products or services and 0 otherwise. These two measures are in accordance with prior research (Wong, 2015 and Barasa et al. 2014).

**Firm size** The relationship between innovation and firm size has been largely examined in several previous works. Wong (2015) measured the size of the firm using an ordinal variable equal to 1 if the firm is small (with less than 20 employees), equal to 2 if the firm has a medium size (with 20 to 99 employees), and equal to 3 if the firm is large (with 100 or more employees). Barasa et al. (2014) used a binary variable as measure of firm size. This variable takes the value 1 if the number of full-time permanent employees is greater than 20 employees and 0 otherwise. Asiedu and Freeman (2009), in turn, used two dummy variables to measure the firm size. The first variable, relative to a small firm, takes 1 if the number of employees is less than 50 and 0 otherwise. The second variable, corresponding to a medium firm, takes 1 if the number of employees is greater than 50 but less than 500 and 0 otherwise. In this paper, we choose the total annual sales for all products and services as a firm size measure. More precisely, the respondents are asked to answer the following question: "In the 2012 fiscal year, what were this establishment's total annual sales for all products and services?"

**Competition** Competition is a dummy variable that measures competitive pressure. It takes 1 if the number of competitors faced by the establishment is greater than 5 and 0 otherwise.

**Finance** We have introduced this variable in our model to know how the surveyed firms fund their operations. We use a dummy variable equal to 1 if the firm has a line of credit or a loan from a financial institution and 0 otherwise.

**Exports** In this paper, we use the information provided by the survey about the percentage of the national establishment's sales. We define exports as a continuous variable that corresponds to the percentage of a firm's sales outside the country.

**Vintage of the firm** The firm's vintage 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 survey year (2013).

**Employee level of education** TThe Enterprise Survey data provides information on the level of education attained by employees. In this paper, we have adopted the number of full-time employees holding a university or higher degree as a measure of the education level attained by employees.

# 4 Model specification and estimation

We analyze the extent to which innovative companies regard corruption as a major obstacle in comparison with those that do not innovate. Indeed, the responses to the question about the different corruption obstacles are classified according to a 5-point scale. The value 0 designates that corruption does not represent an obstacle for the

development of the firm's operations while the value 4 sets corruption as a very severe obstacle. The ordered structure of the dependent variable *corrup_obst* allows the use of ordered discrete choice models. We use an ordered logit model. As the values taken by the ordered multinomial variable *corrup_obst* are grouped into intervals, we obtain only one continuous unobservable latent variable *corrup_obst*$^*$. This kind of model assumes that the values are identical for all observations. Indeed, the level of *corrup_obst*$^*$ is parameterized by the threshold parameters $c_j$, and a constant is therefore not introduced in the linear model. This model is written as follows: [6]

$$corrup\_obst_i = \begin{cases} 0 & if \;\; corrup\_obst_i^* < c_1 \\ 1 & if \;\; c_1 \leq corrup\_obst_i^* < c_2 \\ 2 & if \;\; c_2 \leq corrup_obst_i^* < c_3 \\ 3 & if \;\; c_3 \leq corrup\_obst_i^* < c_4 \\ 4 & if \;\; c_4 \leq corrup\_obst_i^* < c_5 \end{cases} \quad \forall i = 1, ...536 \tag{1}$$

The threshold parameters $c_j$ are in an ascending order ($c_{j+1} \geq c_j$) where the variable *corrup_obst*$^*$ is defined by:

$$corrup\_obst_i^* = X_i\beta + \varepsilon_i \tag{2}$$

where $X_i$ represents the vector of the explanatory variables and $\varepsilon_i$ is a random error term which is assumed to have a logistic distribution. The probabilities that $corrup\_obst_i$ will take on each of the values 0 to 4 are equal to:

$$\begin{aligned} Pr(corrup\_obst_i = 0) &= \Lambda(c_1 - X_i\beta) \\ Pr(corrup\_obst_i = 1) &= \Lambda(c_2 - X_i\beta) - \Lambda(c_1 - X_i\beta) \\ ... &= ... \\ Pr(corrup\_obst_i = 4) &= 1 - \Lambda(x_i\beta) \end{aligned}$$

where $\Lambda(.)$ denotes the standard logistic cumulative distribution function.

The likelihood function of an observation $i$ is:

$$\begin{aligned} L &= \prod_{i=1}^{n}\prod_{j=0}^{4} Pr(y_i = j)^{y_{ij}} \\ &= \prod_{i=1}^{n}\prod_{j=0}^{4} [\Lambda(c_5 - X_i\beta) - \Lambda(c_4 - X_i\beta)]^{y_{ij}} \end{aligned}$$

where $y_{ij}$ is defined as:

$$y_{ij} = \begin{cases} 1 & if \;\; y_i = j \\ 0 & otherwise \end{cases}$$

Parameters $\beta$ and $c_j$, $j = 0, ...4$ are estimated using the ordered logit model by maximizing the log-likelihood function.

6. For further details, see Greene (2003).

# 5 Empirical findings

## 5.1 Descriptive statistics

The Corruption Perceptions Index (hereafter CPI) ranks countries and territories based on how corrupt their public sector is perceived to be. The score 0 indicates that the country is highly corrupt while the score 100 indicates that the country is very clean. According to CPI 2015, Somalia and North Korea have got the lowest score (the most corrupt countries) in the world rankings, while the least corrupt countries are: Netherlands, Sweden, New Zealand, Finland and Denmark. The latter received a score of 91 allowing it to take the first place. The CPI shows that Morocco, Algeria and Egypt are ranked 88$^{th}$ with a score of 36. Compared with these African countries, Tunisia has lost 3 places in the ranking of corruption perceptions. Indeed, Tunisia was ranked 76$^{th}$ out of 168 countries with a score of 38 points.

The Tunisian Institute of Competitiveness and Quantitative Studies (hereafter TICQS) and the World Bank Enterprise Survey (WBES) are interested in the corruption topic. According to TICQS in 2014, 42% of respondents adjudge that corruption has increased compared to 2013 while 44% declare that corruption has kept the same magnitude [7]. Although most of the companies surveyed found that corruption still persisted, only 26% of these companies consider it to be a major or severe obstacle that impedes their activities.

Summary statistics relating to our sample show that around 49% of companies indicated that they have introduced at least one innovation. [8] 25.75% of these companies reported that they have introduced a product innovation during the last three years before 2013 and 23.32% of them mentioned that they have introduced a process innovation (See table 2 below).

Regarding the relationship between innovation and firm size, the 2012 Investment Climate Assessment Survey (hereafter ICAS) demonstrates that 47% of Tunisian firms have introduced an improved or a new product. According to this survey, large firms report the highest level of innovation (55.8%). In contrast with ICAS, we show that 41.6% of innovative firms are medium-sized (having between 20 and 99 employees). This rate is higher compared to the larger firms. We relate this result to the fact that the medium enterprises are more incentivized to avoid the rude competition they face. Thus, their aim would be to commit in R&D efforts in order to reduce their marginal production costs. It would also be to capture additional market shares by improving the quality of their products.

The WBES survey provides information on the firm's business sectors. These sectors are classified into five activities: (1) food, (2) garments, (3) other manufacturing, (4) retail and (5) other services. Based on the data collected from this survey, we also

7. For more details, see the TICQS's 2014- report.

8. A firm is regarded as innovative when declaring that it has introduced (during the last three years, i.e. before the date of the survey) product innovation, process innovation, organizational innovation and marketing innovation.

explore the distribution of innovative companies by business sector. We show that the largest number of innovative companies is located in the third sector (33.97%), followed by companies operating in the fifth one (27.86%).

Firm location can also be a factor affecting the innovation decision. The survey defined five regions: Tunis, Sfax, Northeast, South Coast/West and Interior. According to the World Bank data, table 2 shows that the shares of innovative Tunisian companies in different regions are very close. Indeed, statistics show that both Sfax and Northeast have a large number of innovative companies (24.05%) followed by South Coast/West (22.90%) and Tunis (20.23%) while the Interior region is very low on innovation (only 8.78%).

Table 1 shows that 16.35% of innovative firms regard corruption as a major obstacle to the development of their operations. Also, it indicates that 14.82% of innovative firms consider corruption as a very severe obstacle which obstructs their business activities.

Table 1: Distribution of companies according to their corruption perceptions

| Obstacle_ Corruption | INN_PROD | | INN_PRO | | Total |
|---|---|---|---|---|---|
| | No | Yes | No | Yes | |
| No obstacle | 92 | 43 | 89 | 46 | 135 |
| Minor obstacle | 55 | 31 | 57 | 29 | 86 |
| Moderate obstacle | 96 | 18 | 100 | 14 | 114 |
| Major obstacle | 113 | 24 | 118 | 19 | 137 |
| Very Severe Obstacle | 42 | 22 | 47 | 17 | 64 |
| Total | 398 | 138 | 411 | 125 | 536 |

*Source: Our own calculations based on the WBES.*

Table 2: Distribution of innovative firms by size, location and industry

| | | INNOVATION (262 firms) | | Product Innovation (138 firms) | | Process Innovation (125 firms) | | CORRUPTION (201 firms) | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % | N | % |
| Size | Small (>=5 and <=19) | 81 | 30.92 | 41 | 29.71 | 32 | 25.6 | 78 | 38.81 |
| | Medium (>=20 and <=99) | 109 | 41.6 | 64 | 46.38 | 61 | 48.8 | 89 | 44.28 |
| | Large (>=100) | 72 | 27.48 | 33 | 23.91 | 32 | 25.6 | 34 | 16.92 |
| Industry | Food | 37 | 14.12 | 20 | 14.49 | 22 | 17.60 | 19 | 9.45 |
| | Garments | 45 | 17.18 | 22 | 15.94 | 26 | 20.80 | 28 | 13.93 |
| | Other Manufacturing | 89 | 33.97 | 49 | 35.51 | 50 | 40.00 | 60 | 29.85 |
| | Retail | 18 | 6.87 | 10 | 7.25 | 5 | 4.00 | 19 | 9.45 |
| | Other Services | 73 | 27.86 | 37 | 26.81 | 22 | 17.60 | 75 | 37.31 |
| Location | Tunis | 53 | 20.23 | 25 | 18.12 | 18 | 14.40 | 35 | 17.41 |
| | Sfax | 63 | 24.05 | 40 | 28.99 | 36 | 28.80 | 52 | 25.87 |
| | Northeast | 63 | 24.05 | 36 | 26.09 | 31 | 24.80 | 46 | 22.89 |
| | South Coast/West | 60 | 22.9 | 24 | 17.39 | 26 | 20.80 | 56 | 27.86 |
| | Interior | 23 | 8.78 | 13 | 9.42 | 14 | 11.20 | 12 | 5.97 |

*Source: Our own calculations based on the WBES.*

## 5.2 Empirical validation

Table 3 presents the means, the standard deviations of each variable as well as the correlation matrix between variables used in the models. 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 1.25 and the VIF of each variable is inferior to 10. According to this result, it is proved that there is no multicollinearity problem between the explanatory variables used in these models.

The main results of our models are given in tables 4 and 5. The results stemmed from the ordered logit model revealing that both product and process innovations have negative and statistically significant effects on the corruption obstacle. These results contradict those obtained by Wong (2015) as they depict that innovation softens the corruption obstacle. First, we argue that process innovation can be regarded as a substitute to the cost-reducing corruption. Firms do not need, then, to resort to corruption so as to reduce their marginal production costs. Second, product innovation has a tendency to be also a substitute to the rent-shifting corruption in the sense that firms can capture additional market power by increasing their product varieties.

In line with Emerson (2006), we show that besides the variable of interest *Product/Process Innovation*, the variable *market competitio*n has a negative and statistically significant effect on the perception of corruption. This means that corruption is inversely related to product market competition. We can relate our interesting result to the fact that WBES firms face a corruption related to rent-shifting. This contradicts Alexeev and Song's findings (2013). Indeed, these latter have mentioned that the relationship between competition and corruption depends on the nature of the corruption itself. They have proved that this relationship is positive in the case of a cost-reducing corruption but negative in the case of a rent-shifting corruption. These authors argue that a fierce competition in the product market is generally associated with a greater corruption critical level.

Enterprises' external funding is very important because of the increasing financial needs they face. For instance, the increase in the credit demand by the firm is used to raise its investment activities and therefore its production. In this paper, we introduce the variable *finance* in the model in order to analyze the link between obtaining a financial credit and corruption. Indeed, the question we address in this setting is: does having a line of credit or a loan from a financial institution reduce or increase the corruption level? In response to this question, we show, in contradiction with Wong (2015), that the variable *finance* is negatively correlated with the perceived corruption. The intuition behind this finding is that the increase in credit demand by a firm tends to increase its capital. Therefore, once the company increases its capital, it becomes able to avoid the risk of corruption. Accordingly, the corruption obstacle will be dramatically softened.

Table 3: Summary statistics and correlation matrix between variables

| Variables | VIF | Mean | Std. Dev. | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Innprodt | 1.25 | 1.742 | 0.437 | 1.000 | | | | | | | |
| Innproc | 1.28 | 1.766 | 0.423 | 0.422 | 1.000 | | | | | | |
| competition | 1.33 | 0.516 | 0.500 | 0.020 | -0.092 | 1.000 | | | | | |
| exports | 1.46 | 27.218 | 38.633 | -0.110 | -0.224 | 0.482 | 1.000 | | | | |
| finance | 1.09 | 1.410 | 0.492 | 0.092 | -0.015 | 0.002 | 0.150 | 1.000 | | | |
| agefirm | 1.06 | 1991.668 | 13.906 | -0.045 | -0.094 | 0.019 | 0.162 | 0.080 | 1.000 | | |
| size | 1.27 | 9991369 | 3.20e+07 | -0.103 | -0.125 | 0.061 | 0.074 | -0.148 | -0.112 | 1.000 | |
| Educ_enr | 1.27 | 12.333 | 20.728 | -0.066 | -0.066 | 0.123 | 0.126 | -0.169 | -0.083 | 0.432 | 1.000 |
| Mean VIF | 1.25 | | | | | | | | | | |

Another important result is related to the impact of employees' enrollment level on corruption. Wong (2015) demonstrated that education positively affects, with a decreasing rate, corruption. Unlike Wong (2015) and Shabbir and Anwar (2007), we show in this paper that the link between education enrollment level ($Educ\_enr$) and corruption is negative. This means that the education level can reduce the incidence of corruption. In this setting, we can notice that the education level can be an important tool to fight corruption.

Table 4: Impact of product innovation on corruption

| | Corruption obstacle | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Product innovation | -0.490* | -0.552** | -0.558** | -0.494* |
| | (-1.78) | (-1.98) | (-1.99) | (-1.75) |
| Competition | | -0.534** | -0.517** | -0.442* |
| | | (-2.03) | (-1.97) | (-1.67) |
| Exports | | 0.00442 | 0.00463 | 0.00621 |
| | | (1.10) | (1.15) | (1.28) |
| Finance | | -0.485** | -0.503** | -0.544** |
| | | (-2.12) | (-2.19) | (-2.24) |
| Age of the firm | | 0.00967 | 0.00899 | 0.00947 |
| | | (1.11) | (1.04) | (1.06) |
| Size | | 3.27e-09 | 4.48e-09 | 5.35e-09 |
| | | (0.64) | (1.03) | (1.33) |
| Educ_enr | | | -0.00551 | -0.00729* |
| | | | (-1.26) | (-1.68) |
| Sectors | | | | |
| 1. Food | | | | Reference |
| 2.Garments | | | | 0.389 |
| | | | | (0.64) |
| 3.Other Manufacturing | | | | 0.698* |
| | | | | (1.74) |
| 4.Retail | | | | 1.296** |
| | | | | (2.24) |
| 5.Other Services | | | | 0.953** |
| | | | | (2.27) |
| cut1 | -0.211 | 18.31 | 16.91 | 18.51 |
| | (-0.43) | (1.05) | (0.98) | (1.04) |
| cut2 | 0.487 | 19.03 | 17.63 | 19.24 |
| | (0.97) | (1.09) | (1.02) | (1.08) |
| cut3 | 1.451** | 20.01 | 18.62 | 20.25 |
| | (2.79) | (1.15) | (1.08) | (1.13) |
| cut4 | 2.872** | 21.46 | 20.07 | 21.72 |
| | (5.25) | (1.23) | (1.16) | (1.21) |
| N | 536 | 536 | 536 | 536 |

*Values () represent the t of student*

*p<0.10, **p<0.05, ***p<0.001

Table 5: Impact of process innovation on corruption

| | Corruption obstacle | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Process Innovation | -0.963** | -0.996** | -1.001** | -0.905** |
| | (-3.06) | (-3.03) | (-3.04) | (-2.73) |
| Competition | | -0.482* | -0.465* | -0.399 |
| | | (-1.93) | (-1.86) | (-1.57) |
| Exports | | 0.00559 | 0.00580 | 0.00703 |
| | | (1.42) | (1.47) | (1.41) |
| Finance | | -0.421* | -0.440* | -0.487** |
| | | (-1.83) | (-1.90) | (-1.98) |
| Age of the firm | | 0.00937 | 0.00864 | 0.00936 |
| | | (1.07) | (0.99) | (1.04) |
| Size | | 4.67e-09 | 5.90e-09 | 6.49e-09 |
| | | (0.96) | (1.40) | (1.62) |
| Educ_enr | | | -0.00561 | -0.00714* |
| | | | (-1.31) | (-1.67) |
| Sectors | | | | |
| 1. Food | | | | Reference |
| 2.Garments | | | | 0.396 |
| | | | | (0.63) |
| 3.Other Manufacturing | | | | 0.664* |
| | | | | (1.65) |
| 4.Retail | | | | 1.236** |
| | | | | (2.18) |
| 5.Other Services | | | | 0.850** |
| | | | | (1.98) |
| cut1 | 0.657 | 18.69 | 17.19 | 19.11 |
| | (1.15) | (1.06) | (0.98) | (1.06) |
| cut2 | 1.378** | 19.43 | 17.92 | 19.86 |
| | (2.34) | (1.10) | (1.03) | (1.10) |
| cut3 | 2.361** | 20.43 | 18.93 | 20.87 |
| | (3.86) | (1.16) | (1.08) | (1.16) |
| cut4 | 3.788** | 21.88 | 20.38 | 22.35 |
| | (5.88) | (1.24) | (1.16) | (1.24) |
| N | 536 | 536 | 536 | 536 |

*Values () represent the t of student*

*p<0.10, **p<0.05, ***p<0.001

# 6 Conclusion

This paper endeavored to analyze the extent to which Tunisian firms consider corruption as a major obstacle to their operations. Among these activities, we focus on innovation activities. In this paper, we distinguish between product innovation and process innovation. To test our hypotheses, we rely on the World Bank Enterprise Survey conducted in 2013. By using the ordered logit model, we show that both product and process innovation have a negative but significant effect on the corruption obstacle. We suggest that innovation allows firms to break up with the existing corrupted systems through the creation of information and communication technologies (ICT) that, in turn, induce the rise of a new anti-corruption network. Intuitively, we can relate this result, for instance, to the fact that launching new software applications helps agents to disclose on or ban the observed corruption behavior. In addition, the corruptors will incur higher switching costs when they try to decrypt these ICTs and therefore use them for their own interest. Public authorities have also a tendency to adopt these technologies in a bid to handle the corrupted activities. Indeed, the ICT contribute to lessening the corruption obstacle that private and public decision makers suffer from. On the other hand, in contrast with Kaffenberger (2012), we have found a negative relationship between educational enrollment and corruption.

# Bibliography


Ades, A. and R. Di Tella (1999). Rents, competition, and corruption. *The American Economic Review 89*(4), 982–993.

Alexeev, M. and Y. Song (2013). Corruption and product market competition: An empirical investigation. *Journal of Development Economics 103*, 154–166.

Asiedu, E. and J. Freeman (2009). The effect of corruption on investment growth: Evidence from firms in latin america, sub-saharan africa, and transition countries. *Review of Development Economics 13*(2), 200–214.

Barasa, L., P. Kimuyu, P. Vermeulen, J. Knoben, and B. Kinyanjui (2014). Institutions, resources and innovation in developing countries: A firm level approach.

Barreto, R. A. (2001). Endogenous corruption, inequality and growth: econometric evidence.

Cainelli, G., R. Evangelista, and M. Savona (2006). Innovation and economic performance in services: a firm-level analysis. *Cambridge Journal of Economics 30*(3), 435–458.

Castro, C. and P. Nunes (2013). Does corruption inhibit foreign direct investment? *Política. Revista de Ciencia Política 51*(1), pp–61.

Crépon, B., E. Duguet, and J. Mairessec (1998). Research, innovation and productivity: An econometric analysis at the firm level. *Economics of Innovation and new Technology 7*(2), 115–158.

Duguet, E. (2006). Innovation height, spillovers and tfp growth at the firm level: Evidence from french manufacturing. *Economics of Innovation and New Technology 15*(4-5), 415–442.

Emerson, P. M. (2006). Corruption, competition and democracy. *Journal of Development Economics 81*(1), 193–212.

Greene, W. H. (2003). *Econometric analysis*. Pearson Education India.

Kaffenberger, M. (2012). *The effect of educational attainment on corruption participation in sub-Saharan Africa*. Ph. D. thesis, Vanderbilt University.

Kria, M. and Z. Karray (2010). Innovation and r&d investment of tunisian firms: A two-regime model with selectivity correction. *The Journal of Business 9*(1), 1–21.

Lau, C. K. M., F. S. Yang, Z. Zhang, and V. K. Leung (2015). Determinants of innovative activities: Evidence from europe and central asia region. *The Singapore Economic Review 60*(01), 1550004.

Leff, N. H. (1964). Economic development through bureaucratic corruption. *American Behavioral Scientist 8*(3), 8–14.

Mahagaonkar, P. (2010). Corruption and innovation. In *Money and Ideas*, pp. 81–97. Springer.

Mairesse, J. and P. Mohnen (2003). "R&D and productivity: a reexamination in light of the innovation surveys". In *DRUID Summer Conference*, pp. 12–14.

Mansury, M. A. and J. H. Love (2008). Innovation, productivity and growth in us business services: A firm-level analysis. *Technovation 28*(1), 52–62.

Mauro, P. (1995). Corruption and growth. *The quarterly journal of economics*, 681–712.

Neter, J., M. H. Kutner, C. J. Nachtsheim, and W. Wasserman (1996). *Applied linear statistical models*, Volume 4. Irwin Chicago.

Nguyen, H. and P. A. Jaramillo (2014). Institutions and firms' return to innovation: evidence from the world bank enterprise survey. *World Bank Policy Research Working Paper* (6918).

Raymond, L. and J. St-Pierre (2010). R&d as a determinant of innovation in manufacturing smes: An attempt at empirical clarification. *Technovation 30*(1), 48–56.

Roper, S. and N. Hewitt-Dundas (1998). Innovation, networks and the diffusion of manufacturing best practice. *NIERC Report Series 14*.

Sdiri, H. and M. Ayadi (2014). Internationalization and innovation profitability: the case of tunisian service firms. *Problems and Perspectives in Management 12*(1), 40–50.

Shabbir, G. and M. Anwar (2007). Determinants of corruption in developing countries. *The Pakistan Development Review*, 751–764.

Waldemar, F. S. (2012). New products and corruption: evidence from indian firms. *The Developing Economies 50*(3), 268–284.

Wei, S.-J. (2000). How taxing is corruption on international investors? *Review of economics and statistics 82*(1), 1–11.

Wong, A. (2015). *DO INNOVATIVE FIRMS FIND CORRUPTION TO BE A BIGGER PROBLEM THAN NON-INNOVATIVE FIRMS?* Ph. D. thesis, University of Ottawa.

# Appendix

## A Definition of variables

| Variable | Variable name in ES | Definition |
|---|---|---|
| Corruption Obstacle | j30f | Is corruption No Obstacle (0), a Minor Obstacle (1), a Moderate Obstacle (2), a Major Obstacle (3), or a Very Severe Obstacle (4) to the current operations of this establishment? |
| Product innovation | h1 | During the last three years, has this establishment introduced new or significantly improved products or services? Please exclude the simple resale of new goods purchased from others and changes of a solely aesthetic nature. |
| Process innovation | h3 | During the last three years, has this establishment introduced any new or significantly improved methods of manufacturing products or offering services? |
| Employee level of education | MNAl9a1 | At the end of fiscal year 2012, how many full-time permanent employees in this establishment had the following as their highest education level? University degree or higher/Completed Secondary school including Vocational |
| Size | d2 | In fiscal year 2012, what were this establishment's total annual sales for ALL products and services? |
| Finance | k8 | At this time, does this establishment have a line of credit or a loan from a financial institution? |
| Exports | (100-d3a) | In fiscal year 2012, what percent of this establishment's sales were national sales? |
| Competition | e2 | In fiscal year 2012, for the main market in which this establishment sold its main product, how many competitors did this establishment's main product face? |
| Age of the firm | b5 | In what year did this establishment begin operations? |

*Source: World Bank Enterprise Survey.*