**INSTITUTIONAL QUALITY AND TECHNOLOGICAL INNOVATION**

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**ABSTRACT**

The aim of this study is to analyze the link between institutional quality and technological innovation in Côte d'Ivoire. To achieve this objective, we carried out three estimations using Ordinary Least Squares (OLS), considering three World Bank institutional indicators over the period 2008-2021. The results revealed that institutional factors have a negative and significant effect on technological innovation. This result highlights the low institutional quality marked by the bribe-seeking of public officials towards innovative companies, combined with the lack of respect for established rules and the tense electoral atmosphere, which discourage innovative companies. The article therefore suggests strengthening Ivorian institutions, by promoting respect for established rules, sanctioning offenders, a peaceful electoral climate and the development of regulations adapted to technological innovation.

Keywords : Innovation, technology, institution, artificial intelligence.

JEL classification : P37, K10, O31

**INTRODUCTION**

Schumpeter, one of the key authors to introduce innovation into economic analysis, defines it as the introduction of new means of production, i.e. a new combination in the factors of production needed to produce a good, Schumpeter (1939). According to Schumpeter (1939), innovation occurs when a new product is created, a new method of production is introduced, a new market is opened up, or a new form of organization is introduced.

In recent years, the whole world has been faced with the advent of Artificial Intelligence (AI), the fruit of technological innovation, useful to all sectors of activity. The dazzling success of AI was observed in the USA, then spread to Europe and China, Maxwell (2024), European commission (2024), Service économique régional de Pékin (2025). The USA passed the National Artificial Administration Initiative Act in 2020, to provide a better framework for generative AI research and policy, Maxwell (2024). The European Union has followed suit, with the European Parliament introducing Regulation 2024/1689 establishing the European legal framework for AI, European commission (2024). As for China, with the elaboration of the next-generation AI development plan in 2017, aims to become the World leader in AI, by 2030, Service économique régional de Pékin (2025). This plan is supported by public funding to the tune of 10 to 15 billion US dollars per year, since 2017, Service économique régional de Pékin (2025). However, AI is not yet fully utilized in Côte d’Ivoire, as its development requires financial resources, as well as high-quality institutions.

“Institutions are the rules of the game in society”, stipulated North (1990). In other words, institutions are man-made requirements that regulate human interaction. Good institutional quality refers to compliance with pre-established regulatory, fiscal, financial and ethical conditions. Indeed, Brown et al. (2013) reveal that the institutional framework marked by a country's legal system, notably the strengthening of shareholder protection, stimulates R&D investment by small businesses. Also, Levine et al. (2017) find that the enforcement of insider trading laws stimulates the quantity and quality of innovation production. Thus, the quality of institutions proves important for the development of innovation. However, Heath and Mace's (2020) study reveals that companies benefiting from stronger legal protection of trademarks reduced their capacity for innovation and produced a large number of deteriorated products. So what regulatory, fiscal, financial and ethical conditions need to be put in place to encourage technological innovation? The aim of this study is therefore to examine the relationship between institutional quality and technological innovation in Côte d’Ivoire. This topic has already been studied in Europe and America, but rarely in Africa. To our knowledge, this issue has not yet been studied in West Africa, particularly in Côte d’Ivoire. The interest of this topic is therefore to contribute to the existing empirical literature by assessing the role of institutional quality in the development of technological innovation in Côte d’Ivoire. We hypothesize that institutional quality fosters technological innovation in Côte d’Ivoire.

To achieve our objective, we use data collected over the period 2008-2021. After performing different tests of specification, we move on to estimating our model. Institutional variables are measured by the World Bank's governance indicators, calculated by Kaufmann, Kraay and Mastruzzi (2010). Technological innovation is measured by the Technological Innovation Index of the United Nations Conference on Trade and Development (UNCTAD).

The remainder of this article is structured as follows: section 1 reviews the literature, section 2 presents the methodology of the study, section 3 develops the descriptive statistics, section 4 presents the results and discussion, and finally we conclude.

1. **LITERATURE REVIEW**

« An institution is any standing, social entity that exerts influence and regulation over other social entities as a persistent feature of social life, outlasting the social entities it influences and regulates, and surviving upheaval in the social order », (Hughes 1939). According to Sorensen and Levold 1992), innovation emerges from a complex interplay of precursing economic and institutional conditions, the perceptions and decisions of entrepreneurs, and the ongoing refinement of the innovations as expertise is gained. Thus, in recent decades, institutional factors contributing to the development of innovation have been evaluated and promoted, (Sorensen et Levold 1992).

We review empirical studies about the link between institutional quality and technological innovation, focusing on impact channels. Moser's (2005) study of twelve countries, based on data from 1851 and 1876, shows that the absence of patent law in a country leads its inventors to concentrate their innovative activities in a small number of sectors where secrecy was an effective alternative to patenting, whereas inventors in countries with patent law innovate in a more diversified set of sectors. In this way, patent law encourages technological innovation in a wide range of sectors.

According to the study by Anokhin and Schulze (2009), better control of corruption boosts investor confidence in state institutions, which in turn boosts investment in innovative projects. In the absence of such trust, however, monitoring and other transaction costs would restrict innovation. Their results were verified in sixty-four different countries from 1996 to 2002.

Drawing on two thousand seven hundred companies in twenty-five Chinese cities, the study of Rodríguez-Pose and Zhang (2013) reveals that good institutions facilitate technological innovation by the creation of local networks and the assimilation of spillovers. Poor institutions limit interaction and increase transaction costs (Rodríguez-Pose, 2013). In the same way, Brown et al (2013) study a large sample of companies in thirty-two countries and find that strong shareholder protections lead to significantly higher long-term research and development investment rates in small companies.

Moreover, using industry data from seventy-four economies between 1976 and 2006, Levine et al. (2017) find that the enforcement of insider trading laws boosts the quantity and quality of patent production. Equally, Donges and al. (2022) show that the introduction of the Code civil and the promotion of commercial freedom in Germany after the French Revolution of 1789, had as a result to stimulate technological innovation by increasing the number of patents per capita.

However, Ayyagari and al. (2014) show in their study that innovative companies pay more bribes than non-innovators in twenty-five thousand companies in fifty-seven countries. This finding is most striking in developing countries. Since innovative entrepreneurs do not benefit from better services such as public procurement, these practices discourage innovation in developing countries.

Besides, the study by Heath and Mace (2020) reveals that companies benefiting from enhanced legal protection for US trademarks, between 1870 and 2012, reduced their research and development spending, filed fewer patents and new products, and manufactured a large number of deteriorated products. This decline in technological innovation following the legal protection of trademarks is due to an increase in trademark-related legal actions and a decrease in entries and exits on the markets for the products concerned, Heath and Mace (2020).

1. **METHODOLOGY**

The aim of this study is to analyze the relationship between institutional quality and technological innovation in Côte d'Ivoire. Our model is inspired by Meierrieks (2014) and is specified as follows:

$$innov\_{t}= α\_{0}+ α\_{1}institu\_{t-1}+ α\_{2}X\_{t-1}+ ε\_{t} $$

With t representing the year. t = 2008, ..., 2021

Where $innov\_{t}$ is the dependent variable representing the index of information and communication technology (ICT) infrastructure, i.e. technological innovation. This index assesses the level of ICT infrastructure for technology use, adoption and adaptation. It includes Internet users (as a percentage of the population), fixed (wired) broadband speed (in Megabits per second) and mean download speed (Megabits per second). This variable is from the UNCTAD (United Nations Conference on Trade and Development) database.

$institu\_{t-1}$ measures institutional quality. We selected three indicators from the World Bank's governance indicators, calculated by Kaufmann, Kraay and Mastruzzi (2010), namely control of corruption, rule of law, voice and accountability. Note that voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media, Kaufmann, Kraay and Mastruzzi (2010). Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence, Kaufmann, Kraay and Mastruzzi (2010). Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests, Kaufmann, Kraay and Mastruzzi (2010). Their coefficients should be positive, according to the studies by Levine and al. (2017), Rodríguez-Pose and Zhang (2013), showing the effect of good institutional quality on technological innovation.

$ε\_{t}$ is the error term. $X\_{t-1} $includes the control variables economic growth, population growth rate, trade openness, human capital, net Foreign Direct Investment (FDI) and financial development, inspired by Anokhin and Schulze (2009), Meierrieks (2014), Zhu and al. (2020).

Economic growth, measured by the growth rate of real GDP per capita, should have a positive sign, because according to the study by Anokhin and Schulze (2009), a country's wealth is a prerequisite for innovation measured by the number of patents. The population growth rate should also have a positive sign coefficient, as a younger population on the labour market is more conducive to technological innovation, Derrien and al. (2023). Trade openness, measured by the trade openness rate as a percentage of GDP, is expected also to have a positive sign coefficient, as foreign trade promotes technology transfer through FDI, Anokhin and Schulze (2009). Thus, we expect a positive sign for net FDI, Zhu and al. (2020). We expect a positive sign from education-based human capital, in line with the study by Meierrieks (2014). We expect a positive coefficient of financial development, a fundamental element for the financing of technological innovation, Meierrieks (2014).

Real GDP per capita growth rate, population growth rate, trade openness, and net Foreign Direct Investment (FDI) are from the World Bank database. The human capital index comes from the Penn World Table (PWT) database, Feenstra, Inklaar and Timmer (2015). The financial development index is from the work of the International Monetary Fund (IMF), Svirydzenka (2016).

To estimate the model, we first carry out specification tests, namely the residual normality test, the Ramsey-Reset test, the homoscedasticity test and the autocorrelation test. We then estimate our model by Ordinary Least Squares (OLS), correcting any errors detected.

1. **DESCRIPTIVE STATISTICS**

Descriptive statistics trace the evolution of the variables of interest, as well as their mean, minimum, and maximum.

**Tableau 1 : Mean, minimum and maximum variables of interest from 2008 to 2021**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables**  | Observations  | Mean | Minimum  | Maximum  |
| **Control of corruption** | 14 | -0.717 | -1.173 | -0.396 |
|  **Rule of law** | 14 | -0.879 | -1.438 | -0.593 |
| **Voice and accountability** | 14 | -0.636 | -1.168 | -0.249 |
| **ICT infrastructure** | 14 | 0.179 | 0 | 0.4 |
| **Research and development** | 14 | 0.05 | 0 | 0.1 |

Source: Author based on UNCTADstat and World Bank data from 2008 to 2021.

**Figure 1: Evolution of institutional and technological innovation indicators in Côte d'Ivoire**



Source: Author based on UNCTADstat and World Bank data from 2008 to 2021.

In our descriptive analysis, we have added the Research and Development (R&D) variable from the UNCTAD database, which includes the number of scientific publications on cutting-edge technologies in Scopus and the number of patents filed on these technologies, as an indicator of technological innovation. The graphs above show the evolution of the different institutional variables and those of technological innovation in Côte d'Ivoire. The estimated values of the three institutional variables vary between -2.5 and 2.5. Over the whole period, the estimated value of the rule of law is below that of corruption control and voice-accountability, marking the strong lack of trust and the blatant lack of respect for the rules of society. The three institutional variables evolve in the same direction from 2008 to 2014, with an upward trend marking a gradual evolution in the quality of Ivorian institutions.

From 2015 to 2021, the control of corruption and rule of law indicator shows a downward trend, while the voice-responsibility indicator continues to rise from 2015 to 2020, and then follows the trend of the other two indicators. This upward trend in the estimated value of the voice-responsibility indicator between 2015 and 2020, reaching its peak in 2018, can be explained by the fact that Côte d'Ivoire, in the aftermath of the 2011 post-election crisis, found itself in a period of national reconciliation. During this period, many victims were able to set up associations, express their feelings and were invited to forgive and reconcile. Also during this period, the population was able to participate freely in the 2015 presidential and municipal elections.

However, the downward trend in the control of corruption and the rule of law between 2015 and 2021 is reflected in a crisis of public confidence in state institutions, given the crisis that arose after the 2010 presidential elections; and in the accentuation of corruption within public services.

In terms of technological innovation indicators, ICT infrastructure remained constant from 2008 to 2014, jumped in 2015 and then remained constant until 2021. This jump between 2014 and 2015 is explained by the reduction in the cost of Internet access, and Internet access in inland towns. According to the Centre d'Information et de Communication Gouvernementale de Côte d'Ivoire, CICG (2023), the average price for mobile internet service has fallen from 0.65 FCFA/MB to 0.41 FCFA/MB, a drop of 37% between 2019 and 2024; household internet access has increased by 21% in 2023 compared with 2022, reaching 74%. As for the R&D indicator, after falling between 2011 and 2014, it shows a gradual rise between 2015 and 2021.

**Figure 2: Relationship between institutional variables and technological innovation in Côte d'Ivoire**



Source: Author based on UNCTADstat and World Bank data from 2008 to 2021.

There seems to be an increasing relationship between institutional variables and technological innovation. Our estimates will enable us to verify this relationship.

1. **RESULTS AND DISCUSSION**

The Ramsey Reset test gives the following probabilities: 0.57; 0.31; 0.80. These probabilities are greater than 5%. The H0 hypothesis of good model specification cannot therefore be rejected. The test for normality of the residuals gives probabilities of 0.64; 0.22; 0.17 respectively, all of which are above 5%. Hence, the H0 hypothesis of residual normality cannot be rejected. The homoscedasticity test gives the following respective probabilities: 0.21; 0.92; 0.27. The probabilities are greater than 5%, so the H0 hypothesis of homoscedasticity cannot be rejected. The autocorrelation test gives probabilities of 0.0012; 0.41; 0.009 respectively. The H0 hypothesis of no autocorrelation of errors cannot therefore be rejected for the second model; however, for the first and third models, the H0 hypothesis of no autocorrelation of errors is rejected. Homoscedasticity and autocorrelation errors will be corrected during estimation.

Results of three estimations by OLS are in following table :

**Table : Estimation of technological innovation on its determinants**

|  |  |  |  |
| --- | --- | --- | --- |
| Variables  | Model 1 | Model 2 | Model 3 |
| Control of corruption | -0.3058\*\*\*(0.0288) | - | - |
|  Rule of law | - | -0.2702\*(0.1150) | - |
| Voice and accountability | - | - | -1.0797\*\*(0.2787) |
| GDP per capita growth | -0.0012(0.0021) | 0.0024(0.0066) | 0.0062(0.0037) |
| Population growth | 0.4576\*\*\*(0.0796) | 0.5275\*\*(0.2032) | 0.8490\*\*\*(0.1236) |
| Trade | -0.0038(0.0021) | -0.0031(0.0055) | 0.0055(0.0030) |
| Capital human | 0.9481\*(0.3833) | 1.0162(0.9657) | 5.4985\*\*(1.7616) |
| Net FDI | -0.0023(0.0572) | 0.0365(0.1256) | -0.0571(0.0763) |
| Financial development | -0.9799(1.1111) | -2.5353(3.2142) | 1.6427(2.8192) |
| Intercept  | -2.2711\*\*(0.7804) | -2.3303(1.9332) | -11.9228\*\*(3.4452) |
| R² | 0.9968 | 0.9424 | 0.9906 |

Source: author based on UNCTADstat, IMF, PWT, and World Bank data from 2008 to 2021. Note : values in brackets are standard deviations of coefficients, \*\*\* indicates significance at 1% level, \*\* indicates significance at 5% level, \* indicates significance at 10% level.

These estimates show that the three institutional variables have a significant negative impact on technological innovation. Following a one-unit increase in corruption control, the rule of law and voice and accountability, technological innovation falls by 0.3058, 0.2702 and 1.0797 units respectively, ceteris paribus. Given that we have considered long-run dynamics, by lagging all the explanatory variables by one period, these results are therefore valid in the long run. These results are contrary to our expected results and those of Levine et al. (2017) and Rodríguez-Pose and Zhang (2013). However, Heath and Mace (2020) find similar results, revealing that firms benefiting from stronger legal protection of US trademarks reduced their Research and Development spending and filed fewer patents and new products. This drop in technological innovation following the legal protection of trademarks was due to an increase in legal actions relating to trademarks and a decrease in entries and exits on the markets for the products concerned, Heath and Mace (2020).

As we expected, an increase in institutional quality should encourage technological innovation, because a country with reliable institutions stimulates technological innovation among young people and attracts innovative companies looking for new markets. However, our results show the opposite. These results show that in Côte d'Ivoire, as is generally the case in developing countries, innovative companies pay more bribes than non-innovative companies, without benefiting from certain advantages such as public contracts, Ayyagari et al. (2014). This therefore discourages technological innovation in Côte d'Ivoire. Thus, the poor institutional quality marked by the rent-seeking of public officials towards innovative companies, Ayyagari et al. (2014), the lack of regulations adapted to technological innovation, discourage innovative companies.

Regarding the control variables, the results are in line with our expectations. Population growth and human capital positively and significantly affect technological innovation, indicating the need for a young and educated population to serve technological innovation, Derrien et al (2023), Meierrieks (2014).

**CONCLUSION**

This study analysed the link between institutional quality and technological innovation in Côte d'Ivoire. To achieve this objective, we carried out three estimations using Ordinary Least Squares (OLS), considering three World Bank institutional indicators over the period 2008-2021. The results revealed that institutional factors have a negative and significant effect on technological innovation. This result highlights the poor institutional quality marked by rent-seeking (bribes) by public officials towards innovative companies, combined with a lack of respect for established rules and a tense electoral atmosphere, which discourage innovative companies. Other striking results also emerge from this study. These include the positive and significant effect of population growth and human capital on technological innovation, indicating the need to have a young and educated population at the service of technological innovation.

Then, as economic policy implications, we suggest strengthening Côte d'Ivoire's institutions by promoting compliance with established rules and punishing offenders. Given the progress of artificial intelligence, it is also important for Côte d'Ivoire to equip itself with regulations adapted to technological innovation, to develop more specialities in technological fields and to encourage young people to take an interest. Lastly, it seems undeniable that the authorities should work to ease the electoral climate by raising awareness of the need for peace and respect for the laws in force.

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