



Innovation and economic recession: case of Tunisia

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Abstract

This paper attempts to describe the transitional context of Tunisia, emphasizing the role of innovation in order to overcome the economic recession.

Innovation can be found in this context of political instability and economic recession as a tool to overcome these obstacles and find a path toward economic performance. This passage, however, requires tools and resources.

We use time series econometrics to analyse the causal relationship between innovation and recessions through the study of the causal relationships between requests for patents and the volume of exports and between the amount of migrant remittances, foreign direct investment and tourism revenue in Tunisia during the period 1970-2014. The number of patent applications adjusts more slowly than does the number of exports. In other words, in the case of Tunisia, the demand for patents has caused the development of exports rather than the other way around.

Keywords: democratic transition, political instability, economic growth, innovation, causal relationship.

JEL codes: C22, D72, O31, O40.

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1. Introduction

In the current context of the global economy, globalization has helped people rethink its role in economic development. Some developing countries seek to develop productive systems to create long-term economic and financial stability that provides a production structure with the ability to compete globally within and outside borders of nations.

Theoretical and empirical studies have shown that innovation is essential for long-term growth and development.

Globalization and the advent of new information transmission technologies place knowledge at the heart of regulation and economic development. The rapid growth of trade in goods, services, capital and new ideas is now reinforcing the interdependencies between economies. The competition is

technological, confirming what Schumpeter claimed was real competition.

The economic literature on innovation is structured around two approaches: an approach that considers innovation a linear process that takes its sources from scientific research and innovation as the result of an entire economic, technological, social and political system.

Innovation is essential for economic growth and competitiveness in international trade. According to Nelson (1996) and Aghion and Howitt (1998), economic growth is strongly driven by innovation. Foray and Freeman (1992) argue that innovation also plays an important role in countries' competitive advantage in international trade.

According to the model of economic growth of Grossman and Helpman (1991), innovation comes through a growing variety of consumer



goods. This is caused by an accumulation of knowledge.

According to Aghion and Howit (1992), innovation is creative destruction. New technologies are constantly replacing the old, and new activities are replacing the old. The State must target its interventions on growth-generating areas. It must turn to the knowledge economy, vocational training, and the support of people who move from training to employment.

For Herstad and Sandven (2019), standalone process innovations tend to be introduced after a period of moderate growth, yet, might give rise to large subsequent expansions.

Establishing the institutional structure necessary for economic growth and integration into the global economy is a top priority for the Tunisian economy.

The financial crisis has clearly highlighted Tunisia's economic dependence on the global market as well as some weaknesses in its development and growth model, which is mainly based on exports and tourism. The collapse of demand for goods and services in its main trading partners, particularly in the European Union, has led to a decline in exports and a sharp slowdown in economic growth.

Tunisia is in the process of a democratic transition. This democratic transition implies the abandonment of the old rules of the political game and the emergence of new political actors and new strategic configurations. The challenge is no longer the understanding of the issues but the choice of programs and the modalities of their application.

The balanced political landscape can address economic and social problems through the use of a new, more socially and regionally balanced development model to meet the aspirations of the Tunisian people.

Tunisia has important assets for succeeding in this transition: a high literacy rate, a developed middle class, a very advanced status for women, a skilled workforce with a large enough number of graduates and a high level of education. In addition, the competitiveness of the Tunisian economy, in addition to its strategic location in the

Mediterranean basin, gives it privileged access to the enormous European market.

The Tunisian economy, formerly based on agriculture and phosphates, is now more open to the outside and imports. Since the mid-1980s, reforms have led to the restoration of macroeconomic balances. Approximately 75%¹ of Tunisia's trade with the European market requires increasingly differentiated products and services and safety and environmental aspects. As part of its integration into the global economy, Tunisia is implementing macroeconomic policies and structural reforms to create favorable conditions for economic growth and improved competitiveness.

Tunisia's research and development intensity is lower than that of high-income countries. This national effort in research and development is insufficient to allow Tunisia to contribute to the increase in the country's standard of living.

The Tunisian industrial fabric consists of very small businesses and small businesses. Due to their high flexibility, small companies with an open innovation model can more easily enter the global market.

Tunisian research policy is oriented toward both public and private research, although the latter remains very rare. Public research is developed in higher education and research institutions and in research and development departments within certain public companies. Unlike many countries in North Africa and the Middle East region, Tunisia has experienced a remarkable increase in the number of public researchers and PhD students at research centers in recent decades².

Tunisia can significantly increase the contribution of exports to improving the standard of living of its population by diversifying its high-tech export basket.

The Tunisian economy can further consolidate its participation in value chains by controlling higher value-added segments.

Increased participation in multilateral innovation programs provides opportunities for public researchers and companies in

¹ National Institute of Statistics of Tunisia 2022.

² See statistics provided by the Ministry of Research and Higher Education of Tunisia.

Tunisia to exploit scientific and technological knowledge created in countries closer to the global technological frontier and to be more visible in these countries.

Like many Asian countries, Tunisia can return its technological backwardness by assimilating and improving the scientific and technological knowledge produced in nearby countries to significantly increase its innovation performance. An improvement strategy is more effective in the medium term for Tunisia than a strategy for the development of scientific and technological knowledge.

Our objective is to emphasize innovation as a means to accelerate growth and therapy during the economic crisis, especially in the transition phase, in Tunisia.

To do this, our paper is organized in four sections apart from the introduction. Section two addresses the theoretical and empirical literature reviews and will show the role of innovation in transitional and recession contexts. The third section will empirically examine the causal links between innovation and recessions through the econometrics of time series. The last section concludes the paper.

2. Literature review

Innovation drives competition and competitiveness. Following a reduction in demand after the crisis, competition may intensify. Indeed, the only way for a company to maintain its sales is to steal market share from its competitors.

McKinsey (2010) says that while the crisis led to a reduction in research and development, it also led to efficiencies in the conduct of research and development. In particular, it strengthened accountability for the performance of external research and development.

Aghion, Bloom, Blundell, Griffith and Howitt (2005) indicate that the impact of competition on innovation depends on the link between competition and innovation in product markets.

Economic crises are also an opportunity for businesses and industries to explore new opportunities. Smart companies benefit from the economic crisis. The crisis will not last forever, and recovery will eventually occur. Economic recovery is also likely to cause

structural changes in the composition of output and demand. To reap the opportunities for recovery, companies need to provide new products and improve their services.

According to Cheng and Hou (2021), the critical role that innovation can play in the growth process and states that financial development is no longer a panacea for real economic growth.

Archibugi, Filippetti and Frenz (2013) provide two explanations for the increase in investment in innovation. First, these companies decided to respond to the crisis by innovating because they are the most dynamic; they cannot survive without changing their products and services. The competitive advantage of these companies lies in generating new knowledge, and they are constantly innovating, regardless of the business cycle. Second, these companies are new innovators who were not necessarily involved in innovation before the crisis. These companies could be smaller or entirely new companies that take advantage of the crisis by conquering the market shares of companies affected by the crisis or launching into new markets.

These two explanations derive from Schumpeter's theory. He suggested that business cycles are the consequence of innovation and that innovative activities are reshaped by economic crises.

Following Schumpeter, an economic crisis generated a change in established industries and technological fields. Indeed, new companies exploit new technological opportunities as a way to conquer the market shares of old companies. This process is called a creative destruction process.

The reference document for the development of research and development indicators is the Frascati Manual. The methodology used is relatively simple. We consider research and development as a system whose "inputs" are, on the one hand, human resources (mainly researchers) and, on the other hand, financial resources (public and private expenditures allocated to this sector) and whose "outputs" are, on the other hand, the production of scientific publications (new knowledge) and, on the other hand, patents (new inventions).

In each country, these statistics are compiled by specialized structures. What is decisive in their work, and this is true moreover whatever the system studied, is on the one hand the reliability of the data and, on the other hand, their updating at regular intervals.

Furthermore, because each indicator represents only a part of reality, it is a decision-making tool. In this work, we use the output indicator, the number of patents, which is supposed to measure the technological capacity of a country. In reality, a patent is primarily a tool for protecting industrial property. In practice, each country has a public structure responsible for patents; in Tunisia, for example, it is the National Institute of Standardization and Industrial Property.

Democratic transition is a political process that allows a gradual transition from one regime to another.

The political transition phase is usually followed by a consolidation phase of democracy to ensure stability. A country's development is an important factor in ensuring a democratic transition.

At the political level, the main challenges are maintaining political stability and boosting economic growth to reduce unemployment and marked regional inequalities.

Tunisia has important assets for succeeding in this transition: a high literacy rate, a developed middle class, a very advanced status for women, a skilled workforce with a large enough number of graduates and a high level of education. In addition, the competitiveness of the Tunisian economy, in addition to its strategic location in the Mediterranean basin, gives it privileged access to the enormous European market.

Gouasmi and Haffoudhi (2018) showed that the stimulus policy, "go and stop" undertaken by the transition government in Tunisia explains mostly the deterioration of the public debt and the deterioration of the main economic indicators.

According to Bremmer (2006), democratic transitions often produce a "J-curve", a loss of growth linked to temporary instability before a political and economic recovery. Tunisia needs the help of the international community to avoid the initial phase of decline that its

economy and society cannot afford. In the absence of international aid, there is a great risk that Tunisia will enter a vicious circle characterized by poverty and rising unemployment, leading to political instability, which in turn would lead to increased poverty and unemployment.

Papaioannou and Siourounis (2008) showed that countries that have experienced democratic transitions experience greater economic growth than those that have not.

According to the literature, there is a relationship between political stability and economic performance. However, empirical studies show different results for different regions, countries and periods.

According to Alesina and Perotti (1994), models of political economy begin with the assertion that social planners do not make economic policy choices. In contrast, economic policy is the result of an institutional structure.

Klomp and De Haan (2009) examine the effect of political "institutions" on the volatility of economic growth. Their results indicate that democracy reduces economic volatility. They also find that some dimensions of political instability increase economic volatility.

Alesina, Ozler, Roubini, and Swagel (1996) study the relationship between political instability and per capita GDP growth in a sample of 113 countries for the period 1950-1982.

They define "political instability" as the propensity for government collapse, and they see a model in which political instability and economic growth are determined jointly. Their main result is that with a high propensity for government collapse, growth is markedly low. Jong-A-Pin (2009) identifies four dimensions of political instability: civil protest, politically motivated aggression, instability within political regimes, and instability of the political regime. This shows that for different dimensions of political instability, economic growth is negatively affected.

Carmignani (2003) focused on the relationship between political instability and macroeconomic performance. It explores different models that explain the effect of instability (and political uncertainty) on

growth, fiscal formation, inflation and monetary policy.

Abdelkader (2015) tries to estimate the relationship between economic growth and political instability in Egypt. In addition, the author tests the impact of uncertainty on economic growth in Egypt. The results affirm the positive impact of the level of democracy on economic growth, while they claim that uncertainty has a negative impact on economic growth. However, the impact of political instability on economic growth is ambiguous in the case of Egypt.

Aisen and Veiga (2011) empirically study the effects of political instability on economic growth. They find that higher levels of political instability are associated with lower per capita GDP growth rates. With regard to transmission channels, they find that political instability negatively affects growth by lowering productivity growth rates and, to a lesser extent, the accumulation of physical and human capital.

Fatas and Mihov (2013) present evidence that policy volatility has a strong negative impact on growth. Using data for 93 countries, they construct policy volatility measures based on the standard deviation of residues from government consumption regressions on production. Unruptive governments, which implement frequent changes in government spending unrelated to the economic state of the country, generate low economic growth.

Verdugo, Furceri and Guillaume (2013) analysed the dynamic effect of social and political instability on production. Their results suggest that social conflicts have a significant and negative impact on short-term production. The results also show that the recovery of production in the medium term depends on the country's ability to implement reforms to improve the level of governance following an episode of social instability.

Doucouliaos and Ulubasoglu (2008) conclude that democracy does not have a direct impact on economic growth. However, it has indirect, significant and positive effects through human capital, lower inflation, low political instability and economic freedom.

Barseghyan and DiCecio (2010) examine the relationship between institutional quality and production volatility. Using regressions on

instrumental variables. They find that an increase in the costs of barriers to entry increases production. On the other hand, the protection of property rights has no statistically significant effect on the volatility of production.

Whitford (2014) conducts panel data analysis to examine the impact of institutional quality on economic growth and macroeconomic volatility. It finds a negative and significant effect of institutional quality on macroeconomic volatility, as measured by inflation. In contrast, the quality of institutions does not significantly affect the volatility of production. However, there appears to be a greater negative effect of the quality of institutions on the volatility of output in Latin American countries than in the full sample.

Roe and Siegel (2011) provide strong evidence that political instability hinders financial development. Their results indicate that socioeconomic inequalities lead to political instability. The results indicate the existence of a direct path from structural inequality to political instability, mainly in nondemocratic contexts.

Socioeconomic inequality has a negative effect on economic growth. Giskemo (2012) showed that the effect of socioeconomic inequality on political instability depends on the measures used and that the effect of instability on economic development varies between different analytical models.

Kobbi and Boujelbene (2014) propose measuring political instability in 57 countries in the MENA region and in Africa using a factor analysis of 27 different indicators of democracy and political instability for the period 1994-2006. This approach identifies four dimensions, namely, the level of democracy, political violence, protests and instability within governments. Moreover, they show that the level of democracy and instability within governments are two discriminatory dimensions of the existence of two homogeneous groups between the 57 countries. They test the impact of the four dimensions on the level of per capita growth. They conclude that democracy is conducive to long-term growth, while violence and protests negatively affect a country's economic performance. Moreover, political instability

does not have the same effect on different geographical areas.

The literature provides evidence that institutional quality has a positive effect on economic growth, while higher levels of institutional quality appear to decrease measures of macroeconomic volatility.

3. Analysis Methodology

First, the annual evolution of the number of patent applications is used to measure and assess the variability of innovation. Second, the annual evolution of the volume of exports and the sum of the annual variations in transfers, foreign direct investment and tourism receipts will be used to assess and identify a certain economic recession, that is, a crisis or not.

To appreciate the links between innovation and recessions, the following steps will be taken. The econometrics of time series will be used to analyse the causal relationships between innovation and recessions through the study of the causal relationships between patent applications, the volume of exports and the sum of remittances from emigrants, foreign direct investment and tourism receipts in Tunisia during the period 1970 to 2014.

$$\Delta x_t = (\rho - 1)x_{t-1} + \sum_{j=2}^k \varphi_j \Delta x_{t-j+1} + \varepsilon_t$$

$$\Delta x_t = (\rho - 1)x_{t-1} + \sum_{j=2}^k \varphi_j \Delta x_{t-j+1} + \gamma + \varepsilon_t$$

$$\Delta x_t = (\rho - 1)x_{t-1} + \sum_{j=2}^k \varphi_j \Delta x_{t-j+1} + \gamma + \beta t + \varepsilon_t$$

3.2. Johansen cointegration tests

Studying cointegration allows us to test for the existence of a long-term stable relationship between two nonstationary variables, including delayed and exogenous variables. There are several tests of cointegration. The analysis of cointegration makes it possible to identify the relationship between two variables by seeking the existence of a cointegration vector and eliminating its effect if necessary.

Two series are said to be cointegrated if the following two conditions are verified: they are affected by a stochastic trend of the same order of integration, and a linear combination

The study of this time series will be performed in three stages: unitary root tests, Johansen cointegration tests and Granger causality tests in the framework of an error-corrected vector model.

The annual changes in exports, remittances, foreign direct investment and tourism receipts are calculated. In principle, a negative variation indicates a certain failure of internal and/or external origin. Then, the corresponding variations are added. Summarizing these variations can fill these gaps or accentuate them. A positive summation indicates that the economy can overcome some crisis in one of these sectors. On the other hand, a negative summation indicates that the economy cannot go beyond the crisis. The economy is in a crisis.

3.1. Unit Root Tests

Unit root tests identify the presence of a unit root in a series. No time series has a trend or seasonality. The Dickey–Fuller Augmented test is used for this purpose. This test sought to test the null hypothesis against the alternative hypothesis. The Dickey–Fuller test is based on least squares estimation of the following three models (Mata, 2007):

of these series makes it possible to reduce to a lower order of integration.

Johansen’s cointegration test uses the statistics of the trace and that of the maximum eigenvalue. The asymptotic distributions of these two statistics are nonstandard.

3.3. Error correction and causality model in the sense of Granger

At the theoretical level, identifying causal relationships between economic variables provides elements of reflection conducive to a better understanding of economic phenomena (Bourbonnais, 2003). The presence of a cointegration relationship between two variables implies the existence

of a causal relationship between them in at least one direction. The causal relationship is analysed using the Granger causality test based on the error-corrected vector model (VECM).

According to Granger’s representation theorem, any cointegrated system implies the existence of an error-correcting mechanism that prevents variables from deviating from their long-term equilibrium. In our case, if the three variables studied, namely, patent applications, export volume and the sum of remittances of emigrants, foreign direct investment and tourism receipts, are stuck, it is deduced that there is an error correction mechanism.

The error-corrected model is a particular form of autoregressive model (ARDL).

3.4. The data

The data on the number of resident and nonresident patent applications covered the period 1970-2014 and were extracted from statistics from the World Intellectual Property Organization (WIPO).

The data on exports, foreign investment, remittances and tourism receipts also covered

the period 1970-2014 and were taken from the annual reports of the central bank of Tunisia.

As a proxy for the crisis, we use the variables of the real sphere of the Tunisian economy, namely, the fluctuation in the volume of exports and the sum of remittances from emigrants, foreign direct investment and tourism receipts.

Finally, a mute variable is introduced in the model to capture the years of transition and political turmoil that occurred between 1986 and 1989 and between 2011 and 2014. For a better understanding of the results, we prefer to explain the results in terms of elasticity by transforming the three variables into natural logarithms. We will use the Eviews software in our empirical work.

3.5. Unit Root Test Results

Most macroeconomic series have a temporal trend. They are called “nonstationary” because their average is not constant over time; hence, there is a need to proceed with their “stationarity”. We test the nonstationarity of the series below by the Dickey-Fuller approach.

Null Hypothesis: BREVET has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.049325	0.5573
Test critical values: 1% level	-4.205004	
5% level	-3.526609	
10% level	-3.194611	

*MacKinnon (1996) one-sided p values.

Null Hypothesis: EXPORTATIONS has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.686995	0.2467
Test critical values: 1% level	-4.180911	
5% level	-3.515523	
10% level	-3.188259	

*MacKinnon (1996) one-sided p values.



Null Hypothesis: IDETOURISTEMIGRES has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.845240	0.1897
Test critical values:		
1% level	-4.180911	
5% level	-3.515523	
10% level	-3.188259	

*MacKinnon (1996) one-sided p values.

The ADF of the first line for the three variables is lower than all the critical values at the thresholds of 1%, 5%, and 10%; these three variables are therefore not stationary between 1970 and 2014. To make them stationary, we transform them into a first difference.

3.6. Johansen cointegration test results

Economic theory often suggests that some pairs of economic variables must be linked by a long-term equilibrium relationship. While these variables may move away from balance for some time, economic forces are expected to somehow restore balance.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05 Critical Value	Prob.**
No. of CE(s)	Eigenvalue	Statistic		
None *	0.415396	35.83497	29.79707	0.0089
At most 1	0.244086	14.36218	15.49471	0.0735
At most 2	0.076169	3.169065	3.841466	0.0750

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05 Critical Value	Prob.**
No. of CE(s)	Eigenvalue	Statistic		
None *	0.415396	21.47279	21.13162	0.0448
At most 1	0.244086	11.19311	14.26460	0.1448
At most 2	0.076169	3.169065	3.841466	0.0750

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p values

Normalized cointegrating coefficients (standard error in parentheses)

		IDETOURISTE	
BREVET	EXPORTATIONS	MIGRES	C
1.000000	-4.618440	4.906901	-0.436430



	(0.81120)	(0.90814)	(1.24072)
Adjustment coefficients (standard error in parentheses)			
D(BREVET)	-0.013879 (0.05239)		
D(EXPORTATIONS)	0.115085 (0.03642)		
D(IDETOURISTEMIGRES)	-0.083342 (0.04606)		

These results are interpreted as follows: the analysis of the trace and the maximum eigenvalue reveals a cointegration relationship in the 5% confidence interval of the likelihood test.

The standardized relationship is as follows:

$$Dbrevet = 4.6 Dexportations - 4.9 Didetouristemigres + 0.43$$

In other words, a 1% increase in exports leads to a long-term increase in the number of patent applications. A 1% increase in remittances from emigrants, foreign direct investment and tourism revenues would lead to a long-term decline in patent applications in Tunisia.

This result is of little concern since the same effect is expected from emigrant transfers, foreign direct investment and tourism receipts as exports. Indeed, an economic recession

disrupts exports, remittances, foreign direct investment and tourism receipts.

3.7. Error-Corrected Model Estimation

The above results postulate the existence of a long-term relationship in at least one direction. Recall that the representation theorem of Engle and Granger (1987) shows that nonstationary series, especially those with a unitary root, must be represented as an error-corrected model if they are cointegrated.

According to this long-term relationship, patent applications and exports go hand in hand, while patent applications and remittances from emigrants, foreign direct investment and tourism receipts are negatively linked. The model estimate is provided in the following table.

Vector Error Correction Estimates

Date: 01/06/16 Time: 14:51

Sample (adjusted): 1974 2014

Included observations: 36 after adjustments

Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1
BREVET(-1)	1.000000
EXPORTATIONS(-1)	-1.956992 (0.44606) [-4.38727]
IDETOURISTEMIGRES(-1)	2.996055 (1.53168) [1.95605]
C	-11.95946

Error Correction:

D(BREVET)

D(EXPORTATIONS)

D(IDETOURISTE)



	MIGRES)		
CointEq1	0.019249 (0.00593) [3.24603]	0.178850 (0.03465) [5.16161]	-0.113698 (0.78083) [-0.14561]
D(BREVET(-1))	0.364772 (0.19883) [1.83459]	-0.024945 (0.14464) [-0.17246]	0.059423 (0.12240) [0.48548]
D(BREVET(-2))	-0.259006 (0.20237) [-1.27985]	0.035745 (0.14722) [0.24281]	0.225756 (0.12459) [1.81205]
D(BREVET(-3))	-0.091791 (0.21137) [-0.43426]	-0.068628 (0.15376) [-0.44633]	0.247222 (0.13013) [1.89986]
D(EXPORTATIONS(-1))	-0.301807 (0.28824) [-1.04707]	-0.434678 (0.20968) [-2.07306]	0.139983 (0.17745) [0.78887]
D(EXPORTATIONS(-2))	-0.132895 (0.27712) [-0.47956]	-0.291645 (0.20159) [-1.44674]	0.008862 (0.17060) [0.05195]
D(EXPORTATIONS(-3))	0.295228 (0.26604) [1.10973]	-0.253430 (0.19353) [-1.30953]	-0.340177 (0.16378) [-2.07705]
D(IDETOURISTEMIGRES(-1))	-0.041946 (0.20406) [-0.20556]	0.257592 (0.14844) [1.73531]	-0.242604 (0.12562) [-1.93120]
D(IDETOURISTEMIGRES(-2))	0.118882 (0.21200) [0.56078]	0.410199 (0.15422) [2.65990]	-0.147799 (0.13051) [-1.13247]
D(IDETOURISTEMIGRES(-3))	0.117237 (0.22543) [0.52006]	0.231777 (0.16399) [1.41338]	-0.578286 (0.13878) [-4.16693]
C	0.039490 (0.07906) [0.49947]	0.171636 (0.05751) [2.98423]	0.220231 (0.04867) [4.52469]
R-squared	0.226198	0.347976	0.663725
Adj. R-squared	0.188451	0.087167	0.529214
Sum sq. resids	0.808471	0.611263	0.437782
S.E. equation	0.140424	0.156367	0.132330
F-statistic	5.992560	1.334216	4.934383



Log likelihood	25.49631	22.28166	28.29016
Akaike AIC	-1.022559	-0.626759	-0.960565
Schwarz SC	-0.900910	-0.142906	-0.476712
Mean dependent	0.129367	0.137514	0.113324
S.D. dependent	0.155877	0.163662	0.192862
<hr/>			
Determinant resid covariance (dof adj.)	1.74E-05		
Determinant resid covariance	5.83E-06		
Log likelihood	63.70469		
Akaike information criterion	-1.539149		
Schwarz criterion	0.044370		
<hr/>			

If there is a short-term imbalance, the number of patent applications adjusts more slowly than the number of exports. Indeed, the rate of convergence of patent demand is approximately 1.9%, and that of exports is 17%.

3.8. Granger's causal test

Economic causality is an essential element in developing an economic policy or in making forecasts. Consequently, to draw the necessary conclusions in the case of Tunisia, the proven cointegration of the three variables leads us to analyse the Granger causality test.

Pairwise Granger Causality Tests

Date: 01/06/16 Time: 16:04

Sample: 1970 2014

Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
EXPORTATIONS does not Granger Cause BREVET	38	0.59271	0.62447
BREVET does not Granger Cause EXPORTATIONS		3.04978	0.03957
IDETOURISTEMIGRES does not Granger Cause BREVET	38	1.04003	0.4008
BREVET does not Granger Cause IDETOURISTEMIGRES		0.52986	0.65118
IDETOURISTEMIGRES does not Granger Cause EXPORTATIONS	40	3.34890	0.02917
EXPORTATIONS does not Granger Cause IDETOURISTEMIGRES		0.60136	0.6261

According to this table, six hypotheses were tested simultaneously, namely, the causal relationships between the three variables were tested two by two. The hypothesis of whether exports are causing the growth of patent applications and vice versa was tested. The same assumptions were taken between the sum of the remittances of emigrants, foreign direct investment and tourism receipts and the growth of patent applications as well as between the sum of the remittances of emigrants, foreign direct investment and tourism receipts and exports.

We note that at the 5% level, the Granger test suggests a unidirectional causal link between patent application and exports. In other

words, in the case of Tunisia, the demand for patents has caused the development of exports rather than the other way around. In other words, a minimum level of technological capacity development would be required in Tunisia before observing its beneficial effects on exports. Moreover, still at the 5% threshold, the sum of remittances from emigrants, foreign direct investment and tourism receipts has an influence on the level of export development and not the other way around. This finding follows from the previous one, namely, that a reduction in the sum of the remittances of emigrants, foreign direct investment and tourism receipts, which also



depend on technological capacity, would also generate export development.

4. Conclusion

Several studies find that political instability negatively affects growth by lowering productivity growth rates and, to a lesser extent, the accumulation of physical and human capital.

Innovation drives competition and competitiveness. Following a reduction in demand after the crisis, competition may intensify. Indeed, the only way for a company to maintain its sales is to steal market share from its competitors.

According to our econometric study, in Tunisia, an increase in exports would lead to a long-term increase in the number of patent applications. An increase in remittances from emigrants, foreign direct investment and tourism revenues leads to a long-term decline in patent applications.

This result is of little concern since the same effect is expected from emigrant transfers, foreign direct investment and tourism receipts as exports. Indeed, an economic recession disrupts exports, remittances, foreign direct investment and tourism receipts.

Moreover, in the event of a short-term imbalance, the number of patent applications adjusts more slowly than does the number of exports. In other words, in the case of Tunisia, the demand for patents has caused the development of exports rather than the other way around. In other words, a minimum level of technological capacity development would be required in Tunisia before observing its beneficial effects on exports.

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