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Trade Openness, Growth and Income Inequality: Case of Tunisia, an ARDL and PMG/ARDL Approach

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ABSTRACT

Trade openness has long been a major topic of debate, mainly because of the countless effects it can have on countries, particularly in terms of growth and wealth. While some see it as an efficient catalyst for growth, others claim that it contributes to the polarization of wealth without generating inclusive economic growth, resulting in the marginalization of the poorest social classes.

For the Tunisian case, our analysis using an ARDL model as well as a PMG/ARDL model, allowed us to conclude that trade openness has a positive effect on economic growth. We were also able to detect a negative effect on wage inequalities within the various sectors that constitute the Tunisian economy, in line with the predictions of the traditional theories on the impact of trade openness in developing countries.

Keywords: economic growth, income inequality, trade openness, Tunisia, panel data

JEL Classification: F11, F14, F16, O15, O47

INTRODUCTION

Trade liberalization, which has greatly accelerated since the 1980s, has given a new dynamic to the international interactions. The result has been a massive wave of liberalization on the international stage, driven by an increasing degree of integration and the abolition of all kinds of barriers to the free movement of goods, services and people. Consequently, the integration of economies on the international level and the elimination of barriers have been one of the most salient facts of the last few decades within an increasingly unified world market.

Along the same lines According to Williamson (1990), trade policies had been placed at the top of the development policy agenda. Thus, the international monetary fund† came to support the crucial role of trade policies, describing them as a major pillar of economic growth and a powerful instrument for the convergence of developing countries.

However, many economists expressed doubts about the effects of trade openness, particularly following the failure of several structural adjustment policies, and the emergence and spread of numerous crises, such as the one affecting the Asian dragons and Latin America, More worrying still, in many countries since the 1980s, inequalities have been escalating, affecting mainly the poorest population groups and exacerbating the already deep-rooted poverty in many countries.

So, the claim that openness is an undeniable contributor to growth and poverty reduction has raised a few doubts, and fueled debate between supporters and detractors of the latter, each putting forward their own arguments.

Hence our aim in this article, which is to analyze the effects of trade openness on both

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† IMF (1997), World Economic Outlook, Washington, D. C., IMF.

economic growth and inequality, particularly wage inequality in the case of Tunisia. A developing country that has undeniably pursued a policy of greater openness, the situation is that the country now finds itself encumbered by deepening inequality, which is threatening its peace and social cohesion, especially in the current social and political context, which is already well deteriorated.

LITERATURE REVIEW

The traditional theory of international trade was initiated by Adam Smith (1776) in the 18th century. His theory of absolute advantage revealed that openness and international exchange are beneficial and sources of wealth. However, a main limit to Smith's advances is that if a country does not have an absolute advantage, it will be excluded from international trade.

This is where David Ricardo's analysis (1817) emerged, demonstrating that even for a country with no absolute advantage, it was still in its interest to trade while specializing in the production of the good for which it was the least bad, if not the best, thus giving rise to the theory of comparative advantage.

However, Ricardo's model provides no indication concerning the distribution of these specialization gains. Another limitation of this model is its inability to explain trade and specialization between two countries with no comparative advantage, i.e. two countries with identical productivity, hence the static nature of such model.

The HOS theorem later followed as an extension of Ricardo's model, seeing trade as being mutually beneficial, as each country pursues the production of the good in which it has a comparative advantage. Unlike the Ricardo model, the source of this advantage lies in differences in factor endowments, i.e. capital and labor, where each country should specialize in the production of the good requiring the factor it is best endowed with.

The HOS theorem also studies specialization's effects on the remuneration of production factors, stating that an increase in the price of a specific good will lead to an increase in the remuneration of the factor intensively involved in the production of that good. The theorem predicts that, ultimately, international trade should gradually lead to the equalization of factor remuneration on the world stage, and to uniform levels of development.

Later, these theories faced a large amount of criticism resulting from a series of empirical studies. In fact, in order to validate the HOS approach, Leontief (1953) focused on the case of 200 American industries, the most highly industrialized country at that time, and proposed to calculate the factor endowments of exports and imports, expecting exports to be capital-intensive, i.e. the abundant factor, and imports to be labor-intensive, the less abundant factor, in line with the predictions of traditional theories. However, Leontief came to the opposite conclusion, finding that it was the import industries which were more capital-intensive. This gave rise to Leontief's paradox.

On the other hand, traditional theories do not explain the significant rise in intra-branch trade. Indeed, the creation of the European common market in the late '50s and the dismantling of barriers to trade should naturally have been followed by a specialization movement by member countries, as stated in traditional theories. Instead, intra-sector trade increased sharply, with production structures becoming even more alike.

This led to a new trend in the analysis of international trade, with many critics pointing out that traditional theories were somewhat simplistic, failing to take into account technological progress, transport costs or the international mobility of production, factors which are fundamental to contemporary international trade. This gave rise to the new international trade theories initiated by Paul Krugman in the 1980s.

TRADE OPENNESS AND ECONOMIC GROWTH EMPIRICAL ANALYSIS

Model

In the absence of an inequalities' theory, studies on this topic have evolved within an analytical framework that encompasses not only the contributions of the new international trade theory and those of endogenous growth but also the theory of the new geographical economy, thus shedding light on the various contemporary upheavals in trade within an increasingly integrated world economy.

Many authors have thus proposed to study how these different phenomena could interact with each other and whether openness, growth or technological progress and development was likely to have the greatest influence on inequalities.

Authors such as Young (1991), Grossman and Helpman (1991) and Rivera-Btaiz and Romer (1991), through the development of endogenous growth models, have been able to demonstrate that trade openness via phenomena such as intermediary trade, could generate productivity gains and subsequently influence economic growth. The model of Mankiw, Romer and Weil (1992) also demonstrated that the accumulation of human capital could play an important role in economic growth.

We are particularly interested in this model, which was inspired by Solow's (1957) model of increased growth, and which has been taken up by many authors, such Lin and Liu (2000) and Jones, Li and Owen (2003), and it is presented in the following form

$$Annual\ income\ growth\ rate\ per\ capita = \beta_0 + \beta_1 ln\ Real\ income\ + \beta_2 ln\ Saving\ rate\ +\ \beta_3\ ln\ ln\ human\ capital\ rate + \varepsilon_{it} \quad (1)$$

In our work, we have been inspired by the studies of the authors above who adapted this model to assess the effect of openness and government strategies to increase the attractiveness of the country and then indirectly measure their effects on inequalities.

We will first adapt this model to empirically verify the impact of trade openness on economic growth for the Tunisian case, retaining a certain number of variables to take into account both the different elements linked to this openness and the country's macroeconomic policies.

We will use GDP as the dependent variable to measure economic growth.

We will also use three measures of trade openness, including export openness (EXP), import openness (IMP) and FDI openness. In fact, nowadays, a country's openness cannot be limited to international trade, but it is also characterized by its capacity to host FDI, which are crucial elements of contemporary international trade.

In order to capture the effect of the economic characteristics, we will include a number of variables such the external debt (DEBT) as a measure of the country's indebtedness, the public expenditure (EXPEN) as a proxy for investment in physical capital, and finally the tertiary education enrollment rate (EDU) to represent the human capital, and the GINI index as a measure of inequality[‡].

Will have a model as follows.

$$lnGDP_t = \alpha_0 + \alpha_1 EXP + \alpha_2 IMP_t + \alpha_3 lnFDI_t + \alpha_4 lnEXPEN_t + \alpha_5 lnDEBT_t + \alpha_6 EDU_t + \alpha_7 lnGINI_t + \varepsilon_t \quad (2)$$

Methodology

For the estimations, we will use the ARDL model (Auto Regressive Distributed Lag) which is a combination of the AR models where we retain past values of the dependent variable among the explanatory ones, and the DL models where the explanatory variables include a

[‡] All our data comes from the National Institute of Statistics, the World Bank and the Foreign Investment Promotion Agency.

certain number of variables and their past values.

$$Y_t = f(X_t, Y_{t-p}, X_{t-q}) \quad (3)$$

Where

$$y_t = \beta_0 + \beta_1 y_{t-1} + \cdots + \beta_k y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \cdots + \alpha_q x_{t-q} + \varepsilon_t \quad (4)$$

$y_t, x_t \; et \; \varepsilon_t$, represent respectively the dependent variable, the explanatory variable and the error term.

This modeling is particularly efficient to test the co-integration between two or more time series, i.e. the long-term relations but also the short-term ones that may exist, especially when the series are not integrated of the same order.

This method is also based on a number of tests.

Correlation Matrix

Table 1. Correlation matrix

	EXP	IMP	EXPEN	FDI	DEBT	EDU	GINI
EXP	1.000						
IMP	0.7134	1.0000					
EXPEN	0.3599	0.5811	1.0000				
FDI	0.4674	0.4231	0.7264	1.0000			
DEBT	-0.2067	0.4420	0.2675	-0.0742	1.0000		
EDU	0.3876	0.4758	0.9618	0.7772	0.0719	1.0000	
GINI	-0.1961	-0.4718	-0.9278	-0.6637	-0.3673	-0.8846	1.0000

We notice a problem of multicollinearity between three of our variables, namely the public expenditure, the tertiary education enrolment rate and inequality, which led us to use three separate estimations where we included each of these variables separately.

Stationarity Tests

Table 2. the augmented dickey-fuller and the Phillips Perron time series stationarity Tests

Tests variables	ADF			PP		
	In level	**In first difference**	**Integration order**	**In level**	**In first difference**	**Integration order**
GDP	-0.028 (0.9939)	-5.066 (0.0002)	Integrated 1st order	0.018 (0.9944)	-5.068 (0.0002)	Integrated 1st order
IMP	-1.488 (0.5394)	-5.385 (0.0000)	Integrated 1st order	-1.428 (0.5686)	-5.426 (0.0000)	Integrated 1st order
EXP	-2.175 (0.2156)	-4.760 (0.0001)	Integrated 1st order	-2.257 (0.1861)	-4.741 (0.0001)	Integrated 1st order
EXPEN	-0.123 (0.9927)	-4.717 (0.0007)	Integrated 1st order	0.017 (0.9944)	-4.694 (0.0007)	Integrated 1st order
FDI	-3.726 (0.0207)	-------	Stationary at level	-3.709 (0.0218)	--------	Integrated 1st order
DEBT	-0.4 (0.9869)	-4.239 (0.0039)	Integrated 1st order	-0.607 (0.9786)	-4.214 (0.0043)	Integrated 1st order
EDU	1.408 (0.9968)	-3.420 (0.0488)	Integrated 1st order	0.849 (0.9978)	-3.402 (0.05)	Integrated 1st order
GINI	-2.619 (0.2713)	-4.042 (0.0077)	Integrated 1st order	-2.620 (0.2709)	-3.995 (0.0089)	Integrated 1st order

The Cointegration Test of Pesaran et al. (2001)

Table 3. Cointegration Test

Model to estimate	GDP EXP IMP EXPEN FDI DEBT, maxlags(2) aic			GDP EXP IMP EDU FDI DEBT, maxlags(2) aic			GDP EXP IMP GINI FDI DEBT, maxlags (2) aic		
Optimal lag	**lags(2 2 2 2 1 1)**			**lags(1 0 1 2 0 0)**			**lags(1 2 0 2 2 2)**		
F-statistic	3.107			3.525			3.743		
Critical Value Bounds	Significance	I0 Bound	I1 Bound	Significance	I0 Bound	I1 Bound	Significance	I0 Bound	I1 Bound
	10%	2.26	3.35	10%	2.26	3.35	10%	2.26	3.35
	5%	2.62	3.79	5%	2.62	3.79	5%	2.62	3.79
	2.5%	2.96	4.18	2.5%	2.96	4.18	2.5%	2.96	4.18
	1%	3.41	4.68	1%	3.41	4.68	1%	3.41	4.68

Also called Bounds test of Cointegration, it was initially developed by Pesaran and Shin (1998), this test is particularly useful to check the long run relationships known as Cointegration relationships between one or more time series, especially when they are not integrated of the same order.

We can emphasize that our variables are not integrated of the same order and that none of them is integrated of the second order, thus supporting the use of the Cointegration test of Pesaran et al. (2001).

However, before applying the cointegration test we must choose the most appropriate model by determining firstly the optimal lag structure to include in our ARDL model.

We will use the Akaike Information Criteria (AIC) for the choice of the optimal lag structure to introduce in our model to obtain the most appropriate one.

Results

Table 4. Estimation results

VARIABLES	(1) GDP	(2) GDP	(3) GDP
L.GDP	1.310***	0.947***	0.920***
	(0.279)	(0.0872)	(0.0525)
L2.GDP	-0.423	-------	-------
	(0.247)	--------	-------
EXP	0.135**	0.127**	0.105**
	(0.0438)	(0.0530)	(0.0442)
L.EXP	-0.00707	--------	-0.0489*
	(0.0589)	--------	(0.0233)
L2.EXP	0.0892*	--------	0.0335*
	(0.0466)	--------	(0.0189)
IMP	-0.169***	-0.141**	-0.0943*
	(0.0506)	(0.0557)	(0.0504)
L.IMP	-0.108	-0.0459*	--------
	(0.0674)	(0.0226)	--------
L2.IMP	-0.0886	--------	--------
	(0.0498)	--------	--------
EXPEN	0.0997*	--------	--------
	(0.0550)	--------	--------

L.EXPEN	0.0609	---------	---------
	(0.0739)	---------	---------
L2.EXPEN	-0.100	----------	----------
	(0.0639)	---------	---------
FDI	0.0289***	0.0192**	0.0211***
	(0.00816)	(0.00779)	(0.00700)
L.FDI	0.0197*	--------	-------
	(0.00986)	--------	-------
DEBT	0.734***	0.223**	0.140*
	(0.202)	(0.0860)	(0.0735)
L.DEBT	-0.196	--------	--------
	(0.113)	--------	--------
EDU	-------	0.107	--------
	-------	(0.0990)	-------
L.EDU	-------	-0.255	--------
	-------	(0.155)	--------
L2.EDU	--------	0.168	--------
	--------	(0.108)	--------
GINI	-------	-------	0.0659
	-------	-------	(0.145)
L.GINI	-------	-------	0.213
	-------	-------	(0.174)
L2.GINI	--------	-------	-0.344**
			(0.131)
Constant	-0.205	0.216	0.687
	(0.623)	(0.897)	(0.906)
Observations	27	27	27
R-squared	0.999	0.998	0.999

Model Diagnostic Tests

Table 5. Diagnostic tests

Breusch-Godfrey LM test for autocorrelation		
Estimation 1	**Chi2**	**Prob chi2**
	0.083	0.7729
Estimation 2	**Chi2**	**Prob chi2**
	1.783	0.1818
Estimation 3	**Chi2**	**Prob chi2**
	1.766	0.1839
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		
Estimation 1	**Chi2**	Prob chi2
	0.00	0.9611
Estimation 2	**Chi2**	**Prob chi2**
	2.52	0.1126
Estimation 3	**Chi2**	**Prob chi2**
	0.05	0.8208
Skewness/Kurtosis tests for Normality		
Estimation 1	**Chi2**	**Prob chi2**
	1.49	0.4755
Estimation 2	**Chi2**	**Prob chi2**
	1.14	0.5656
Estimation 3	**Chi2**	**Prob chi2**
	1.83	0.4007

This step aims to confirm our estimated model validity, via a number of tests such as the autocorrelation test, the heteroscedasticity test, the normality test and finally the stability test.

We have set out above the results of the different tests, which confirm that the residuals show all the desired properties, validating even more the robustness of our results.

The CUSUM stability test also shows that the estimated parameters are stable over time, confirming the null hypothesis of stability of the relationship.

Discussion

Our results show that the effect of trade openness interacts with a number of factors that significantly influence economic growth and respond to the policies pursued by the state to improve access to investment and increase physical and human capital, highlighting even more the importance of macroeconomic policies to complement trade openness and enhance its impact on economic growth.

Many consider that international trade induces a better reallocation of resources leading to a redeployment of production factors from the less productive sectors to the more dynamic ones, leading thus to a greater factors productivity (Dowrick et al., 1991).

It can also contribute to the increase of available goods (Romer & Rivera Batiz, 1991) as well as to the transmission of new technologies and knowledge (Grossman & Helpman, 1991; Keller, 1996).

With regard to our estimations, the positive and statistically significant effect of exports can be explained by the fact that they are perceived today as excellent drivers of economic growth, they constitute opportunities for national production as well as a source of foreign currency inflows to compensate the effect of imports on the trade balance, and they constitute revenue for the state to finance local economies.

Indeed, it is agreed today that the exports participate actively in developing countries to reduce unemployment and poverty, boost public revenues and increase the import capacity of capital goods, thus increasing production and economic growth.

As for the negative and statistically significant effect of imports, this can be explained by the fact that today the country suffers from a trade balance deficit due in large part to imports that significantly exceed exports, the latter find their origins in the increase in imports of food products and consumer goods in relationship with the purchase of textiles and clothing or electrical and mechanical consumables.

It should also be emphasized that the on-going dinar devaluation has made these imports even more expensive, leading to an inflationary trend that is significantly affecting both the purchasing power and the economic growth. (Kholis, 2012; Mogoe et al., 2014).

As for the positive and statistically significant effect of FDI, it further supports the results of a large number of studies that agree on the crucial role of FDI in the development process, often perceived as catalysts of economic growth bringing to host countries their lots of innovations, technologies, productions and opportunities for the local workforce.

Regarding public expenditure, our results support their positive effect. In fact, Tonzi and Zee (1997) suggest that public spending can have a positive impact on economic growth through at least two channels.

The direct one by the increase of the economy's physical capital stock via public investment complementary to private investment, or indirectly by increasing production factors' marginal productivity through spending in education or health, which works towards human capital accumulation.

For its part, the variable representing the external debt has a negative and statistically significant effect on economic growth, this is consistent with the findings of many works such as those of Fosu (1999) or Bernardin et al. (2018) who have shown that the increase in the external debt is harmful to the economic growth. For the Tunisian case, it has experienced an

exceptional increase of its debt in recent decades to reach 100.9%[§] of GDP in 2020.

The counterintuitive effect of the education variable can be explained through the fact that Tunisia is characterized by a highly disrupted labor market, suffering from the political uncertainty that has prevailed for years, thus accentuating the unemployment rate, which rose in 2020 to 17.4%[**], and the latter is even more apparent for higher education graduates, who suffer from an unemployment rate close to twice the national average.

As for the relationship between inequality and economic growth, this has been the subject of much interest for decades, especially in the lack of a general consensus.

In our case we have concluded to a negative impact of inequalities measured by the Gini index on economic growth, it must be stated that Tunisia suffers from an inequality already well anchored and persistent with a population that has not ceased to denounce it, an inequality that has come to disrupt the social climate creating even more tensions, it is moreover one of the major causes of the several protest movements coming to disrupt even more the economic aspect.

This is confirmed by Fernandez and Rodrik (1991), Alessina and Drazen (1991), Durlauf (1996) and Alessina and Perotti (1996).

Michael Forster also said, in an OECD report, "What is remarkable is that the negative impact of inequality on growth is demonstrated in the majority of the studied countries. It cannot be asserted that inequality is responsible for all the loss of growth, but at least for part of it.

The same report later concluded that any increase in inequality leads to lower economic growth and that correcting inequality is essential to make our societies more equitable and our economies stronger.

This then led us into exploring the effect of trade openness on income inequality, to see whether it was exacerbating or reducing it.

So, in the next section we intend to study the effect of trade openness combined with other variables on income inequality.

To this end, we used the PMG/ARDL approach introduced by Pesaran et al. (1999).

It enables us to identify both short and long-run relationships, and can be used as an error-correction model.

This method consequently allows us to analyze short and long-term relationships without worrying about the variables' level of integration, whether they are integrated of order 0 (I(0)) or order 1 (I(1)), as long as they are not integrated of order 2 (I(2)).

In addition, this approach overcomes the endogeneity problem posed by certain variables by including the lags of both endogenous and exogenous variables, resulting in more concrete estimations and a more coherent analysis of long-term relationships.

The choice of the lags is mainly based on the Akaike Information Criterion (AIC), which gives us the optimum ones.

The PMG approach is distinguished by the fact that it considers the individual characteristics of the different entities in the panel studied. In fact, it assumes that coefficients are heterogeneous in the short term, and are then more restricted to be homogeneous over the long term.

[§] https://www.ceicdata.com/en/indicator/tunisia/external-debt--of-nominal-gdp
[**] http://www.ins.tn/statistiques/153

TRADE OPENNESS AND INCOME INEQUALITY EMPIRICAL ANALYSIS

Model

On the modeling level, we relied on the work of authors such as Katz and Autor (1999) to obtain an equation of the following form:

$$ln(INEQ)_{it} = \beta_0 + \beta_1 X_{it} + \delta_i + \xi_{it} \quad (5)$$

INEQ: Refers to our dependent variable representing relative wages, which is, the ratio of the average annual wage of skilled workers to that of unskilled workers, used as a measure of income inequality. As to (X) this is a vector covering all our explanatory variables.

Katz and Autor (2008) have used variables such as the minimum wage (SMIG) to take account of institutional effects, the opening rate (OP) as a proxy for trade liberalization, and the unemployment rate (UN) and labor demand (DEM) to reflect cyclical fluctuations in the labor market.

Acemoglu et al. (2002) have also introduced the variable governance (G), which provides information on institutional quality, as it measures how policies and institutions support their economies.

Afterwards, in accordance with our PMG/ARDL approach, we will have the basic equation of the model in the following form:

$$\Delta Y_{it} = \alpha_0 + \sum_{j=1}^{p} \alpha_{1i} \Delta Y_{it-j} + \sum_{i=0}^{q} \alpha_{2i} \Delta X_{it-j} + \beta_{1i} Y_{it-1} + \beta_{2i} X_{it-1} + \varepsilon_{1it} \quad (6)$$

Where y is the dependent variable, x is the vector of explanatory variables α_{1i} and α_{2i} are the short-term effects, β_1 and β_2 are the long-term effects, $\triangle$ is the first difference, α_0 is the constant, and ε_{1it} is the error term.

By applying the general form of the ARDL model to our initial model variables, we obtain the following equation:

$$\Delta lnINEG_{it} = \alpha_0 + \alpha_{1i} lnINEG_{it-1} + \alpha_{2i} OP_{it-1} + \alpha_{2i} lnDEM_{it-1} + \alpha_{2i} lnSMIG_{it-1} + \alpha_{3i} UN_{it-1} + \alpha_{4i} lnG_{it-1} + \sum_{j=1}^{p} \beta_{1i} \Delta lnINEG_{it-j} + \sum_{i=0}^{q} \beta_{2i} \Delta lnOP_{it-j} + \sum_{i=0}^{q} \beta_{2i} \Delta lnDEM_{it-j} + \sum_{i=0}^{q} \beta_{3i} \Delta lnSMIG_{it-j} + \sum_{i=0}^{q} \beta_{2i} \Delta lnUN_{it-j} + \sum_{i=0}^{q} \beta_{4i} \Delta lnG_{it-j} + \varepsilon_{1it} \quad (7)$$

In a second step, if a cointegration relationship is established, proving the existence of a long-term relationship, we can estimate an error correction model (ECM) associated with the long-term estimations, presented as follows:

$$\Delta lnINEQ_{it} = \alpha_0 + \sum_{j=1}^{p-1} \beta_{1ij} \Delta lnINEQ_{it-j} + \sum_{i=0}^{q-1} \beta_{2ij} \Delta OP_{it-j} + \sum_{i=0}^{q-1} \beta_{2ij} \Delta lnDEM_{it-j} + \sum_{i=0}^{q-1} \beta_{3ij} \Delta lnSMIG_{it-j} + \sum_{i=0}^{q-1} \beta_{4ij} \Delta UN_{it-j} + \sum_{i=0}^{q-1} \beta_{4ij} \Delta lnG_{it-j} + \mu_{1i} ECT_{1,it-1} + \varepsilon_{1it} \quad (8)$$

Panel Presentation

For the purposes of our sample, we looked at the Tunisian economy as a whole, grouping together the six manufacturing industry sectors, food processing, building materials and glass, mechanical and electrical engineering, chemicals, textiles, clothing and leather, and miscellaneous manufacturing, to which we have added the service sector, comprising sectors such as transport and communications, banking and insurance, hotels, coffee shops and bars, other market services, and finally trade, to end with the non-manufacturing sectors, such as mining and hydrocarbons, for a 30 years period from 1990 to 2020.

Stationarity Tests

Table 6. Panel unit root test results: series in level

	INEQ		OP		DEM		G		SMIG	UN	
	intercept	trend	intercept	trend	intercept	trend	intercept	trend	intercept	intercept	trend
LLC	-1.90876 (0.0281)	-1.56326 (0.0590)	-6.17560 (0.0000)	-4.73884 (0.0000)	-4.69634 (0.0000)	0.10481 (0.5417)	-4.27271 (0.0000)	1.66031 (0.9516)	4.76417 (0.9934)	-2.10228 (0.0178)	-2.22587 (0.0130)
IPS	0.99094 (0.8391)	-1.30706 (0.0956)	-4.42221 (0.0000)	-2.70435 (0.0034)	-1.41704 (0.0782)	1.73501 (0.9586)	-1.78318 (0.0373)	5.36170 (0.9996)	3.14920 (0.9992)	-2.51172 (0.0060)	0.27534 (0.6085)
PP	13.8382 (0.9751)	50.7278 (0.0026)	110.543 (0.0000)	54.2924 (0.0009)	52.1480 (0.0017)	25.3270 (0.5005)	26.4984 (0.4360)	1.51455 (0.9998)	9.43598 (0.9988)	41.3558 (0.0286)	18.6941 (0.8491)
Breitung	-	-1.25298 (0.1051)	-	1.34099 (0.9100)	-	1.91911 (0.9725)	-	3.55503 (0.9974)	-1.06289 (0.1439)	-	-2.82366 (0.0024)

Table 7. Panel unit root test results: series in first difference

	INEQ		OP		DEM		G		SMIG		UN	
	intercept	trend			intercept	trend	intercept	trend	intercept	trend	intercept	trend
LLC	-7.26480 (0.0000)	-5.10715 (0.0000)	-	-	-5.97687 (0.0000)	-6.53642 (0.0000)	-5.08628 (0.0000)	-6.64015 (0.0000)	-6.70386 (0.0000)	-1.65778 (0.0487)	-11.2581 (0.0000)	-9.62064 (0.0000)
IPS	-10.8959 (0.0000)	-8.99339 (0.0000)	-	-	-8.95059 (0.0000)	-9.17803 (0.0000)	-5.23968 (0.0000)	-5.95378 (0.0000)	-11.8374 (0.0000)	-9.45621 (0.0000)	-9.44887 (0.0000)	-7.42262 (0.0000)
PP	333.250 (0.0000)	1072.09 (0.0000)	-	-	239.775 (0.0000)	693.352 (0.0000)	92.8712 (0.0000)	83.2527 (0.0000)	257.557 (0.0000)	204.651 (0.0000)	250.319 (0.0000)	249.663 (0.0000)
Breitung	-	-9.45291 (0.0000)	-	-	-	-0.96384 (0.1676)	-	-6.98163 (0.0000)	-	0.22022 (0.5871)	-	-10.1788 (0.0000)

To test the stationarity of our variables, we used a set of tests such as in Pesaran et al. (2003), Levin et al. (2002), or Breitung (2000).

Our table shows that, at the 5% level, the null hypothesis stipulating the presence of a

unit root cannot be rejected.

Accordingly, the results of our stationarity tests based on our panel data reveal that, apart from the variable representing trade openness, which is integrated of order 0 and therefore stationary in level, all our remaining variables are integrated of order 1 and are stationary in first difference.

Cointegration Tests

Table 8. Cointegration tests

Dep. var	F-Statistic	Probability	Result
INEQ	-3.195515	0.0007***	Cointegration
INEQ	-1.718178	0.0429**	Cointegration

Authors such as Pedroni (1999) and Kao (1999) have developed cointegration tests for panel data, enabling us to test the presence of a long- run relationship between our variables.

Non-rejection of the null hypothesis asserts that the panel variables are not cointegrated, while rejection of the null hypothesis at the 5% level allows us to assume the alternative hypothesis of variable cointegration.

Our results confirm the existence of a cointegrating relationship and so a long-run relationship between our different variables.

Causality Tests

Table 9. Pairwise Dumitrescu Hurlin Panel Causality Tests

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
OP does not homogeneously cause INEQ	1.46367	0.85186	0.0006
INEQ does not homogeneously cause OP	2.63429	3.45098	0.3943
DEM does not homogeneously cause INEQ	7.35359	13.9292	0.0000
INEQ does not homogeneously cause DEM	2.24407	2.58459	0.0097
G does not homogeneously cause INEQ	2.69489	3.58554	0.0003
INEQ does not homogeneously cause G	3.59318	5.57999	2.E-08
UN does not homogeneously cause INEQ	1.50339	0.94006	0.3472
INEQ does not homogeneously cause UN	1.32536	0.54477	0.5859
SMIG does not homogeneously cause INEQ	6.76499	12.6223	0.0000
INEQ does not homogeneously cause SMIG	1.63431	1.23072	0.2184

The table above shows the causal relationships between the various variables included in our model.

We can see a unidirectional causal relationship between trade openness and wage inequality, as well as between the minimum wage and inequality.

Furthermore, there is a bidirectional causality both between relative labor demand and wage inequality, and between the governance variable and inequality.

However, no causal link was observed between the unemployment rate and wage inequality, supporting the hypothesis of neutrality between these two variables.

Results Interpretation

Table 10. Estimated long and short-run coefficients using the PMG/ARDL approach

Variable	Coefficient	t-Statistic	Prob.*
Long Run Equation			
OP	-0.333630	-2.483480	0.0140
G	2.279540	5.422847	0.0000
DEM	-2.816547	-8.432301	0.0000
UN	-3.552290	-2.475167	0.0143
SMIG	0.992670	7.570212	0.0000
Short Run Equation			
ECT(-1)	-0.210209	-2.810662	0.0055
△(INEQ(-1))	-0.147567	-1.917845	0.0569
△(OP)	-0.301192	-1.576932	0.1167
△(OP(-1))	-0.505677	-1.827891	0.0694
△(OP(-2))	-0.449339	-1.520885	0.1302
△(G)	0.085108	0.456870	0.6484
△(G(-1))	0.583618	1.174208	0.2420
△(G(-2))	0.669992	2.034043	0.0436
△(DEM)	0.560907	3.128084	0.0021
△(DEM(-1))	0.061966	0.314299	0.7537
△(DEM(-2))	0.050629	0.145448	0.8845
△(UN)	1.812074	2.223924	0.0275
△(UN(-1))	-1.470978	-1.831271	0.0689
△(UN(-2))	1.280917	1.153957	0.2502
△(SMIG)	0.430578	1.089247	0.2776
△(SMIG(-1))	1.266316	2.910820	0.0041
△(SMIG(-2))	0.085550	0.219789	0.8263
C	4.946971	2.561307	0.0113

We note that both trade openness and relative labor demand had negative and statistically significant effects on the wage ratio at the 1% level, leading to a decline in the wage gap between skilled and unskilled workers.

The bottom line is that Job creation in the Tunisian case tends to respond much more to the needs of unskilled jobseekers.

This result can be explained by the fact that, following the economic deregulation, there has not been the expected spillover effect in terms of technology transfer or the development of production systems, with the Tunisian economy largely dominated by sectors such as textiles, clothing and leather, which rely heavily on low-skilled labor.

Indeed, employment has tended to respond much more to the needs of jobseekers with lower educational levels, reflecting a growing mismatch between supply and demand on the Tunisian job market, given the number of skilled workers, which continues to expand every year, and it should be pointed out that in Tunisia they are the ones who suffer the most from unemployment, as testified by the rate of unemployed higher education graduates, which reached 30%[††] in 2020, for a national rate of 15%[‡‡].

These findings are in phase with those of Munshi (2012), who focused on Bangladesh, and Chaudhry and Imran (2013) for Pakistan. These researchers concluded that the trade openness had increased the need for unskilled labor, which in turn helped to raise their wages, thus also reducing the wage gap between unskilled and skilled workers.

As for the minimum wage, it exerts a positive and statistically significant effect. This can be explained through the fact that the minimum wage, which is indexed to price trends, is notably outpaced by other wages. For example, between 1997 and 2012, the minimum wage increased by just 0.5%[§§], generating wide disparities between wages, particularly between skilled and unskilled workers.

As regards the effect of the unemployment rate, it turns out to be negative and statistically significant at the 1% threshold, leading to a reduction in the wage gap between skilled and unskilled workers. This counterintuitive effect is further evidence of the situation prevailing in Tunisia, characterized by a disconnect and mismatch between the labor market and the education system, with young graduates struggling to integrate the professional sphere. It is the latter who suffer most from the high unemployment rate.

The effect of the governance variable was negative and significant. With regard to this theme, Tunisia has a lot of work to do and a long way to go, especially in terms of the quality of its institutions. Tunisia ranks 119th out of 162[***] countries, and is at the bottom of the international ranking.

And The observation is hardly brilliant at the Arab world level where Tunisia is ranked 9th out of 12[†††] countries.

For Acemoglu et al. (2002), institutional quality is an essential determinant of economic performance, supporting the statement that a well-functioning market is largely conditioned by the quality of its institutions, thereby reducing information asymmetries and risks by ensuring the respect of rights and clarifying responsibilities and limits of action.

CONCLUSION

The relationship between trade openness, growth and wage inequality has been covered in a vast number of studies involving a wide range of developed and developing countries. However, most of these studies have produced very contrasting results and conclusions

With no general consensus on this subject on the international stage, opinions remain fairly mixed, and the topic is still highly debated.

Meanwhile, the World Bank (2005) later stated that deeper international integration is an excellent catalyst for economic growth, and proved to be an excellent initiative for developing countries.

However, the advantages of trade liberalization will be altered if the benefits and wealth created are distributed unequally, leading to an increase in disparities that will mainly affect

[††] NSI data on unemployment among higher education graduates 2020
[‡‡] Skills mismatch in Tunisia: what are the determinants of underemployment? ITCEQ 2019
[§§] ITCEQ Notes and Analysis No. 13: Wage growth and productivity
[***]https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=1&countries=TUN
[†††] ITCEQ Economic Freedom Index EFI 2021.

the poorest communities, pushing them further into poverty and precariousness.

It is therefore crucial that openness be not associated with inequalities, which highlights the importance of good governance, i.e. putting in place the right policies and the right institutional framework to help prevent the undesirable effects of these disparities.

For the Tunisian case, we concluded that openness boosted economic growth, but also reduced income inequalities, particularly between skilled and unskilled workers, supporting the predictions of classical theories and a number of studies on developing countries.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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