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Modeling the Evolution of the Romanian Textile Industry: Empirical Evidence of Lead-lag and Causal Relationships

Abstract

The objective of this paper is to investigate and explain the evolution of the Romanian textile industry over the last decade. Potential explanatory factors, both systematic and industry-specific, for the dramatic industry decay are identified e.g. the disappearance of the primary industry, the continuous increase in the minimum wage in Romania, an acute labour shortage, the liberalisation and full integration of the textile industry into GATT in 2005 and the recent global economic crisis. Furthermore we present empirical evidence of the linkages and causality between the overall economic growth of Romania, the evolution of the country's textile industry and the rate of growth of the minimum wage in the economy during June 2000 and January 2011. We found that the lagged minimum wage growth and lagged textile industry sales growth together explain 80% of the future rate of growth in the country's gross domestic product (GDP). All econometric tests conducted using our dataset agree that past and contemporaneous increases in minimum wages have had a significant negative impact on the textile industry. Finally, Granger causality tests reveal that the rate of growth in the GDP is driven by sales in the textile industry, and at the same time textile industry sales also drives macroeconomic growth. This bilateral causality is significant at 5% in both cases, being stronger from the industry-level to the economy-level.

Key words: Romanian textiles industry, explanatory factors, GDP growth, minimum wages, Granger causality.

■ Introduction

The Romanian textile industry began to decline significantly after the 1989 revolution which removed the communist regime that had been leading the country for decades. Many factors have contributed to the regress of a once strong industry, both systematic and industry-specific. The actual decline began a few years after the revolution, caused by a strengthening national currency, which then worsened as a result of the subsequent flood of cheap products from Asia and the rising costs of the labor market, especially after the country's integration into the EU structures. *Table 1* reflects the increasing trend of the minimum wage in Romania over the 2000 - 2011 time period and related legislation.

Another problem that contributed to the decline of the Romanian textile industry is represented by the dramatic disappearance of the primary industry which supplied raw materials for the textile industry. *Figure 1* clearly shows the significant decay in the provision of primary products to the Romanian textile industry in 2003 compared to 1989 (data retrieved from [2]).

In addition, the industry has been struggling for years with an acute labour shortage, caused both by migration and the closure of many small enterprises: statistics released by the Romanian Federation of Light Industry Employers (FE-PAIUS) show that in 2007 - 2008 almost 80,000 employees were laid off or left voluntarily, and in 2009 another 58,000 people were laid off in the textile indus-

Table 1. Evolution of minimum wage in Romania (domestic currency) and related legislation: 2000 - 2010; **Source:** [1].

Year	Minimum wage	Legislation (Government Decision)
2000	1,000,000 ROL	GD 1166/2000
2001	1,400,000 ROL	GD 231/2001
2002	1,750,000 ROL	GD 1037/2001
2003	2,500,000 ROL	GD 1105/2002
2004	2,800,000 ROL	GD 1515/2003
2005	3,100,000 ROL	GD 2356/2004
2006	330 RON	GD 1776/2005
2007	390 RON	GD 1824/2006
2008	540 RON	GD 1507/2007
2009	600 RON	GD 1051/2008
2010	600 RON	GD 1051/2008
2011	670 RON	GD 1193/2010

try. Ironically, the significant decrease in the number of employees gives the impression of an increase in labour productivity, but if one looks at the overall Romanian economy, [3] it is revealed that the productivity increment compared to 1990 has been achieved not by making work more efficient but as a result of an acute drop in the number of employees in Romania; hence owing to a significant rise in the gross added value achieved by work carried out. Hence, statistics regarding labour productivity should be interpreted with care.

Also an important international factor that affected the industry was the complete abolition of quotas on textile imports by the WTO on January 1st, 2005 - a process which started in 1995 with the Uruguay Round agreement on textiles and clothing. Liberalisation has been controversial because both textiles and clothing contribute to employment in developed countries, particularly in regions where alternative jobs may be difficult to find. In the European Union, for example, the sector is dominated by small and medium-sized enterprises concentrated in a number of regions that are highly dependent on this sector (see [4]). The Agreement on Textiles and Clothing (ATC) negotiated during the GATT Uruguay Round provided for the gradual reduction of bilateral quotas and the integration of the textile industry into GATT. [5] shows that in the first stage, which began on January 1 of 1995, 16% of the textile tariff lines were integrated into GATT, and the growth rate of quota volumes for the remaining items increased by 16%, from 3 to 3.48%. The second and third stages, covering 17 and 18% of the items, respectively, occurred on January 1, 1998, and January 1, 2002. The corresponding quota growth rates for the remaining textile trade items increased to 4.35% and 5.52%, respectively, as each stage was reached. In the last stage, reached on January 1, 2005 and affecting 49% of the tariff lines, the textile industry was to achieve complete integration into GATT rules.

The Doha round and full integration of the textile industry into GATT has dramatically changed the international environment for the textile industry as a whole. Before liberalisation, the Multi-Fiber Agreement (MFA) - in effect from January 1, 1974 - provided a system of voluntary export restraints on textiles and clothing exports from developing coun-

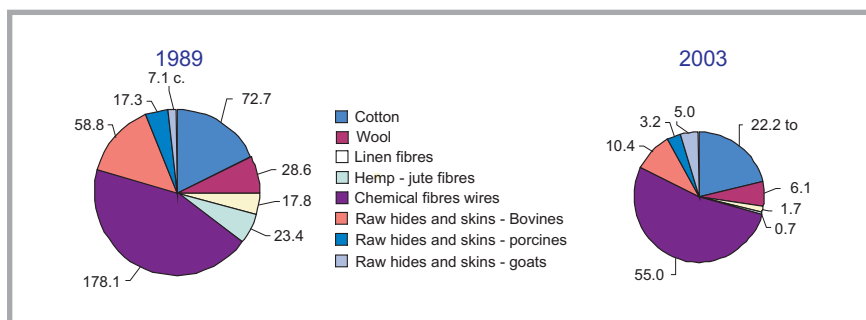


Figure 1. Provision with basic raw materials 1989 versus 2003 (mil tones).

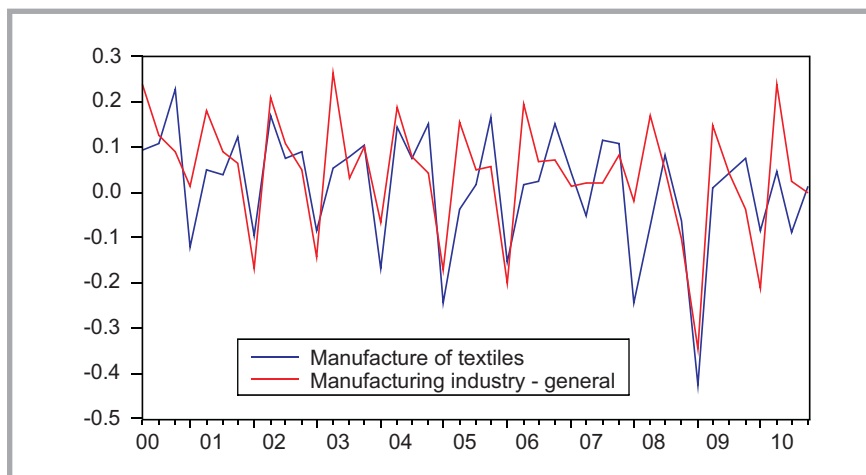


Figure 2. Time evolution of industry sales growth: 2000Q1 - 2010Q4.

tries and subsequently provided substantial protection to the textile industries of the developed countries. In addition, for many developing countries, the quota system had facilitated access to developed countries' markets i.e., guaranteed shares of their textile and clothing market (see [6]). However, as mentioned before, the expiration of the Multi-Fiber Agreement in 2005 had a substantial impact on the textile industry at an international level. [5 - 9] provide evidence in this respect. [8] shows that the fall in price and non-price barriers to trade in the textile and clothing industry due to trade liberalization/globalization has adversely affected US firms, workers and communities, while [9] predicts there will be a shift in demand away from the beneficiaries of former preferential access to the US market such as Mexico and Sub-Saharan African countries to South Asia. [6] reveals that during the first 6 months since the elimination of the quota system, for example, Chinese textile and apparel exports to the US rose by about 64%, with skirts rising by 879% and nightwear by 647%. These developments led the US to invoke the safeguard provision with China in May, 2005, holding \$1.31 bil-

lion worth of imports in seven categories to a maximum growth rate of 7.5%.

For the Romanian textile industry, full integration of the textile industry into GATT was harmful in two ways: First, the domestic market, already suffocated by Chinese goods, became that much harder or even impossible to be regained by domestic manufacturers after the removal of import quotas. Secondly, Romanian exporters would lose an important part of their traditional market - the European Union - which accounted for 85% of Romania's textile exports, according to FEPAIUS estimates.

As Figure 2 shows, aside from the global economic crisis from 2007-2009, trade liberalisation brought the most significant decrease in industry sales both for the overall Romanian manufacturing industry (the red line) and for its "manufacture of textiles" sub-division (the blue line) e.g. in the first trimester of 2005, aggregate textile industry sales decreased by 24.5%, while the most significant quarterly decrease during the decade analysed happened in the first trimester of 2009, when industry sales dropped by

Table 2. Descriptive Statistics of Quarterly Series (2000 Q1 – 2010 Q4); *Source:* Author's estimations, RNIS data.

	Manufacture of textiles	Manufacturing industry - general	GDP growth	Min wage growth
Mean	0.013307	0.042721	0.0574	0.0417
Median	0.044476	0.051310	0.1742	0.0000
Maximum	0.227821	0.265409	0.2810	0.3567
Minimum	-0.424522	-0.344144	-0.5114	0.0000
Std. Dev.	0.129278	0.131853	0.2601	0.0912
Skewness	-1.166080	-0.766234	-1.2447	2.2923
Kurtosis	4.641906	3.568152	2.7251	7.2997
Jarque-Bera	14.57489	4.785995	11.238	70.781
Probability	0.000684	0.091355	0.00363	0.0000
Sum	0.572183	1.837016	2.4687	1.7918
Sum Sq. Dev.	0.701940	0.730174	2.8418	0.3493
Observations	43	43	43	43

Table 3. Correlation Matrix for the analyzed time series; *Source:* Author's estimations, RNIS data.

	Min wage growth	Manufacturing industry – general	Manufacture of textiles	GDP growth
Min wage growth	1	-0.48	-0.54	-0.73
Manufacturing industry – general	-0.48	1	0.67	0.80
Manufacture of textiles	-0.54	0.67	1	0.75
GDP growth	-0.73	0.80	0.75	1

42.45 % under the influence of the global economic crisis.

The remainder of the study is organised as follows: Section **Data** presents and describes the data; Section **Contemporaneous and lead/lag linkages between the textile industry, overall economic growth and the evolution of the minimum wage** econometrically investigates contemporaneous and lead/lag linkages between the textile industry, overall economic growth and the evolution of the minimum wage, while Section **Granger causality tests** defines the methods employed by Granger causality tests, estimates it based on our dataset and analyses the empirical results. Finally, Section **Summary and conclusions** concludes this research.

■ Data and statistics

Data

All data used in this study was retrieved from the Romanian National Institute of Statistics (RNIS) TEMPO database and covers the 2000-2011 period. As a proxy for general economic development in Romania we employed the quarterly Gross Domestic Product at market prices (GDP), defined by RNIS as the main macro-economic aggregate

of national accounting, representing the final result of production activity for resident productive units for a certain period - a quarter, respectively.

In order to measure the Romanian textile industry's performance we used the monthly rate of growth of industry sales for the 'manufacture of textiles' division in the TEMPO database, which was subsequently transformed into quarterly logarithmic growth. In addition, we gathered data on the evolution of the minimum wage in the country, which was a potential explanatory factor for the industry's rate of growth.

Both the GDP and aggregate industry sales revenue have not been adjusted for seasonality because we wanted to keep as much information as possible, and we were also interested in short-term causality.

The sample period extends from January 2000 to January 2011 and therefore includes 43 quarterly observations for each series.

Descriptive statistics

As **Table 2** shows and **Figure 2** confirms, the evolution of manufacturing of the textile industry was the most modest

among the economic variables analysed, registering a quarterly average growth of just 1.33%, as compared to a mean rate of growth of 4.27% for the whole manufacturing industry and 5.74% for the general Romanian economy during the sample period. The minimum wage in Romania registered an average quarterly growth of 4.16 percent over the decade analysed. These findings already provide an insight that the textile industry was affected by specific factors and did not fluctuate solely under the action of macroeconomic influences.

Contemporaneous and lead/lag linkages between the textile industry, overall economic growth and the evolution of the minimum wage

Correlation analysis

A simple investigation of the correlation matrix between the time series can provide important information for subsequent Granger causality tests. The correlation coefficients are reported in **Table 3**. As expected, we can notice that the manufacturing industry moves closely with the overall economy (a correlation coefficient of 0.8), while its textile subdivision has a slightly weaker contemporaneous correlation with the GDP (0.75). In addition, the Romanian manufacturing industry and textiles sub-division are even less correlated among each other than they are with the overall economy (correlation coefficient equal to 0.67). Also, as expected, the increase in the minimum wage in the country has negative effects both on its overall economic growth, and at the industry-level.

In order to confirm the findings above, i.e. a positive relationship between the evolution of the Romanian textile industry and the overall economy and a negative effect of the increase in the minimum wage on the textile industry, we proceeded to estimate univariate and multivariate regression models (section **Regression models**) and perform Granger causality tests (section **Granger causality tests**).

Regression models

In the first set of OLS regression models, we assessed the contemporaneous and lead-lag impact of the overall macroeconomic growth, as represented by the quarterly growth of the Gross Domestic Product, and of the rate of growth of the

minimum wage on the manufacture of the textile industry's quarterly revenue growth (MTQS).

The coefficients, heteroskedasticity-corrected standard errors, t-statistics and goodness-of-fit statistics are shown in Panel A of **Table 4**. It is found that the combination of independent variables that best explains textile industry growth is represented by the same quarter GDP and minimum wage growth together. Other results show that past GDP growth and past increase in the minimum wage are both significant explanatory factors for future textile industry growth. While an increase in the minimum wage in year t produces a significant decrease in textile industry sales for four quarters into the future - in year $t+1$ - (slope coefficient = -0.91), GDP growth in year t is positively correlated with future sales in the textile industry (slope = 0.34).

The second set of OLS regression models considers the Quarterly GDP Growth to be the dependent variable, on the other hand the contemporaneous and lagged quarterly growth of textile industry sales and that of the minimum wage are potential explanatory factors, either simultaneously or in an univariate setting. Estimation of different model specifications has, in all cases, statistically significant coefficients. Results clearly reveal that the textile industry is a leading indicator of future macroeconomic growth, and also that past and contemporaneous increases in minimum wages affect the textile industry in a more significant negative manner than it affects the overall economy (absolute values for the slope coefficients greater than 2 in the univariate models). The multiple regression model with lagged minimum wage growth and lagged textile industry sales growth as independent variables helps explain 80% of the future rate of growth in the country's GDP. Thus we can econometrically confirm a previous intuition: the increase in the minimum wage caused the decline of the Romanian textile industry, which, in turn, negatively affected the overall macroeconomic growth.

■ Granger causality tests

Next a Granger causality test was used to ascertain with more precision the causal relationship between our time series. Granger causality tests are widely used in applied economics as a way of establishing if a variable has been a leading

Table 4. OLS Regressions with manufacture of textiles quarterly sales (MTQS) growth as the dependent variable; *significant at 0.01, **significant at 0.05, ***significant at 0.1. Source: Author's estimations, RNIS data.

	Independent Variable	Coefficient	Std. Error	t-Statistic	R-squared	Adjusted R-squared
PANEL A: Dependent Variable MTQS growth	Min Wage growth(-4)	-0.4310	0.2520	-1.710***	0.5356	0.5098
	GDP growth(-4)	0.2239	0.0927	2.416**		
	Min Wage growth	0.000464	0.2172	0.00214	0.5635	0.5417
	GDP growth	0.3732	0.0761	4.901*		
	Min Wage growth	-0.7723	0.1873	-4.122*	0.3014	0.2843
	Min Wage growth (-4)	-0.9146	0.1628	-5.618*	0.4603	0.4457
	GDP growth (-4)	0.3497	0.0577	6.057*	0.4979	0.4843
PANEL B: Dependent Variable Quarterly GDP Growth	Min Wage growth(-4)	-1.5859	0.2432	-6.522*	0.8168	0.8066
	MTQS growth (-4)	0.8731	0.1724	5.065*		
	Min Wage growth	-1.3040	0.2908	-4.485*	0.7096	0.6950
	MTQS growth	1.0054	0.2051	4.9012*		
	Min Wage growth	-2.0864	0.3037	-6.870*	0.5351	0.5238
	Min Wage growth (-4)	-2.3002	0.2557	-8.994*	0.6862	0.6777
	MTQS growth(-4)	1.5250	0.2046	7.454*	0.6003	0.5895

Table 5. Results of the ADF and PP unit root tests; * Significant at 1%, ** Significant at 5%, *** Significant at 10%. Source: Author's estimations, RNIS data.

	ADF test at level	ADF test (first differenced series)
Manufacture of textiles quarterly sales (MTQS)	-3.238***	-12.20*
GDP growth series (GDP)	0.348	-5.479*
Min wage growth	-1.746***	-17.687*

indicator of another in the past. It is very important to note that a Granger causality test can only be conducted on stationary time series. Therefore it was necessary to investigate the existence of a unit root in the time series before we could study the causal relationship between GDP, the textile industry and evolution of the minimum wage.

Unit Root test

Augmented Dickey-Fuller (ADF) tests were used to test the null hypothesis of unit root non-stationarity in the level as well as the first difference of the time series analysed. As [10] indicated, the Dickey-Fuller tests assume the errors to be independent and have a constant variance. The ADF test (augmented Dickey-Fuller) estimates the following regression equation:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \dots + \delta_p \Delta y_{t-p} + \varepsilon_t,$$

where α is a constant, β represents the time trend and p is the lag order of the autoregressive process. The ADF test was carried out by testing the null hypothesis of a unit root in the stochastic process generating y_t ($H_0: \gamma = 0$) against the alternative hypothesis $H_a: \gamma \neq 0$, i.e. the time series does not have a unit root and is stationary.

We chose to use the Schwartz Information Criterion (SIC) to establish the lag length.

Results of the unit root tests are presented in **Table 5**. For each series, the graphical representation suggested the specifications to include in the test (i.e. intercept, trend and intercept, or none). Whereas all the first-differenced time series are stationary, with the statistically significant ADF statistic at 1%, tests conducted at this level have mixed results. In the test results for the time series of the GDP, the null hypothesis could not be rejected (ADF statistic had an insignificant value of 0.34), while in the other two cases the null hypothesis of a unit root could only be rejected at 10%. We therefore decided to estimate the unit root test for the first-differenced series. In this case the null hypothesis could clearly be rejected in all cases, which is why we proceeded to test for Granger causality for the stationary first-differenced time series.

Granger causality tests: method and empirical results

Testing causality in the Granger sense involves using F -tests to test whether lagged information on variable Y provides any statistically significant information about variable X in the presence of lagged X . If

Table 6. Granger Causality Test Results; **Note:** * significant at 1%, ** significant at 5%, *** significant at 10%. **Source:** Author's estimations, RNIS data.

H ₀ : Variable X does not Granger cause Variable Y	F-Statistic	Probability
GDP growth → MTQS	3.15507**	0.02807
MTQS → GDP growth	4.00323**	0.01017
Min wage growth → MTQS	2.71441**	0.04847
MTQS → Min wage growth	0.90987	0.47082
Min wage growth → GDP growth	1.99135	0.12127
GDP growth → Min wage growth	2.18863***	0.09425

not, then 'Y does not Granger-cause X'. In other words, variable Y is said not to Granger-cause variable X if the distribution of X, conditional on past values of X alone, equals the distribution of X, conditional on past realisations of both X and Y. If this equation does not hold, Y is said to Granger-cause X. If Y can predict future X, over and above what lags of X itself can, then Y Granger causes X.

We tested for Granger causality by estimating the following VAR models for each pair-wise combination of stock returns series ([11]):

$$X_t = \mu_1 + \sum_{i=1}^p \alpha_{1,i} Y_{t-i} + \sum_{i=1}^p \beta_{1,i} X_{t-i} + \varepsilon_{1,t}$$

If the null hypothesis:

$$H_0 : \sum_{i=1}^p \alpha_{1,i} = 0$$

is rejected, Y is said to Granger cause X.

$$Y_t = \mu_2 + \sum_{i=1}^p \alpha_{2,i} X_{t-i} + \sum_{i=1}^p \beta_{2,i} Y_{t-i} + \varepsilon_{2,t}$$

If the null hypothesis:

$$H_0 : \sum_{i=1}^p \alpha_{2,i} = 0$$

is rejected, X is said to Granger cause Y.

If the null hypothesis is rejected from both cases, it is said that there is a feedback relationship between X and Y.

Results of Granger causality tests are presented in **Table 6**.

Previous findings are confirmed by Granger causality test results: GDP growth and growth of textile industry sales are two interactive variables, with the relation of causality being stronger from the textile industry to the general economy. Also the increase in minimum salaries causes a decrease in the overall sales of the textile industry, with the causal relationship being statistically significant at 5%. In conclusion, the rate of growth of GDP Granger causes sales in the textile industry, while sales of the textile industry also leads to macroeconomic growth.

This bilateral causality is significant at 5% in both cases, being stronger from the industry-level to the economy-level.

Summary and conclusions

Many factors contributed to the regress of the Romanian textile industry after the 1989 revolution against the communist regime, both systematic and industry-specific. Amongst them, we encounter the disappearance of the primary industry which supplied its raw materials, a continuous increase in the minimum wage in Romania, and an acute labour shortage, which was caused by migration, the closure of many small enterprises, and the liberalisation and full integration of the textile industry into GATT in 2005. Liberalisation not only exposed Romanian manufacturers to fierce competition from a growing number of international suppliers, especially from Asia, but also caused them to lose their most important and traditional market, the European Union. Of course, the aforementioned industry-specific factors added to the effects of the economic recession which followed the recent global economic crisis, affecting the overall Romanian economy.

Prospects for the industry are equally bleak: the repeated hikes in utility prices will lead to increased costs of production, and the increase in VAT to 24% will continue to hurt an already weak industry.

Furthermore, after calibrating contemporaneous and lead/lag univariate and multivariate regression models and employing Granger causality tests, we present empirical evidence of linkages and causality between the overall economic growth of Romania, the evolution of the country's textile industry and the rate of growth of the minimum wage in the economy during June 2000 and January 2011. We found that the lagged minimum wage growth and lagged textile industry sales growth together explain 80% of the future rate of growth in the country's GDP. All econometric tests

agree that past and contemporaneous increases in the minimum wage have had a significant negative impact on the textile industry. Finally, Granger causality tests reveal that the rate of growth of GDP causes sales in the textile industry, and at the same time sales of the textile industry also leads to macroeconomic growth. This bilateral causality is significant at 5% in both cases, being stronger from the industry-level to the economy-level.

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