International Journal of Economic Practices and Theories, Vol. 5, No. 3, 2015 (May), Special Issue on Competitiveness and Economic & Social Cohesion, e-ISSN 2247–7225
www.ijept.org

Statistical Methods and Techniques Used in the Analysis of Romania's Foreign Trade in Agricultural Products with Developing Countries

by
Calcedonia Enache
The Bucharest University of Economic Studies, Romania
calcedoniaenache@yahoo.com

Abstract. Romania's foreign trade accounted for and in the future will also be an important activity of the national economy with a significant influence on the development, growth and modernization of both production and services and economic efficiency and increasing revenue in general. In the case of agricultural products, the trade with developing countries has experienced an upward trend after the accession to the European Union. The export effort of agricultural products in developing countries gradually increased from 1.34 percent in 2007 to 8.79 percent in 2013. In contrast, the penetration rate of agricultural products imports from developing countries decreased by 1.46 percentage points up to 1.72 percent. In this context, the present paper proposes that by using statistical and econometric techniques to test and reveal regularities in the evolution of the two components of the trade balance in agricultural products with developing countries, the extrapolation of the investigated characteristics being performed based on it.

Key words: autocorrelation function, developing countries, foreign trade, seasonality, Holt Winters model
JEL classification: C53, F170, O11

1 Introduction

In 2008, the trade balance in agricultural products with developing countries recorded a surplus of EUR 100.64 million, compared with a deficit of EUR 310.61 million in 2007, mainly due to higher exports to Turkey, Pakistan, Ethiopia and Iraq. Subsequently, the trade surplus of agricultural products with developing countries gradually increased from EUR 18.04 million in 2009 to EUR 1178.28 million in 2013, provided for a faster growth pace in exports compared to imports. The export effort of agricultural products in developing countries reached 8.79 percent in 2013, compared to 1.34 percent in 2007. In addition, the penetration rate of the imports of agricultural products from developing countries amounted to 1.72 percent in 2013, while for the countries in the region the values of the same indicator stood at 5.01 percent in Bulgaria, 3.58 percent in Czech Republic, 2.2 percent in Slovakia, 2.06 percent in Hungary.

The foreign trade in agricultural products with developing countries was characterized by a high degree of concentration in the period 2007-2013. Thus, the annual variation in the physical volume was sustained for more than 90 percent of three groups of products (live animals; cereals; seeds and fruits, industrial and medicinal plants, straw and fodder) for exports and for more than 69 percent of four groups of products (edible fruits; edible vegetables, roots and tubers; coffee, tea, mate and spices; seeds and fruits, industrial and medicinal plants, straw and fodder) for imports.

In 2013, 48.92 percent of the agricultural exports in developing countries were destined for Africa countries and 31.59 percent for Asian countries. On the import side, 25.63 percent of the purchases of agricultural products from developing countries came from Asian countries, 22.36 percent from American countries, 8.5 percent from Republic of Moldova, 6.32 percent from Ukraine.

The elasticity analysis of the foreign trade in agricultural products with developing countries in relation to the modification of the exchange rate, as well as how it has influenced the current account balance, achieved using arc-type coefficients obtained in 3 variants:

$$\frac{y_t - y_{t-1}}{y_{t-1}} : \frac{x_t - x_{t-1}}{x_{t-1}}; \qquad \frac{y_{t+1} - y_{t-1}}{y_{t-1}} : \frac{x_t - x_{t-1}}{x_{t-1}};$$

$\frac{y_{t+2}-y_{t-1}}{y_{t-1}} : \frac{x_t - x_{t-1}}{x_{t-1}}$, where: y_t – the 2-month average of the export/import of agricultural products to/from developing countries in period t (for the previous, next and future period the t-1, t+1 and t+2 indices were used); x_t – the 2-month average of the exchange rate in period t (t - 2 successive months interval) shows that for the 3 intervals of steeper increase of the exchange rate, the effects were favourable for improving the trade balance.

Table 1. The arc-type elasticity coefficients, calculated for Romania's foreign trade in agricultural products with developing countries

Period	Average values for:			Elasticity for:	
	Exports (EUR million)	Imports (EUR million)	Exchange rate RON/EUR	Exports	Imports
Sep - Oct 07	17.54	43.23	3.35		
Nov - Dec 07	18.96	55.84	3.50	a). 1.81	a). 6.51
Jan - Feb 08	20.44	30.62		b). 3.69	b). -6.51
Mar - Apr 0	50.50	41.11		c). 41.97	c). -1.09
May –Jun 08	27.17	28.49	4.21		
Jul – Aug 08	45.38	17.19	4.25	a). 70.54	a). -41.74
Sep – Oct 08	71.59	18.63		b). 172.07	b). -36.42
Nov –Dec 08	55.08	27.08		c). 108.12	c). -5.21
May –Jun 12	44.85	24.86	4.45		
Jul – Aug 12	68.15	15.79	4.53	a). 28.90	a). -20.29
Sep – Oct 12	75.25	24.85		b). 37.70	b). -0.02
Nov –Dec 12	95.17	32.41		c). 62.41	c). 16.89

Note: If by adding a positive coefficient on export with a negative coefficient on import we obtain a value above par, then, according to the MLR condition, the exchange rate has a positive effect on the current account.
(Source: Own calculations based on the data released by EUROSTAT)

The most notable results were recorded in the median interval. Thus, amid the stint of the domestic demand and investments, adding the elasticity coefficients resulted in the following values: 112.28, 208.49 respectively for a one time delay and 113.33 for a 2 time delay.
In the context of the financial crisis, the export of agricultural products to developing countries was responsive to the variation of the exchange rate, also observed after a 2-3 months delay. In contrast, the import of agricultural products from developing countries was less sensitive to the depreciation of the national currency, the negative coefficients of elasticity recorded values between 41.72 and 0.02.

The present study proposes that by the use of statistical and econometric techniques, to test and reveal the rules in the evolution of the two components of the trade balance of agricultural products with developing countries, the extrapolation of the investigated characteristics being performed based on it. Furthermore, the study is structured as follows. Section 2 presents the econometric model used. Section 3 describes the data used. Assessments of the results provided by the econometric model are presented in Section 4. The final conclusions are summarized in Section 5.

2 The econometric model

In the present study I used the Holt Winters model that is applied for modelling time series with trend and seasonality. The model includes a forecasting equation and three smoothing equations - one for the level of series a_t, one for the trend b_t and one for the seasonal component s_t, with the smoothing constants ι, υ, η, each between 0 and 1.
We denote by m the number of periods that define the length of the seasonality cycle (for monthly data m = 12). Taking into account the additive or multiplicative model in which the influence of the seasonal factor manifests itself, there are two versions of H-W.
In case of the multiplicative model, the forecast made at time "t" for the horizon "t + h", $\hat{y}_{t+h}$ is calculated using the relation:

$$\hat{y}_{t+h|t} = (a_t + hb_t)s_{t-m+h} \qquad h = 1,2,... \tag{1}$$

$$a_t = \iota \frac{y_t}{s_{t-m}} + (1-\iota)(a_{t-1} + b_{t-1})$$

$$b_t = \upsilon(a_t - a_{t-1}) + (1-\upsilon)b_{t-1}$$

$$s_t = \eta \frac{y_t}{a_t} + (1-\eta)s_{t-m}$$

The estimate of the seasonal component is a weighted average between the seasonality index (y_t/a_t) calculated at time t and the value of the same index value at t-m, using the model. The

estimate of the trend component at time t is a weighted average between ($a_t - a_{t-1}$) şi b_{t-1} – the slider of the constant term t is always more important than that of the slope υ. The estimate for the level of the series calculated at time t includes the current deseasonalized value (y_t/s_{t-m}), determined as the ratio between the current value and the latest seasonal index for that season.

In order to initialize the Holt-Winters model initial estimates of the level, trend and seasonal factors must be obtained in advance. The most common:

$$a_m = \frac{y_1 + y_2 + ... + y_m}{m} \quad (2)$$

$$b_m = \frac{[(y_{m+1} + y_{m+2} + ... + y_{m+m}) - (y_1 + y_2 + ... + y_m)]}{m^2} \quad (3)$$

$$s_i = \frac{y_i}{a_m}, \quad where \quad i = 1,2,...,m \quad (4)$$

The sliding formulas for a_t, b_t and s_t depending on the e_t prediction / realization error are the following:

$$a_t = a_{t-1} + b_{t-1} + \iota \frac{e_t}{s_{t-m}}, \quad (5)$$

$$b_t = b_{t-1} + \iota\nu \frac{e_t}{s_{t-m}}, \quad (6)$$

$$s_t = s_{t-m} + \eta \frac{e_t}{a_{t-1} + b_{t-1}}, \quad (7)$$

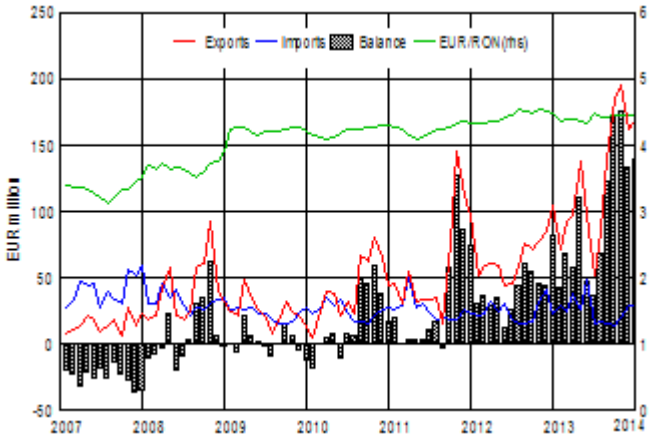
where:

$$e_t = y_t - \hat{y}_{t|t-1} = y_t - (a_{t-1} + b_{t-1})s_{t-m}.$$

The three smoothing constants are determined so as to minimize the sum of the squared prediction errors, particularly on the chosen horizon.

3 Data

For the study of the variation I will use the data on the variation of the two flows of the foreign trade of agricultural products with developing countries during the period January 2007 - December 2013.



(Source: EUROSTAT)

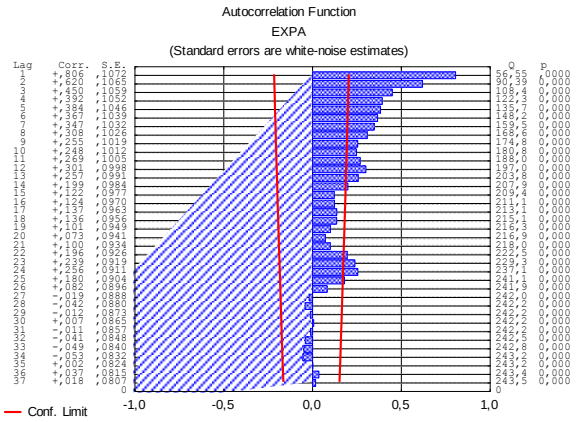
Figure 1. Romania's trade balance in agricultural products with developing countries and exchange rate on forex market

In the period 2007-2013, the exports of agricultural products in developing countries registered a monthly average of EUR 53.3 million. The absolute amplitude of variation, calculated as difference between the extreme values of the series was EUR 190.85 million. The variation coefficient level (80.06 percent) indicates that the series is heterogeneous**,** while the flattening coefficient indicates a leptokurtic distribution. Instead, the imports of agricultural products from developing countries registered a monthly average of EUR 28.36 million, the ratio between the maximum and minimum value being 4.23 times. The variation coefficient level (35.47 percent) indicates that the series is non-homogenous. The flattening coefficient indicates a leptokurtic distribution.

Table 2. Descriptive indicators

Series EXPA/IMPA Sample 2007M01 2013M12 Observations 84		
Mean	53.30451	28.35896
Median	39.79991	26.98917
Maximum	195.7322	60.20815
Minimum	4.883999	14.22365
Std.Dev.	42.67776	10.05949
Skewness	1.465409	1.030817
Kurtosis	4.828357	3.810269
Jarque-Bera	41.76404	17.17405
Probability	0.000000	0.000187

In order to determine whether the considered data series were affected by seasonality, we determined the autocorrelation and partial autocorrelation coefficients using the Statistics program – the ARIMA model.



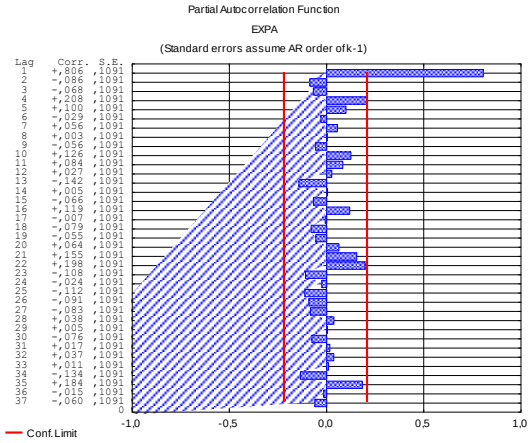
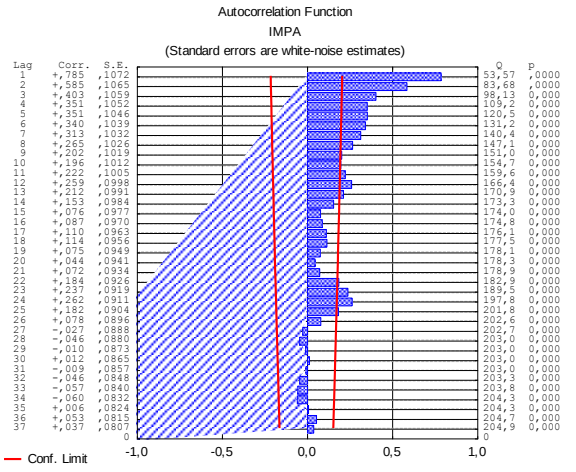


Figure 2. The correlogram for Romania's exports of agricultural products in developing countries



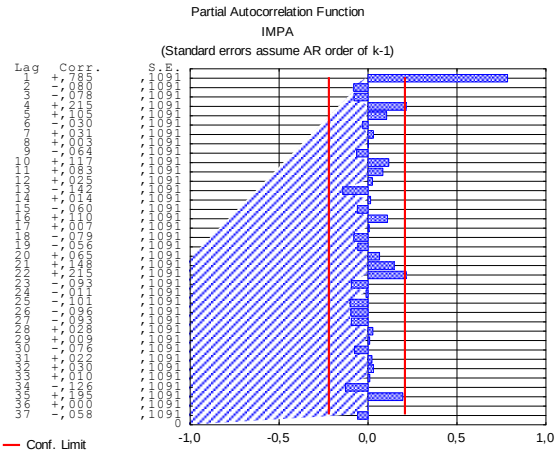


Figure 3. The correlogram for Romania's imports of agricultural products from developing countries

The results obtained confirm the presence of seasonality.

4 Results and discussions

After applying the Holt-Winters model for the monthly data on both foreign trade flows in agricultural products with developing countries, in 2007-2013, we obtained the results in Table 3.

Table 3. Method: Holt-Winters Multiplicative Seasonal

Series		EXPA	IMPA
Parameters	IOTA	0.600	0.480
	UPSILON	0.000	0.000
	ETA	0.000	0.000
Sum of squared residuals		26186.15	2560.576
Root mean squared error		17.65616	5.521145
Seasonals	M01	0.827621	0.908760
	M02	0.860843	0.973840
	M03	1.276267	1.380478
	M04	1.239167	1.075383
	M05	0.815528	1.285787
	M06	0.629551	0.831049
	M07	0.637674	0.742003
	M08	0.994770	0.728976
	M09	1.117628	0.702060
	M10	1.525067	0.988373
	M11	1.068798	1.160326
	M12	1.007086	1.222966

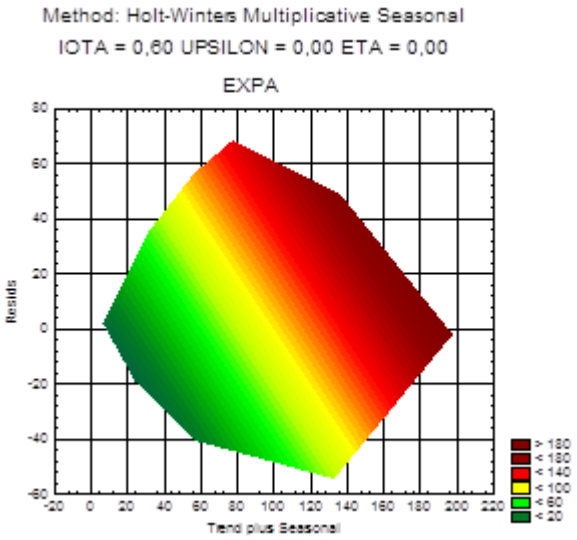


Figure 4. The components of the time series on the exports of agricultural products in developing countries

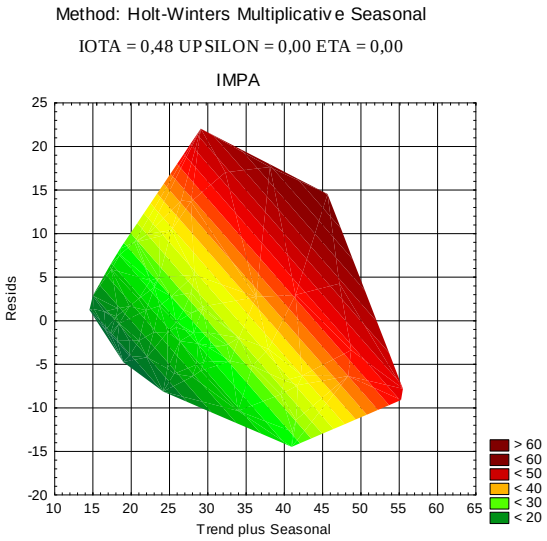


Figure 5. The components of the time series on the imports of agricultural products from developing countries

In January and February, the seasonal factor caused a decrease in the activity of the foreign trade in agricultural products with developing countries compared to the trend line, on average, by 15.6 percent for exports and 5.9 percent for imports in the conditions of: the prohibition of trading pig meat in the first quarter of 2007; the effect of the vaccination campaign against swine fever (December 2006); the restriction of the consumption of pork meat with the appearance of the first cases of AH1N1 virus contamination in Europe (January 2009); the implementation on 1st January 2012 of the provisions of the European Union on the poultry breeding conditions which led to a shortage of supply for a short period of time; the tendency of the people to buy cheaper meats immediately after the winter holidays.

In March and April, the seasonal factor caused, on average, an increase of the exports of agricultural products in developing countries by 27.63 percent and 23.92 percent above the long-term trend, on the backdrop of: positive results on the vegetal segment (2008, 2010, 2013); the increase in the supply of sheep and mutton mainly to Bosnia and Herzegovina, Jordan, Lebanon and Libya by the restriction of the domestic supply (2011, 2012, 2013); the decision of some farmers to limit the sales on the domestic market in the context of rising international prices (2010). On the import side, in March and April the seasonal factor caused, on average, an increase of the inflows of agricultural products from developing countries by 38.05 percent and 7.54 percent compared to the trend line on account of: the unfavourable weather conditions (2007, 2010, 2012) which led to increased imports of cereals, edible fruit and nuts, peel of citrus fruits or melons mainly from Turkey, China, Egypt; the modest results recorded in the livestock subsector; the losses registered on the pork and beef market due to higher production costs.

In May, the seasonal factor caused a decrease in the supply of agricultural products on the markets of developing countries by 18.45 percent compared to the trend line and an increase in purchases by 28.58 percent. Thus, in the case of the foreign trade of agricultural products with developing countries, the coverage of imports by exports amounted to 42.45 percent.

In the period from June to August, the seasonal factor caused the decrease of the activity of foreign trade of agricultural products with developing countries compared to the trend line, the most important explanatory factors being the competition in this market segment and the excess of the domestic supply in the conditions of a decrease in the growth rate of demand.

In September and October, the seasonality indices calculated for the two components of the

trade balance with agricultural products with developing countries were supra-units for exports and sub-units for imports. This seasonal variation tendency may be related to: the insufficient adaptation of the domestic producers to the requirements of the domestic and international markets; the prohibition or limitation of wheat exports by the traditional suppliers for Romania (Serbia, Ukraine) in order to stop the price increase on the domestic market by 30 June 2008 (September 2007); the contraction in the consumption of pork with the appearance of the first cases of dioxin contamination (2008); the resumption of the supply of poultry meat and eggs to Russia (2011); the increase in slaughtering on the poultry meat segment due to the high costs of feeding stuffs (2012).

The seasonal factor caused an increase of the foreign trade of agricultural products with developing countries compared to the trend line in November and December. In case of imports, the highest seasonality was reached in December - characterized by the year-end holiday season.

Both models are statistically valid, as long as the theoretical value for a significance threshold ά = 0,05 and 1, respectively 82 degrees of freedom, taken from the Fischer distribution table is lower than the calculated F test value for exports of agricultural products in developing countries ($F_{ά,\ k,\ T-k-1} = 3.96 < F_{calc}=93.51$), as well as for imports of agricultural products from developing countries ($F_{ά,\ k,\ T-k-1} = 3.96 < F_{calc}=63.8$). As regards the models determination, these explain 90.93 percent and, respectively 83.37 percent of the evolution of the two components of the trade balance with agricultural products with developing countries.

For January and February 2014, the punctual estimations of the previewed levels for the investigated indicators and the confidence intervals calculated for a ά = 0.05 significance level are: $\hat{y}_{01/2014} = 140.41$ million euro $\in [103,99;176,82]$; $\hat{y}_{02/2014} = 210.08$ million euro $\in [173,64;246,52]$ for the exports of agricultural products in developing countries; $\hat{y}_{01/2014} = 20.80$ million euro $\in [9,41;32,19]$; $\hat{y}_{02/2014} = 22.08$ million euro $\in [10,68;33,48]$ for the imports of agricultural products from developing countries.

5 Conclusions

A feature of the Romania's transactions in agricultural products is the increase of the trade surplus with partners from developing countries up to EUR 1178.28 million in 2013, 11.71 times higher than in 2008. The export effort of agricultural products in developing countries reached 8.79 in 2013. Compared to 2007 this indicator increased by 7.45 percentage points. Under these conditions we obtained a corresponding decrease in the rate of penetration of imports of agricultural products from developing countries, which was by 1.46 percentage points under the comparison period. The increase of the export effort generated a decrease in the supply on the domestic market for some products (e.g. the increase in the supply of sheep and mutton, mainly to Bosnia and Herzegovina, Jordan, Lebanon and Libya). In the context of the financial crisis, the agricultural export to developing countries was responsive to the variation of the exchange rate, fact that was also observed after 2-3 months of delay. In contrast, the import of agricultural products from developing countries was less sensitive to the depreciation of the national currency, which highlights the difficulties of adapting to a relatively stable less elastic domestic demand and to a varied and difficult to modify supply in the short and medium term.

Romania, as an EU member, provides technical assistance to developing countries in order to integrate trade in their economic policies, in programs and strategies for recovery and sustainable development in view of the participation of these countries in negotiations and the implementation of the results of the Doha Development Agenda. In this context, the share of trade balance in agricultural products with developing countries in gross domestic product equalled 0.82 percent in 2013.

Acknowledgment

This work was cofinanced from the European Social Fund through Sectoral Operational Programme Human Resources Development 2007-2013, project number POSDRU/159/1.5/S/142115 „Performance and excellence in doctoral and postdoctoral research in Romanian economics science domain".

References

Bermudez, J.D., Segura, J.V. and Vercheri, E. (2010), Baysesian forecasting with the Holt-Winters model, *Journal of the Operational Research Society*, 61: 164-171.

Capanu, I. Wagner, P., Mitrut, C. (1994), *System of National Accounts and Macroeconomic Aggregates*, Bucharest, All Publishing House.

Chatfield, C. and Yar, M. (1988), Holt-Winters forecasting: some practical issues, *Journal of the Royal Statistical Society - Special Issue: Statistical Forecasting and Decision-Making*, Series D (The Statistician), 37(2): 129-140.

Gelper, S., Fried, R. and Croux, C. (2010), Robust forecasting with exponential and Holt-Winters smoothing, *Journal of Forecasting*, 29: 285-300.

Holt, C.C. (1957), *Forecasting trends and seasonals by exponentially weighted averages*, Carnegie Institute of Technology, Pittsburgh ONR memorandum no. 52.

Pecican, E.S. (2005), *Econometrics for ... economists*, Bucharest, Economic Publishing House.

Toderoiu, F. (2012), The Romanian agri-food economy – performance reductive effects five years of EU membership, *Agricultural Economics and Rural Development*, 2012, vol. 9 (1), pages 25-45.

* * * Balance of Payments (2007-2013), National Bank of Romania.

* * * Inflation Reports (2007-2014), National Bank of Romania.

* * * Financial Stability Reports (2007-2014), National Bank of Romania.

* * * http://ec.europa.eu/eurostat

Author description

Calcedonia Enache - Postdoctoral student at the Academy of Economic Studies of Bucharest. Research fields: statistics, econometrics, macroeconomics.