Economic Forecast on the Basis of Linear Trend Analysis and "Bottom-up" Approach

INGRID MAJEROVÁ, TOMÁŠ PRAŽÁK
Department of Economics and Public Administration
Silesian University in Opava, School of Business Administration
Univerzitni namesti 1934, 73401 Karvina
CZECH REPUBLIC
majerova@opf.slu.cz   http://www.opf.slu.cz

Abstract: - Prediction of economic development is very important for every country. Over time, the estimations are becoming more sophisticated and they are based on serious data supported by statistical methods. Time series analysis is often used for estimations of economic development of countries. The prediction based on development of macroeconomic indicators might be analyzed by various models. For our purpose two models– linear trend analysis and "Bottom-up" approach of the International Monetary Fund – have been chosen. We estimate economic development of Papua New Guinea using the indicators such as gross domestic product, the growth of gross domestic product, inflation, current account and budgetary balance as a percentage of gross domestic products. The aim of this article is to verify the hypothesis of differences in predictions using the model of linear trend analysis and bottom-up approach. It was found out that these two types of analyses considerably diverge in their results.

Key-Words: - Linear trend analysis, "Bottom-up" approach, Comparison, Forecast, Development, Gross domestic product, Inflation rate, Budget balance, Balance of payment

1 Introduction

Prediction of economic development is very important for every country, not only it is an indicator but also a signal for investors and prosperity. Over time, the estimations are becoming more sophisticated and they are based on serious data supported by statistical methods. Plenty of methods are used for economic evaluation and estimation – for example Analytic Hierarchy Process [1], panel regression [2], cluster analysis [3], ARMA-GARCH model according to [4], nonparametric transfer function models as [5] or fuzzy rule-based systems, agent-based models non-linear dynamic systems [6], autoregressive integrated moving average (ARIMA) model that is used by some databases or Linear trend analysis LTA. The last mentioned analysis is not only used in economic field but also in other sciences (for example environmental one, see [7], [8] or medical one [9]).

The latter two models were used as the most suitable in our previous research (see [10]). Our aim was to compare your own model (LTA) of forecast of the economic development with the existing model based on statistical and mathematical approach, which was just ARIMA model, created by database of Trading Economics. ARIMA models are fitted to time series data either to better understand the data or to predict future points in the forecasting. They are applied in some cases where data show evidence of non-stationarity, where an initial differencing step can be applied to reduce the non-stationarity. A linear trend analysis is used as one of the options to describe a future trend, as it reflects dynamics of variables over time. A rather untypical economy, but one of the most prosperous countries of the world, Papua New Guinea (PNG hereinafter) has been chosen for the purposes of that article.

The results of compared methods were different in forecasting, and we decided our next research focus on the comparison of method LTA with another method to determine whether the solution of the comparison with other methods will be the same or different again. The method of the "bottom-up" approach have been chosen. It is used by the International Monetary Fund (IMF) in the World Economic Outlook database (WEO). According to [11] the IMF´s a "bottom-up" approach means that country teams within the IMF generate projections for individual countries. These are then aggregated, and through a series of iterations, where the aggregates feed back into individual countries'

forecasts, the forecasts converge to the projections reported in the WEO. As the forecasts are made by the individual country teams, the methodology varies from country to country and series to series, depending on many factors.

According to IMF staff, poor data situation does not allow analysts to apply any formal economic model to the PNG economy. So they (staff) rely on both qualitative and quantitative information in forecasting macroeconomic indicators, visiting the country and interviewing officials, bankers and researchers.

The first method has been chosen due to its clarity and possibility of comparison with the second method. The data used for linear trend analysis and description of the economic situation of PNG have been drawn from the statistics of the World Bank [12]-[15], Asian Development bank [16], [17] Bank of Papua New Guinea [18], the International Monetary Fund [19] and UNCTAD [20]-[22], regarding the fact that the analyses must be conducted on specific data.

A prediction of five macroeconomic indicators was developed and applied, including GDP, GDP growth, inflation, current account and budgetary balance as a percentage of gross domestic products in the years 2014-2016.

The aim of the article is to verify the hypothesis that both the methods determine different values of predicted variables. The article is divided into four parts - introduction, initial economic conditions, methodology and conclusion. Introduction is focused on a brief description of the nature of the article, the second part deals with initial conditions and the status of PNG economy in the years 2006-2013 in detail, which is a basis for understanding the future development of this developing Pacific island country. In the following part a linear trend analysis is characterized, calculations of the estimation are made and subsequently compared with "bottom-up" approach. In the part of conclusion the basic findings reached by the authors are summarized and the initial hypothesis is confirmed.

2 Problem Formulation

Papua New Guinea is currently one of the fastest growing economies in the world. According to [23] PNG belatedly and briefly experienced rapid and uneven economic growth during the 1990´s, despite not always conception steps of the government in the public sector (according [24] or [25]). Since 2005, PNG has experienced sustained and strong economic growth that has not been seen before, the

growth averaged out 5 per cent between 2005 and 2009, despite the global financial crisis [26]. On the other hand the [27] claimed that Papua New Guinea has failed to develop since its independence, resulting in shocking social consequences. However, economic development, [28] as well as labour market reforms [29], are actively undermined by Papua New Guinea natural resources.

However, since the beginning of the reporting period PNG has disposed mainly with trade balance surplus, a low unemployment rate (to 2013 PNG it showed only 2.1% of the unemployed), good fiscal discipline and a high degree of export openness (in case of PNG the growth is led by export – see [30]).

2.1 Internal Economic Situation

The economic growth in Papua New Guinea is one of the fastest in the world nowadays. The concept of the economic development in PNG is supported by government program, the aim of which is to achieve the status of a middle income country by 2030. The primary instrument for achieving this goal is the realization of a project of liquefaction of natural gas with a budget of more than USD 15 billion, planned from 2015 onwards. The PNG government involved in the project with less than 20% calculates with the creation of up to 8,000 new jobs and at least doubling GDP [31]. The financial resources obtained in this project will then be invested in improving infrastructure, education and health. As claims [32], financial capital is important in uplifting the socio-economic conditions in the community as it affects the capacity of households to mobilize assets and endure periods of uncertainties. From the perspective of the economic growth, tourism industry appears to be very promising.

Neither the global crisis influenced the positive development of the economic growth of PNG. It caused only a slight decline in GDP in 2009 and in 2013 (see Table 1). The high growth rates of GDP involved the high prices of raw materials and commodities exported from PNG (especially in 2011). For the next few years the growth of GDP is expected to continue, however, it should slow down due to completion of the implementation of the above mentioned project. After its launch, a reverse and a significant increase of GDP is expected due to exports of this commodity.

On the other hand, we can observe a positive development of GDP per capita that during the eight years almost tripled - rose from less than 900 to $ 2,540.

The high inflation rate of the country (from 2008) has been the result of government supporting the large mining projects and high prices of the imported commodities since 2008. Although the inflation was reduced in 2009 due to the fact that the Central Bank of PNG responded by increasing interest rates and mandatory level of bank reserves. In subsequent years, the level of inflation fluctuated (between 4.4 and 6%), and is expected to continue to decline.

The indicators of the inherent stability of economy include, besides GDP growth and inflation rate development, fiscal discipline as well as the management of public resources. In the period monitored, the government of PNG managed an almost balanced budget and its ratio of budget balance to GDP can be envied by any developed economy. It is interesting that the funds resulting surpluses are placed in the so called trust funds, which are then used to finance priority spending and investment. In recent years, however, we monitor the deterioration of fiscal discipline, which is showed off by expansionary fiscal policy in the form of higher expenditures. They were reflected in the budget deficit and declining budgetary balance as % of GDP (from the plus 3 to minus 7 percent), there has been a significant increase in overall public debt.

Table 1 Internal Indicators of PNG 2006-2013

Indicators	2006	2007	2008	2009
GDP (mil USD)	5599	6329	8010	7915
GDP growth (%)	2.6	7.2	6.7	5.5
GDP per capita (USD in PPP)	896.5	989.5	1223.1	1180.7
Inflation rate (%)	2.4	0.9	10.8	6.9
Indicators	2010	2011	2012	2013
GDP (mil USD)	9480	12393	15654	15 289
GDP growth (%)	8.0	9.0	8.0	5.4
GDP per capita (USD in PPP)	1382.7	1844.5	2168.0	2539.1
Inflation rate (%)	6.0	4.4	4.5	5.0
Indicators	2006	2007	2008	2009
Revenues	6311.5	7006.6	7073.3	6651.3
Expenditures	5767.3	6552.4	7551.8	6687.2
Budgetary balance	+544.2	+454.2	-478.5	-35.9
Budgetary balance % GDP	3.2	2.4	-2.2	-0.2
Indicators	2010	2011	2012	2013
Revenues	8278.9	9304.9	9566.0	9374.6
Expenditures	8092.6	9370.6	10047.0	11872.4
Budgetary balance	+189.3	-65.7	-480.9	-2497.8
Budgetary balance % GDP	0.7	-0.2	-1.5	-7.2

2.2 External Economic Situation

Basic indicators of foreign trade were selected to characterize the external economic situation, such as trade balance, export and import, current account and balance of payments (without foreign exchange reserves).

As a major exporter of commodities, Papua New Guinea consistently runs merchandise trade surpluses (see Table 2). Papua New Guinea exports mainly minerals (gold, oil, copper, coffee, cocoa, vegetable oils), which account for 52% of total exports, fish and wood. PNG is primarily dependent on the regular import of food for daily consumption and finished products. The highest value belongs to the import of manufactured goods (51% of total import), where import of building materials is the most evident, associated with the implementation of large investment projects. Other important import commodities are fuel and chemicals. The main trading partner of PNG is Australia, other important partners, particularly import partners are the U.S.A, and Singapore (increased investments and the inflow of materials for implementation of large projects). The second largest export country is Japan, PNG also cooperates with countries of Europe, mostly Germany. Other major partners are China, the Philippines and Malaysia, Hong Kong and Vietnam [33]. The development of trade balance and net export reached positive results until 2009, when both items declined due to the global crisis and net export decreased very significantly. Mentioned items showed a positive trend in the coming years, which was however interrupted in 2012, there was a decline in both trade balance and exports (due to weaker trading-partners activities).

The current account balance as a percentage of GDP provides an indication on the level of international competitiveness of a country. Countries recording a strong current account surplus have an economy heavily dependent on exports revenues, with high savings ratings but weak domestic demand. On the other hand, countries recording a current account deficit have strong imports, a low saving rates and high personal consumption rates as a percentage of disposable incomes. Until 2008, PNG showed a positive balance, but in the post-crisis years the value started to decrease and reach negative numbers. In 2009, other investments in the financial account (bank lending to government sector or business loans abroad) were the main reasons for its negative value and in 2012 it was the high current account deficit. The reason for the negative current account balance was a global crisis, when the increasing deficit of the balance of services including tourism, transport

or insurance, could not offset the income from international trade in goods. PNG's current account deficit has been around one-third of GDP in the last monitored year. This deficit has been due to the large amount of imports of equipment and workers especially for the PNG's liquefied of natural gas project, and has been funded by foreign direct investment. According to the [34], the current account balance will reach positive values in 2015.

The balance of payments is compiled both for monitoring cross-border flows of goods, services, capital and money, and for providing information to government institutions on the status of the economy in the world and support decision-making on monetary and fiscal policy. The balance of payments must always be balanced, which is an option of reserves items. For purposes of our analysis the payment balance account without the balancing items was used. PNG balance of payments showed a negative value in three years, in 2008, 2012 and 2013. The deficit in the year 2008 was caused by the large increase in imports of capital necessary for initiation of the above-mentioned project. The last two years deficit was caused by high current account deficits due to above mentioned costs on liquefied of natural gas project.

Table 2 External Indicators of PNG 2006-2013

Indicators	2006	2007	2008	2009
Merchandise Trade Balance (mil. USD)	2214	2119	2665	1522
Export growth (%)	27.3	12.4	22.1	-23.1
Import growth (%)	30.7	30.3	19.2	-8.5
Current Account to GDP (%)	8.0	2.9	9.9	-7.2
Current Account (mil. USD)	443.0	185.5	795.6	-586.1
Overall Balance of Payment	640.6	536.9	-221.5	627.6
Indicators	2010	2011	2012	2013
Merchandise Trade Balance (mil. USD)	2216	2689	1566	487
Export growth (%)	30.7	20.3	-8.5	-11.5
Import growth (%)	23.1	20.5	12.0	7.7
Current Account to GDP (%)	-6.5	-1.3	-14.9	-21.5
Current Account (mil. USD)	-633.3	-172.6	-2300.5	-3307.7
Overall Balance of Payment	391.9	464.9	-408.1	-753.1

3 Problem Solution

Time series analysis is a comparison of ratio indicators or any variables in time and is used mainly to detect negative trends (orientations) of indicators. In order to use the results of time series analysis to simple economic estimates of future economic development, a suitable form of functional dependence which best describes the revealed trend of the time series evolution must be found. For these reasons we have used statistical methods of regression and correlation relationships with the help of a few, previously identified and recommended functions for monitoring the economic development. One possible description of trends in time series is trend analysis, which belongs to one of the frequently used methods, as it allows a relatively simple estimate of future values of time series and analysis using moving average, which is used for longer periods of time, because unlike the first method it does not expect constant parameters.

For our analysis, two specific methods were selected and compared, linear trend analysis (hereinafter LTA) and the "bottom-up" approach used to produce individual country forecasts. The methods vary substantially depending on characteristics of each country but they do not differ according to the proposed uses of the forecasts. Country authorities usually used the judgment, macro framework or their own forecasts more than econometric models, vector-autoregression or reduced - form equations. These methods will not be analyzed in detail, we will focus on the description of the first method according to which the below mentioned data were calculated.

The calculation of trend analysis is done using equation:

$$T_t = \frac{\sum yt}{n} + \left[\left(\sum yt * \frac{t'}{\sum t'^2} \right) * t \right] \tag{1}$$

where $\frac{\sum yt}{n} = \beta_0$, $\sum yt * \frac{t'}{\sum t'^2} = \beta_1$, n is the number of years of examined time series and t is a time coefficient for the predicted year.

Then the equation can be as follows

$$T_t = \beta_0 + \beta_1 * t \tag{2}$$

In the calculation it was necessary to choose a time series yt, in this case the above mentioned economic indicators, and to determine the period of availability of data of yearly values for the period

1992-2012. Then, for each value of time series in individual year time coefficient $t´$ is given, which takes values $<-t´, +t´>$ according to the time series length. This factor is firstly compounded by the square and then multiplied by a time series $(yt*t´)$. After performing these calculations separately for each year, sums of indicators are calculated $\sum yt$, $\sum t´^2$ and $\sum yt*t´$. For the calculation of the first necessary coefficient into the equation trend analysis, which is β_0, we needed to know $\sum yt$ and the coefficient n. Then it can already be put into the equation $\beta_0 = \sum yt / n$ and the value of β_0 could be calculated for predicted year. The second coefficient β_1 is a simple proportion of already determined values $\sum yt*t´$ and $\sum t´^2$. The last unknown in the equation trend analysis is t, which is a time coefficient for the predicted year, which always achieves one higher value than the maximum value $+t´$. Finally, and T_t the resulting value of the trend analysis of time series predicted for the first year. By repeating the procedure, in which already the value of the time series for the preceding predicted year is subsequently incorporated, the value of the time series for the predicted following year can be calculated. Calculations and results are given in Appendix A to E.

To find the reciprocal independent between set variables, we applied the chi-square test for independence. The significant level is 0.05. For that we state two hypotheses. The null hypothesis (H_0) states that the level of variable 1 (v1) does not help predict the level of variable 2 (v2). That is, the variables are independent. The alternative hypothesis (H_1) is that the level of v1 can help predict the level of v2.

H_0: Variable 1 and variable 2 are independent.
H_1: Variable 1 and variable 2 are not independent.

If the probability value (p-value) is less than the significance level of 0.05, null hypothesis is rejected, which means that the variables are not independent.

The second test that we made was the t-student test that shows the statistical significance. Even in this case null and alternative hypotheses are determined and tested at a significance level 0.05:

H_0: Variables v1 and v2 are equal to zero.
H_1: Variables v1 and v2 are not equal to zero.

If the probability value (p-value (F)) is less than the significance level of 0.05, null hypothesis is rejected, which means that the variables are statistically significant.

These two tests were used for all indicators by OLS model with 24 number of observation, where dependent variable (v1) was the predicted variable by LTA, v2 than predicted variable used by IMF. The results are shown in the Table 3 below.

Table 3 Results of Tested Variables

GDP

	Coefficient	Std. Error	t-ratio	p-value
const	1807.82	568.73	3.1787	0.0043
v2	0.668759	0.0584256	11.4463	<0.0001

R-squared	0.856227
adjusted R-squared	0.849691
p-value(F)	9.79e-11

GDP Growth

	Coefficient	Std. Error	t-ratio	p-value
const	0.779241	0.585259	1.3314	0.1967
v2	0.789102	0.079464	9.9303	<0.0001

R-squared	0.817595
Adjusted R-squared	0.809304
P-value(F)	1.37e-09

Inflation Rate

	Coefficient	Std. Error	t-ratio	p-value
const	-0.465864	0.276493	-1.6849	0.1061
v2	1.02673	0.0308189	33.3150	<0.0001

R-squared	0.980563
Adjusted R-squared	0.979680
P-value(F)	2.54e-20

Budgetary Balance

	Coefficient	Std. Error	t-ratio	p-value
const	0.0397927	0.317218	0.1254	0.9016
v2	0.727972	0.10511	6.9258	<0.0001

R-squared	0.727137
Adjusted R-squared	0.711978
P-value(F)	1.79e-06

Current Account

	Coefficient	Std. Error	t-ratio	p-value
const	-421.651	218.776	-1.9273	0.0699
v2	0.395968	0.169079	2.3419	0.0309

R-squared	0.233539
Adjusted R-squared	0.190957
P-value(F)	0.030885

In all cases, the probability value (p-value) is less than the tested significance level of 0.05, null hypothesis is rejected, which means that that the level of v1 can help predict the level of v2.

The values of correlation coefficient, which are shown as R-squared indicates the strength of dependence of selected variables (with exception of current account). Specifically, it means that the predicted values set by LTA are approximately 72-98% dependent on changing of the prediction of IMF – the most in the case of inflation rate, the least in the case of budgetary balance. On the other hand the value of current account by LTA is dependent on the changing of prediction of IMF only in 23%.

Other values shown in the table are the values of adjusted R-squared – it indicates how much of the total variance of the dependent variable is explained by this model. With exception of last adjusted variable with only 19%, it is more than 70% in all cases.

The level of significance is compared with the p-values (F) in the table above. Thus, if these values are lower than the level of significance (they are in all cases), the null hypothesis can be rejected and so the alternative hypothesis is valid, therefore, variables are statistically significant.

3.1 Linear Trend Analysis versus "Bottom-up" Approach

For comparison of basic economic indicators (GDP, GDP growth, inflation rate, the state budget balance to GDP and current account) and for verification of the hypothesis, the data of IMF WEO database are used [35]. These data are then compared with our own values calculated by linear trend analysis (LTA) in the years 1993 to 2013, see Appendix A-E.

The calculated values, compared with the "bottom-up" approach, are shown in Table 4. The years 2014-2016 were selected as a predicted period. A longer-term analysis is meaningless because of the processing time series of historical data that do not reflect current economic and political situation in the monitored economies.

As can be observed from the table below, the value of different approaches are very different - while the method LTA shows worse results in the case of gross domestic product and current account balance, the "bottom-up" approach can speak about pessimistic predictions in the case of GDP growth, inflation and budgetary balance.

Table 4 Prediction of Basic Economic Indicators of PNG by LTA and "Bottom-up" Approach

Indicators	Est.	2014	2015	2016
GDP (mil. USD)	LTA	12220	12348	12527
	IMF	16096	20328	21085
GDP growth (%)	LTA	8.69	8.44	7.17
	IMF	5.8	19.6	3.3
Inflation rate in CPI (%)	LTA	2.58	3.07	3.30
	IMF	5.3	5.0	5.0
Budgetary balance (% GDP)	LTA	-1.02	-0.94	-1.07
	IMF	-7.22	-2.47	-2.11
Current account (mil. USD)	LTA	-1571	-1616	-1645
	IMF	-1827	2749	1999

The first indicator compared in our research was the prediction of future GDP development. Among all of the monitored indicators, there is the biggest difference between the two predictions. The LTA method predicts a much slower development of the GDP and slowing GDP growth (from 8.7 to 7.2 percent between 2014 and 2016), but country authorities of IMF estimates a sharp increase in GDP based on current investments and further GDP growth in 2015.

The development of inflation is positive in the case of LTA in absolute values than in the method used by IMF (2-3% versus 5%), but reach the growth (from 2.6 percent to 3.3 percent in the period, compared with 5.3% and 5% of IMF). Regarding fiscal discipline LTA method is much more optimistic and foresees a deficit of around 1 percent, while the IMF estimates the deficit to decline from 7.2 to 2.1 per cent in the period 2014 to 2016.

The situation is similar in variables of the current account, where the method LTA does not occurred the excessive deficit improvement (it still remains about 1,600 mil. USD), but the bottom-up approach predicts a surplus already in 2015. A positive trend is that every year the value of exports and imports is increasing and shows a greater involvement of PNG in the international division of labour.

4 Conclusion

Despite of the fact that Papua New Guinea belongs to developing economies of the Pacific region, it has a high rate of economic growth and other economic indicators, which are higher than the development in the world economy. Recent global crisis has affected only PNG's external debt (similarly to other developing economies, see [36]). The economic situation of the country as a base for further

estimation was described in the first part of this paper. However, the situation in the future may be different. Though the prospects of PNG economy are very promising, we assessed, whether the results of estimation may vary if we use different statistical methods. The forecast by World Economic Outlook was compared with the method of linear trend analysis LTA. We have chosen five macroeconomic indicators such as gross national product, its growth, as well as budget balance to GDP and current account. These indicators are monitored in 2014-2016. We have set the hypothesis that the two methods used for the determination come to different values of variables and the purpose of the article was to verify the hypothesis.

By comparison of these two methods it was found out that there are differences not only in values, but also in the degree of the difference. LTA method was more pessimistic in predicting GDP and current account but it was optimistic for the following three indicators (GDP growth, inflation rate and budgetary balance). As regards GDP indicator, the validity of trend analysis is the most noticeable. It is based on the fact that GDP has been growing recently, but considering the historical developments it should not reach such high numbers as WEO database expects. While the trend analysis expects a drop compared to 2013, and then a slight increase, the available prediction by WEO database takes into account a potential positive impact of the investment project and mining. PNG would still continue to be one of the fastest growing economies in the world. A possible decline in GDP growth in the predicted period, according to the LTA, is associated with the completion of the construction of natural gas liquefaction project, which would bring a decline in mining of raw materials. After implementation of this project into practice in 2015, GDP growth should increase again.

From the above mentioned it is obvious that the hypothesis was verified - regarding all the measured parameters, the values of the two methods differed. It can be concluded that for predicting the development of PNG, a combination of trend analysis and an appropriate prediction is the right alternative. The conclusions of trend analysis can be considered to be theoretical values, which PNG should reach according to its historical development, while the prediction according to "bottom-up" approach includes the temporary status and changes, which may be very useful for the exact prediction.

Not only a method based on a linear basis, but also non-linear methods are used for forecasts. We will continue to monitor trends in the economic development of this interesting economy and our future research in this area will be based on application of one of the second mentioned method, and this method of Double Exponential Smoothing. This method is applied for updating of the trend by using non-linear optimization techniques, such as the Marquardt Algorithm.

Acknowledgement

References:
[1] J. Nevima and Z. Kiszová, Multiplicative and Additive Approach in Analytic Hierarchy Process – Case Study of Competitiveness Evaluation of Czech and Slovak Regions. *International Journal of Mathematical Models and Methods in Applied Sciences*, Vol. 5, No.7, 2013, pp. 490-499.
[2] S. Chudárková and T. Verner, Production Function and Human Capital: The Case of Visegrad Countries, *Proceedings of 31st International Conference Mathematical Methods in Economics 2013*, pp. 321-325. College of Polytechnics Jihlava, 2013.
[3] M. Halásková and R. Halásková, Role of Public Administration and Public Services in the European Administrative Area, *Proceedings of the 2nd International Conference on European Integration 2014 (ICEI 2014)*, pp. 202-210, 2014.
[4] L. Wei and W. Su-Sheng, Empirical Studies of the Effect of Leverage Industry Characteristics, *WSEAS Transaction on Business and Economics*, Vol. 10, No. 4, 2013, pp. 306-3015.
[5] J. M. Liu, Nonlinear Forecasting Using Nonparametric Transfer Function Models, *WSEAS Transaction on Business and Economics*, Vol. 6, No. 5, 2009, pp. 209-218.
[6] P. Hájek and F. Neri, An Introduction to the Special Issue on Computational Techniques for Trading Systems, Time Series Forecasting, Stock Market Modeling, Financial Assets Modeling, *WSEAS Transaction on Business and Economics*, Vol. 10, No. 4, 2013, pp. 291-292.
[7] A. Hess, H. Iyer and W. Malm, Linear trend analysis: a comparison of methods, *Atmospheric Environment*, Vol. 35, No. 30, 2001, pp. 5211-5222.
[8] Y. Zhaoe and Q. Zhang, Monitoring vegetation dynamics by coupling linear trend analysis with change vector analysis: a case study in the Xilingol steppe in northern China, *International Journal of Remote Sensing,* Vol. 33, No. 1, 2012, pp. 287-308.
[9] N.E. Pearce and P. C. Cryer, Analysis of the Components of a Linear Trend in Proportions, *American Journal of Epidemiology*, Vol. 12, No. 1, 1986, pp. 127-133.

[10] I. Majerová and T. Pražák, Estimation of Economic Development in Papua New Guinea: Linear Trend Analysis or Moving Average Model? *Procedia Social and Behavioral Sciences: Contemporary Issues in Business, Management and Education Conference 2013.* Elsevier, 2013.

[11] International Monetary Fund, *World Economic Outlook October 2014 – Legacies, Clouds, Uncertainties*, Washington, DC, 2014.

[12] World Bank, *International Debt Statistic 2013*, Washington DC, 2013.

[13] World Bank, *GDP, Inflation, GDP Growth*, [online], [10 March 2015], from: http://data.worldbank.org/country/papua-new-guinea.

[14] World Bank, *Global Economic Prospect. June 2013. East Asia and the Pacific Region. Annex*, Washington DC, 2013.

[15] World Bank, *World Development indicators*, Washington, DC, 2014.

[16] Asian Development Bank, *Key Indicators for Asia and the Pacific*, Mandaluyong City, Philippines, 2013.

[17] Asian Development Bank, *Key Indicators for Asia and the Pacific 2014*. Mandaluyong City, Philippines, 2014.

[18] Bank of Papua New Guinea, *Quarterly Economic Bulletin June 2012*, Port Moresby, Papua New Guinea, 2012.

[19] International Monetary Fund, *World Economic Outlook April 2013 - Growth Resuming, Dangers Remain*, Washington, DC,2013.

[20] UNCTAD, *Handbook of Statistics. United Nations Conference on Trade and Development,* United Nations, Geneva, 2010.

[21] UNCTAD, *Handbook of Statistics. United Nations Conference on Trade and Development,* United Nations, Geneva, 2012.

[22] UNCTAD, Unctadstat. Total export and import values, [online], [11 March 2015], from: http://unctadstat.unctad.org/TableViewer/table View.aspx.

[23] J. Connell*, Papua New Guinea: The Sturuggle for Development*, Routledge, 2005.

[24] R. J. May, *Policy making and implementation: studies from Papua New Guinea*, Canberra, 2009.

[25] C. Kannapiran, *Institutional Rural Finance in Papua New Guinea: Lessons from the Failure and the Need for Reforms*, NRI Discussion Paper Nr. 86, Port Moresby, 1995.

[26] Department of National Planning and Monitoring, *Papua New Guinea Medium Term Development Plan*, Port Moresby, 2010.

[27] S. Gosarevski, H. Hughes and S. Windybank, Is Papua New Guinea viable?, *Pacific Economic Bulletin*, Vol. 19, No. 1, 2004, pp. 134-148.

[28] G. Banko, Understanding ´resource´ conflicts in Papua New Guinea, *Asia Pacific Viewpoint*, Vol. 49, No. 1, 2008, pp 23-34.

[29] T. Levantis, *Papua New Guinea: employment, wages and economic development*, Canberra: Asia Pacific Press, 2001.

[30] P. K. Narayan, S. Narayan, B. Ch. Prasad and A. Prasad, Export-led growth hypothesis: evidence from Papua New Guinea and Fiji, *Journal of Economic Studies*, Vol. 34, No. 4, 2007, pp.341-351.

[31] World Bank Group, *Papua New Guinea Economic Briefing 2013-1*. Washington DC, 2013.

[32] C.R.C. Almaden, Asset-based Determinants of Poverty Intensity: A meso-level Application in the Philippines. *WSEAS Transaction on Business and Economics*, Vol. 12, 2015, pp. 88-98.

[33] United Nations ESCAP, *Statistical Yearbook for Asia and the Pacific 2012 - Country Profiles. Economic and Social Commission for Asia and the Pacific.* Geneva: United Nations Publication,Switzerland, 2012.

[34] World Bank, *Global economic prospects. Exports and Imports*, [online], [10 March 2015], from: http://databank.worldbank.org/data/views/repor ts/tableview.aspx.

[35] K.H., Oh, *Papua New Guinea. Selected Issues,* IMF Country Report No. 14/326, IMF, 2014.

[36] I. Majerová, Angresano criteria as one of the evaluation possibilities of the economic level: Case of the North Africa countries, *WSEAS Transaction on Business and Economics,* Vol. 11, No. 1, 2014, pp. 582-591.

Appendix A. Linear Trend Analysis of GDP (in mil. USD, constant prices)

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$	year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$	year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1995	4 636	-9	81	-41 724	1994	5 503	-10	100	-55 030	1993	4 975	-11	121	-54 725
1996	5 155	-8	64	-41 240	1995	4 636	-9	81	-41 724	1994	5 503	-10	100	-55 030
1997	4 937	-7	49	-34 559	1996	5 155	-8	64	-41 240	1995	4 636	-9	81	-41 724
1998	3 789	-6	36	-22 734	1997	4 937	-7	49	-34 559	1996	5 155	-8	64	-41 240
1999	3 477	-5	25	-17 385	1998	3 789	-6	36	-22 734	1997	4 937	-7	49	-34 559
2000	3 521	-4	16	-14 084	1999	3 477	-5	25	-17 385	1998	3 789	-6	36	-22 734
2001	3 081	-3	9	-9 243	2000	3 521	-4	16	-14 084	1999	3 477	-5	25	-17 385
2002	2 999	-2	4	-5 998	2001	3 081	-3	9	-9 243	2000	3 521	-4	16	-14 084
2003	3 536	-1	1	-3 536	2002	2 999	-2	4	-5 998	2001	3 081	-3	9	-9 243
2004	3 927	0	0	0	2003	3 536	-1	1	-3 536	2002	2 999	-2	4	-5 998
2005	4 902	1	1	4 902	2004	3 927	0	0	0	2003	3 536	-1	1	-3 536
2006	5 599	2	4	11 198	2005	4 902	1	1	4 902	2004	3 927	0	0	0
2007	6 329	3	9	18 987	2006	5 599	2	4	11 198	2005	4 902	1	1	4 902
2008	8 010	4	16	32 040	2007	6 329	3	9	18 987	2006	5 599	2	4	11 198
2009	7 915	5	25	39 575	2008	8 010	4	16	32 040	2007	6 329	3	9	18 987
2010	9 480	6	36	56 880	2009	7 915	5	25	39 575	2008	8 010	4	16	32 040
2011	12 394	7	49	86 758	2010	9 480	6	36	56 880	2009	7 915	5	25	39 575
2012	15 654	8	64	125 232	2011	12 394	7	49	86 758	2010	9 480	6	36	56 880
2013	15 289	9	81	137 601	2012	15 654	8	64	125 232	2011	12 394	7	49	86 758
.	.	.	.	.	2013	15 289	9	81	137 601	2012	15 654	8	64	125 232
total	124 630	0	570	322 670	2014	12 220	10	100	122 204	2013	15 289	9	81	137 601
					.	.	.	.	.	2014	12 220	10	100	122 204
					total	142 353	0	770	389 844	2015	12 348	11	121	135 828
n	19				n	21				.	.	.	.	.
β_0	6 559				β_0	6 779				total	159 676	0	1012	470 947
β_1	566				β_1	506								
t	10				t	11								
Tt_{2014}	12 220				Tt_{2015}	12 348				n	23			
										β_0	6 942			
										β_1	465			
										t	12			
										Tt_{2016}	12 527			

Appendix B. Linear Trend Analysis of GDP growth (in %)

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1995	-3,31	-9	81	29,79
1996	7,73	-8	64	-61,84
1997	-3,9	-7	49	27,3
1998	-3,77	-6	36	22,62
1999	1,86	-5	25	-9,3
2000	-2,49	-4	16	9,96
2001	-0,12	-3	9	0,36
2002	-0,16	-2	4	0,32
2003	2,16	-1	1	-2,16
2004	2,72	0	0	0
2005	3,6	1	1	3,6
2006	2,58	2	4	5,16
2007	7,2	3	9	21,6
2008	6,7	4	16	26,8
2009	5,5	5	25	27,5
2010	8	6	36	48
2011	9	7	49	63
2012	8	8	64	64
2013	5,4	9	81	48,6
-	-	-	-	-
total	56,7	0	570	325,31
n	19			
β_0	2,98			
β_1	0,57			
t	10			
Tt_{2014}	8,69			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1994	5,94	-10	100	-59,4
1995	-3,31	-9	81	29,79
1996	7,73	-8	64	-61,84
1997	-3,9	-7	49	27,3
1998	-3,77	-6	36	22,62
1999	1,86	-5	25	-9,3
2000	-2,49	-4	16	9,96
2001	-0,12	-3	9	0,36
2002	-0,16	-2	4	0,32
2003	2,16	-1	1	-2,16
2004	2,72	0	0	0
2005	3,6	1	1	3,6
2006	2,58	2	4	5,16
2007	7,2	3	9	21,6
2008	6,7	4	16	26,8
2009	5,5	5	25	27,5
2010	8	6	36	48
2011	9	7	49	63
2012	8	8	64	64
2013	5,4	9	81	48,6
2014	8,69	10	100	86,9
-	-	-	-	-
total	71,33	0	770	352,81
n	21			
β_0	3,40			
β_1	0,46			
t	11			
Tt_{2015}	8,44			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1993	18,2	-11	121	-200,2
1994	5,94	-10	100	-59,4
1995	-3,31	-9	81	29,79
1996	7,73	-8	64	-61,84
1997	-3,9	-7	49	27,3
1998	-3,77	-6	36	22,62
1999	1,86	-5	25	-9,3
2000	-2,49	-4	16	9,96
2001	-0,12	-3	9	0,36
2002	-0,16	-2	4	0,32
2003	2,16	-1	1	-2,16
2004	2,72	0	0	0
2005	3,6	1	1	3,6
2006	2,58	2	4	5,16
2007	7,2	3	9	21,6
2008	6,7	4	16	26,8
2009	5,5	5	25	27,5
2010	8	6	36	48
2011	9	7	49	63
2012	8	8	64	64
2013	5,4	9	81	48,6
2014	8,69	10	100	86,9
2015	8,44	11	121	92,84
-	-	-	-	-
total	97,97	0	1012	245,45
n	23			
β_0	4,26			
β_1	0,24			
t	12			
Tt_{2016}	7,17			

Appendix C. Linear Trend Analysis of Inflation rate (CPI, in %)

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1995	17,28	-9	81	-155,5
1996	11,62	-8	64	-92,96
1997	3,96	-7	49	-27,72
1998	13,57	-6	36	-81,42
1999	14,93	-5	25	-74,65
2000	15,6	-4	16	-62,4
2001	9,3	-3	9	-27,9
2002	11,8	-2	4	-23,6
2003	14,71	-1	1	-14,71
2004	2,1	0	0	0
2005	1,84	1	1	1,84
2006	2,37	2	4	4,74
2007	0,91	3	9	2,73
2008	10,76	4	16	43,04
2009	6,92	5	25	34,6
2010	6,02	6	36	36,12
2011	4,44	7	49	31,08
2012	4,53	8	64	36,24
2013	4,96	9	81	44,64
-	-	-	-	-
total	157,6	0	570	-325,9
n	19			
β_0	8,30			
β_1	-0,57			
t	10			
Tt_{2014}	2,58			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1994	2,85	-10	100	-28,5
1995	17,28	-9	81	-155,5
1996	11,62	-8	64	-92,96
1997	3,96	-7	49	-27,72
1998	13,57	-6	36	-81,42
1999	14,93	-5	25	-74,65
2000	15,6	-4	16	-62,4
2001	9,3	-3	9	-27,9
2002	11,8	-2	4	-23,6
2003	14,71	-1	1	-14,71
2004	2,1	0	0	0
2005	1,84	1	1	1,84
2006	2,37	2	4	4,74
2007	0,91	3	9	2,73
2008	10,76	4	16	43,04
2009	6,92	5	25	34,6
2010	6,02	6	36	36,12
2011	4,44	7	49	31,08
2012	4,53	8	64	36,24
2013	4,96	9	81	44,64
2014	2,58	10	100	25,8
-	-	-	-	-
total	163,1	0	770	-328,6
n	21			
β_0	7,76			
β_1	-0,43			
t	11			
Tt_{2015}	3,07			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt*t'$
1993	4,97	-11	121	-54,67
1994	2,85	-10	100	-28,5
1995	17,28	-9	81	-155,5
1996	11,62	-8	64	-92,96
1997	3,96	-7	49	-27,72
1998	13,57	-6	36	-81,42
1999	14,93	-5	25	-74,65
2000	15,6	-4	16	-62,4
2001	9,3	-3	9	-27,9
2002	11,8	-2	4	-23,6
2003	14,71	-1	1	-14,71
2004	2,1	0	0	0
2005	1,84	1	1	1,84
2006	2,37	2	4	4,74
2007	0,91	3	9	2,73
2008	10,76	4	16	43,04
2009	6,92	5	25	34,6
2010	6,02	6	36	36,12
2011	4,44	7	49	31,08
2012	4,53	8	64	36,24
2013	4,96	9	81	44,64
2014	2,58	10	100	25,8
2015	3,07	11	121	33,778
-	-	-	-	-
total	171,1	0	1012	-349,4
n	23			
β_0	7,44			
β_1	-0,35			
t	12			
Tt_{2016}	3,30			

Appendix D. Linear Trend Analysis of Budgetary Balance as % GDP

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1999	-2,60	-7	49	18,20
2000	-2,00	-6	36	12,00
2001	-3,40	-5	25	17,00
2002	-3,80	-4	16	15,20
2003	-0,90	-3	9	2,70
2004	1,70	-2	4	-3,40
2005	0,10	-1	1	-0,10
2006	3,20	0	0	0,00
2007	2,40	1	1	2,40
2008	-2,20	2	4	-4,40
2009	-0,20	3	9	-0,60
2010	0,70	4	16	2,80
2011	-0,20	5	25	-1,00
2012	-1,50	6	36	-8,98
2013	-7,22	7	49	-50,52
-	-	-	-	-
total	-15,91	0	280	1,30
n	15			
β_0	-1,06			
β_1	0,00			
t	8			
Tt2014	-1,02			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1998	-1,80	-8	64	14,40
1999	-2,60	-7	49	18,20
2000	-2,00	-6	36	12,00
2001	-3,40	-5	25	17,00
2002	-3,80	-4	16	15,20
2003	-0,90	-3	9	2,70
2004	1,70	-2	4	-3,40
2005	0,10	-1	1	-0,10
2006	3,20	0	0	0,00
2007	2,40	1	1	2,40
2008	-2,20	2	4	-4,40
2009	-0,20	3	9	-0,60
2010	0,70	4	16	2,80
2011	-0,20	5	25	-1,00
2012	-1,50	6	36	-8,98
2013	-7,22	7	49	-50,52
2014	-1,02	8	64	-8,19
-	-	-	-	-
total	-18,74	0	408	7,51
n	17			
β_0	-1,10			
β_1	0,02			
t	9			
Tt2015	-0,94			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1997	0,20	-9	81	-1,80
1998	-1,80	-8	64	14,40
1999	-2,60	-7	49	18,20
2000	-2,00	-6	36	12,00
2001	-3,40	-5	25	17,00
2002	-3,80	-4	16	15,20
2003	-0,90	-3	9	2,70
2004	1,70	-2	4	-3,40
2005	0,10	-1	1	-0,10
2006	3,20	0	0	0,00
2007	2,40	1	1	2,40
2008	-2,20	2	4	-4,40
2009	-0,20	3	9	-0,60
2010	0,70	4	16	2,80
2011	-0,20	5	25	-1,00
2012	-1,50	6	36	-8,98
2013	-7,22	7	49	-50,52
2014	-1,02	8	64	-8,19
2015	-0,94	9	81	-8,43
-	-	-	-	-
total	-19,47	0	570	-2,71
n	19			
β_0	-1,02			
β_1	0,00			
t	10			
Tt2016	-1,07			

Appendix E. Linear Trend Analysis of Current account (in mil. USD)

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$	year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1999	144,55	-7	49	-1 011,87	1998	34,99	-8	64	-279,90
2000	351,92	-6	36	-2 111,55	1999	144,55	-7	49	-1 011,87
2001	271,00	-5	25	-1 355,00	2000	351,92	-6	36	-2 111,55
2002	-129,04	-4	16	516,14	2001	271,00	-5	25	-1 355,00
2003	139,67	-3	9	-419,02	2002	-129,04	-4	16	516,14
2004	185,13	-2	4	-370,26	2003	139,67	-3	9	-419,02
2005	647,54	-1	1	-647,54	2004	185,13	-2	4	-370,26
2006	443,03	0	0	0,00	2005	647,54	-1	1	-647,54
2007	185,63	1	1	185,63	2006	443,03	0	0	0,00
2008	795,58	2	4	1 591,16	2007	185,63	1	1	185,63
2009	-586,08	3	9	-1 758,25	2008	795,58	2	4	1 591,16
2010	-633,33	4	16	-2 533,31	2009	-586,08	3	9	-1 758,25
2011	-172,57	5	25	-862,84	2010	-633,33	4	16	-2 533,31
2012	-2 300,50	6	36	-13 802,98	2011	-172,57	5	25	-862,84
2013	-3 307,73	7	49	-23 154,11	2012	-2 300,50	6	36	-13 802,98
.	.	.	.	.	2013	-3 307,73	7	49	-23 154,11
					2014	-1 571,03	8	64	-12 568,20
total	-3 965,19	0	280	-45 733,79	.	.	.	.	.
					total	-5 501,22	0	408	-58 581,89
n	15				n	17			
β_0	-264,35				β_0	-323,60			
β_1	-163,33				β_1	-143,58			
t	8				t	9			
Tt_{2014}	-1 571,03				Tt_{2015}	-1 615,85			

year	$\sum yt$	$\sum t'$	$\sum t'^2$	$\sum yt * t'$
1997	-116,47	-9	81	1 048,27
1998	34,99	-8	64	-279,90
1999	144,55	-7	49	-1 011,87
2000	351,92	-6	36	-2 111,55
2001	271,00	-5	25	-1 355,00
2002	-129,04	-4	16	516,14
2003	139,67	-3	9	-419,02
2004	185,13	-2	4	-370,26
2005	647,54	-1	1	-647,54
2006	443,03	0	0	0,00
2007	185,63	1	1	185,63
2008	795,58	2	4	1 591,16
2009	-586,08	3	9	-1 758,25
2010	-633,33	4	16	-2 533,31
2011	-172,57	5	25	-862,84
2012	-2 300,50	6	36	-13 802,98
2013	-3 307,73	7	49	-23 154,11
2014	-1 571,03	8	64	-12 568,20
2015	-1 615,85	9	81	-14 542,64
.	.	.	.	.
total	-7 233,55	0	570	-72 076,27
n	19			
β_0	-380,71			
β_1	-126,45			
t	10			
Tt_{2016}	-1 645,21			