Estimating the Factors Affecting the Remittance Inflow to Armenia with Statistical Tools

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Հայաստանի դրամական փոխանցումների ներհոսքի վրա ազդող գործոնների գնահատում վիճակագրական գործիքներով

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**Ամփոփում`** Հոդվածի հիմնական նպատակն է վերլուծել ներքին և արտաքին տնտեսական գործոնների ազդեցությունը Հայաստան դրամական փոխանցումների ներհոսքի վրա: Ժամանակային շարքերի վերլուծության համար օգտագործվում են ARIMA և ARIMAX մոդելները: Ըստ արդյունքների` Ռուսաստանի իրական ՀՆԱ աճի տեմպը և Հայաստանի գործազրկության մակարդակը բացասաբար են ազդում Հայաստան եկող դրամական փոխանցումների վրա: Հնարավոր բացատրությունն այն է, որ գործազուրկ հայերը արտագաղթում են, իսկ հարազատները դադարում են գումար ուղարկել դեպի Հայաստան, ինչը բացասաբար է անդրադառնում դրամական փոխանցման ներհոսքի քանակի վրա: Չերք բերված արդյունքները նաև ենթադրում են, որ նավթի գների փոփոխականությունը նշանակալի կարևորություն ունի մոդելում և դրականորեն է անդրադառնում մեր կախյալ փոփոխականի վրա: Աշխատանքի նպատակն է հետագայում գնահատել աշխատանքում ձերք բերված արդյունքները և տալ մակրոտնտեսական մեկնաբանություններ, որոնք կիասատեն եզրակացությունները: Ժամանակի շարքի վերլուծություններն իրականացվում է Փիթոնով:
Վճռորոշ բառեր` դրամական փոխանցումներ, ժամանակային շարքերի վերլուծություն

Оценка факторов, влияющих на приток денежных переводов в Армению с помощью статистических инструментов

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Резюме: Основная цель статьи - проанализировать влияние внутренних и внешних экономических факторов на приток денежных переводов в Армению.Для проведения анализа временных рядов используются модели ARIMA и ARIMAX. Согласно полученным данным, темпы роста реального ВВП России и уровень безработицы в Армении оказывают негативное влияние на денежные переводы, поступающие в Армению. Возможное объяснение состоит в том, что безработные армяне эмигрируют, а родственники прекращают отправлять деньги в Армению, что негативно влияет на объем притока денежных переводов. Результаты также показывают, что переменная цены на нефть является существенной в модели и положительно связана с нашей зависимой переменной. Целью работы является дальнейшая оценка результатов, полученных в документе, и предоставление макроэкономических интерпретаций, которые подтвердили бы полученные данные. Весь анализ временных рядов проводится в Питоне.
Ключевые слова: денежные переводы, анализ временных рядов.

Introduction

Remittances are cross border transfers of money from workers in one country back to the country of origin. Over the past years, the analysis of the effects of remittances made by migrant workers towards their home countries has yielded a great interest among researchers in economics, sociology and political science (Adams and Page, 2005). The intensity of remittances has undoubtedly had a positive influence on restraining poverty and the growth of the home countries (Acosta, Baerg, and Mandelman, 2009). Since the collapse of the Soviet Union, many Armenians started to emigrate to get temporary jobs, and this trend significantly

contributed to the amount of remittances coming to Armenia. Hence, internal factors such as the unemployment rate and the real effective exchange rate are included in the analysis. On the other hand, the phenomenon of remittances is hard to explain without the inclusion of external factors. External factors are the world price of crude oil, real GDP growth rates of Russia and the USA, and the unemployment rate of Armenia. The regression analysis will include the real GDP growth rates of Russia and the USA, because these countries have the biggest Armenian Diasporas and most of the Armenian households receive remittances predominantly from these countries. The research also shows that the poor countries receiving remittances from host countries, which are oil producers, are highly dependent on the fluctuation of global oil prices (Asatryan, Bittschi & Doerrenberg, 2016).

Based on initial assumptions, the increase in the unemployment rate will increase the inflow of remittances in Armenia, as more unemployed Armenian households will need remittances to maintain their old standard of living. Meanwhile, the close relationship between Russian and Armenian economies makes us assume that an increase in the Russian real GDP growth rate will stimulate an increase in the inflow of Armenian remittances. As the majority of Armenian migrants work in Russia, where the economy is heavily dependent on global oil prices, it is assumed that an increase in global crude oil prices will increase wages of Armenian migrants in Russia, which will have a positive effect on the inflow of remittances. All these assumptions will be tested in the subsequent sections of the paper.

Literature Review

The majority of studies regarding remittances focus on the effect of remittances on the behavior of households. In general, remittances can be sent for various reasons, such as having a positive contribution to the lives of the relatives and making their lives better. This is an example of sending remittances based on altruistic motives (Lucas and Stark 1995). In general, migrants send remittances when their relatives face hardships in the home country. Moreover, the continuation of these hardships leads to more migration which later on increases the inflow of remittances significantly (Singer,2010). Remittances can also have an impact on the increase in household consumption and household investment (Murrugarra, 2002). Numerous studies have shown the relationship between the unemployment rate in the country and the inflow of remittances. The unemployment rate in Pakistan has had a positive impact on real

remittances inflow, where more Pakistani residents have left the country to get temporary jobs in the host countries. This has positively affected the inflow of remittances in Pakistan (Ahmad, Hussain & Sial, 2007). On the other hand, the unemployment rate variable has been used in certain regression analysis, where the researchers have taken the unemployment rate of the destination country. The results have shown that the increase in the unemployment rate in the host country has a negative impact on the inflow of remittances (Lianos,1997). Several studies have analyzed the relationship between global oil prices and the inflow of remittances. The results of the studies indicate that there is a positive relationship between these variables, meaning that an increase of global oil price stimulates the inflow of remittances from oil-producing countries (Lueth and Ruiz-Arranz, 2007). This finding can be very useful in Armenia's case as the majority of Armenian residents get temporary jobs in Russia whose economy heavily depends on oil production. Therefore, the fluctuations of global oil prices can have a significant impact on Armenian remittances. Alleyne (2008) included the real effective exchange rate variable in their model of estimation. Interestingly enough, the real effective exchange rate and its effect on remittances were positive in the fixed-effect model, meanwhile being completely insignificant in FMOLS (fully modified OLS) model (Alleyne, Kirton, & Figueroa, 2008). The major use of remittances for Armenians is basic consumer consumption, however, migrants also send them for specific objectives such as covering costs for mortgages (Gois, 2014).

Data and Methodology

Let us take a look at the time series plot of the Armenian remittances. From the plot below, we observe seasonal patterns in our time series. The seasonal changes are additive and the drastic decrease in 2014 is most certainly because of economic fluctuations in the Russian economy for the relevant period.

Econometric Model

The econometric model aims to find out the potential economic factors affecting the remittances coming to Armenia and estimate their impact on these transfers. In the times series model remittances depend on its lags, lags of the error term and the exogenous variables present in the dataset. For this purpose, we will use an ARMAX model, which is an extension of regular ARMA (p, q) model, where p is the number of autoregressive lags, and q is the number of moving

Figure1: Time Series of Armenian Remittances.
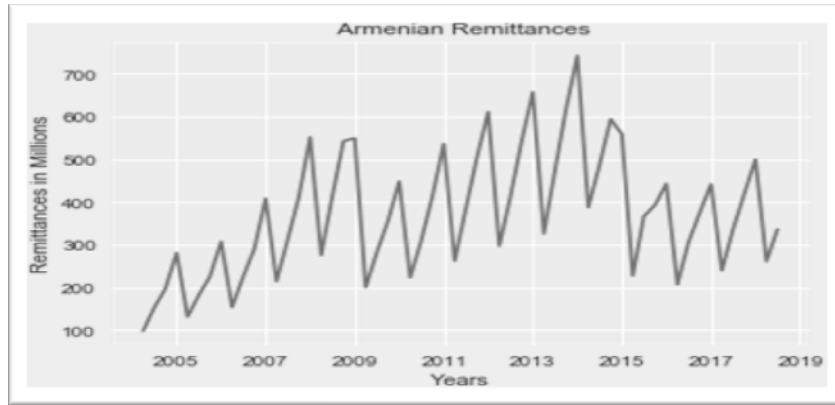
Source: Central Bank of Armenia.

Figure 2: Decomposition of Remittances
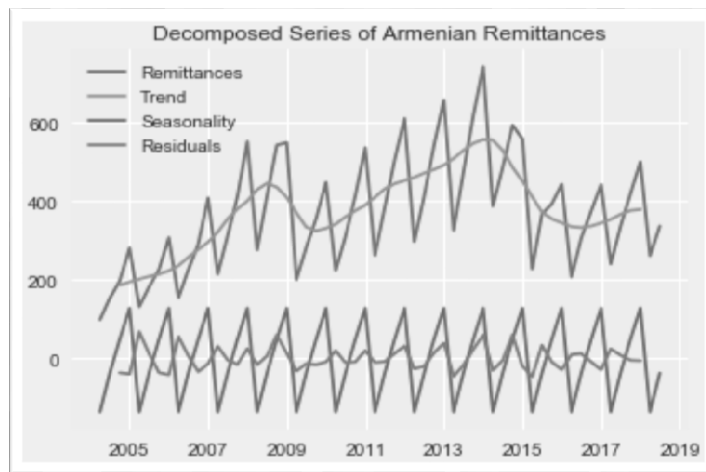
average lags. The order of p and q will be decided by applying the Akaike Information Criterion (AIC) and the Bayesian\Schwartz Information Criterion, which for a given data compare the relative quality of statistical models and give out the optimal values which minimize the AIC and BIC scores. We control for stationarity, and make sure moving averages are white noise process, and the residuals are normal in the model. The analysis is conducted with the Box Jenkins methodology. Dickey-Fuller stationary test indicates that all the variables in the dataset are non-stationary. The respective t-statistics First, simple moving average de-trending method is applied to better account for the nonlinear trend. Before calculating moving averages, remittances, crude oil, and Armenian real effective exchange rate variables are transformed into natural logarithms. The moving average formula applied is as the following.

$$Y_t = \frac{Y_{t-1} + Y_{t-2} + Y_{t-3} + Y_{t-4}}{4}$$

After estimating the above model, the trend from the original series is subtracted and, we end up with a de-trended version of the Remittances series. After conducting another Dickey-Fuller test, we see an improvement in some of the variables' respective t statistics. P value from testing stationarity on Remittances decreases from 0.063 to 0.033, meaning that our variable has become stationary at a 5% critical level. The P value of REER decreases from 0.2169 to 0.0672, becoming significant at a 10% critical level. Other variables are not notably affected. The goal is to have highly stationary variables significant at a 1% level, thus as a final preprocessing step classical decomposition technique is applied to remove the remaining trend and seasonality. The classical decomposition includes four main components: the long- term tendency or trend, seasonal movements within each year, cyclical movements imposed upon long term trend and the residual variations otherwise known as the irregular component (Dagum & Bianconcini, 2006). Our remittances

126

series does not demonstrate a clear increasing   pattern, for that reason we choose the additive

Table 1: Initial Estimation Results.

Dep. Variable Log Remittances	Model1 ARMA(0,1)	Model 2 ARMAX(1)	Model 3 ARMAX(2)	Model 4 ARMAX(3)	Model 5 ARMAX(4)	Model 6 ARMAX(5)
Constant	0.0004 std 0.0052	0.0005 std 0.003	0.0004 std 0.02	0.0002 std 0.001	0.0003 std 0.001	0.0005 std 0.002
ϵ_{t-1}	-0.1525 std 0.2517	-0.4905*** std 0.105	-0.9735*** std 0.113	-0.6527*** std 0.101	-0.8838*** std 0.066	-0.5107*** std 0.105
Log_Crude Oil		0.2950*** std 0.048	0.4073*** std 0.072	0.3706*** std 0.064	0.4227*** std 0.070	0.3855*** std 0.066
Log_REER			0.4509 std 0.316	0.4282 std 0.282	0.4684* std 0.271	0.0154 std 0.255
Unemployment Rate %				-0.0057*** std 0.002	-0.0039** std 0.002	-0.0075*** std 0.002
US_Real_GDP%					-0.0048 std 0.006	-0.0029 std 0.005
Russian_Real GDP%						-0.0268** std 0.013
AIC/BIC	-175.9964 -170.0295	-197.294 -189.338	-198.014 -188.069	-196.38 -184.447	-194.925 -181.002	-197.218 -181.306
Shapiro Wilk	P=0.1654	P=0.5420	P= 0.8521	P=0.4397	P=0.64250	P=0.520

* Statistically significant at p < 0.1

** Statistically significant at p <0.05

*** Statistically significant at p < 0.01

structure, which is the summation of the mentioned typical components.

This method is used to transform all the variables in the dataset. With this method, we estimate and remove both trend and seasonality from the series and end up with the nonsystematic irregular component. The irregular component becomes the de-trended and decentralized series, and this series is tested for stationarity. The decomposed Series of Armenia Remittances is plotted in Figure 2.

The Null hypothesis for the Dickey-Fuller test says that there is a unit root in the times series sample, while the alternative hypothesis is that the three is no unit root, or we have a stationary process. For all the variables in the dataset, the null hypothesis is rejected at a 1% confidence interval, which means we have stationary processes. The t statistic for the Remittances changes from -2.76 to -7.79, for crude Oil from -3.018 to -7.379, for Unemployment Rate from -1.45 to -8.456, for REER from -2.17 to -6.789, for US Real GDP growth from -4.88 to -9.397 and for the Russian Real GDP from -3.61 to -8.079.

After making the variables stationary, we proceed to determine the number of autoregressive and moving average components of the remittances by first looking at the autocorrelation and partial autocorrelation graphs. ARMA (0,1) gives us comparably low AIC score (-202.5) and BIC score (-192.635), with a P value for the errors of 16.54%, which allows us not to reject the null hypothesis and conclude the errors of the ARMA (0,1) process are normal. After understanding the order of MA we decide which exogenous variables need to be included into our final model alongside the MA (1) process. As a part of the exogenous variables, we include the real Armenian effective exchange rate, the Armenia unemployment rate, the real growth rates of Russia and the United States and the Crude Oil Prices. In the final model, we will only include variables that have statistical significance.

Estimation

With 54 observations, the estimations of different models are presented, and after removing the insignificant variables and including the second lag of remittances, which was significant from the partial autocorrelation graph, we obtain the final model.

In the final model, the first moving average variable is significant at a 90% confidence level, and the rest of the variables are significant at a 99% confidence level, so the model can be considered statistically good for interpretation. We observe that a 1% increase in the crude oil prices increases the Remittances coming to Armenia by 0.3375%. When the Russian Real GDP grows by 1%, the remittances coming to Armenia decrease by 4.23%, and when the unemployment rate in Armenia grows by 1%, the remittances coming to Armenia decrease by 0.69 %. If we compare the overall normality, variable significance and AIC/BIC scores of this model with the rest, we can see it provides better measures. A plot diagnostic for the final model is also presented, which along with the correlogram, allows us to observe the normal distribution of the errors.

Limitations

In this analysis, we considered a few of the important variables which affect remittances, however, because of data limitations, a few variables of interest were not obtained. Examples of such variables are the quarterly democracy index and quarterly political stability of the country. Such factors can significantly contribute to the goodness of fit of the model and evoke interesting findings. Including significant variables can also eliminate or highly reduce the biases, which are present in other variables' coefficients in the model, thus it is recommended to include such variables for better model results and interpretation.

Conclusion

In this paper, we analyze the determinants of the remittance inflows to the Armenia economy. As an initial step, we check the stationarity of the variables in the dataset. All of the variables are non-stationary at a 5% significant level, so certain steps are taken. Simple moving averages and classical additive decomposition are applied, and we obtain the stationary component from the original series. After trying different ARMAX models, comparing the significances of the variables and normality measures, it is concluded that remittances depend on its first moving average, oil prices, Russian real GDP and the Armenian unemployment rate. Remittances and oil prices are presented in logarithmic forms. The important findings of the paper are, that the increase in the Russian real GDP and Armenian unemployment rate negatively impact the money transfers coming to Armenia, which contradict to our initial hypothesis. One explanation for this phenomenon might be migration, where people choose to leave the country with their families as opposed to temporary work and thus they send less money to Armenia. Another reason might be the fact, when the economy of a foreign country is doing well, one might invest the money in the host country rather than send the money home, and this partially explains the reason for the negative relationship between remittances and the Russian Real GDP.

Table 2: Final Model Results.

Log Remittances	ARMAX Model
Constant	0.0003 std err 0.003
Y_{t-2}	-0.3269*** std err 0126
ϵ_{t-1}	-0.2207 * std err 0.127
Log_Crude_Oil	0.3375*** std err 0.056
Unemployment Rate %	-0.0069*** std err 0.002
Russian Real GDP%	-0.0423*** std err 0.015
Number of Observations	52
AIC/BIC	-197.567 /-183.909
Shapiro Wilk	0.5749
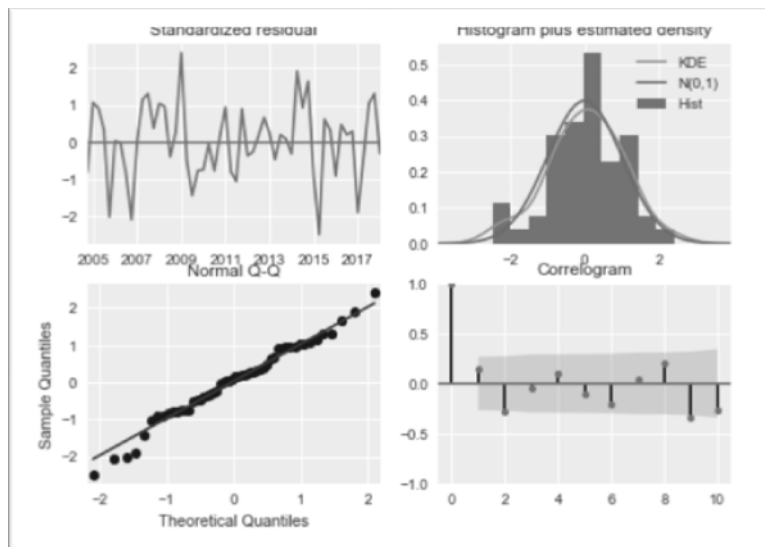
Figure 3: Diagnostic Test for the Residuals.

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