THE ECONOMIST DIWAN

Issue 2 | Spring 2018

ABOUT THE JOURNAL

The Economist Diwan is be a student-run academic journal that provides an opportunity to publish the best research done in economics and related fields at the American University of Sharjah (AUS). Starting its first publication in Spring 2017, this journal operates under the AUS Department of Economics in the School of Business Administration (SBA). Our aim is to publish research carried out by students in the American University of Sharjah (AUS), exchange students at AUS and potentially extending our reach to publishing undergraduate research from other universities in the region as well.

Through this journal, the AUS Department of Economics intends to promote the diverse application of economics related concepts amongst its current and prospective students. For any other inquiries or if you wish to contribute, feel free to contact us via economistdiwan@aus.edu.

EDITOR'S NOTE

The Economist Diwan is a journal meant for students to have an overview of the research fellow students have conducted in Economics. One of the aims of this student-run journal is for other undergraduates to understand the various applications of the theories and empirical methods pursued in Economics to explore and gain a different perspective of topics beyond the customary demand and supply applications in the classroom. Economics provides the essential foundation in developing our society through its broad scope and unique attributes. Using a few concepts from many fields of study such as Physics, Mathematics, and Business and applying a behavioral context to qualitative data, economists analyze datasets and results in a different perspective from fellow peers in other streams of study.

It has become a common phenomenon for sociologists, economists and mathematicians, for example, to collaborate on a specific research topic and conduct optimal analysis to maximize results. The quality of research publications has certainly improved over the past decades along with the refinement of economics as a field of study. Many political and behavioral theories are in existence today thanks to the empirical methods. The empirical methods of economics serve as the backbone on which many political and behavioral theories have been created.

Our first edition published last year was welcomed with an overwhelming response providing us with an indication to further consolidate the journal's footing. Through this journal, we aspire to provide a platform to young motivated economists and enable them to independently conduct research at an undergraduate level and subsequently, publish their findings. The journal seeks to integrate the economics community regionally where like-minded individuals even outside AUS collaborate together on research topics.

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MESSAGE FROM THE DEAN

Teaching and research are the pillars of academia. Professors transfer knowledge to their students and simultaneously conduct analytical studies that help expand the boundaries of their respective disciplines. The results of this research find its way back to the students and enrich classroom discussions and directed studies. As students go through their degree programs and evolve from memorizing to understanding to applying and finally to synthesizing knowledge, they increasingly become part of this academic cycle. The brightest of them transform from being mere consumers to seekers and creators of knowledge, using an array of analytical tools. Examples of this student-based knowledge creation that touch on a variety of exploratory topics in Economics are showcased in this new research journal. I hope that by publishing their early work, our student authors will achieve two objectives, offer interesting reading to peers in their discipline and incentivize fellow students to follow suit and start engaging in quality research too. For academics, research is a fascinating part of life. The student authors featured in this journal's first edition have shown great promise and could possibly one day, if they continue on this path, join the professorial ranks themselves.

Well done!

Jorg Bley, PhD

MESSAGE FROM THE HEAD OF THE DEPARTMENT OF ECONOMICS

A well rounded university education is a first step to a successful career in the 'real' world. It is becoming more and more clear that no educational experience is complete unless they provide students with an opportunity to apply what they learn in the classroom. That is why, we at the Department of Economics in the AUS strive to prepare our students for future challenges while paying close attention to present circumstances around us. Our students know all too well that obliviousness to this fact comes at a huge cost down the road. Just to illustrate, knowing that 'demand curve slopes downward' could only get you so far, but not the whole way to the target. Therefore, cognizant of this point, our students set out to produce an outlet to showcase their efforts in connecting theory with empirics, and thus, classroom with the world around. Then came this journal. This was a challenge, but they knew that every challenge was an opportunity. They worked hard, and they finally made it happen. The journal represents some of the valuable examples of quite competent student scholarship in the department. The topics and methods employed in all these papers are fascinating given the academic level of the authors. We the faculty and administration are so proud of them! With this journal, we hope to transform classroom knowledge into permanent public records for the benefit of everybody for all times.

And, the next step is to broaden the authorship (and hopefully the readership) of the journal to all interested parties in the school, university, country, region, and the world. But all these will take time and endless efforts, with unquestionably extraordinary rewards.

Congratulations young scholars! You have done a great job!

Ismail H. GENC, PhD

THE IMPACT OF REMITTANCE INFLOWS AND GDP GROWTH IN THE INDIAN SUBCONTINENT

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ABSTRACT

This paper examines the effect of remittances on economic growth and inflation in the Indian Subcontinent. It uses panel data from four countries (Pakistan, India, Bangladesh, and Sri Lanka) for the period 1976-2015. In the first part of the empirical section, we regressed real GDP growth on real remittance growth, while for the second part inflation was regressed on nominal remittance growth. Four empirical models were estimated for each of these, where country fixed effects and time fixed effects were used to control for variations across countries and years. In our final model, we added interaction variables to examine the effect of remittance inflows on each country separately. We found that remittance inflows hinder economic growth in Bangladesh and Sri Lanka. Also, we found that remittance inflows result in higher inflation for Sri Lanka. We conclude by discussing our findings.

INTRODUCTION

The Indian subcontinent is the largest exporter of human resources to the developed world. Workers who leave their home countries to seek better employment opportunities which most of them find abroad, usually cannot afford to bring their families along with them. This is primarily due to the high living cost in the countries where they have migrated to, so they share accommodations with other fellow immigrants instead. Therefore, when the immigrant workers ultimately send funds to their dependents, these become remittance inflows for the receiving countries. Remittances are generally more stable and predictable than foreign direct investment or international aid. Furthermore, several developing countries rely heavily for their expenditures on remittance inflows, which not only provide funds and liquidity, but also greatly improve the balance of payments. Therefore, the inflow of remittances is a very important macroeconomic variable, the behavior of which still has much scope for development research. In one empirical paper, for example, it was found that remittance inflows could sometimes even affect unemployment rates (Mekawy, 2016). However there is no clear indication on whether remittances help towards economic growth of the receiving country or not.

In this paper, we attempt to examine the effect of remittance inflows on the receiving countries' GDP growth using data from four main countries of the Indian subcontinent (Pakistan, India, Sri Lanka and Bangladesh) over the period 1975-2014. Additionally, we examine whether remittance inflows induce inflation in the Indian subcontinent. To come up with robust empirical findings, we use panel data for the four countries and control for some other important variables in the model, which are suggested by macroeconomic theory.

This paper is structured as follows. Section 2 reviews the literature that includes the findings of several relevant scholarly works. Section 3 describes the data and methodology.

Section 4 presents the empirical results. Section 5 discusses the conclusion and policy recommendations.

LITERATURE REVIEW

Mekawy (2016) shows how remittance inflows have varying impacts on different countries. He chose countries within the North African region and concludes that remittance inflows worsened the unemployment rate in Algeria, yet over the same time period helped reduce the unemployment rates in Morocco and Sudan. He added that the findings were different for Algeria since Algerians were eligible for up to 50 percent of their monthly salary as unemployment benefits. This factor, combined with incoming remittances, increased the reservation wage for Algerian workers and therefore raised unemployment. Nevertheless, the general phenomenon observed in the other two north African countries was that emigrating workers, by migrating to other countries would nonetheless decrease the domestic unemployment rate by reducing the labor force participants and the unemployed in their home countries.

It is evident that remittance inflows favorably influence both consumption of goods and services and the balance of payments. In particular, the increase in consumption spending technically aids the developing countries in poverty alleviation. Adams and Page (2005) examined this research question empirically using data on poverty, inequality, migration, income, and remittances from 71 developing countries and found a strongly negative correlation between poverty and remittance inflows. This was also true when poverty was regressed on international migration. Hence Adams and Page (2005) concluded that remittance inflows into the country and emigrating workers outside the country have been two key factors that have assisted developing countries in their fight against poverty. These findings have been broadly accepted by researchers

and were not subject to much debate. However the impact of remittance inflows on economic growth of developing countries has been much more controversial.

Some researchers, rather, argue that remittance inflows have made the developing countries less vulnerable to economic growth. Bajaras et al. (2009) state that there has been a lack of empirical evidence when it comes to the relationship between remittance inflows and economic growth. They mention that there have been several countries with their remittance inflows significantly above 10 percent of their GDP; however, there has not been a single success story of any of these countries being developed due to incoming remittances. The reason that they provide is that the inflow of remittances is effectively a kind of social insurance that helps dependents finance their purchases. Therefore, these remittances affect household consumption but have no significant impact on investments or savings that cause economic growth. Additionally, the paper suggests there could be a problem of reverse causality and multi-collinearity (between remittances and migration) in the studies that have been conducted on remittances. For instance, even if remittance inflows would help families get better education, the family members might later migrate, and the long-term impact of remittances may not be realized. Other researchers, as we shall see below, have shown a more optimistic viewpoint in favor of remittance inflows as a development tool for developing countries. Their argument is mainly based on the fact that remittance inflows have a multiplier effect in the receiving country that results in the expansion of both households and industries. Some hypothesize that remittance inflows also provide developing countries with the means to afford better education and healthcare and thus help achieve better macroeconomic results in the long run.

Akter (2016) specifically studied the impact of remittance inflows on the economic growth of Bangladesh. She mentioned that most of the remittances received by dependents in Bangladesh

were mostly from the GCC countries. By using time-series regression and correlation analysis, she found that remittance inflows have positively affected the GDP growth rate of Bangladesh, and therefore concluded that remittance inflows have been an important source of economic development for the country. The effect of remittances thus has a multiplier effect, which makes it an essential macro-economic tool, the effects of which could also be studied on other countries in the region which also rely on remittance inflows to a varying degree.

In addition to economic growth, there has been another effect of remittance inflows on the economy of Bangladesh. Khan and Islam (2013) have examined the effect of remittance inflows on inflation in Bangladesh using vector autoregressive techniques with annual data from the period 1972 to 2010. They concluded that there is a strongly positive and significant relationship between inflation and remittance inflows that prevails only in the long run. They further conduct the Granger Causality test and show that the causal relationship is unidirectional, and it is remittance growth that causes inflation and not vice versa.

Balderas and Nath (2008) found similar results for Mexico, which also relies greatly on remittance inflows. They cited Durand et al.(1996) who explained that nearly three quarters of remittances received by Mexico would be consumed right away. This would cause a rightward shift in the demand curve for these goods and services that would cause a disproportionate increase in the relative prices. They estimated the impact of remittance inflows on inflation and found a statistically significant and positive correlation between the variables.

Ngoc and Nguyen (2014) conducted their empirical study using quarterly data on Vietnam and found that the impact of remittance inflows on inflation could rather be seen with a lag of two quarters. Furthermore, they found that under a fixed exchange rate regime (as was the case with Vietnam), remittance inflows would increase the money supply in the immediate quarter. They

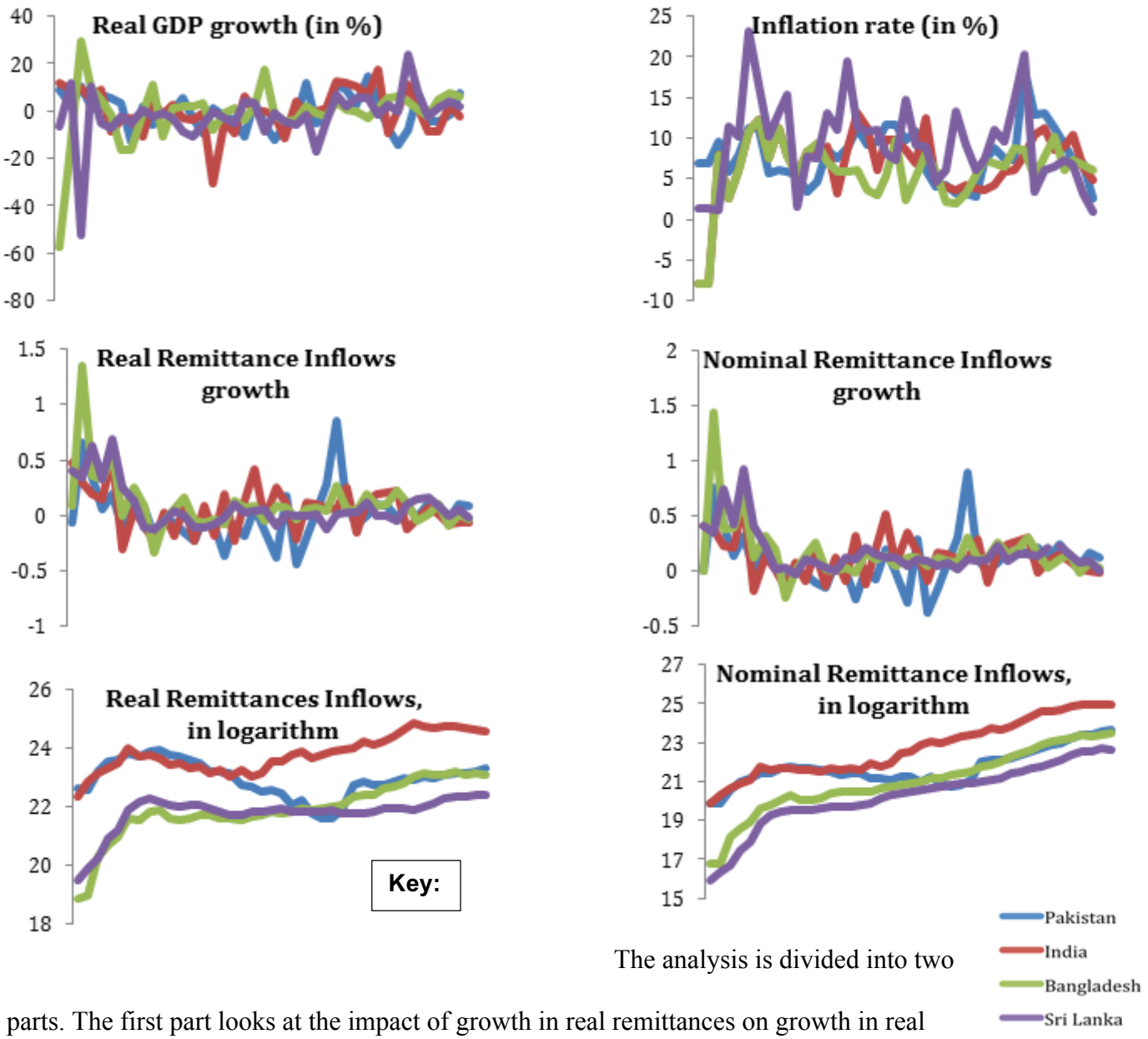
concluded that countries with flexible exchange rate regimes may not have such severe impacts on their inflation rates due to remittance inflows as was the case with Vietnam.

Narayan et al. (2011) used dynamic panel data for 54 developing countries that included 19 from Africa, 17 from Central and South America, 8 from Europe and 7 Asian countries. They conducted System Generalized Method of Moments (GMM) estimation and came up with 11 different models, finding the coefficient of remittance growth statistically significant across all of the 11 models. The control variables varied across these models but were mainly the following: trade (as a percentage of GDP), GDP growth, current account deficit (as a percentage of GDP), total debt (as a percentage of GDP), crude oil price growth, U.S. interest rate, democracy, government stability, military, and law and order. This was a very important contribution to the literature that studied the overall impact of remittances on inflation as a generalizable trend for developing countries.

Al Kaabi (2016) undertook a different study on remittances examining the outflows and their impact on GDP growth and inflation. He conducted a panel study on the GCC (Gulf Cooperation Council) countries (UAE, Bahrain, Saudi Arabia, Kuwait, Qatar, and Oman). He showed that remittance outflows negatively affected the real GDP growth rate of Saudi Arabia, whereas investments had a positive impact on their economies all over the GCC. The policy implication was that expatriates should be encouraged to keep their families with them, since this would reduce remittance outflows for the GCC countries. Furthermore, the study also found that remittance outflows negatively affected inflation in Bahrain, while having no significant impact on other GCC countries. This was particularly since Bahrain was the smallest country in the study and thus most vulnerable to price level drops due to increases in remittance outflows and vice versa.

DATA AND METHODOLOGY

The data for this study has been collected from the World Bank for 4 countries of the Indian Subcontinent (Pakistan, India, Bangladesh, and Sri Lanka) over the 1975-2015 period. Here, we are primarily interested in growth in remittance inflows (both real and nominal), real GDP growth, and inflation. The following charts depict the behavior of these key variables over time:



The analysis is divided into two parts. The first part looks at the impact of growth in real remittances on growth in real

GDP, while the second part examines the impact of growth in nominal remittances on inflation. Four models are estimated for each, all using panel data from 1975 through 2015. The first model does not include fixed effects, while the second model includes both time and country fixed effects. Next, separate Wald tests are conducted to see if the time dummy variables and the country dummy variables are needed. Then, based on the Wald test results in Model 2, we estimate Models 3 and 4. Model 4 includes four interaction variables in order to identify the effects on individual countries separately. Finally, we conduct the Wald test in order to see whether it is reasonable to assume that remittance inflows affect real GDP and inflation of the four countries differently.

In the second part for inflation, we initially thought of using one-year lags for growth in nominal remittance inflows, because we expected the effect of remittance inflow growth on inflation would not be realized immediately as explained by the Keynesian view of sticky prices. Not all remittances are consumed simultaneously as they are received by the households, and even if they were to be consumed immediately, the price levels may not change immediately. However, based on the preliminary estimations, we found that the effect of remittance inflows was realized within a year, and hence the lagged variables were not used for the estimations in this paper.

Furthermore, since it is essential to take into consideration other factors that may play a role in affecting the dependent variables, we include several control variables from economic theory: These are growth in government spending, money supply, consumption, exports and imports of goods and services, and population in addition to the rate of depreciation in the domestic currency. Details of these variables are provided in the following table:

Variable	Brief description	Details
g	Real GDP growth rate: growth in real gross domestic product using constant 2010 USD.	GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
RREM	Growth in real remittance inflows using constant 2010 USD.	Personal remittances comprise personal transfers and compensation of employees. These include all current transfers between resident and nonresident individuals in cash or kind.
NREM	Growth in nominal remittance inflows using current USD.	
RCON	Growth in real household final consumption using constant 2010 USD.	The term that has traditionally been used is private consumption.
RGOV	Growth in real general government final consumption expenditure using constant 2010 USD.	This variable includes purchase of goods and services (including employee compensations) and expenditure on national defense and security (but excludes the military expenditure that is a part of government capital formation).
NGOV	Nominal general government final consumption expenditure in current USD.	
NSAV	Nominal gross domestic savings in current USD.	These are calculated as GDP less final consumption expenditure (total consumption)
RIMP	Growth in real imports of goods and services using constant 2010 USD.	Imports and exports of goods and services include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.
NIMP	Growth in nominal imports of goods and services using current USD.	
REXP	Growth in real exports of goods and services using constant 2010 USD.	
NEXP	Growth in nominal exports of goods and services using current USD.	
RMS	Real money supply growth (broad money) using constant 2010 USD.	This variable includes currency outside banks, demand deposits (other than those of the central government), the time, savings, and foreign currency deposits of resident sectors (other than the central government), bank and traveler's checks, and other securities such as certificates of deposit and commercial paper.
NMS	Nominal money supply growth (broad money) using current USD.	
POP	Population growth rate (for the total population living in the country).	
INF	The inflation rate, computed using the Consumer Price Index (CPI). This is computed using the changes in log (CPI) multiplied by a hundred.	

DEP This is the rate of depreciation of domestic currency with respect to the USD (nominal exchange rate), used in the inflation model (Study 2) as a control variable, being a major determinant of inflation. Hence this can be seen as the growth rate for E (which is the annual percentage increase in price of 1 USD)

All the above variables were used as growth rates, leaving us with one less observation (resulting in the exclusion of the year 1975 from our study). The primary source of data is the World Bank database, retrieved on March 3, 2017

EMPIRICAL ESTIMATIONS AND RESULTS

This section is divided into two parts. The first part examines the effect of real remittance growth on real economic growth, and the second part studies the effect of nominal remittance growth on inflation.

EMPIRICAL ESTIMATIONS AND RESULTS FOR REAL GDP GROWTH

Model 1 for real GDP growth contains no fixed effects as follows:

$$g_{it} = \alpha_0 + \beta_1 RREM_{it} + \beta_3 RCON_{it} + \beta_4 RGOV_{it} + \beta_5 RIMP_{it} + \beta_6 REXP_{it} + \beta_7 RMS_{it} + \beta_8 POP_{it} + \mu_{it} \quad (1)$$

The OLS estimates of Model 1 are reported in column 2 of Table 1. We then include time and country fixed effects using dummy variables in the following model:

$$g_{it} = \beta_1 RREM_{it} + \beta_2 RCON_{it} + \beta_3 RGOV_{it} + \beta_4 RIMP_{it} + \beta_5 REXP_{it} + \beta_6 RMS_{it} + \beta_7 POP_{it} + \alpha_1 t_{77} + \alpha_2 t_{78} + \ldots + \alpha_{39} t_{15} + \Upsilon_1 PAK + \Upsilon_2 IND + \Upsilon_3 BAN + \Upsilon_4 SRI + \mu_{it} \quad (2)$$

The OLS estimates of Model 2 are reported in column 3 of Table 1. Next, we conduct separate Wald tests on the fixed effect dummy variables. We reject the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{39}$ with a p-value of 0.001, concluding that the intercept term significantly varies across time and therefore, the time dummy variables are collectively considered important in the model. However, when we repeat the test for the country dummy variables, we are unable to reject the null hypothesis that $\Upsilon_1 = \Upsilon_2 = \Upsilon_3 = \Upsilon_4$ with a p-value of 0.466. Therefore, we conclude that the intercept

term is not significantly different across countries and therefore, formulate the following model with time fixed effects only:

$$g_{it} = \beta_1 RREM_{it} + \beta_2 RCON_{it} + \beta_3 RGOV_{it} + \beta_4 RIMP_{it} + \beta_5 REXP_{it} + \beta_6 RMS_{it} + \beta_7 POP_{it} + \alpha_1 t_{76} + \alpha_2 t_{77} + \ldots + \alpha_{40} t_{15} + \mu_i \quad (3)$$

The OLS estimates of Model 3 are reported in column 4 of Table 1. We again conduct the Wald test for the time dummies by testing the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{40}$ which we reject with a p-value of 0.001, hence concluding that the intercept term varies across the years. In our final model, we add four interaction variables to observe the effect of growth in real remittance inflows on growth in real GDP for each country separately, as follows:

$$g_{it} = \beta_{1,1} RREM_{it} PAK + \beta_{1,2} RREM_{it} IND + \beta_{1,3} RREM_{it} BAN + \beta_{1,4} RREM_{it} SRI + \beta_2 RCON_{it} + \beta_3 RGOV_{it} + \beta_4 RIMP_{it} + \beta_5 REXP_{it} + \beta_6 RMS_{it} + \beta_7 POP_{it} + \alpha_1 t_{76} + \alpha_2 t_{77} + \ldots + \alpha_{40} t_{15} + \mu_{it} \quad (4)$$

The OLS estimates of Model 4 are reported in column 5 of Table 1. Once again, we are able to reject the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{40}$ with a p-value of 0.001. Additionally, we also test whether the parameters of the interaction variables are significantly different from each other. Based on the Wald test results, we reject the null hypothesis that $\beta_{1,1} = \beta_{1,2} = \beta_{1,3} = \beta_{1,4}$ with a p-value of 0.001, concluding that remittance inflows affect the countries in the sample differently.

The results in Model 4 illustrate that the parameter estimates of remittance inflows for Bangladesh and Sri Lanka are both negative. The parameter estimate for Sri Lanka is statistically significant while the parameter estimate for Bangladesh is statistically significant using a one-tailed test with an absolute t-value of 1.55. Our results make sense since Sri Lanka is the smallest country in the sample and, therefore, the most vulnerable to a change in remittance inflows. It was found that a one percent point increase in real remittances results in a 0.21 percent point decrease

in real GDP of Sri Lanka, while reducing Bangladesh's real GDP by only 0.05 percent point. One explanation would be that remittances are generally consumed by the households and do not result in an increase in investment that is required for economic expansion. An alternative view explained by Mekawy (2016) is that an increased reliance on these remittances results in a higher reservation wage of the households, which results in a lower willingness to work at the prevailing market wage. This consequently increases unemployment or reduces the labor force participation, resulting in a decline in real economic growth.Finally, we see that increased government spending has worsened real economic growth due to the crowding out effect, while monetary policy has played a significant role in expanding real output

Table 1: Dependent Variable: Real GDP growth rate – 1976 to 2015

	Model (1)	Model (2)	Model (3)	Model (4)
RREM	**-0.053 (2.13)**	-0.038 (1.41)	**-0.048 (1.78)**	
RREM_PAK				-0.017 (0.56)
RREM_IND				0.011 (0.25)
RREM_BAN				**-0.052 (1.55)**
RREM_SRI				**-0.210 (4.00)**
Control Variables:				
RCON	0.103 (0.69)	-0.062 (0.34)	-0.025 (0.13)	-0.151 (0.92)
RGOV	**-0.210 (1.91)**	**-0.192 (2.27)**	**-0.199 (2.20)**	**-0.225 (2.49)**
RIMP	0.019 (0.38)	0.050 (0.96)	0.042 (0.80)	0.065 (1.35)
REXP	-0.028 (0.54)	-0.042 (0.89)	-0.044 (0.97)	-0.060 (1.31)
RMS	**0.692 (9.86)**	**0.708 (7.50)**	**0.691 (7.28)**	**0.664 (8.43)**
POP	-0.123 (0.18)	-0.491 (0.20)	0.809 (1.05)	0.143 (0.18)
Year Fixed Effects	No	Yes	Yes	Yes
Country Fixed Effects	No	Yes	No	No
Adjusted R-squared	0.64	0.64	0.64	0.67
Number of Observations	160	160	160	160

Note: Countries included in the sample are Pakistan, India, Bangladesh and Sri Lanka. Numbers in parentheses are the absolute (Newey West) t-statistics that have been corrected for hetroskedasticity and serial auto-correlation. Model 2 has country dummy variables that replace the intercept. Depending on the data point that whether if it is from Pakistan, India, Bangladesh, or Sri Lanka, the dummy variables(PAK, IND, BAN, or SRI) would take the value of 1, and zero otherwise. Similarly, Models 2, 3 and 4 include time dummy variables which take the value of 1 if the data point corresponds to the specified year and zero otherwise. The coefficients are rounded to the nearest 3rd decimal place, while the t-values in parenthesis are rounded to the nearest 2nd decimal place.

EMPIRICAL ESTIMATIONS AND RESULTS FOR INFLATION

Model 1 for inflation, which was estimated without any fixed effects is:

$$INF_{it} = \alpha_0 + \delta_1 NREM_{it} + \delta_2 NGOV_{it} + \delta_3 NIMP_{it} + \delta_4 NEXP_{it} + \delta_5 NMS_{it} + \delta_6 DEP_{it} + \mu_{it} \quad (1)$$

The OLS estimates of Model 1 are reported in column 2 of Table 2. We then include time and country fixed effects using dummy variables in the following model:

$$INF_{it} = \delta_1 NREM_{it} + \delta_2 NGOV_{it} + \delta_3 NIMP_{it} + \delta_4 NEXP_{it} + \delta_5 NMS_{it} + \delta_6 DEP_{it} + \alpha_1 t_{77} + \alpha_2 t_{78} + \ldots + \alpha_{39} t_{15} + \Upsilon_1 PAK + \Upsilon_2 IND + \Upsilon_3 BAN + \Upsilon_4 SRI + \mu_{it} \quad (2)$$

The OLS estimates of Model 2 are reported in column 3 of Table 2. Next, we conduct Wald tests on fixed effect dummy variables. We reject the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{39}$ with a p-value of 0.001. Additionally, we also reject the null hypothesis that $\Upsilon_1 = \Upsilon_2 = \Upsilon_3 = \Upsilon_4$ with a p-value of 0.019, concluding that time and country fixed effects are both important and should be included. Subsequently, we introduce interaction variables in Model 3, to find out the effect of growth in nominal remittance inflows on inflation of each country separately, as follows:

$$INF_t = \delta_{1,1} NREM_{it} PAK + \delta_{1,2} NREM_{it} IND + \delta_{1,3} NREM_{it} BAN + \delta_{1,4} NREM_{it} SRI + \delta_2 NGOV_{it} + \delta_3 NIMP_{it} + \delta_4 NEXP_{it} + \delta_5 NMS_{it} + \delta_6 DEP_{it} + \alpha_1 t_{77} + \alpha_2 t_{78} + \ldots + \alpha_{39} t_{15} + \Upsilon_1 PAK + \Upsilon_2 IND + \Upsilon_3 BAN + \Upsilon_4 SRI + \mu_{it} \quad (3)$$

The OLS estimates of Model 3 are reported in column 4 of Table 2. We again conduct the Wald tests for fixed effect dummy variables and reject the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{39}$ with a p-value of 0.001. However, we fail to reject the null hypothesis that $\Upsilon_1 = \Upsilon_2 = \Upsilon_3 = \Upsilon_4$ with a p-value of 0.445, concluding that the intercept term is significantly different across time, but the same across countries. Furthermore, in order to determine whether the effect of growth in nominal remittance inflows on inflation is the same across countries or not, we test the null hypothesis that $\delta_{1,1} = \delta_{1,2} = \delta_{1,3} = \delta_{1,4}$, which we reject with a p-value of 0.001, concluding that the slope parameters significantly differ across countries. Also, since the country dummy variables are now insignificant, we can exclude them and estimate our final model as follows:

$$INF_t = \delta_{1,1}NREM_{it}PAK + \delta_{1,2}NREM_{it}IND + \delta_{1,3}NREM_{it}BAN + \delta_{1,4}NREM_{it}SRI + \delta_2 NGOV_{it} + \delta_3 NIMP_{it} + \delta_4 NEXP_{it} + \delta_5 NMS_{it} + \delta_6 DEP_{it} + \alpha_1 t_{76} + \alpha_2 t_{77} + \ldots + \alpha_{40} t_{15} + \mu_{it} \quad (4)$$

The OLS estimates of Model 4 are reported in column 5 of Table 2. Once again, we see from the Wald test that the time dummies are significantly different from each other as we reject the null hypothesis that $\alpha_1 = \alpha_2 = \ldots = \alpha_{39}$ with a p-value of 0.001. We also reject the null hypothesis that $\delta_{1,1} = \delta_{1,2} = \delta_{1,3} = \delta_{1,4}$, which we reject with a p-value of 0.001. The parameters of the interaction variables, which represent the effect of nominal remittance inflows on inflation, greatly vary across countries.

The results in Model 4 illustrate that the parameter estimate of remittance inflows for Sri Lanka is highly significant. Recipient households of remittances increase their demand for goods and services which as a result, raises price levels in the country. Specifically for Sri Lanka, we found that a 1 percent point rise in nominal remittance inflows resulted in an increase in inflation by 8.62 percent points. Our results make sense since Sri Lanka is the smallest country in the sample and, therefore, the most vulnerable to a change in remittance inflows. In 2015, personal remittance inflows alone, were as high as 8.5 percent of Sri Lanka's GDP (World Bank). This ratio was the highest when compared with other countries in the sample. Additionally, we also find that high government expenditure in the Indian Subcontinent is associated with high inflation. Conversely, we do not find statistically significant results for Bangladesh as found by Khan and Islam (2013). Nevertheless, this paper does not contradict the findings of Khan and Islam (2013), but extends their study to other countries of the Indian Subcontinent (Pakistan, India, and Sri Lanka), with more recently available data.

Table 2: Dependent Variable: Inflation rate – 1976 to 2015

	Model (1)	Model (2)	Model (3)	Model (4)
NREM	-1.143 (0.75)	1.255 (0.66)		
NREM_PAK			4.595 (1.34)	4.481 (1.31)
NREM_IND			-2.737 (0.96)	-1.921 (0.75)
NREM_BAN			-0.710 (0.35)	-1.997 (1.07)
NREM_SRI			5.456 (1.31)	**8.624 (3.18)**
Control Variables:				
NGOV	**7.521 (1.87)**	**7.600 (1.93)**	**7.385 (1.89)**	**8.224 (2.33)**
NIMP	5.221 (1.30)	0.516 (0.17)	-1.012 (0.32)	-1.274 (0.41)
NEXP	3.143 (0.92)	-0.511 (0.16)	-0.053 (0.02)	-0.076 (0.03)
NMS	4.590 (0.64)	0.891 (0.15)	-3.346 (0.50)	-5.177 (0.86)
DEP	**32.894 (3.74)**	**19.672 (2.87)**	11.889 (1.30)	10.384 (1.18)
Year Fixed Effects	No	Yes	Yes	Yes
Country Fixed Effects	No	Yes	Yes	No
Adjusted R-squared	0.13	0.45	0.47	0.47
Number of Observations	160	160	160	160

Note: Countries included in the sample are Pakistan, India, Bangladesh and Sri Lanka. Numbers in parentheses are the absolute (Newey West) t-statistics that have been corrected for hetroskedasticity and serial auto-correlation. Models 2 and 3 have country dummy variables that replace the intercept. Depending on the data point that whether if it is from Pakistan, India, Bangladesh, or Sri Lanka, the dummy variables(PAK, IND, BAN, or SRI) would take the value of 1, and zero otherwise. Similarly, Models 2, 3 and 4 include time dummy variables which take the value of 1 if the data point corresponds to the specified year and zero otherwise. The coefficients are rounded to the nearest 3rd decimal place, while the t-values in parenthesis are rounded to the nearest 2nd decimal place.

CONCLUSION AND POLICY RECOMMENDATIONS

The findings of this paper show that remittance inflows have adversely affected real economic growth of Bangladesh and Sri Lanka during the period 1976-2015. Additionally, over the same period, faster growth in remittance inflows resulted in higher inflation in Sri Lanka. Both these factors tell us that remittance inflows would serve as a very poor macroeconomic tool for development.

As households in Bangladesh and Sri Lanka get more and more remittances, their reservation wage rises, which means that they would no longer be willing to work at a wage that they would otherwise have happily accepted. Hence, although these remittances may improve their living standards, they may reduce the likelihood that the receivers would participate in the labor force, which would, as a result, hinder economic growth.

Also, what we deduce from the findings of this paper is that macroeconomic policies for developing countries must be carefully devised, considering the potential impact that remittance inflows would have on inflation. In particular, they must consider that remittance inflows would cause inflation as we see in the case of Sri Lanka. It is, therefore, important to understand that depending on a continued source of funds from other countries may not be an optimal solution for the developing world. Sri Lanka in particular, should, therefore, reduce their reliance on remittance inflows and attempt to achieve real economic growth through other competitive means such as trade, commerce, and industry. In general, developing countries must create opportunities for their workforce domestically, by providing the necessary infrastructure, law and order to enable the hardworking population to prosper without having to migrate to a foreign land.

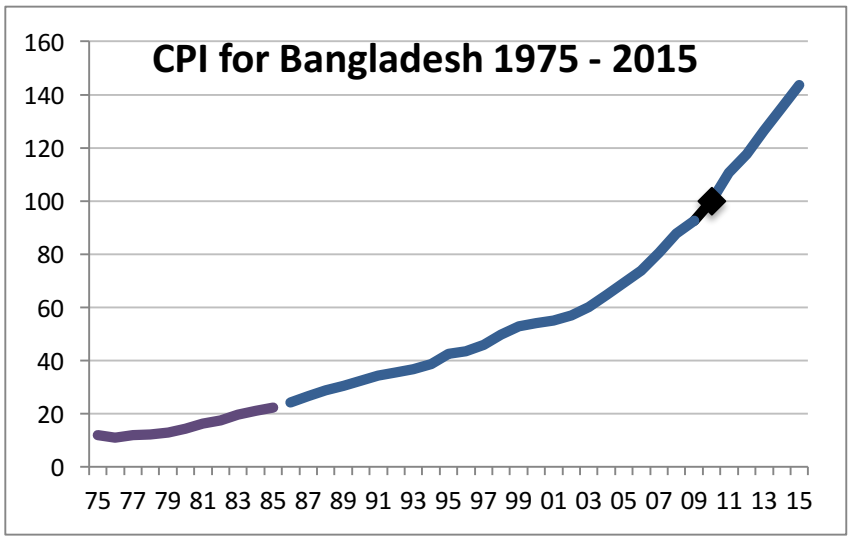
Appendix – Estimating Inflation for Bangladesh for the missing years

The CPI for Bangladesh from 1975 until 1985 was not available; however, we found that the CPI for Bangladesh is strongly correlated with the CPI for the other three countries for 1986-2015. As such, the numbers in the following table have been comp

uted using data from 1986 to 2015:

Correlation with CPI Bangladesh	1.000	0.997	0.996	0.993
CPI in 1986	24.280	17.081	13.320	8.704

We can see from this table that the CPI of Bangladesh is most strongly correlated with the CPI of its neighboring country India. Therefore, for the purpose of this study, the CPI of India has been used to substitute for the CPI of Bangladesh over the years 1975 to 1985, after adjusting for the proportionate difference in the year 1986 between the CPI for India and the CPI for Bangladesh. The following chart distinguishes between the CPI from 1986 to 2015 and the estimated CPI from 1975 to 1985:



Note: Actual values are in blue, while estimated values are in purple. The point in bold is that of 2010, the base year.

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USING PROFESSIONAL PREDICTIONS OF OUTPUT AND INFLATION TO FORECAST THE US 10-YEAR TREASURY RATE

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ABSTRACT

Economic agents and policy-makers constantly seek for accurate forecasts of macroeconomic variables, with the interest rate receiving the widest attention. In this paper, we focus on forecasting the US 10-year Treasury bond rate (TBR) by using professional forecasts of output growth and inflation from the Survey of Professional Forecasters (SPF). Specifically, we formulate a vector autoregressive (VAR) model with three variables; the TBR, the SPF forecasts of output growth, and the SPF forecasts of inflation. Using recursive estimation, with the data starting from 1981, we generate the one-, two-, three-, four-quarter-ahead forecasts of the TBR for 1992-2016. Our results show that both the SPF and VAR forecasts are biased. However, we find that the two-, 3, and four-quarter-ahead VAR forecasts contain distinct information from those of the random walk forecasts, and combining the VAR and random walk forecasts improve accuracy. This indicates that researchers can utilize the SPF forecasts of output growth and inflation in order to produce more accurate forecasts of the TBR.

INTRODUCTION

Economic agents and policymakers constantly seek for accurate forecasts of macroeconomic and financial variables, with the interest rate receiving the widest attention. This is due to the fact that agents need accurate forecasts of interest rates in order to make more informed saving and investments decisions. Similarly, policy makers need accurate forecasts in order to make more informed macroeconomic policy decisions.

In this paper, we focus on forecasting the US 10-year Treasury bond rate (TBR), which is used as a benchmark in pricing mortgages and many other types of consumer loans. The TBR is also among the leading indicators for US economic activity. Due to its importance, there are various surveys aiming to collect the forecasts of the TBR. One of these is the Survey of Professional Forecasts (SPF), conducted quarterly by the Federal Reserve Bank of Philadelphia. The SPF collects the professional forecasts of the TBR in addition to the forecasts of output growth, inflation, and other major indicators.

The purpose of this paper is to use a vector autoregressive (VAR) model in order to forecast the TBR. This VAR model includes three variables: the TBR, the SPF forecasts of output growth, and the SPF forecasts of inflation. We use recursive information with the data starting from 1981 to generate the one-, two-, three-, and four-quarter-ahead forecasts for 1992-2016.

We then compare the VAR forecasts to the SPF and random walk forecasts of the TBR. Our results show that both the SPF forecasts and VAR forecasts of TBR are biased, and, consistent with the efficient market hypothesis, fail to beat random walk forecasts. However, we find that the two-, three-, and four-quarter-ahead VAR forecasts contain distinct information from that of the random walk forecasts, and combining the VAR and random walk forecasts improve accuracy.

Based on our findings, we recommend researchers utilize the SPF forecasts of output growth and inflation in order to produce accurate forecasts of the TBR.

This paper is organized as follows: Section 2 includes the literature review. Section 3 describes the data, the SPF, VAR, and random walk forecasts of the TBR. Section 4 presents the forecast evaluation results. Finally, Section 5 summarizes our findings and concludes the paper.

LITERATURE REVIEW

In this section, we first present the efficient market hypothesis, which simply states that the best forecast of the long-term interest rate is today's rate (Reichenstein, 2006, p.116). We then go on to review the empirical findings of the existing studies in the literature.

EFFICIENT MARKET HYPOTHESIS

The efficient market hypothesis states that it is impossible to beat a random walk forecast. This is because the random walk forecast includes all the relevant information that is required for forecasting future rates. To demonstrate, let f_t represent the one-period forward rate at time *t* and $R_{n,t}$ denote the pure discount (or spot) rate at time *t* on an n-period bond. According to the pure expectations hypothesis, the forward rate at time t is equal to the expected one-period discount rate at time t (denoted by r_t), Therefore, $f_t = r_t$ implies that:

$$(1 + R_{n,t})^n = (1 + r_t)(1 + r_{t+1})(1 + r_{t+2}) \dots (1 + r_{t+n-1)})$$

In other words, the pure expectations theory argues that that today's n-period discount rate is the average of today's one-period discount rate and one-period discount rates expected to prevail over the next *n-1* periods (Reichenstein, 2006). Raising to the power of $\frac{1}{n}$ and subtracting both sides by 1 gives us:

$$R_{n,t}=(1 + r_t)(1 + r_{t+1})(1 + r_{t+2}) \dots \left(1 + r_{t+n-1)}\right)^{\frac{1}{n}} - 1$$

Substituting f_t back instead of r_t for clarification purposes and taking the linearized version of this equation shows the following (Schiller, 1979):

$$R_{n,t+1} - R_{n,t} = \frac{1}{n}((_{t+n}f_{t+1} - \ _tf_t) + (_{t+1}f_{t+1} - \ _{t+1}f_t) + \ldots + (_{t+n-1}f_{t+1} - \ _{t+n-1}f_t))$$

Here, $_{t+1}f_t$ represents the one-period forward rate found at time *t* for period *t+1*. Taking the expectation of both sides, we have:

$$E_t[R_{n,t+1}] - R_{n,t} = \frac{1}{n}(_{t+n}f_t - \ _tf_t) \qquad (1)$$

The right side of the equation goes to zero as n approaches a large number, thus we will end up with the following simple equation:

$$E_t[R_{n,t+1}] \approx R_{n,t}$$

which states that the optimal forecast of the long-term interest rate is today's rate. If we relax the the time-invariant term-premium assumption and include the expected change in the term premium over time in equation (1) and substitute r_t for f_t, we end up with:

$$E_t[R_{n,t+1}] - R_{n,t} = \frac{1}{n}(r_{t+n} - r_t) + E_t[\Omega^n_{t+1}] - \Omega^n_t$$

which shows that if the expected near-term change in the term premium ($E_t[\Omega^n_{t+1}] - \Omega^n_t$) at time t is minimal then, again, the long-term interest rate exhibits the characteristics of a random walk. Given the above equation, we cannot make any theoretical conclusions about the behavior of the short-term interest rates. That is, the short-term interest rates (r_t) may or may not exhibit random walk behavior and, as Pesando (1979) argues, it is basically an empirical question (Baghestani et al., p. 113).

LITERATURE FINDINGS

We start off by examining Friedman's (1980) seminal paper, "Survey evidence on the 'rationality' of interest rate expectations" which set a lot of groundwork for economists to study the issue of the accuracy and usefulness of professional forecasts. Friedman studies the forecasts

that are collected through a survey taken by *The Goldsmith Nagan Bond and Money Market Letter*. The Goldsmith Nagan letter has been conducting these surveys since 1969 by asking around 50 market professionals to provide their one- and two-quarter-ahead expectations of interest rates. The results are then published as the consensus (mean) of the individual responses. The survey includes 11 different types of interest rates, but Friedman's study focuses on 6 of them: 1) federal funds, 2) three-month US Treasury bills, 3) six-month Eurodollar certificates of deposit, 4) twelve-month US Treasury bills, 5) new issues of high-grade long-term utility bonds, and 6) seasoned issues of high-grade long-term municipal bonds. Friedman's results indicate that professionals made biased predictions and did not efficiently use the information contained in past interest rate changes. More relevant to our paper is Friedman's finding on the forecasts of the long-term interest rate. His results show that professionals fail to "exploit efficiently the information contained in common macroeconomic and macro-policy variables other than the money stock" (p. 453). Friedman's (1980) study has motivated researchers to further study different types of survey data and see whether or not these forecasts are also biased and fail to account for important information. In what follows, we look at the findings of some of these studies.

Brooks and Gray (2004) examine the accuracy of interest rate forecasts published by the *Wall Street Journal* (WSJ). The WSJ survey has been conducting a survey since 1982 by asking around 64 experts to provide their forecasts of the short-term and long-term interest rates around June and December of each year. Brooks and Gray find that the WSJ consensus (mean) forecasts predict the directional change of the TBR correctly only 35% of the time. Furthermore, the forecast errors of the naïve forecasts are lower than those of the WSJ consensus forecasts, indicating that the consensus forecasts are less accurate than the random walk.

Reichenstein (2006) shows that Brooks and Gray's results are consistent with the efficient market hypothesis and other empirical work. He goes on to argue that the naive model provides not only more accurate forecasts but also pass several tests which indicate that the naive forecast is rational.

Mitchell and Pearce (2007) also look at the survey forecasts published by the *Wall Street Journal*. They show that most experts produce unbiased forecasts but none of them beat the random walk when it comes to directional change. Furthermore, they also find that the majority of survey forecasts of short-term interest rates are as accurate as the naïve forecasts. On the other hand, the survey forecasts of long-term interest rates are less accurate than the naïve forecasts.

Several other studies examine the accuracy of Blue Chip consensus forecasts of interest rates. The Blue Chip surveys around 50 professional forecasters around the beginning of each month. The survey participants are asked to provide their forecasts of interest rates for the current quarter, one-, two-, three-, and four-quarter-ahead. Then, the survey uses the individual forecasts to calculate and report the consensus (median) response in the*Blue Chip Financial Forecasts* (BCFF). Baghestani (2009) finds that the Blue Chip consensus forecasts of the TBR and Moody's Aaa corporate bond rate are biased and inferior to the random walk forecasts. In addition, these forecasts fail to accurately predict directional change. Therefore, we can see that the results obtained by Brooks and Gray (2004), Reichenstein (2006), Mitchell and Pearce (2007), and Baghestani (2009) all converge towards agreeing with the efficient market hypothesis, since they all show that professional forecasts are inferior to random walk forecasts.

Next, Baghestani et al. (2015) look at the accuracy of Blue Chip forecasts of short and long-term interest rates in addition to forecasts of the country risk premium for several countries for 1999-2008. They show that the long-term interest rate forecasts do not beat the random walk,

just as the efficient market hypothesis would suggest. On the other hand, their findings on the accuracy of short-term forecasts are mixed. Furthermore, Baghestani et al. (2015, p. 1) show that "Blue Chip is more (less) accurate in predicting country risk premiums associated with short-term (long-term) interest rates".

However, in another study, Baghestani's (2010) findings go against the efficient market hypothesis. More specifically, he formulates an augmented-autoregressive (A-A) model of the TBR that uses the predictive information in expected inflation and past information in the TBR. He shows that the A-A forecasts outperform the random walk forecasts. Perhaps, this may be because expectations may not be rational as assumed by the efficient market hypothesis.

THE SPF, VAR AND RANDOM WALK FORECASTS OF TBR

In the middle of every quarter, the Federal Reserve Bank of Philadelphia conducts a survey of around 50 private professional forecasters to gather the forecasts of the TBR in addition to the forecasts of outgrowth and inflation, among others. More specifically, each forecaster is asked to provide their forecast for the current-quarter, one-, two-, three-, four-quarter-ahead. The survey uses the individual forecasts to calculate and report the consensus (median) forecasts. The SPF forecasts of TBR are available from 1992 to 2016. For example, in the middle of February 1992, the forecasters were asked to provide their forecasts for 1992Q1, 1992Q2, 1992Q3, 1992Q4, and 1993Q1. Also, in the middle of November 2015, the forecasters were asked to provide their forecasts for 2015Q4, 2016Q1, 2016Q2, 2016Q3, and 2016Q4. This means that the current-quarter forecasts start from 1992Q1 and run through 2015Q4, the one-quarter-ahead forecast starts from 1992Q2 and run through 2016Q1, the two-quarter forecasts start from 1992Q3 and run through 2016Q2, the three-quarter forecasts start from 1992Q4 through 2016Q3, and the four-quarter forecast starts from 1993Q1 through 2016Q4.

The VAR model includes the actual TBR and the SPF forecasts of both output growth and inflation as follows:

$$\begin{cases} R_t = a_{10} + b_{11} R_{t-1} + b_{12} R_{t-2} + c_{11} Y_{t-1} + c_{12} Y_{t-2} + d_{11} \pi_{t-1} + d_{12} \pi_{t-2} + u_{1t} \\ Y_t = a_{20} + b_{21} R_{t-1} + b_{22} R_{t-2} + c_{21} Y_{t-1} + c_{22} Y_{t-2} + d_{21} \pi_{t-1} + d_{22} \pi_{t-2} + u_{2t} \\ \pi_t = a_{30} + b_{31} R_{t-1} + b_{32} R_{t-2} + c_{31} Y_{t-1} + c_{32} Y_{t-2} + d_{31} \pi_{t-1} + d_{32} \pi_{t-2} + u_{3t} \end{cases}$$

where R_t is the actual TBR, Y_t is the SPF forecast of output (GDP) growth, and π_t is the SPF forecast of the GDP deflator inflation forecast. More specifically, Y_t is the average of the SPF current-quarter, one-, two-, three-, four-quarter-ahead forecasts of output growth made in the middle of quarter *t*, and π_t is the average of the SPF current quarter, one-, two-, three-, four-quarter-ahead forecasts of inflation made in the middle of quarter *t*.[1]

We choose to include forecasts of output growth and inflation in our VAR model since theory suggests that both of these variables are relevant in determining the interest rate. Expectations of positive output growth send a message to policy-makers that they should fight off the inflation that is bound to happen by increasing the interest rate. In addition, forecasts of inflation are important determinants of the TBR. For instance, when expected inflation is predicted to increase, the nominal interest rate would increase. This is based on Irving Fisher's *expectations augmented Fisher equation* which states that where the nominal interest rate is equal to the real

[1]The data on the 10-year Treasury rate (TBR) are obtained from the Federal Reserve Bank of St. Louis (https://fred.stlouisfred.org/). The data on the SPF output growth and inflation forecasts are taken from the Federal Reserve Bank of Philadelphia's website (https://www.philadelphiafed.org/). The SPF provides both the mean and median forecasts. We have chosen the median in order to leave out any perverse values (extremely large or small) that could heavily skew the consensus forecasts.

interest rate plus the expected rate of inflation. Hence, it is clear that an increase in expected inflation leads to an increase in the nominal interest rate.

To generate the VAR forecasts of the TBR, we estimate the VAR model recursively, with the data starting in 1981Q3.[2] That is, we start with estimating the VAR model for 1981Q3-1991Q4 and use the coefficient estimates to forecast the TBR for 1992Q1-1993Q1. These forecasts are the VAR current quarter, one-, two-, three-, four-quarter-ahead forecasts of the TBR made in the middle of 1992Q1. We then estimate the VAR model for 1981Q3-1992Q1 and use the updated coefficient estimates to forecast the TBR for 1992Q2-1993Q2. These forecasts are the VAR current, one-, two-, three-, four-quarter-ahead forecasts of the TBR made in the middle of 1992Q2. We continue this process until the last forecasts for 2016 are generated.

The random walk forecasts are generated from the following model:

$$PR_{t+f} = R_{t-1} \quad f = 0, 1, 2, 3, \text{ and } 4$$

where PR_{t+f} is the *f*-quarter-ahead random walk forecast of the TBR, since it is equal to the actual TBR in quarter *t-1* which is the rate most recently known at the time of the forecast (or the middle of quarter *t*)

FORECAST EVALUATION RESULTS

As discussed above, we have three sets of forecasts of the TBR: the SPF forecasts, the VAR forecasts, and the random walk forecasts. In what follows, we examine whether the one-, two-, three-, four-quarter-ahead SPF and VAR forecasts are unbiased, and whether they are free of systematic bias. We then examine whether the SPF and VAR forecasts are more accurate than the random walk forecasts. Finally, we examine whether combining the forecasts improve accuracy.

[2] The SPF forecasts of output growth and inflation are available starting 1981Q3.

To start, we use the following test equation to see whether the SPF and VAR forecast are unbiased:

$$A_{t+f} = \alpha + \beta P_{t+f} + u_{t+f} \qquad (1)$$

where A_{t+f} is the actual TBR in quarter t+*f* and P_{t+f} is a general notation representing the SPF and VAR forecasts made in the middle of quarter *t*. We use the Newey and West (1987) method to correct for both heteroscedasticity and the implied autocorrelation in the error term u_{t+f}. Failure to reject the joint null hypothesis (H_0: $\alpha = 0$ and $\beta = 1$) means that the forecast is unbiased.

Table 1 presents the OLS estimates of the test equation in (1). The estimates of β in rows 1-4 range from 0.969 to 1 for the SPF and are significantly different from zero. The same is true for the VAR forecasts in rows 5-8 with the estimates of β ranging from 0.773 to 0.933.Consistent with these results, the calculated adjusted R^2 is high. However, the p-value for testing the joint null hypothesis of unbiasedness (H_0: $\alpha = 0$ and $\beta = 1$) for every forecast is 0.001. Accordingly, we reject the null hypothesis and conclude that the SPF and VAR forecasts are all biased.

Table 1: Test of Unbiasedness

		$A_{t+f} = \alpha + \beta P_{t+f} + u_{t+f}$			
Row no.	f	α	β	$\bar{R}^2$	P-value
SPF Forecasts					
1	1	-0.108(0.75)	0.978[a] (31.73)	0.91	0.001
2	2	-0.214(0.89)	0.969[a] (18.66)	0.84	0.001
3	3	-0.405(1.20)	0.981[a] (13.77)	0.79	0.001
4	4	-0.660(1.48)	1.000[a] (11.26)	0.75	0.001
VAR Forecasts					
5	1	0.150(1.43)	0.933[a] (38.66)	0.93	0.001
6	2	0.283(1.07)	0.857[a] (16.10)	0.83	0.001
7	3	0.353(0.86)	0.803[a] (10.41)	0.76	0.001
8	4	0.344(0.67)	0.773[a] (8.40)	0.73	0.001

Note: The calculated absolute t-statistics are in parentheses. Coefficient estimates with an exponent of "a" are significant at the 10% level or lower.

Next, we follow Holden and Peel (1990) and estimate the following test equation,

$$A_{t+f} - P_{t+f} = \alpha' + u_{t+f} \quad f = 0, 1, 2, 3, \text{ and } 4 \qquad (2)$$

Note that $(A_{t+f} - P_{t+f})$ is the forecast error and, therefore, α' is the mean forecast error (ME). Failure to reject the null hypothesis that H_0: $\alpha' = 0$ means that the ME = 0 and, therefore, the forecast is free of systematic error.

Table 2 presents the OLS estimates of the test equation in (2). The estimates of α' in rows 1-4 range from -0.638 to -0.209 for the SPF and are significantly different from zero. The same is true for the VAR forecasts in rows 5-8 with the estimates of α' ranging from -0.835 to -0.157. Also, compared to the mean absolute forecast errors (MAEs), the ME estimates are large. Accordingly we conclude that the SPF and VAR forecasts fail to be free of systematic bias.

Table 2: Test of systematic bias

		$A_{t+f} - P_{t+f} = \alpha' + u_t$	
Row no.	f	α' = ME	MAE
SPF forecasts			
1	1	-0.209[a] (4.13)	0.446
2	2	-0.360[a](4.28)	0.627
3	3	-0.500[a] (4.42)	0.771
4	4	-0.638[a] (4.75)	0.897
VAR forecasts			
1	1	-0.157[a] (3.50)	0.446
2	2	-0.410[a](4.40)	0.627
3	3	-0.636[a] (4.97)	0.771
4	4	-0.835[a] (5.55)	0.897

Notes: see the notes in Table 1

Next, we compare the SPF and VAR forecasts in terms of predictive information by estimating the following test equation:

$$A_{t+f} = \delta_0 + \delta_1 PS_{t+f} + \delta_2 PV_{t+f} + u_{t+f} \qquad (3)$$

where PS_{t+f} represents the SPF forecasts while PV_{t+f} represents the VAR forecasts in quarter t + *f*. The possible outcomes for this encompassing test are:

1) The coefficient estimates of δ_1 and δ_2 are both positive and significant. This means that PS_{t+f} and PV_{t+f} contain distinct information.
2) The coefficient estimate of δ_1 is positive and significant but the coefficient estimate of δ_2 is negative or insignificant. This means that PS_{t+f} is superior to PV_{t+f}.
3) The coefficient estimate of δ_2 is positive and significant but the coefficient estimate of δ_1 is negative or insignificant. This means PV_{t+f} is superior to PS_{t+f}.
4) The coefficient estimates of δ_1 and δ_2 are both insignificant but the population $\bar{R}^2 \neq 0$. This means that the PS_{t+f} and PV_{t+f} contain similar information.

Table 3 presents the OLS estimates of the test equation in (3). The estimates of δ_1, ranging from 0.306 to 0.618, are positive and significant. Similarly, the estimates of δ_2, ranging from 0.327 to 0.655, are positive and significant across all four forecast horizons. This implies that the VAR forecasts contain distinct information from the SPF forecasts.

Table 3: Encompassing test results: SPF vs. VAR forecasts

$$A_{t+f} = \delta_0 + \delta_1 PS_{t+f} + \delta_2 PV_{t+f} + u_{t+f}$$

Row no.	f	δ_0	δ_1	δ_2	$\bar{R}^2$
1	1	0.007(0.08)	0.306[a] (3.75)	0.655[a] (8.07)	0.94
2	2	-0.113(0.55)	0.544[a] (3.74)	0.400[a] (2.71)	0.86
3	3	-0.276(0.93)	0.618[a] (3.03)	0.327[a] (1.65)	0.81
4	4	-0.430(1.12)	0.587[a] (2.39)	0.357[a] (1.59)	0.77

Notes: See notes in Table 1

To check the robustness of these results, we also include the random walk forecasts in the test equation as follows:

$$A_{t+f} = \gamma_0 + \gamma_1 PS_{t+f} + \gamma_2 PV_{t+f} + \gamma_3 R_{t+f} + u_{t+f} \quad (4)$$

where PS_{t+f} represents the SPF forecasts, PV_{t+f} represents the VAR forecasts in quarter t + f, and R_{t+f} represents the random walk forecasts.

Table 4 presents the OLS estimates of the test equation in (4). The estimates of γ_1, ranging from -0.029 to -0.123, are all negative and insignificant. However, the estimates of γ_2, ranging from 0.08 to 0.327, are all positive. More importantly, the t-statistics on the estimates of γ_2 in rows 2-4 are fairly large and close to the threshold for statistical significance. This implies that the two- through the four-quarter-ahead VAR forecasts are more informative than the corresponding SPF forecasts of the TBR and may also have distinct predictive information from the corresponding random walk forecasts.

Table 4: Encompassing test results: SPF and VAR forecasts vs. random walk benchmarks

$$A_{t+f} = \gamma_0 + \gamma_1 PS_{t+f} + \gamma_2 PV_{t+f} + \gamma_3 R_{t+f} + u_{t+f}$$

Row no.	f	γ_0	γ_1	γ_2	γ_3
1	1	0.226[a] (2.53)	-0.109(1.45)	0.080(0.59)	0.970[a] (5.94)
2	2	0.267[a] (1.63)	-0.029(0.19)	0.194(1.61)	0.740[a] (4.59)
3	3	0.262(0.84)	-0.030(0.12)	0.245(1.51)	0.668[a] (3.26)
4	4	0.178(0.78)	-0.123(0.44)	0.327[a] (1.68)	0.645[a] (3.31)

Notes: See the notes in Table 1.

In order to check the efficiency of the estimates of the above test equation, we drop the SPF forecasts. The new test equation compares the predictive information of the VAR forecasts with the random walk benchmark as follows:

$$A_{t+f} = \eta_0 + \eta_1 PV_{t+f} + \eta_2 R_{t+f} + u_{t+f} \qquad (5)$$

Table 5 presents the OLS estimates of the test equation in (5). The estimate of η_1 in row 1 is insignificant but the estimate of η_2 is positive and significant. This means that the one-quarter-ahead VAR forecast in row 1 fails to beat the random walk forecast. The estimates of η_1 and η_2 in rows 2-4 are positive and significant. This means that the two-through four-quarter-ahead forecasts of the VAR contain distinct predictive information from the random walk forecasts. This further implies that a combination of the VAR and random walk forecasts will improve forecast accuracy.

Table 5: Encompassing test results: VAR vs. random walk benchmarks

$$A_{t+f} = \eta_0 + \eta_1 PV_{t+f} + \eta_2 R_{t+f} + u_{t+f}$$

Row no.	f	η_0	η_1	η_2	$\bar{R}^2$
1	1	0.172[a] (2.12)	0.099(0.71)	0.849[a] (5.95)	0.95
2	2	0.247[a] (1.63)	0.191[a] (1.64)	0.718[a] (6.21)	0.88
3	3	0.235(0.94)	0.241[a] (1.62)	0.647[a] (4.63)	0.83
4	4	0.186(0.55)	0.307[a] (1.78)	0.564[a] (3.61)	0.80

Notes: See the notes in Table 1.

We generate the combined forecasts by using the weights on PV_{t+f} (ranging from 0.191 to 0.307) and the weights on R_{t+f} (ranging from 0.564 to 0.718) in rows 1-3. Table 6 reports the mean absolute forecast errors (MAE) and the root mean squared forecast errors (RMSE) of the two- through four-quarter-ahead VAR, random walk, and combined forecasts.

Table 6: Combined forecast results

	MAE				RMSE		
$fPV_{t+f}R_{t+f}$	Combined			$PV_{t+f}R_{t+f}$	Combined		
2	0.688	0.494	0.456		0.826	0.611	0.572
3	0.897	0.591	0.538		1.077	0.740	0.675
4	1.067	0.659	0.568		1.253	0.831	0.729

Based on the statistics in columns 1, 2, and 3 in Table 6, the combined forecast has a lower MAE for each forecast horizon. Also, the statistics in columns 4, 5, and 6 indicate that the RMSE is lower for the combined forecasts. This means that the predictive information in the VAR forecasts help improve forecast accuracy.

CONCLUSION

Accurate forecasts of the interest rate are important to both economic agents in making sound savings and investment decisions and to policy-makers in making sound macroeconomic policy decisions. In this paper, we focus on forecasting the 10-year Treasury bond rate (TBR) using a vector autoregressive (VAR) model for the period 1992-2016. For comparison, we use the TBR forecasts from the Survey of Professional Forecasters (SPF) in addition to the random walk forecasts. Our VAR model includes three variables: the actual TBR, the SPF forecasts of output growth, and the SPF forecasts of inflation. Our results indicate that the one-through four-quarter-ahead SPF and VAR forecasts are biased and contain distinct predictive information. However, when introducing the random walk forecasts along with the SPF and VAR forecasts in the test equation, the SPF forecasts prove to be inferior to both the VAR and random walk forecasts. Additional results indicate that the two-through four-quarter-ahead VAR forecasts contain distinct predictive information from the random walk benchmark. Based on these results, we combine the VAR and random walk forecasts. Using the MAE and RMSE statistics, we find that the two-through four-quarter-ahead combined forecasts do indeed improve accuracy over both the VAR and the random walk forecasts. Hence, we recommend researchers utilize the SPF forecasts of output growth and inflation in order to produce accurate forecasts of the TBR.

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EXAMINING THE IMPACT OF FERTILITY ON FEMALE LABOR FORCE PARTICIPATION IN NORTH AMERICA AND MEXICO

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ABSTRACT

This paper examines the relationship between female labor force participation rates and fertility rates in North America (Canada and the United States) and Mexico, a region that has signed the free trade agreement NAFTA. Utilizing panel data for the period 1991–2014, we find mixed results across these countries. In particular, our results indicate a negative (positive) correlation between fertility rates and female labor force participation rates in Mexico (the US), but no relationship in Canada. As we shall explain, these mixed results can be attributed to factors such as rising unemployment rates, the rise in women's earnings, and the availability of purchased childcare in the market.

Keywords: Female labor participation; Fertility; Panel data analysis; NAFTA countries

INTRODUCTION

Female labor participation is an important factor influencing the well-being of the economy. Aguirre et al. (2012) have shown that raising the female labor force participation rate to the country-specific male level would increase GDP in the US by 5 percent, Egypt by 34 percent, and Japan by 9 percent. Thus, it is important to understand the major factors that influence the female labor force participation rate. The fertility (defined as child-bearing) rate is an important constraining factor to female employment; the arrival of a newborn inhibits workforce participation for the woman who has just become a mother in order to allocate more time towards raising her child (Bernhardt, 1993). Child rearing and economically productive work are said to be incompatible. Especially in today's world, work sites are usually far from home and schedules set by employers lack the flexibility required to look after children.

In this study, we examine the intriguing question of whether the fertility rate reduces the female labor force participation rate in North America (Canada and the United States) and Mexico, a region that has signed the free trade agreement NAFTA. Utilizing panel data for the period 1991-2014, we find mixed results across these countries. In particular, our results indicate a negative (positive) correlation between fertility rates and female labor force participation rates in Mexico (the US), but no relationship in Canada. The mixed results could be attributed to factors such as, the rising unemployment rates, the rise in women's earnings, and the availability of purchased childcare in the market.

This study is organized as follows: section 2 provides the literature review. Section 3 presents the data, empirical results, and interpretations. Section 4 presents the discussion

of the results, and section 5 concludes by suggesting further research on certain areas of this topic.

LITERATURE REVIEW

There is consensus among economists that there generally exists a negative relationship between fertility and women's employment. However, the causal nature of the relationship is less clear and has been the topic of heated debate for many years now. Bumpas and Westoff (1970, p. 95) were among the earliest to explore the causal nature of the relationship by asking "Do women limit their fertility in order to pursue their nonfamily-oriented interests or do women work if their fertility permits them to do so?" As also noted by Rindfuss and Brewster (2000), the direction of causality could go either way; that is, fertility could lower female participation, or female participation could lower fertility. In particular, Weller (1977) cites four possible explanations for the observed negative relationship between fertility and female labor force participation:

1) Fertility affects labor force participation
2) Labor force participation affects fertility
3) Both women's fertility and labor force participation affect each other
4) The observed relationship is spurious and is caused by other factors

The literature contains considerable research on the relationship between fertility and female employment. Some argue that it is fertility that affects labor force participation, while others argue the opposite. Despite such disagreement, the relationship between the two remains important for formulating public policies in both developed and developing countries (Brewster and Rindfuss 2000). Accordingly, in what follows, we divide our

literature review by focusing on two strands of research. First, studies that take female labor force participation as a function of fertility and then studies that take fertility as a function of female labor force participation.

FEMALE LABOR FORCE PARTICIPATION AS A FUNCTION OF FERTILITY

The presence of children influences a woman's decision about whether to enter the labor force or not. Most employed women leave work at some time around birth. It is not childbearing only but child rearing (the process of taking care of a child from birth to adulthood) that leads to the negative relationship between fertility and female labor force participation (Bernhardt 1993). In Germany for instance, women tend to leave the labor force for an extended period of time following a birth due to the serious shortage of childcare and school day schedules that vary according to the age of the child (Brewester and Rindfuss 2000; Schierman 1991). Also, the presence of young children can increase women's reservation wage (the wage that makes a woman indifferent between working or staying at home) which, in turn, lowers the probability of participation (Connelly, 1992).

The hypothesis that fertility hinders women's participation in the labor market is widely accepted. Many research studies on the determinants of female labor force participation rate have thus used fertility rates as one of the independent variables. There are plenty of studies in the literature that confirm the negative effect that fertility has on female labor force participation. For instance, Rindfuss et al. (2003) use data on 22 low fertility countries for 1960-1980 and find that an increase in fertility rates results in a reduction in female labor force participation rates. One reason that they cite is the incompatibility between child bearing/rearing and work.

Like Rindfus et al. (2000) in the case of the OECD countries, other studies show that when the fertility rate increases, the female labor force participation decreases. Cruces and Galiani (2007) focus on Argentina and Mexico to show that an additional child in a family reduces women's employment. Knaul and Parker (1997) also focus on Mexico and show that the presence of one child lowers the probability of women working outside their home even for part time jobs. However, the probability of working increases when there is someone to help at home with childcare.

More recent studies suggest a positive relationship between fertility rate and female labor force participation rate, especially after 1980. According to Engelhardtand Prskawetz (2004, p.36), "the countries that now have the lowest levels of fertility are those with relatively low levels of female labor force participation, and the countries with higher fertility levels tend to have relatively high female force participation rates". Labor market institutions, unemployment rate, childcare benefits and government policies are cited as the reasons for the positive relationship between fertility and female labor force participation rates.

Ahn and Mira (2002) use panel data on OECD countries from 1970-1995 and show that the relationship between fertility rate and female labor force participation was negative during the 1970s and then turned positive after 1980. They cite three possible explanations for this reversal of relationship, female real wages, childcare, and unemployment rate. More specifically, as female real wages increase, more and more women choose to work. As a main determinant of fertility decisions, real wage increases induce both income and substitution effects on fertility. According to the theory of labor supply, at initially low wage levels a further increase in wages generates the substitution effect, leading to an

increased female labor supply, and fertility would drop for those entering the labor force, thus resulting in an inverse relationship between fertility and participation. However, at initially high female wages, a further increase in wages generates an income effect that leads to higher fertility. Under the fixed hours restriction (no change in hours of work), a wage increase has the income effect. That is, higher wages will lead to higher fertility (assuming children are normal goods), resulting in a positive relationship between fertility and female participation. Thus, the income effect is one factor that could explain the positive relationship between fertility and female labor force participation.

The second reason cited by Ahn and Mira (2002) is the availability of purchased childcare in the market, as is the case in some developed countries. The availability of purchased childcare allows women to allocate more time towards their work, reducing the incompatibility between work and child rearing and allowing them to have children without leaving the workforce for a long period of time. On the other hand, the higher the price of childcare, the lower the fertility rate, which keeps the relationship between fertility and female employment negative. However, as more women work, there is more political pressure for generous childcare subsidies, which reduces the price of childcare. Also, due to the increased demand for jobs that are compatible with childrearing, more jobs are created with flexible hours of work, and working from home. Thus, childcare affordability explains the positive relationship between fertility and female participation. In addition, the income effect of female wage changes on fertility is more important relative to the substitution effect because the price of childbearing depends less on the mother's wages and more on the market price of childcare. Therefore, because of higher wages in the 90's, "the effect of higher female wages on fertility becomes less negative or more positive when

we consider affordable childcare, facilitating the reversal of the relationship between fertility and female participation" (Ahn and Mira 2002, p.19).

The third reason cited by Ahn and Mira (2002) for the positive relationship is the rise in unemployment in the 1980s. Unemployment negatively affects fertility because "more women will enter the workforce as insurance strategy against the negative shocks to their husband's wage or employment" (Ahn and Mira,2002, p.21). Also, fewer women would leave the labor market to have more children as it could ruin their future job prospects. Ahn and Mira (2002) argue that countries with lower female participation rates and wages tend to have higher unemployment rates, which greatly reduces fertility. Again, this could explain the positive relationship between fertility and female participation.

Other studies give similar explanations for the observed positive relationship. Rocha and Fuster (2006), for example, investigate the relationship between fertility and female labor force participation rate in OECD countries for 1986-1995 and find a reversal in the relationship from negative to positive. The author explains that labor market frictions (i.e., the low probability of finding a job) induce females to postpone giving birth or avoid fertility due to two reasons. First, a decrease in the probability of finding a job increases the length of a career interruption, which is costly in terms of foregone wages in addition to a depreciation of human capital. By spacing births, females can avoid a costly career interruption. Second, since children are costly and, as income is low when females are young, they may postpone births (Rocha and Fuster, 2005). These two effects intensify as the unemployment rate increases among females.

Adsera (2004) also studies how different labor market arrangements caused this

reversal of trend. She also finds that high unemployment rate and easy accommodation of the entry-exit of the labor market of the US are two factors responsible for the change in the relationship. She finds that availability of childcare and part-time work, as well as the benefits that mothers receive from the job, increases both the likelihood of having a child and working simultaneously.

Utilizing the Canadian data up to 1995, Engelhardt and Prskawetz (2004) find a positive relationship between the variables fertility and female labor force participation. Canada's population growth rate has not been increasing as much as the US population but has experienced large migration flows, which could lead to simultaneously lower fertility rates and lower female labor force participation rates. The pattern of fertility in Canada differs between native born women and women who migrated to Canada early on. For instance, a survey conducted by Adsera and Ferer (2014) finds that fertility patterns for women who migrated to Canada early on tend to be lower than the native born. Immigrants from Asia and Africa who arrived in Canada early have significantly lower fertility levels than the Canadian-born. These immigrants tend to have higher levels of schooling and later fertility than similarly aged native born persons. One reason to explain the lower fertility is their high educational attainment. At the same time, recent data indicate that 70% of Canadian labor force consists of immigrants. With growing immigration as the main contributor to Canada's labor force in recent years, and the fact that women who migrated to Canada early on tend to have lower fertility levels than the native born, one may expect a weaker (or nonexistent) link between fertility rates and female labor force participation rates.

FERTILITY AS A FUNCTION OF FEMALE LABOR FORCE PARTICIPATION

Some studies have shown that the inhibiting effect of fertility on female labor force participation tends to be short lived; that is, the negative impact of childbearing on labor force participation ends when the youngest child reaches school age(Brewster and Rinfuss 2000; Waite and Stolzenberg 1976; Hout 1978; Smith-Lovin and Tickameyer 1978). In particular, the effect of labor force participation on fertility tends to be weaker in the short-run but stronger in the long-run. According to Cramer (1980) current employment lowers both actual and expected fertility, and since this builds up over time, employment may in the long run have a great effect on fertility(Bernhardt 1993). The studies by Cramer (1980) and other studies suggest that the dominant effect in the short-run is from fertility to female employment, and from employment to fertility in the long-run. However, these studies have been highly criticized for having statistical shortcomings. Despite this, the negative impact of female labor force participation on fertility has a theoretically strong foundation (Brewster and Rindfuss, 2000).

More specifically, economic theory suggests that an increase in the opportunity costs of having children should be associated with lower fertility rates (Lehrer and Nerlove 1986). Labor force participation is known to increase the opportunity cost of childbearing in terms of foregone wage earnings and could reduce the time left for leisure (Brewster and Rindfuss, 2000). Accordingly, it is not surprising that women in the labor force tend to have lower fertility levels on average than women who are out of the labor force (United Nations, 1976). Economic theory also suggests that mothers who have greater stocks of human capital have higher opportunity costs associated with child bearing and rearing (Lehrer and Nerlove 1986).

One of the ways in which fertility rates decline due to an increase in female labor force participation is through women delaying the transition to parenthood. For example, one survey found that in the US, married women with paid jobs are more likely than married women who do not work to postpone the birth of their first child (Brewster and Rindfuss 2000; Blau and Robins, 1988). These decisions reflect the higher opportunity costs for childbearing among women with high human capital and earnings.

However, studies investigating the impact of employment on fertility have been inconclusive due to a number of reasons. Some studies indicate that the observed relationship between higher employment and lower fertility is just a matter of the choice of lifestyle. Women who want to work longer tend to also have lower fertility ambitions (Bernhardt 1993). For instance, Hoem and Hoem (1989) tested the hypothesis that the opportunity cost of a second or third birth is higher for Swedish women with better education or with a secure position in the labor force. Their results indicate that the effect of present employment and those who have spent the most time in the labor force since the birth of the first child on the propensity for a third birth among mothers with two children is not different from mothers who are primarily housewives. Also, there was no difference on the effect of employment on fertility among woman who worked full time or part-time. Surprisingly, the excess risk of third births among housewives has reduced over time, while that of working women has been more stable. A woman's personal values rather than employment seem to be a stronger determinant of her choice to have more children.

DATA, EMPIRICAL RESULTS, AND INTERPRETATIONS

In line with most of the literature, we focus on investigating the female labor force

participation rate as a function of the fertility rate. Other determinants of the female labor force participation rate, as cited in the literature, include economic (GDP) growth, inflation rate, and urbanization. We utilize these determinants as control variables in our model. Theoretically, each of these control variables is expected to positively influence the female labor force participation rate.

Specifically, our panel regression model is,

$$\mathbf{FLP_{it}} = \boldsymbol{\beta_1} + \boldsymbol{\beta_2}\mathbf{FR_{it}} + \boldsymbol{\beta_3}\mathbf{Y_{it}} + \boldsymbol{\beta_4}\mathbf{UP_{it}} + \boldsymbol{\beta_5}\mathbf{CPI_{it}} + \boldsymbol{\mu_{it}} \quad (1)$$

where **i = 1, 2, … , N and t = 1, 2, … , T**

- **FLP** = Female labor force participation rate
- **FR** = Total fertility rates
- **Y** = Annual percentage growth rate of GDP
- **UP** = Urban population as a percentage of population
- **CPI** = Inflation rate (in%)
- **μ** = Error term

The data for female labor force participation rates, fertility rates, GDP growth rates, percentage of urban population, and inflation rates for all three countries (US, Canada, and Mexico) were retrieved from the World Bank[3] for the time period 1991-2014. The dependent variable in this model is the female labor force participation rate, which is the proportion of the population between the ages 15-64 who are either working or actively searching for a job. The independent variable of interest is the total fertility rate, which represents the number of children that would be born to a woman if she were to live up to the end of her childbearing years and reproduce according to the age-specific fertility rates

[3] http://databank.worldbank.org/data/home.aspx

for the specified year (World Bank, 2014). Table1 reports the descriptive statistics for both the female labor force participation rate and the fertility rate.

As can be seen from Table 1 the mean value of female labor force participation rate in Mexico (42.64) is much lower than those for Canada and the US. However, the mean value of the fertility rate in Mexico happens to be well above those for Canada and the US.

Table 1 – Descriptive statistics **(female labor force participation rate & fertility rate)**

Number of observations = 72	**Canada**	**Mexico**	**US**
Female labor force participation rate:			
Mean	71.47	42.64	68.22
Min	67.80	35.90	66.10
Max	74.70	48.30	70.0
Fertility rate:			
Mean	1.60	2.69	2.00
Min	1.49	2.24	1.86
Max	1.71	3.38	2.12

As for the control variables in Equation (1), we have: the annual percentage growth rate of GDP, the percentage of people living in urban areas, and the inflation rate. They are all included to account for the positive relationship between them and the female labor force participation rate. The method of estimation is ordinary least squares (OLS) panel regression with the standard errors corrected for heteroscedasticity and autocorrelation using the Newey-West procedure. The total number of observations is 72.

Column 1 of Table 2 reports the regression estimates of Equation (1). Of the control variables, urbanization has the correct sign and is significant in determining the female labor force participation rate. However, both GDP growth and inflation rate are

Table 2 - Regression estimates (**dependent variable: Female labor force participation rate** 1991-2014)

	Equation (1)	**Equation (2)**	**Equation (3)**	**Equation (4)**
FR	**-22.700 (-9.45)**	**-5.233 (-1.74)**	**-4.391 (-2.82)**	
DM*FR				**-6.607 (-4.20)**
DC*FR				3.569 (0.71)
DUS*FR				**14.356 (3.09)**
Control Variables:				
Y	0.090 (0.32)	0.201 (0.99)	0.056 (0.59)	**0.125 (1.44)**
UP	**0.791 (1.75)**	1.343 (1.08)	0.739 (4.33)	**0.811 (5.44)**
CPI	0.176 (1.07)	0.066 (0.69)	0.023 (0.38)	**0.078 (1.39)**
Year Fixed Effects	No	Yes	No	No
Country Fixed Effects	No	Yes	Yes	Yes
R^2	0.852	0.985	0.983	0.988
Number of observations	72	72	72	72

Note: The countries included in the model are Mexico, Canada, and the US. The numbers in parentheses are the absolute t-value.

Model 1: $FLP_{it} = \beta_1 + \beta_2 FR_{it} + \beta_3 Y_{it} + \beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}$

Model 2: $FLP_{it} = \alpha_1 D_M + \alpha_2 D_C + \alpha_3 D_{US} + \gamma_1 D91 + \gamma_2 D92 \ldots + \gamma_{24} D2014 + \beta_2 FR_{it} + \beta_3 Y_{it} + \beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}$

Model 3: $FLP_{it} = \alpha_1 D_M + \alpha_2 D_C + \alpha_3 D_{US} + \beta_2 FR_{it} + \beta_3 Y_{it} + \beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}$

Model 4: $FLP_{it} = \alpha_1 D_M + \alpha_2 D_C + \alpha_3 D_{US} + \delta_1 D_M FR_{it} + \delta_2 D_C FR_{it} + \delta_3 D_{US} FR_{it} + \beta_3 Y_{it} + \beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}$

insignificant. The parameter estimate on fertility rates is negative, suggesting that an increase in fertility rate reduces the female labor force participation rate in all three countries under investigation. However, we do not trust Equation (1), because it assumes
that the intercept term is constant across the three countries and over time, which may not be a realistic assumption.

Thus, we specify the following country and time fixed effects model which allows the intercept to vary across the countries:

$$\mathbf{FLP_{it}} = \boldsymbol{\alpha_1 D_M + \alpha_2 D_C + \alpha_3 D_{US} + \gamma_1 D91 + \gamma_2 D92 \ldots \gamma_{24} D2013 + \beta_2 FR_{it} + \beta_3 Y_{it}} + \boldsymbol{\beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}} \quad (\mathbf{2})$$

where the dummy variable D_M (=1 for Mexico and 0 otherwise), D_C (=1 for Canada and 0 otherwise), and D_{US} (=1 for US and 0 otherwise); the dummy D91 (=1 for 1991 for every country and 0 otherwise), D92 (=1 for 1992 for every country and 0 otherwise), and so on. The OLS estimates of Equation (2) are reported in column 2 of Table 2. The results show that the adjusted R^2 increases by around 13%. The parameter estimates on the country dummies (not reported in Table 2) are all insignificant but different from each other in terms of size. To confirm whether they are in fact different from each other, we use the Wald test for examining the null hypothesis that $H_0: \alpha_1 = \alpha_2 = \alpha_3$. The *p*-value of the Wald test is less than 0.01, which indicates that the null hypothesis is rejected and, thus, the intercept varies across the countries. Again, we use the Wald test for examining the null hypothesis that $H_0: \gamma_1 = \gamma_2 = \cdots = \gamma_{24}$. The *p*-value of the Wald test is 0.99, which indicates that the null hypothesis cannot be rejected and, thus, the intercept does not vary across time. Using these results, we specify the following time fixed effects model which only allows the intercept to vary across the countries:

$$\mathbf{FLP_{it} = \alpha_1 D_M + \alpha_2 D_C + \alpha_3 D_{US} + \beta_2 FR_{it} + \beta_3 Y_{it} + \beta_4 UP_{it} + \beta_5 CPI_{it} + \mu_{it}} \quad (\mathbf{3})$$

The OLS estimates of Equation (3) are reported in column 3 on Table 2. The results indicate that adjusted R^2 increases slightly to 0.983. Again, both GDP growth and inflation rate are insignificant. The parameter estimate on fertility rates is negative, suggesting that an increase in fertility rate reduces the female labor force participation rate in all three countries under investigation.

To improve these estimates, we assume that the intercept and the slope parameters on the fertility rate also vary across the countries, which is a more realistic assumption. This results in the following model:

$$\mathbf{FLP_{it}} = \boldsymbol{\alpha_1 D_M} + \boldsymbol{\alpha_2 D_C} + \boldsymbol{\alpha_3 D_{US}} + \boldsymbol{\delta_1 D_M FR_{it}} + \boldsymbol{\delta_2 D_C FR_{it}} + \boldsymbol{\delta_3 D_{US} FR_{it}} + \boldsymbol{\beta_3 Y_{it}} + \boldsymbol{\beta_4 UP_{it}} + \boldsymbol{\beta_5 CPI_{it}} + \boldsymbol{\mu_{it}} \quad (\mathbf{4})$$

where the slope parameter of $\delta_1, \delta_2,$ and δ_3 represent the impact of fertility on female labor force participation rates in Mexico, Canada, and the US respectively. The OLS estimates of Equation (4) are shown in the last column of Table 2. The results indicate that the adjusted R^2 increases to 0.988. We use the Wald test for examining the null hypothesis that $H_0: \delta_1 = \delta_2 = \delta_3$. The *p*-value of the Wald test is 0.045, which indicates that the null hypothesis is rejected and, thus, the slope on the fertility rate varies across the countries. The estimate of δ_1 is negative and significant; this means that an increase in the fertility rate lowers the female labor force participation rate in Mexico. The estimate of δ_3 is positive and significant; this means that an increase in fertility rate increases the female labor force participation rate in the US. In contrast, the estimate of δ_2 is insignificant; this means that there exists no relationship between fertility and female participation in Canada. In addition, the parameter estimates on the control variables are all significant with expected signs.

DISCUSSION

In this section, we discuss our results for each country. As can be seen from Table 2 (Equation 4), there exists mixed results across the countries. In Mexico, when fertility increases by 1 point, female labor force participation rate decreases significantly by 6.607 percentage points. The result in Mexico is consistent with the literature, which maintains that the role incompatibility between childbearing and work is the main reason why mothers leave the labor force in Mexico. The presence of an additional child requires mothers to allocate more time towards childrearing, which makes it difficult for them to work even in part-time jobs.On the other hand, in the US when fertility increases by 1 point, the female labor force participation increases significantly by 14.356 percentage points. The result in the US can be explained by the recent literature, which provides several reasons to explain the reversal in sign of the relationship from negative to positive. According to this literature, the rise in unemployment rate, the increase in female real wages, and the wide availability of purchased childcare explains the positive relationship between fertility and female labor force participation. The rise in the unemployment rate is responsible for the positive relationship, as countries with lower female participation rates and wages tend to have higher unemployment rates, which reduces fertility. Unemployment reduces fertility, as more women will enter the workforce as an insurance strategy against the adverse shocks to their husband's wage or employment. Also fewer women would leave the labor market to have more children as it could ruin their future job prospects (Ahn & Mira, 2002).An increase in female wages could be another possibility for the positive relationship, as it induces more and more women to work and at the same time generates the income effect which leads to higher fertility. Also, the availability of affordable childcare is another important factor responsible for the positive relationship, as it allows women to allocate

more time toward their work as well as it allows them to have children without leaving the workforce for a long period of time.

In contrast, in Canada there exists no significant relationship between fertility and female labor force participation. This result is unexpected and could be due to an external factor, such as migration. More specifically, migration could simultaneously lead to both lower fertility and lower female labor force participation since most of Canada's labor force is made up of immigrants and research indicates that Canadian immigrants tend to have lower fertility levels than the Canadian-born. Our results indicate a positive relationship but not significant.

CONCLUSION

In conclusion, the relationship between fertility and female participation is important for policy decisions in both developed and developing countries. Although the direction of causality between the two variables has been less clear. However, many studies use female labor force participation as a function of fertility rather than vice versa. In line with these studies, we take female labor force participation as a function of fertility. We find mixed results; female labor force participation rate is negatively correlated with fertility rate in Mexico due to perhaps the high level of role incompatibility between childbearing and work. While in the US the correlation turned positive due to the recent explanations in the literature, such as the increase in female real wages, the rise in unemployment rates, and the availability of purchased childcare, which reduces the role incompatibility between child rearing and work. Furthermore, there exists a positive but insignificant correlation between the two variables in Canada. Future studies should investigate the reasons for the absence of correlation between female labor force participation and fertility in Canada. We also recommend further research on the relationship

between fertility and female labor force participation by including factors such as female real wages, unemployment rates, availability of market childcare, and maternity benefits in the model, in order to examine how each of these factors could possibly influence the relationship between the two variables.

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