Transmission of United States Economic Shocks to Jamaica: An Empirical Assessment

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Abstract

This study assesses the transmission of economic shocks from the United States of America (U.S.) to Jamaica's economyusing a structural vector autoregressive model, with the Hamilton (2016) method used to extract the cyclical component. In addition to the traditional transmission channels found in the literature, remittance and tourism channels are also explored as additional channels of importance. The findings indicate that U.S. supply shocks produce relatively significant fluctuations in Jamaica's economy, and shutting down the remittance and tourism channels resulted in a lower effect on real GDP for each shock.

Keywords: Business Cycles; Structural Vector Autoregressive Models; Jamaica; United States

JEL Codes: E32, E44, F44

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1. Introduction

Jamaica is categorized as a Small Island Developing State (United Nations, 2016) which is a relatively open economy based on its trade. The country's integration with the global economy has not only allowed it to benefit from globalization, but has left the economy vulnerable to external shocks. What is of concern to Jamaica, and other economies in the Caribbean, is the magnitude of domestic economic fluctuations thatare attributed to external versus internal sources, as well asthe avenues via which they are transmitted throughout the economy.

Jamaica's economy has been financially liberated since 1985(Howard, 2001). By 1996, the country experienced a major financial crisis which Worrell, Cherebin and Polius-Mounsey (2001) attributed to three factors: rapid liberalization, differences in reserve requirements among financial institutions, and tight monetary policies in 1995-96. The economy is relatively open, with the total value of exports and imports as a share of gross domestic product (GDP) averaging 90 percent, for the period 1998 to 2015 (see Figure 1, in the Appendix). To date, the United States of America (U.S.) is regarded as Jamaica's principal and relatively closest trading partner. In terms of general merchandise trade, Jamaica's share of export to and import from the U.S. averages 41 percent and 37 percentfor the period 2004-2014, respectively (BOJ, 2015).In addition to trade, Jamaica has a strong financial interdependence with the U.S. financial market. This is the case formosteconomies of the Caribbean Community (CARICOM). Undoubtedly, the recent global financial crisis of 2007re-emphasized the vulnerability of Jamaica's economy to U.S. economic shocks. The financial crisis was a significant factor in the decline in Jamaica's GDP due to a slowdown in tourism inflows, and a decline in exports given weak external demand for bauxite, alumina and other primary exports items (BOJ, 2010). For the 1998-2015 period, the Jamaican economy is characterized by relatively high debt to GDP ratio and recorded an average annual growth rate of 0.5 percent (STATIN, 2015) (see Figure 2, in the Appendix). The Government of Jamaica's currently under an International Monetary Fund (IMF)

programme which is aimed at providing balance of payment support and requires of the country to undertake structural adjustments.¹

The objective of this study is to address three questions. First, I assess ifeconomic shocks from the U.S. are transmitted to Jamaica's economy, and if so via what channels. Rebelo (2005) mentions monetary, demand, supply and oil as possible economic shocks that can provide information on the possible effects on key macroeconomic variables. This studyhowever focuses on three U.S. economic shocks: supply, monetary and price. The common transmission channels explored in the literature, across developed and developing economies, encapsulate real sector and financial sector (Sims, 1980; Canova, 2005; Murray, 2007; Feldkircher and Huber, 2016). This study will includetourism and remittances as additional channels of interest via which U.S. shocks are transmitted to a Caribbean economy as suggested by Sun and Samuel (2009). As the absence of these two channels lowers the output effect from external shocks.Second, I examine the existence of co-movements between U.S. and Jamaica macroeconomic variables after a U.S. shock. Third, I quantify the magnitude of the contribution of the U.S. shocks, while making a distinction of shocks inherent to Jamaica and those independent of the two countries.

The use of the tourism channel broadens the trade channel instead of solely relying on the traditional export-import ratio approach. Exploration of the tourism channel is valid for a Jamaica-U.S. assessment as the U.S. is Jamaica's largest tourist market (JTB, 2016).² Jamaica's visitors expenditure as a share of GDP averaged 14.6 percent per annum over the 1998 to 2015 period, which is approximately 41.5 percent of the country's export earnings (STATIN, 2016 (see Figure 3, in the Appendix).The importance of remittancesto Jamaica is reflected in its contribution and impact on foreign exchange flows, balance of payment support and source of household income (McLean, 2008).³ For the 1998-2015 period, total remittance inflows to Jamaica as a share of GDP has trended upwards and averaged 13.5 percent per annum. Relative

¹Over the past four decades, the IMF and Jamaica has entered into numerous arrangements which resulted in Jamaica undertaken a number of fiscal restraints and debt management (see Boughton (2001) for further details).

 $^{^2}$ The Hotel and Restaurant industry which caters to the tourists is a major foreign exchange earner and provides positive economic spill-over to other industries of the economy.

³ Adam and Page (2005) and Spatafora (2005) have also indicated that remittance provide support to receiving households and poverty reduction.

to exports, remittances is on average 38 percent for the same period. Within the U.S., many Jamaican nationals who reside and work there remit significant amount of funds to their country of origin. Recent numbers, indicate that remittance flows from the U.S. make up approximately 62 percent of total remittance inflowto Jamaica (BOJ, 2016).⁴For the period 1998-2015, the value of remittance inflow and visitor expenditure have on average being equal (see Figure 4, in the Appendix).

This study adds to the literature in the following areas. First, rather than the Hodrick Prescott approach, I use Hamilton (2016) to extract the cyclical component of all variables used in the study. Hodrick-Prescott and first difference approaches are two commonde-trending procedures used in the literature on Jamaica.Second, a structural vector autoregressive model is used to simultaneously examine tourism and remittance channels as additional channels via which U.S. economic shocks are transmitted to Jamaica.Third, the co-movement between the U.S. and Jamaica's variables are measured conditional on each economic shock. Fourth, verify the importance of the remittance and tourism channels on Jamaica's real GDPas well as the co-movements by way of counterfactual assessment.

The findings indicate that all three U.S. supply shocks (positive supply, contractionary monetary and negative inflation) produce relatively significant fluctuations in Jamaica's economy. However, the U.S. supply shock has the strongest impact. Remittances and price channels play significant roles in response to all three U.S. shocks. Of note, the real effective exchange rate channel was only significant for a short time during the interest rate shock.On average, U.S. shocks (driven primarily by supply) accounted for approximately 30.8 percent of the variation across Jamaica's macroeconomic variables. Absence of the remittances and tourism channels result in a lower effect on real GDP for each shock. The conditional comovement between Jamaica and U.S. real GDP are for the most part positive and significantly large.

The structure of the rest of the paper is as follows. Section 2 explores the literature on the transmission of economic shocks with emphasis on the application to Jamaica. Section 3

⁴ Remittance from the United Kingdom is next with 15.2 percent (BOJ, 2016). Ramocan (2011) 2010 Remittance Survey done in Jamaica indicates that a significant portion of remittance received by individuals is used for basic consumption. A similar allocation is reported Lake (2005).

discusses the data and empirical specification. The results are presented in section 4, while section 5 concludes and presents policy implications of the results.

2. Literature Review

The transmission of shocks in a business cycle analysis can be grouped into three: domestic channels, shocks common to all economies and economic interdependence (Craigwell and Maurin, 2007). Since the work of Sims (1980), the vector autoregressive (VAR) method has been widely used to analyse how economic shocks are transmitted via internal and external sources. The VARs are categorized into three broad varieties by Stock and Watson (2001), namely reduced form, recursive and structural. The reduced form is based on a variable regressed on its own lags, and other variables and their lagged values. The recursive VAR (Cholesky decomposition) is based on a statistical ad hoc approach that models the contemporaneous relation that exists among variables. In a structural VAR (SVAR), the model is however constructed with the guidance of economic theory to associate the correlation between economic variables. In addition, other VAR hybrids used to identify economic shocks include factor augmented, narrative method, high frequency identification, external instruments/proxy SVAR, restrictions at longer horizons and estimated DSGE models (Ramey, 2015).⁵ What is important for empirical study is that, whichever approach is used, a balance should be attained between relaxing the theoretical restrictions and letting the data bring out the features of the model (Giacommi, 2013).

The analysis of economic fluctuations is undertaken using the cyclical component of macroeconomic variables. Studies examining the transmission of economic shocks in Jamaica have considered the impact of both domestic and external factors and employed a structural vector autoregressive (VAR) and/ or VAR models ranging from small scale economic models (Robinson, 2001) to relatively large scale models (Murray, 2007). What is common with these studies is that the cyclical components are extracted using one of thesemethods: (1) first difference, (2) Hodrick-Prescott (1997) filter or (3) Kalman filter. The most common of the

⁵Sharpio and Watson, (1988) and Blanchard and Quah (1989) have utilized the restriction on the long-run multipliers in order to identify the shocks.

three, Hodrick-Prescott (HP) filter has a major drawback in that it has the possibility of generating spurious cycles, carries out over-smoothing and is biased in large samples (Harvey and Jaeger, 1993; Hamilton, 2016). Hamilton (2016) proposes a filtering technique that is relatively more efficient than HP filter in de-trending a series without the drawbacks.

Using a panel VAR in difference, Borda, Manioc and Montauban (2000) study of the business cyclesoftwelve (12) Caribbean countries and hypothesizedthat the cycles can be attributed to four factors: domestic supply shocks, demand shocks, real exchange rate shocks and U.S. interest rate shocks. It was found that short-run fluctuations of output in Caribbean economies with flexible exchange rate regimes are primarily attributed to real exchange rate and domestic supply shocks. Further, the United States interest rate shock plays a greater role in countries under a flexible rate regime, relative to fixed exchange rate.

Robinson (2001) use a SVAR model to examine the effect of the cyclical components of the real exchange rate, terms of trade, domestic interest rate and U.S. real GDP on Jamaica's business cycle. Using first differenced logannual data for the period 1970-2000, it was found that U.S.aggregate GDP shock accounted for approximately 50 percent of variation in Jamaica's GDP. The transmissionis suggested to occurprimarily via the tourism and capital flow channels, with terms of trade playing a notable role. In this case the tourism channel was not explicitly modelled, however, my study will account for the tourism channel.

Studying the 1990-2001 periods with data at monthly frequency, McFarlane (2002) examined Jamaica's exchange rate pass through to consumer price inflation using the full information maximum likelihood approach to estimate a vector error correction model (VECM) applying the Cholesky decomposition. The variables were ordered as based money, interest rate, exchange rate and base money. It was revealed that although the extent of the pass-through has slowed down relative to prior periods due to a tighter domestic monetary policy, changes in the exchange rate had a significant effect on inflation. She suggested that because the openness and size of the economy has not change significantly over the period of assessment, they could not have any influence on the transmission process. Although this is true, Jamaica's economy is still relatively very open (see Figure 1, in Appendix). Allen, Hall and Robinson (2002) estimated a VECM model with HP-filtered quarterly data over the period 1980-2000 and found that the

exchange rate was the main transmission channel for Jamaica's monetary policy. This is corroborated by a later study by Allen and Robinson (2004) who used Kalman filtered quarterly data for the period 1990 to 2002. This means that if Jamaica's interest rate responds positively to a contractionary U.S. monetary shock (increase interest rate) then the real effective exchange rate channel should come into play.

Murray (2007) uses a structural VAR model, with quarterly data for the period 1990-2005, to identify and disaggregate factors that influence Jamaica's business cycle. The contemporaneous relationship was specified using the Cholesky decomposition. The study included HP filteredcomponent of a total of 15 domestic and U.S. variables.⁶ A variable that captured the effect of weather on the economy was also included.Relative to other studies on Jamaica, Murray (2007) included a larger number of U.S. variables in an effort to increase the identification potential of the model. The block exogeneity approach was used to assist in identifying the system of equations. Murray's findings suggest that domestic factors were the main drivers of Jamaica's business cycle. The U.S. economic shocks (in particular U.S. foreign price) accounted for an average of 29 percent of the variation in Jamaica's output, price and interest rate. Although the response of Jamaica's output, price and interest rate to U.S. shocks are relatively in line with expectation. However, the only significant impact was reflected in Jamaica's positive output response to the positive U.S. real GDP shock. In light of this outcome, it will be interesting to see if there will be any difference in outcome given myalternate approach, variable composition and covering a periods before and after the 2007 financial crisis. Kandil (2011) assessed the transmission of U.S. aggregate demand shocks to Latin America and Caribbean economies for the 1960-2006. In relation to Jamaica, the results indicate that expansionary shocks to U.S. GDP had a negative effective on the country's GDP, with anticipated and unanticipated shocks expected to cause declines of 0.12 percent and 0.017 percent from a one percent increase, respectively. While the accompanying inflationary effects in Jamaica are increases of 0.3 percent and 0.75 percentage points, respectively. Roach (2013) carried out a SVAR analysis of oil price shocks on Jamaica's key macroeconomic variables over the period 1997-2012. The

⁶ Murray (2007) Jamaica and U.S. variables are GDP, prices, interest rates, real asset returns, import and export prices. Other Jamaica variables are government spending, taxes, money stock and level of rainfall. The findings indicated that weather shocks are not considered one of the main factors that influence output in Jamaica.

results indicate that most of the shocks died out within 4 quarters. Kiani (2011) use a VAR model with quarterly real GDP series for the period March 1966 to September 2002 and found that there is evidence that statistically significant business cycle asymmetry exists in Jamaica's real GDP series. He added that given the result, policymakers would not be in a position to anticipate the impact of a stabilization policy using linear models.

Using quarterly data for the period 1989 to 2002, Malcolm (2003) uses an error correction model (ECM) regress tourist arrivals on the income of source countries, U.S. and United Kingdom, and predicted that income has a significant influence in explaining the demand for Jamaica's tourism product. Sun and Samuel (2009) examined the impact of the U.S. economy on the Eastern Caribbean Currency Union (ECCU) and other selected Caribbean countries business cycle. The assessment was carried using (i) the common trend and common cycle methodology and (ii) a VAR analysis. Using annual data for period 1963-2007, the results indicate that ECCU is sensitive to both temporary and permanent economic fluctuations originating in the U.S. However, the U.S. monetary policy and tourism channels were not important channels of transmission to the ECCU. The tourism channel is only important for Antigua & Barbuda, one of the ECCU countries studied. Jamaica and Guyana business cycles were found to be influenced by that of the U.S. Rochester (2011) use a general method of moments to show that tourists have a preference for destinations closer to home. Relative to other Caribbean countries examined, Jamaica is the closest to U.S. and this gives it an advantage over other destinations in the Caribbean. This translates into greater economic value from tourist arrivals. Apart from distance being a factor, income in source country, real exchange rate and cost of travel are other factors that must be considered (Rochester, 2011). Therefore, taking into consideration both income and relative distance factors of a developed country from Jamaica, the U.S. has a relatively stronger impact on Jamaica's tourism channel and hence output. As indicated by Canova and Dallari (2013) failure to model the tourism channel in the destination country would result in lower output effects. In the case of the Mediterranean Basin, supply shocks originating in tourist source country has a significant influence on tourism flows in a destination country and shutting down this channel is expected to reduce output effects by approximately 25 percent.

Clarke and Wallsten (2003) utilized a household panel data set from the Jamaica Survey of Living Conditions for 1989 and 1992 to assess the relationship between hurricane damage and

remittance inflow. Estimates from the panel regression indicate that remittance inflows to Jamaica act as a form of insurance. Further, for each dollar of damaged caused by a hurricane in the country, remittance inflow to is expected to increase by 25 cents. Since the negative effects of natural disasters are expected to be reflected in a country's output, it would be safe to model Jamaica's real GDP cycle as an influencing factor in additional remittance inflow. In terms of the broader Caribbean region, Jackman (2014) found that annual remittances to Barbados (1970-2009) and Jamaica (1976-2009) are influenced by their respective business cycles, while that of Dominica (1976)and Trinidad & Tobago (1975-2009) are affected by the U.S. business cycle. This study will however focus on thetransmission of U.S. shocks to Jamaica's economy with the remittance flow modelled explicitly as a channel. By doing so, it will be possible to verify if this countercyclical possibility holds given the different shocks.

Canova (2005) used sign restriction to identify U.S. supply, monetary and real demand shocks and examine how they are transmitted to eight Latin American countries. The model include group of variablesthat capture developments in the world independent of U.S. and Latin America. Using quarterly data over the period 1980 to 2002, Canova (2005) carried out a twostep procedure where he first estimated a VAR for the U.S. economy to extract the structural shocks then estimated a VAR for each Latin America country treating the identified U.S. economic shocks as exogenous variables. It is found that U.S. monetary shock is the main source of fluctuation in the Latina American region. Although a different set of Latin American countries were used, Feldkircher and Huber (2016) conclusion was in line with Canova (2005). Feldkircher and Huber (2016) used a Bayesian version of the global VAR model to examine the transmission of U.S. shocks to selected advanced economies, emerging Europe, Asia and Latina America countries. Although the spill-over effects are significant, the monetary policy shock is reported to having the strongest effect on international output. Overall, U.S. shocks are transmitted internationally via the financial channel (interest rate) and trade channel (real effective exchange rate).

After careful review of the literature, I use a structural vector autoregressive model, with Hamilton (2016) de-trended series, to examine the transmission of U.S. economic shocks to Jamaica to arrive at a conclusion as to the possible effect on the economy. The study imposes structural restrictionsbased on economic theory and empirical studies. Relative to the literature

on Jamaica, this study uses a different group of variables, dataset and de-trending technique. In addition, the tourism and remittances transmission channels are included along with the traditional channels outlined in the literature.

3. Data and Methodology

This study assumes that economic fluctuations in Jamaica's macroeconomic variables are mainly driven by three external shocks originating in the U.S. The selected group of variables is expected to capture any economic relationship that determines the economic behaviour of Jamaica in response to U.S. economic developments.Given Jamaica's close geographical proximity to the U.S., a close financial and trade relationship has developed overtime (Murray, 2007; Kandil, 2011; Rochester, 2011). According to Kandil (2011), the close proximity hascontributed to increase business cycle synchronization.

3.1 Data

The assessment of the transmission of U.S. economic shocks to Jamaica utilizes quarterly data over the period March 1995 to December 2015.⁷ Information for the U.S. is gathered from the FRED economic database of the Federal Reserve Bank of St. Louis. For Jamaica, financial data are collected from the Bank of Jamaica; real sector and remittance inflows data from the Statistical Institute of Jamaica; tourism data from the Jamaica Tourist Board. The study also incorporates a group of control variables that are expected to capture the state of the world economy independent of the U.S. and Jamaica economies (Canova, 2005). These world variables are gathered from Bloomberg database.

The four variables chosen to represent the U.S. economic block are real GDP, all consumer price inflation, the 180-day Treasury Bill yield and the real money supply (M1). Theseare most commonly used in the literature when examining the effects of U.S. economic shocks on other economies (Sims, 1980;Canova, 2005; Craigwell and Maurin, 2005; Murray, 2007; Borda, 2011;Feldkircherand Huber, 2016). The U.S. real GDP, interest rate and inflation is use to reflect supply, monetary and price shocks, respectively. As indicated by Canova(2005), the world

⁷ The period of assessment is selected based on availability of all information for Jamaica, so as to make the dataset balanced.

variable may contribute to co-movements in these two economies. To account for this, the emerging market bond (ebi), emerging market equity (eqi) and commodity price (wpi)indices. The variables for Jamaica are real GDP, all consumer price index inflation, 180-day Treasury bill yield, trade, real effective exchange rate, tourist arrivals and remittance inflow.⁸ With the exception of tourist arrivals and remittance inflow which are selected based on Sun and Samuel (2009), the other variables are inline with Canova (2005).⁹As indicated by Sun and Samuel (2009), visitor arrivals and remittances inflows are two additional channels via which US economic shocks are transmitted to Caribbean countries.Real GDP is use as a measure foroutputfor each country, while the 180-day Treasury Bill yield is a proxyfor the nominal interest rate.¹⁰ Real M1 is a measure of real money balances used todifferentiate monetary demand from other forms of real demand factors (Canova, 2005). The trade variable is measured by ratio of value of real imports. Real effective exchange rate (REER) capturesJamaica's international competitiveness, which is computed as the nominal exchange rate of the Jamaican Dollar to a United States Dollar (E) times the ratio of the U.S. consumer price index (P') to Jamaica's CPI (P).¹¹An increase (decrease) in the REER indicates that exports are cheaper (expensive) and imports become expensive (cheaper) thus signalling a gain (loss) in Jamaica's trade competitiveness. Inflation is measured by the change in the all consumer price index. Tourist arrivals, comprise stop-over and cruise ship passengers, and captures the tourism channel. The use of tourist arrivals for the tourism channel was also used by Canova and Dallari (2013). Remittance inflow to Jamaica is assumed to reflect the majority of Jamaican nationals who live and work in the U.S. and remit money to Jamaica.¹²All variables are used in their seasonally adjusted form and transformed with natural logarithm, with the exception of inflation, theinterest rate and the trade variable. I extract the cyclical component of all selected variables using the Hamilton (2016) de-trending approach for use in the structural VAR model.

⁸The 180-Day treasury bill yield is used instead of the 90-day yield

⁹ As indicated in the literature review, tourism channel is corroborated by Malcolm (2003) and remittance by Jackman (2014).

¹⁰ Canova (2005) utilized the slope of the term structure of 90-day market interest rate or the lending/deposit rate ratio.

 $^{{}^{11}}REER = E * (P'/P)$

¹² Of total remittance inflow to Jamaica, for the period January 2013 to May 2016, an average of 62 % is from the U.S., 15 % from United Kingdom and 10.7 % from Canada.

The use of the Hamilton (2016) de-trending approach is considered to be relatively more efficient than the HP Filter used by other business cycle studies on Jamaica. Hamilton's (2016) approach involves using ordinary least toregress a variable (s_t) at time (t + h) on the four most recent values as of timet, with the residual (\hat{v}_t) being the cyclical component (see Equation 1 & 2). When compared to the HP filter, Hamilton's approach produces cyclical component of a variable that is free from spurious dynamics relations that is more in line with the data generating process and eliminates spurious predictability. A disadvantage of this approach indicated by Hamilton is the possibility that the model may fail to make a correct prediction ath period aheadin the event of cyclical factors. For example, a recession happening two years ahead and how soon the economy will recover. The h period ahead corresponds to two years ahead. For the study that uses variables at quarterly frequency h = 8. For a relatively large sample, the cyclical component is estimated using equations [3] and [4] as β_0 and β_1 converges to zero and 1, respectively.

$$s_t = \beta_0 + \beta_1 s_{t-8} + \beta_2 s_{t-9} + \beta_3 s_{t-10} + \beta_4 s_{t-11} \qquad \dots [1]$$

$$\hat{v}_t = s_t - \hat{\beta}_0 - \hat{\beta}_1 s_{t-8} - \hat{\beta}_2 s_{t-9} - \hat{\beta}_3 s_{t-10} - \hat{\beta}_4 s_{t-11} \qquad \dots [2]$$

$$s_t = \beta_0 + \beta_1 s_{t-8} + v_t \qquad \dots [3]$$

$$\hat{v}_t = s_t - s_{t-8}$$
[4]

(Figure 5 Here)

Description of the Data

This section examines the statistics of the cyclical component of the variables at hand which assists in establishing some business cycle or stylized facts. Using the standard deviation as a measure of volatility, it is found that with the exception of inflationwhich is half as volatile, Jamaica's variables are very volatility relative to its real GDP as shown in Table 1.Remittance inflow is 4 times more volatile than real GDP, while the interest rate is 1.3 timesmore volatile.

The other variables are almost twice as volatile.Assessment of the autocorrelation function, indicate that with the exception of inflation which has low persistence, all other Jamaica's macroeconomic variables have relatively high level of persistency. Further examination of Jamaica's statistics indicates that the real effective exchange rate is not dependent on Jamaica's real GDP. Remittance inflow shows sign of high pro-cyclicality compared to visitor arrival which is moderately pro-cyclicality. Inflation shows low pro-cyclicality, while trade and the interest rate are counter-cyclical.¹³

(Table 1 Here)

A comparison of the relative volatility of Jamaican and U.S. variables, real GDP, interest rate and inflation, shows that Jamaica's real GDP is twice as volatile, while Jamaica's inflation and interest rate are three times more volatile. The relatively high level of volatility for Jamaica's variables relative to that of the U.S. can be attributed to developing countries having fewer automatic stabilizers than developed countries, as well as developed countries beingbetter able to manage their business cycles (Rand and Tarp, 2002).

3.2 Model

Before proceeding to estimating the model, the study performs the Augmented Dickey Fuller (ADF) unit root test to ensure that all variables used in the analysis are free of unit root. A unit root free or stationary variable is characterized by a constant mean and a finite variance. This assessment is important, as using non-stationary time series data in regression analysis may produce spurious or meaningless results (Enders, 2010). The null hypothesis of the ADF unit root test tests if the series has a unit root (series is non-stationary) against the alternative hypothesis test that the series does not have a unit root (series is stationary).

Rather than merely assuming that the unilateral relationship from US to Jamaica's economy holds, a block exogeneity test is performed as done by Canova (2005) and Murray (2007). This test attempts to detect if the lags of one variable Granger causes another variable in the VAR system (Enders, 2010). The exogeneity test is performed by estimating a VAR then carrying out

 $^{^{13}}$ The strength of absolute correlation is 0 < Low \leq 0.3, 0.3 < Moderate \leq 0.5 and 0.5 < High < 1. This range is subjective.

the Granger causality/Block exogeneity test of the exogeneity of the U.S. block of variables with respect to that of the block of Jamaica variables. The null hypothesis tests if the lags of the Block of Jamaica variables can be excluded from that of the block of US variables in the VAR system, against the alternative hypothesis that the lags of Jamaica block should not be excluded in the US block equation in the VAR system. The test is also done for the block of Jamaica's variables with respect to the U.S. block.

Once the unilateral relationship is established, a VAR model is estimated and structural shocks identified. The optimal lag length for the VARis selected using the Akaike Information Criteria and Schwarz Information Criteria. Additionally, the length selected will be one that preserves the degrees of freedom given the relatively small sample, while ensuring that the model is free of auto-correlation and meets the stability condition.¹⁴The results should provide information on direction, magnitude and persistence of Jamaica's response to the U.S. economic shocks after examining the impulse response functions. Additionally, the forecast error variance decomposition result will indicate the contribution of each shock to the fluctuation of Jamaica's modelled macroeconomic variables. Estimation of the VAR model without the remittance and tourism variables will provide informationabout the importance of them in the transmission process and the effect their absence has on Jamaica's output.

In performing the estimation, the VAR model is represented as:

$$J_{t} = a_{11}J_{t-i} + a_{12}x_{t-1} + a_{13}w_{t} + u_{1t} \qquad \dots [5]$$
$$x_{t} = a_{22}x_{t-i} + a_{23}w_{t-1} + u_{2t} \qquad \dots [6]$$

Where 'J' represents the block of Jamaica variables, 'x' represents the block of U.S. variables and 'w' represents the world variables. The world variables are common to both country equations on the premise that they are available to capture external developments outside of

¹⁴The AIC is used as it does not penalize for over parameterization, unlike the SIC (Enders, 2010).

Jamaica and the United States. While u_{1t} and u_{2t} are structural shocks of J and x, respectively, which are assumed to be normally distributed with mean zero and constant variance, $N \sim [0,1]^{15}$:

$$\begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \sim N \begin{bmatrix} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \qquad \dots \dots [7]$$

Expressing the equations [5] and [6] in structural form VAR we have:

$$\begin{bmatrix} 1 & a_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} J_t \\ x_t \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ 0 & a_{22} \end{bmatrix} \begin{bmatrix} J_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{1t} \end{bmatrix} \qquad \dots \dots [8]$$

By rearranging the terms, we get the reduced form:

$$\begin{bmatrix} J_t \\ x_t \end{bmatrix} = \begin{bmatrix} \beta_{11} & \beta_{12} \\ 0 & \beta_{22} \end{bmatrix} \begin{bmatrix} J_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{1t} \end{bmatrix} \qquad \dots \dots [9]$$

The VAR model is expected to uncover the dynamic relationship that exists among the variables in the model. The structural VAR and the VAR are linked by the structural shock and the residuals, respectively. This provides the matrix framework were the restrictions can be imposed in the model in the form $Au = \varepsilon$, where 'A' is the invertible squared matrix that is estimated on which restrictions are imposed and the vector of shocks are orthogonal.

A common set of identifyingrestrictions imposed for the Structural VAR in the literature is based on Gali (1992), where the restrictions represent the relationship between the goods and money market (IS-LM model) in a closed economy setting.¹⁶ In this regard, the monetary variables, inflation, interest rate and money balances are not expected to have any long-run effect on real GDP. However, permanent changes in the money supply is not expected to have a long-run effect on interest rate, but is expected to have long-run effect on inflation based on the neutrality of money concept.

¹⁵Ordinary least squares would not be appropriate for this estimation procedure as the error terms are correlated with the contemporaneous variables.

¹⁶ IS-LM: Investment Savings – Liquidity Preference of Money

A supply shock is expected to have atleast some short-run effect on real GDP and any other real variables, given the slow reaction of the nominal variables in the model. Prices are expected to fall in response to a positive supply shock. In the short-run, real GDP, the interest rate and inflation are expected to affect real money balances. In addition, there is no expected contemporaneous effect of real balances, inflation and the interest rate on real GDP. It is expected that the monetary authorities take into consideration the current level of inflation and output when setting the policy rate. While output and inflation reacts to the monetary policy action with a lag. On the contrary, Sims (1986) however believes that the interest rate does have an impact on output in the same period. The relationship that exists between real GDP, inflation and interest rate holds for both U.S. and Jamaica. However, given the open economy model that is proposed in this study, the U.S. economy will be the dominant economy with the potential to affect economic fluctuation in Jamaica's Small Island Economy as shown in equation [10].

г 1	0	0	0	0	0	0	0	0	0	ך0				
C _{2,1}	1	0	0	0	0	0	0	0	0	0	$\begin{bmatrix} u_{y*} \end{bmatrix}$		$\begin{bmatrix} \varepsilon_{y*} \end{bmatrix}$	
C _{3,1}	C _{3,2}	1	0	0	0	0	0	0	0	0	u_{π^*}		$\mathcal{E}_{\pi*}$	
C _{4,1}	C _{4,2}	C _{4,3}	1	0	0	0	0	0	0	0	u_{R*} u_{m1*}		\mathcal{E}_{R*}	
C _{5,1}	C _{5,2}	C _{5,3}	$C_{5,4}$	1	0	0	C _{5,8}	0	0	0	u_{v}		\mathcal{E}_{v}	
C _{6,1}	C _{6,2}	C _{6,3}	C _{6,4}	C _{6,5}	1	0	0	0	0	0	u_{π}	=	επ	[10]
C _{7,1}	C _{7,2}	C _{7,3}	C _{7,4}	C _{7,5}	C _{7,6}	1	0	0	0	0	u_R		ε_R	
<i>c</i> _{8.1}	C _{8.2}	C _{8.3}	C _{8.4}	0	C _{8.6}	0	1	C _{7.8}	0	0	u _{trade}		E _{trade}	
C _{9.1}	C _{9.2}	C _{9.3}	C _{9.4}	0	0	0	0	1	0	0	<i>u</i> _{reer}		Ereer	
$c_{10.1}$	$C_{10.2}$	$C_{10.3}$	$C_{10.4}$	0	0	0	0	C _{7.8}	1	0	u _{visit}		E _{visit}	
$[c_{11,1}]$	C _{11,2}	C _{11,3}	C _{11,4}	<i>C</i> _{11,5}	0	0	0	0	0	1	Lu _{remit}	I	L ^e remit-	I

The restrictions imposed on the model in equation [10] are as follow. All U.S. variables will contemporaneously affect Jamaica. For both countries, real GDP will contemporaneously affect inflation and the interest rate, while inflation will affect interest in the same period. All three U.S. variables will affect real M1 is the same period. These restrictions are in line with Gali (2009). Additional restriction see real GDP having a contemporaneous effect on remittance inflow based on Clarke and Wallsten (2003) and Jackman (2014) attributing one of the factors

influencing individuals remitting funds to country of origin is the state of the economy.¹⁷Jamaica's inflation is expected to affect trade and the real effect exchange rate in the same period given the effect on Jamaica's relative price of goods and services. Adjustment in the real effective exchangerate is expected to affect trade and visitor arrivals in the same period, given the effect on Jamaica international competiveness. Since Jamaica's real GDP is a function of exports and imports, trade is modelled to affect Jamaica's contemporaneously. The three world variables will serve as control variables affecting the economies of U.S. and Jamaica. The model is also estimated without the tourism and remittance variables to assess their importance to the transmission of U.S. shocks. Importantly, a set of dummy variables are included in the model to control for outliers in the data as was done by Feldkircher and Huber (2016). These account for sharp changes in Jamaica's interest rate and visitor arrivals as well as sharp changes in U.S. prices and real M1 (see Table 2, in the Appendix). The identification equation is represented in the $\Box Au = \varepsilon$ format with c_{ii} '(*i*= row and *j* = column) representing the restrictions imposed on the contemporaneous variables in the mode. In [10], y, π , R and m1 represents real GDP, inflation, interest rate and real M1 economic shocks, respectively. The use of '*'indicate U.S. variables. Visitor arrivals and remittance inflow are represented by visit and remit, respectively.

Diagnostic Tests

After the VAR equations are estimated for the U.S. and Jamaica, adiagnostic test of the residuals is done to test for normality and autocorrelation to ensure the model is robust. In addition, a stability test is also performed on the VAR. Model. In performing the normality test of residuals, a multivariate normality test is carried out. It is important to note that for VAR models, it is not

¹⁷ This study is not concerned with the reasons people remit. Jackman (2014) indicated that other macroeconomic factors are likely to influence remittance inflows after individuals have made their decisions such as demographic, financial and political. It has been cited that remittance inflows to developing economies tend to be countercyclical (Bettin, Presbitero and Spatafora, 2014).

uncommon for the residuals to be not multivariate normal as indicated by Lanne and Lütkepohl (2010).

A priori expectations for Transmission of U.S. shocks toJamaica economy

In an effort to provide a benchmark for the results of this study, Table 3provides a base on which the transmission of external shocks are expected to affect Jamaica. The expectations of the transmission of U.S. shocks to Jamaica are largely guided by Canova (2005). The overall effect of external shocks on an economy depends on how the economy interprets the shocks and the interaction between the various channels of transmission as highlighted by Feldkircher and Huber (2016).

(Table 3 Here)

For a positive U.S. supply shock, it is expected that U.S. prices should decrease. Thereafter, Jamaica's term of trade, measured as the ratio of export price to import price, should rise. Consequently, exports and real GDP should decrease and imports increase and cause the trade balance to deteriorate. Domestic prices may either not change or decline on the premise thatthe REER adjusts, or if domestic demand has a greater influence on prices or production. The response of Jamaica's interest rate will depend on whether the monetary policy is driven by price concerns or the level of output. However, if all the U.S. price change is not reflected in Jamaica's prices, the REER should adjust in order to achieve equilibrium. On the basis that remittance inflow is countercyclical as indicated by Bettin, Presbitero and Spatafora (2014), the decline in real Jamaica's tourism product is influencedbyprice, all other things being equal, a fall in the REER is expected to negatively affect visitor arrivals.

In response to a positive U.S. interest rate shock (monetary tightening), Jamaica's interest rate is expected to increase, given the U.S.'s pivotal role in the international financial market. As a result, capital will move to the U.S. economy and have a negative effect on economic activity in Jamaica. The movement in capital from Jamaica should reduce the net international reserves of the country and put pressure on the value of the domestic currency leading to an increase in theREER(depreciate). If the REER fully adjusts immediately to the shock, there should be no

expected change in Jamaica's macroeconomic variables. However, if the full adjustment in the REER occurs overtime, there should be observed decline in Jamaica's real GDP and prices (Borda, Manioc and Montauban, 2000;Canova, 2005). The adjustment in REER in response to U.S. interest rate change is an indication that the uncovered interest rate parity condition is met. Visitor arrivals are expected to respond positively with REER movement.

The response of Jamaica's economy to an increase in U.S. price shock is expected to be opposite the U.S. positive supply shock. With Jamaica being a price-taker given its relative small role in the goods market, domestic prices should increase as the intermediate price of goods increases. The monetary authority is expected to react with contractionary policy (rise in its policy rate) in accordance with its mandate to maintain price stability. A positive impact is effect expected on the REER.

4. Results

This section presents the findings of the study. The ADF unit root test revealed thatall filtered variables have no unit root. That is, they are all integrated of order zero (I(0)) (see Table 4, Appendix). The result of the block exogeneity test indicates that the block of U.S. variables Granger-cause the block of Jamaica variables at the one percent level of significance. The test for instantaneous causality indicates that there is instantaneous causality between the U.S. and Jamaica block of variables. On the other hand, the block exogeneity test for Jamaica with respect to U.S. indicated that the block of Jamaica variables does not Granger-cause the U.S. variables at the 10 percent level of significance (see Table 5, in Appendix). Based on the lag length criteria, test for autocorrelation and stability of the VAR, a lag length of 2 quarters was selected. The VAR modelwas also found to be stable as the modulus values of all the roots fall within the unit circle (see Table 6, in Appendix). The SVAR was then estimated using maximum likelihood method.

4.1 Impulse Responses to U.S. Economic Shocks

Figures 6 to 7 summaries the implications of a positive one standard deviation U.S. supply, monetary policy and price on Jamaica's economy, respectively. Assessment is done using the accumulated impulse response functions and forecast error variance decomposition. The point estimate of the impulse responses are provided with the 90 percent confidence interval from zero to 30th quarter horizon. For a stationary VAR model, the accumulated responses are expected to asymptote to a non-zero constant.Theimpulse responses of the other variables are interpreted as percent deviation from the steady state or long-run trend given a one standard deviation shock. The U.S. supply shock hasthe largest effect on Jamaica's economy with the REER, remittance and tourism channels playing dominant roles. On the other hand, the U.S. monetary and inflation shocks have little effect.

(Figure 6 Here)

A positive U.S. supply shock results in asignificant accumulated increase in real GDP, from the point of impact untilthe ninth quarter, of 5.2 percent from the steady stateas shown in Figure 6. This behaviour is evidence of temporary supply-side driven effects on Jamaica's real GDP. The response of real GDP, triggersaccumulated decline in inflation below its steady state, which is significant between the third and ninth quarters. The interest rate is significantly increased in tenth to 17th quarter which coincided and contributed with the slowdown in real GDP. This could reflect the monetary authority taking a policy stance to maintain pricestability. Importantly, the delayed reaction on the part of the monetary authority could be linked to the monetary authority making a decision to continue to foster an environment suitable for increased economic activity. Thereal effective exchange rate showed significant increase after a year with an accumulated increase of 85 percent above the steadyby the end of the horizon. This behaviour is indicative of the REERadjusting in order to achieve equilibrium on the premise that all the effect of the shock was not transmitted to domestic prices. The depreciation of the local currency would have boosted Jamaica's international competitive and contributed to a significant accumulated increase in trade balance after a year. Although visitor arrivals responded positively on impact to

the shock, the pace jumped sharply and became significant atthe same time of the significant rise in the REER. This reflects a relatively more attractive Jamaica tourism product, all other things being equal, given the depreciation of the Jamaican currency over the horizon. The accumulated positive response was significant until the end of the end of 30 quarters with increase of 61 percent above the steady state. This is in line with Malcolm (2003) conclusion of the importance of U.S. income to Jamaica's tourism and bolstered by the close proximity to Jamaica as indicated by Rochester (2011). Remittance response was positive with a significant impact coming after six quarters until the end of the horizon. The accumulated response is85 percent. Thetwo quarters delay inremittance positive and significant response after the depreciation can be attributed to remittance senders acting rational by speculating on a continued depreciation of the Jamaican dollar. As further depreciation translates into increased spending power for Jamaica's recipient of remitted funds from the U.S. and additional benefit to households since the majority of the funds are used for consumption purpose as indicated by Ramocan (2011).

(Figure 7 Here)

In response to a contractionary monetary policy (increase in U.S. interest rate), Jamaica's output reacted with a quarter delay but showed significant accumulated decline over the horizonas shown in Figure 7. The accumulated decline was greatest in quarter nine at 4 percent, and showed signs of slight a recovery thereafter. Inflation showed a significant but short-lived decline in the first quarter and a more prolonged significant decline in the seven to 13 quarter. In quarter 13, the accumulated decline in inflation was 0.01 percent above the steady state. Remittance inflow showed a significant accumulated decline from the second to the ninth quarter, where the accumulated decline was 17 percent in the ninth quarter. The other channels of transmission played no significant role. Although not playing a significant role in the transmission process and not increasing as expected, the interest rate declined after a year, an indication of the monetary authority facilitating a recovery in the economy and decline in inflation away from its long-run path.

The negative shock to U.S. inflation (greater rise in prices) resulted in the expected accumulated decline in real GDPwhich was significant up to 19 quarters as shown in Figure 8. The accumulated decline in output reached its highest of 3 percent two years after the shock, with a

slight recovery observed afterwards. Jamaica's inflation response was relatively low and shortlived with a significant increase after the shock observed in the second and third quarters. The significant impact on trade was also negligible and short-lived with a decline on impact and an increase in the third quarter. Remittances and tourist arrivals responses to the shock were low, with the negative and positive impacts lasting between one and two years, respectively.

Overall, the expansion in U.S. output generates positive spill-over effects on the Jamaican economy which is evident in the expansion in output. This reinforces the importance of U.S. output to Jamaica and is consistent with the policymakers predicating the country's economic growth over the short to medium term on growth in the international economy, in particular the United States of America. This has implications for the Government of Jamaica's expected tax revenue inflow, in particular from international tax receipts. Accompanying economic growth in the U.S. is an expected increase in income which means increased demand for Jamaica's tourism product and higher remittance inflows. Although the counter response of Jamaica's interest rate to that of the U.S. contractionary monetary policy was not significant, it would reflect the Bank of Jamaica reacting more to domestic economic conditions in an optimistic but cautious manner. As the Bank of Jamaica would be taking an accommodative policy stance by gradually lowering its policy rate, all other things being, in an attempt to foster an environment that can stimulate demand in its weak economy so as to achieve economic recovery. The rise in U.S. inflation had little effect on the trade balance, with the domestic output falling given the rise in the cost of intermediate inputs coming from the U.S. The full adjustment was reflected in domestic price in a short time and the adjustment in the REER was insignificant.

4.2 Relative Importance of U.S. Shocks

In examining the importance of U.S. factors in explaining fluctuation in Jamaica's macroeconomic variables, the forecast error variance decomposition is employed. An overview of the variance decomposition looks at the average effect economic shocks have on Jamaica's variables 12 quarters ahead (see Table 7, in Appendix). This highlights the variance decomposition of Jamaica's real GDP (y), inflation (π), interest rate (R), trade balance (trade), real effective exchange rate (REER), visitor arrivals (vist) and remittance inflow (remit) explained by U.S. along with the world variables and Jamaica's economic shocks.

Together, the U.S. and world variables account for a significant portion of the variation in Jamaica's macroeconomic variables. This highlights the importance of the world economy and the very openness of Jamaica's economy. The U.S. economic shocks accounts for an average of 30.8 percent of the variation across all Jamaica's variables. Inparticular, U.S. supply shock has the main influence across domestic variables, with US monetary shock having notable influence on output and U.S. inflation on trade balance. This differs from Murray's (2007) assessment of Jamaica in that his study identified U.S. price as the major influence on real GDP, interest rate and price with average contribution of 12.6 percent. The other U.S. shocks were relatively low. The differences in de-trending method, composition of variables, empirical approach and sample period. In addition, my study included a group of variables that captured the state of the world economy independent of United States and Jamaica. The inclusion of the world variables highlights the need for Jamaica to monitor the effect of shocks from its other major trading partners which are United Kingdom, Canada and CARICOM.

4.3 Examination of Co-movements of U.S. and Jamaica Business Cycles

In this section an assessment is done to assess the conditional impact the U.S. shocks have on Jamaica's business cycle. This assessment is performed by computing the cross correlation function of real GDP, the inflation rate and the interest rate between Jamaica and the U.S., in response to US shocks. The magnitude, direction and significance of the correlation will varywith the type of shock. Table 8 shows the cross-correlation results for the impulse response functions for the respective variables and shocks. These correlations look at the conditional correlation and differ from those discussed in Section 3 that are based on an unconditional correlation.

(Table 8 Here)

The expansion in U.S. supply generated a positive response in Jamaica's real GDP and negative response in inflation. This shock produced positive comovement in U.S. and Jamaican real GDP with the significant point contemporaneous correlation estimate of 0.76. The correlation was also

significant at the first lead and lag. The contemporaneous effect on inflation is 0.43 and significant, while the interest rate was not significant. The contemporaneous correlation of real GDP and inflation to the monetary shock are significant with 0.78 and -0.54, respectively. For the U.S. inflation shock, the correlation between inflation for both countries is positive and significant at 0.5, while the correlation between real GDP for both countries negative and significant at 0.59. Overall, the U.S. supply and monetary shocks generate relatively large comovement in real GDP, while negative comovement from an inflation shock.

Examination of the conditional correlation between Jamaica's output and remittance inflow showed that the contemporaneous correlation is positive and significant with point estimates of 0.81, for both monetary and inflation shocks. As appreciation in the U.S. currency means greater spending power in Jamaica and for the latter extra remittance flow to restore purchasing power to households receiving remittance funds. The comovement as a result of a supply shock was negative but not significant. This would not be in support of Jackman (2014) countercyclical claim of remittance inflow to Jamaica. For the conditional correlation between U.S. real GDP and visitor arrivals to Jamaica, positive and significant of point estimates are shown in response to supply shock and monetary shock. The latter was however lower with point estimate of 0.54.

4.4 How Important is Remittances and Tourism to Transmit U.S. Shocks?

This section examines the role of remittance and tourism channels in transmitting U.S. shocks. As previously mentioned, the second SVAR model is estimated without the tourism and remittance variables and the contribution of these two channels assessed by comparing differences in the impulse response functions, forecast error variance decompositions and the cross correlations to the original model.

The assessment shows that both tourism and remittance inflows play important roles in Jamaica economy. Estimation of the SVAR without these channels showed that with the exception of the inflation response to a U.S. monetary shock, all other significant responses were short-lived to the respective shocks. In response to a U.S. supply shock, real GDP significantly increased by 2 percent on impactas shown inFigure 6. The positive response is in-line with Murray's (2007) study of Jamaica, but is at a higher level. The expansion resulted from an initial and significant

rise in trade which was short-lived. There is no significant interest rate, REER or inflation perturbations. The U.S. monetary shock resulted in a significant negative effect on real GDP and inflation. This effect on real GDP was significant in the third to ninth quarter, with the accumulated decline being highest in the seventh quarter at 0.02 percent. The accumulated decline in inflation from the shock was significant after a year of the shock and died out in year three at 0.012 percent. An increase in U.S. inflation significantly decreased real GDP in the third quarter and trade on impact, but both effects lasted only for a quarter. Significant increases in inflation in the third quarter and REER in 2 years were also short-lived.

(Figure 6 Here)

The absence of both channels from the examination of the transmission of U.S. shocks resulted in a lower effect on Jamaica's real GDP relative to the original model. For the U.S. supply shock, the real GDP response at the 5th quarter (where the response was last significant) fell to 2 percent from 4 percent. This translates into a lower real GDP effect of 46 percentlower than that of the original model at the comparable quarter as shown in Figure 6. In response to the monetary shock, real GDP in the 8thquarter fell to 2 from 4 percent, a lower effect of 54 percent as shown in Figure 7. The response of real GDP to inflation shock in the counterfactual model is negligible when compared to the 1 percent contraction in the original model as shown in Figure 8.On average, the effect on real GDP is lower by 67 percent. This behavior is consistent with idea that tourism and remittance play a critical role in the Caribbean country of Jamaica in term of foreign exchange earnings for both and the latter as support to household for consumption purpose. This conclusion is broadly in line with Canova and Dallari (2013) that absence of the tourism channel in an assessment of the transmission of positive output shock from source country to a destination country lowers its output effect by 25 percent.

The absence of these two additional channels to the SVAR estimation produced forecast error variance decomposition that showed that the overall contribution of U.S. shocks to fluctuations across Jamaica's macroeconomic variables are lower. This resulted in greater fluctuations attributed to domestic factors. Notwithstanding these result, the U.S. supply shock is still the

dominant shock originating in the United States contributing to fluctuation in Jamaica's economy as shown in Table 7.

(Table 7 Here)

In the counterfactual case, the cross correlation matrix showed that the comovement in real GDP was still strong and significant for the U.S supply and monetary shock. However, the contemporaneous estimate of the former fell to 0.52 from 0.76. The response of inflation to supply shock is now negative and significant as shown in Table 8.

(Table 8 Here)

5. Conclusion

The paper attempts to assess the transmission of economic shocks from the U.S.toJamaica's economy. Emphasis is placed on three U.S. economic shocks: supply, monetary and price. In addition to traditional transmission channels, the tourism and remittance channels are included as additional channels of importance. A structural vector autoregressive model is estimated with the shocks identified using both economic theory and empirical evidence. The response of the Jamaican economy to the U.S. shocks are studied, quantify the contribution of the shocks, while making a distinction of shocks inherent to Jamaica and those independent of the two countries. A counterfactual assessment is done with the absence of remittance and tourism to assess their importance to Jamaica in response to the shocks. These additional channels are important given their contribution to Jamaica's economic activity and major source of foreign currency inflow to build the country's net internal reserves. Remittanceinflow is not only a source of foreign exchange for the country, but serves as support to households who use it primarily for consumption purposes.

Economic shocks originating in the U.S. (supply, monetary and inflation) contribute to an average of 30.8 percent of the economic fluctuation experienced in Jamaica's macroeconomic variables. Together with the other external shocks, it's an average of 80.5 percent of the

fluctuation attributed to external sources. In terms of the U.S. shocks, the supply disturbance has the greatest effect across all of Jamaica's variables. The response of real Jamaica GDP to a positive U.S. supply shock has a significant and positive impact up to the ninth quarter where accumulated growth was 5.0 percent above the steady state. All channels of transmission have significant and relatively strong responses, with remittance, tourism and the real effective exchange rate playing major roles. The interest rate channel played an insignificant role in the transmission of U.S. monetary shocks. On the other hand, inflation and remittance channels played significant but delayed roles in the transmission process of monetary shocks with the response evident in year 3 and the latter between 2nd and 9th quarter. For the inflation shock, the remittance and tourism channels play a crucial and significant role with 2 years of the shock.

The importance of the remittance and tourism channels was made clear from the counterfactual assessment, as absence of these two channels resulted in an average lower real GDP (output) effect of 67 percent across all three shocks examined. The absence made the transmission channels weaker and any significant responses observed were short-lived. Further, the average fluctuation in the macroeconomic variables attributed to U.S. shock was lower by 6.3 percent on average.

The conditional comovement in real GDP between the U.S. and Jamaica are strong and significant in response to supply and monetary shocks. However, the correlation in response to inflation shock is negative. Absence of the two additional channels resulted in a lower comovement in response to a supply shock. The relationship between U.S. real GDP and tourist arrivals was as expected, significant and positive in response to U.S. supply and monetary shocks. In terms of the relationship between Jamaica's real GDP and remittance inflow, U.S. monetary and inflation shocks are significant and positively related. This is an indication of ability of remittance sender to increase or restore the spending power of household recipients. The relationship was counter cycle as indicated by Jackman (2014), but low and insignificant, given a U.S. supply shock.

The findings of the study have important implications for Jamaica's policymakers in mitigating or tempering economic fluctuations. Although attempts are being made by the policymakers, greater emphasis and policy changes are needed in light of the fact that the economy is relatively open and approximately 80.5 percent of the cyclical movements are attributed to external sources, of which 30.8 percent originates in the United States. Both tourism and remittance inflows generate positive spill-over effects on the domestic economy in case of a U.S. output expansion. This reinforces the importance of U.S. output to Jamaica's economy and is consistent with the policymakers short to medium term plans in predicating itsown economic growth prospect over the short to medium term on growth in the United States of America. It just requires the continued monitoring of international conditions in an effort to isolate the shocks specific to the U.S. against others, in order to formulate the best policy prescription to achieve the desired policy objective in stabilization the domestic economic in face of external pressures. However, although there is significant conditional comovement between Jamaica and United States output, the outcome depends on how policymakers and the country as a whole interpret the shocks.

The result on my study is a valuable contribution to the Jamaica's literature on economic fluctuation. Relative to other studies, my paper uses a more efficient de-trending technique without the drawbacks associated with the HP filter. A different set of variables is included in the SVAR with two additional channels of transmission (remittances and tourism) that have never being explicitly modelled for Jamaica's economy. I also control for the state of the world economy independent of United States and Jamaica. The identifying of the economic shocks is guided by economic theory and empirical studies, instead of the cholesky decomposition which is an ad hoc approach. In the end, the responses of Jamaica's macroeconomic variables to U.S. economic shocks, in particular U.S. supply shock, are stronger and significant.

Future research should use the technique employed in this study in a panel setting to examine the effects of the transmission of U.S. shocks on a typical CARICOM economy to see what business cycle dynamic can be uncovered. In addition, if a relatively larger and reliable dataset is available for Jamaica at a later date, the study can be broadened to incorporate time varying coefficient VAR which would display heteroskedastic shocks. Other measures of tourism channels could also be explored.

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7. Appendix

Figure 1



Figure 2: Jamaica Macroeconomic Variables (1995 - 2015)







Figure 4:





Figure 5: Extracted Cyclical Component using Hamilton (2016) De-trending Method



Figure 6: Jamaica Accumulated Response to Positive U.S.Supply Structural One S.D. Shock





Model ••••• 90% C.I.



Figure 8: Jamaica Accumulated Response to Positive U.S. Inflation Structural One S.D. Shock

Table 1: Stylized Facts

	Standard					
	Deviation (%)	std(i)/std(y)	autocorrelation	Cross-corre	elation	
U.S.		· · · · · · · · · · · · · · · · · · ·				
Real GDP	2.29	1.00	0.89			
Inflation	0.55	0.24	0.21	0.20		
Interest Rate	1.67	0.73	0.89	0.55		
Real M1	8.21	3.59	0.84	-0.45		
Jamaica						
Real GDP	3.51	1.00	0.76			
Interest Rate	4.38	1.25	0.81	-0.09		
Inflation	1.64	0.47	0.25	0.11		
Trade	6.23	1.77	0.73	-0.23		
REER	7.26	2.07	0.91	0.00		
Visitor Arrivals Remittance	8.30	2.36	0.79	0.48		
Inflow	14.00	3.98	0.85	0.63		
			Cross	Correlation		
<u>US-Jamaica</u>			lag 1	0.00	Lead 1	
USY - Jam Y			0.24	0.30	0.32	
USY-Jam Interest	Rate		-0.46	-0.47	-0.39	
USY - Jam Inflati	on		-0.07	-0.06	-0.10	
US R - Jam Y			-0.08	-0.03	0.02	
US R - Jam R			-0.16	-0.17 -0.21		
US R - Jam Inflat	ion		-0.08	-0.03	0.00	
US P - Jam Y			0.13	0.11	0.15	
US P- Jam R			-0.14	-0.20	-0.11	
US P - Jam Inflati	ion		0.13	0.50	0.14	

Table 2: Dummy Variables

Country	Variable	Dummy Variable	
United States	Inflation	2008Q4-2009Q2:	Impulse and Interactive
	Real M1	2008Q3-2015Q4:	Shift Dummy
Jamaica	Interest Rate	2003Q3, 2008 :	Impulse and Interactive
	Tourist Arrivals	2001Q3-Q4, 2008Q1	I-Q4 : Impulse and Interactive

 Table 3: Expected Response of Jamaica's Macroeconomic Variables to U.S. Economic Shocks on Impact

Jamaica Macroeconomic Variables													
	Real		Interest			Visitor							
Shocks	GDP	Inflation	Rate	Trade	REER	Arrivals	Remittance						
Supply	1	\downarrow	\downarrow	_	\downarrow	↓	1						
Monetary	\downarrow	\downarrow	\uparrow	_	\downarrow	\downarrow	_						
Price	\downarrow	Ť	1	Ť	↑	1	—						

Note: \uparrow (increase), \downarrow (decrease) and – (any direction)

Variables	Test Statistics	Lags	Order of Integration						
Emerging Market Bond	-3.41**	3	I(0)						
Index									
Commodity Price Index	-4.531***	1	I(0)						
Emerging Market Equity	-2.29**	3	I(0)						
Index									
			TO						
U.S. Real GDP	-3.347**	2	I(0)						
U.S. Interest Rate	-4.600***	3	I(0)						
U.S. Inflation	-7.307***	1	I(0)						
U.S. Real M1	-3.259**	1	I(0)						
<u>Jamaica</u>									
Real GDP	-4.003***	5	I(0)						
Interest Rate	-6.162***	2	I(0)						
Inflation	-7.084***	1	I(0)						
Trade	-5.182***	3	I(0)						
Real Effective Exchange	-5.859***	1	I(0)						
Rate									
Visitor Arrivals	-4.514***	5	I(0)						
Real Remittance Inflow	-4.1306***	0	I(0)						
Notes: All test performed	Notes: All test performed with constant only. *** indicates significance of								

 Table 4: Augmented Dickey Fuller Unit Root TestResults

Notes: All test performed with constant only. *** indicates significance of Test Statistics at 1% level, ** significance at 5% and * significance at 10%.I(0) indicates that variable is integrated at level. So there is no need to difference. The AIC criterion was used to select the lag levels.

 Table 5: Block Exogeneity Test

<u>US Block to Jamaica Block</u>

TEST FOR GRANGER-CAUSALITY:

H0: "U.S. Block of variables" do not Granger-cause "Jamaica Block of Variables"

Test statistic l = 1.7574 pval-F(l; 56, 451) = 0.0011

TEST FOR INSTANTANEOUS CAUSALITY:

H0: No instantaneous causality between "U.S. Block of variables " and "Jamaica Block of Variables"

Test statistic: c = 78.2749 pval-Chi(c; 28) = 0.0000

Jamaica Block to U.S. Block

TEST FOR GRANGER-CAUSALITY:

H0: "Jamaica Block of Variables" do not Granger-cause " U.S. Block of Variables"

Test statistic l = 1.2457 pval-F(l; 56, 451) = 0.1193

TEST FOR INSTANTANEOUS CAUSALITY:

H0: No instantaneous causality between "Jamaica Block of Variables" and "U.S. Block of Variables"

Test statistic: c = 78.2749pval-Chi(c; 28) = 0.0000



Table 6: VAR Diagnostic Test Results

	Y	π	R	Trade	REER	Visit	Remit	Average
Shocks								
World variables	43.2	67.8	60.3	47.3	39.3	39.2	50.6	49.7
US	38.3	13.8	17.5	32.0	35.6	48.8	29.8	30.8
Jamaica	18.5	18.4	22.2	20.7	25.1	12.0	19.6	19.5
		Co	<u>unterfactual</u>					
World variables	20.3	50.8	47.1	47.7	33.3			39.8
US	36.8	18.0	14.4	29.6	23.6			24.5
Jamaica	42.9	31.2	38.5	22.8	43.1			35.7

Table 7: Average Forecast Error Variance Decomposition showing Relative Contribution of U.S. Economic Shocks

Note: The averages are calculated based on the forecast error variance decomposition over a 12 quarter horizon.

		Economic Shocks											
		Supply			Monetary	7	Inflation						
Variables	-1	0	1	-1	0	1	-1	0	1				
Real GDP	0.64*	0.76*	0.48*	0.8*	0.78*	0.80*	-0.69*	-0.59*	-0.39*				
Interest Rate	-0.12	0.00	0.18	-0.22	-0.28	-0.25	-0.24	-0.28	-0.55*				
Inflation	-0.11	0.43*	-0.58*	-0.13	-0.54*	0.13	-0.16	0.51*	-0.05				

Table 8: Cross-Correlations of Jamaica Macroeconomic Variables in Responses to U.S.Economic Shocks

	Supply			Monetary			Inflation		
Real GDP	0.38*	0.52*	-0.13	0.89*	0.72*	0.58*	-0.46*	-0.30	-0.03
Interest Rate	0.66*	0.77*	0.81*	-0.27	-039*	-0.45*	0.13	-0.04	-0.26
Inflation	0.61*	-0.40*	-0.32	0.52*	-0.72	0.06	-0.15	0.63*	0.15

Counterfactual

Notes: Table shows cross-correlation(x_t , J_{t-1}), i = -1,0,1 where x_t represent the U.S. variable and y_t represents the Jamaica variable. Cross-correlation is based on the actual (not accumulated) impulse response function. A * indicates that the 95% band does not include zero.

	Supply				Monetar	y	Inflation			
Variables	-1	0	1	-1	0	1	-1	0	1	
JamY-Remit	0.21	-0.31	-0.02	0.64*	0.81*	0.82*	0.81*	0.81*	0.78*	
USY -Visit	0.75*	0.86*	0.94*	0.53*	0.54*	0.68*	0.63*	0.04	-0.25	

Notes: Table shows cross-correlation between Jamaica's real GDP(JamY_t) and remittance inflow (Remit_{t-i}) were i= -1, 0, 1. USY-Visit shows the cross-correlation between U.S. real GDP(time t) and visitor arrivals (t-i), where i= -1, 0, 1. Cross-correlation is based on the actual (not accumulated) impulse response function. A * indicates that the 95% band does not include zero.