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# Business Cycles in the Eastern Caribbean Economies

## The Role of Fiscal Policy and Interest Rates

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## Abstract

This paper analyzes the business cycle characteristics of the economies of the Organization of Eastern Caribbean States using a model of a small open economy subject to interest rate and fiscal expenditure shocks and financial frictions. The paper shows that macroeconomic aggregates in this region are quite volatile, with consumption exhibiting higher volatility than gross domestic product. The analysis also finds that in these economies real interest rates are highly volatile and strongly countercyclical with gross domestic product and other macroeconomic aggregates. Similarly, fiscal expenditures show significant volatility, but are pro-cyclical with gross domestic product. The results suggest two major directions for designing policies to help reduce the volatility experienced by the Organization of Eastern Caribbean States economies. First, Organization of Eastern Caribbean States countries should seek a greater openness to international financial markets, which could help them smooth out the effects of fundamental shocks, such as shocks to technology and terms of trade, and shocks associated with natural hazards. However, this removal of international financial barriers needs to be accompanied by improvements in domestic financial conditions, as this would reduce the vulnerability of these economies to country risk premium shocks. Second, the Organization of Eastern Caribbean States region should try harder to move toward a countercyclical fiscal policy stance, as this could help to stabilize the domestic risk premium and cushion the negative effects of interest rate shocks on economic activity, hence reducing volatility.


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# Business Cycles in the Eastern Caribbean Economies: The Role of Fiscal Policy and Interest Rates

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## 1. Introduction

The Caribbean region is home to some of the smallest states in the world. Although similar in their smallness, there are marked differences among them. Caribbean nations differ in size, income levels, and economic structure. [1] In terms of economic structure, the region hosts a few commodity-exporters (such as the Dominican Republic, Guyana, Belize, Suriname, and Trinidad and Tobago) while others are service-oriented economies (such as Barbados, Grenada, Bahamas, St. Lucia and others). Similarities include proximity to major markets in North and South America, and for most countries, a transition from agriculture or mining to a service-driven economy, anchored in particular on tourism and financial services. Common challenges include exposure to frequent natural disasters; vulnerability to external shocks; high debt; and lack of economies of scale.

The commodity-exporting group has done very well until recently when commodity prices started to fall, with most of the countries showing high growth, solid fiscal stances, and sustainable debt levels. Now, with the end of the commodity super-cycle, these countries are facing fiscal pressures and their debts are increasing. The tourism-based economies, on the other hand, were the ones suffering the most with low growth rates since the global financial crisis that led to low tourism, low remittances, high non-performing loans in banks, and considerable fiscal strain. They are now the ones who stand to benefit the most from the current state of affairs as oil prices remain low and the main sources of tourism-related revenues and remittances, namely the US, Canada, and Europe, start to grow faster.

Because the tourism-dependent countries are the smallest open economies in the region, they tend to suffer the most with volatility associated with terms of trade shocks. The members of the Organization of Eastern Caribbean States (OECS)[2] are especially vulnerable. Their growth performance has been uneven over the last three decades or so due to reasons that range from the need to reinvent themselves after the end of preferential trade agreements with Europe in the 1980s to the occurrence of natural hazards. After growing faster than the rest of the world in the 1980s at an annual average of 6 percent, the OECS countries have experienced a significant growth slowdown since the 1990s with annual growth rates of 2 percent or less on average. More recently, the region was severely hit by the effects of the global financial crisis of 2008-09 because of their close ties with the economies of the U.S., Canada, and Europe which are their main source of tourist arrivals.

Understanding the sources and consequences of macroeconomic volatility comprises one of the key challenges facing policy makers in developing countries, and especially so in small island states. The main objective of this paper, therefore, is to provide an in depth exploration of the sources of macroeconomic volatility in the Eastern Caribbean economies, contrast them with other developing economies, and evaluate their effects on the macroeconomic performance of

[1] From the small island states of the Organization of the Eastern Caribbean States (OECS, with some 600,000 inhabitants in total) to Jamaica (2.7 million people). Guyana has one of the lowest GDPs per capita in the world (USD3,600 in 2014), while Barbados, on the other hand, is an upper middle income country (with GDP per capita of USD16,300 in 2014).

[2] The OECS, establihed in 1981, comprises six independent countries and three British Overseas Territories (Anguilla, Montserrat, and the British Virgin Islands). In this paper, we will cover only the six independent OECS countries: Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines.

these countries. Such analysis will help us isolate the key shocks and frictions affecting the Eastern Caribbean economies and focus the policy discussion on them.

We start by documenting the economic growth and business cycle characteristics of the member countries of the Organization of Eastern Caribbean States (OECS). We show that macroeconomic aggregates in these countries are quite volatile, with consumption exhibiting higher volatility than GDP. We also find that in these economies real interest rates are very volatile and strongly countercyclical with GDP and other macroeconomic aggregates. Fiscal expenditures also show significant volatility, but are pro-cyclical with GDP.

We then analyze these facts through the lens of a small open economy model calibrated to replicate the growth and business cycle facts in an average OECS country. The model has two key features. The first is that domestic financial markets are subject to a friction – firms have to pay a share of the bill for the factors of production before production takes place and revenues are realized. This creates a need for working capital by firms. The second key feature of our model is the presence of a fiscal authority. The fiscal authority levies lump-sum taxes and uses tax revenues to provide public consumption. We will allow public expenditures to have different cyclical properties. These two features of the model will generate transmission channels through which real interest rates and fiscal policy shocks will affect the level of economic activity.

We use the model to quantitatively evaluate the role played by financial frictions, pro-cyclical fiscal policy, and various shocks (i.e. productivity, real interest rate, and government spending shocks) facing an average OECS economy in driving its business cycles.

We find that the model matches the data in the OECS countries very well. It predicts volatile consumption and countercyclical interest rates. We then show that eliminating fiscal policy shocks reduces the volatility of consumption and trade balance, but leaves the volatility of GDP unchanged. Eliminating shocks to interest rates reduces the volatility of GDP by 14%, and volatility of consumption by 21%. The majority (60-70%) of this decline in volatility is achieved by eliminating the shocks to risk-premium.

We also show that domestic financial market development plays an important role in buffering the effects of interest rate shocks on the economy. Eliminating the working capital constraint, while keeping all shocks in place, reduces the volatility of GDP, consumption, employment and government spending significantly. For instance, GDP volatility is reduced by 14%, while that of consumption declines by 24%.

This analysis suggests a few directions for policy in these countries. First, it is important that OECS countries continue opening up their economies to international financial markets as it could help these countries to share risks with the rest of the world. Second, greater openness must be accompanied by improvements in domestic financial markets and government's efforts to stabilize the domestic risk-premium. By reducing the frictions in the domestic financial markets, these economies can cushion the negative effects of interest rate shocks on domestic economic activity, and achieve lower volatility. Furthermore, if pro-cyclical government policies induce higher country risk-premium in the international markets, governments of the OECS countries can stabilize their country's risk-premium by switching to countercyclical policies.

The rest of the paper is structured as follows. After this Introduction, section 2 discusses the effects of volatility on growth in line with the current literature. Section 3 discusses the cyclicality and volatility of fiscal policy and interest rates along with some stylized facts for the OECS countries. Section 4 outlines the main features of our model and discussed our calibration of the model to the OECS countries. Section 5 presents the results of a number of computational experiments that simulate the impacts of different shocks and frictions on the economy. Section 6 concludes with several major policy implications for the OECS economies that could help them reduce the volatility they experience: seek greater openness to international financial markets, reduce domestic financial imperfections, and adopt a countercyclical fiscal policy stance.

## 2. The Effects of Volatility on Growth

A common finding in the literature is that volatility is often associated with lower economic growth, especially in less developed economies. For instance, Hnatkovska and Loayza (2005) estimate that a one standard deviation increase in macroeconomic volatility (measured as standard deviation of output gap) leads to a 1.28% average loss in annual per capita GDP growth.[3] The negative effects of volatility on growth may arise if recessions are accompanied by tighter financial constraints, thus leading to lower consumption and investment rates. To the extent that lower investment hinders growth, we will see a negative relationship between growth and volatility. Similarly, increased volatility can lead to lower investment and, therefore, lower growth if there are irreversibilities in investment as in Aizenman and Marion (1993). Ramey and Ramey (1991) further show that if firms make production plans before shocks are realized, then volatility can lead to lower mean output as firms may find themselves producing at inefficient levels, ex post. Since lower current output restricts factor accumulation, economic growth is adversely affected.

In the same spirit, a negative link from volatility to growth may arise in the presence of fiscal constraints. Specifically, if fiscal constraints are tighter during downturns, recessions can lead to less human capital development and lower productivity – for instance, through cuts in expenditures on infrastructure, public health, education, etc. – leading to lower growth rates (see Martin and Rogers 1997; Talvi and Végh 2005).[4]

Volatility also typically entails substantial welfare costs in developing countries. This is because in these countries the risk-sharing mechanisms are few and underdeveloped. Therefore, macroeconomic volatility in these countries leads to much more unstable consumption paths than in developed economies. Moreover, by reducing economic growth in these countries, volatility also lowers future consumption. It is therefore not surprising that the welfare gains from reducing volatility in developing countries can be substantial (see, for instance, Athanasoulis and van Wincoop (2000)).

[3] For more empirical evidence on volatility-growth relationship, see Ramey and Ramey (1995), Martin and Rogers (2000), Kroft and Lloyd-Ellis (2002), Servén (2003).

[4] The link between volatility and growth can also be *positive* in the presence of a creative destruction process as in Joseph Schumpeter (1939) and modern treatment of the same idea in Caballero and Hammour (1994) and others; or if one adopts a "portfolio view" according to which higher mean return (and growth) comes with higher risk (and volatility) as in Obstfeld (1994); or in the presence of precautionary savings (Mirman, 1971). Overall, the theoretical link between volatility and growth is ambiguous.

In addition, volatility often leads to greater inequality. Hausmann and Gavin (1996), for instance, have shown that both volatility and income inequality are higher in Latin American countries relative to industrial economies. Breen and García-Peñalosa (2005) consider a larger sample of countries and show that greater volatility increases the Gini coefficient and the income share of the top quintile, while it reduces the income share of the other quintiles.

The challenges associated with macroeconomic volatility are even more pronounced in the smaller island states due to their higher intrinsic volatility, smaller size, lack of scale economies, less diversified production structure, and tighter financial and fiscal constraints.[5] In what follows, we investigate the main sources of volatility in the Eastern Caribbean economies, how volatility affects some key macroeconomic variables, and how it is related to the cyclicality of interest rates and government spending.

We are interested in looking at the behavior of two key variables over the business cycle – the volatility and cyclicality of real interest rates and fiscal expenditures. The reason is that the dynamics of these variables often reflect the quality of the "shock absorbers" present in the economy, either through financial markets to diversify macroeconomic risk or through stabilization policies to cushion aggregate shocks. Thus, these variables influence the transmission mechanism from various shocks to economic activity. We discuss each of them in turn.

First, it is generally found that in emerging economies real interest rates are volatile, countercyclical and lead the business cycle (see, for example, Neumeyer and Perri (2005), Uribe and Yue (2006)). This is in sharp contrast with developed economies where real rates are typically mildly pro-cyclical or a-cyclical, and not very volatile. This implies that developing countries face volatile borrowing costs in the international financial markets, which results in greater macroeconomic volatility in these economies. Moreover, when domestic financial markets are under-developed so that domestic households and firms face binding financial constraints that become tighter in bad times, the effects of interest rate fluctuations on domestic activity are likely to be amplified. To the extent that higher volatility leads to lower investment rates, output and consumption, it will result in lower economic growth and welfare.

Second, a number of studies have shown that fiscal policy tends to be pro-cyclical in developing countries, while it is countercyclical in developed economies. The pro-cyclicality of the fiscal policy is defined as a positive response of government spending to an exogenous expansionary business cycle shock. Gavin and Perotti (1997) showed that this is the case in Latin America. Talvi and Végh (2005) and Ilzetzki and Vegh (2008) showed that pro-cyclical fiscal policy is not limited only to Latin America, but instead characterizes the entire developing world.

More recent studies have found signs of improvement in the fiscal policy stance of developing countries in recent years. For instance, Frankel, Vegh, and Vuletin (2013) showed that while fiscal policy still remains predominantly pro-cyclical in developing countries, many of these countries are moving away from pro-cyclicality. Carneiro and Garrido (2015) extend this analysis to a larger sample of countries, consider various sub-periods and stages of the business cycle, as

[5] See Becker (2012) and Tumbarello, Cabezon and Wu (2013) for a discussion of these issues in the small Pacific island countries; and Easterly and Kraay (2000) for a broader perspective on the characteristics of small states.

well as employ a variety of de-trending methods to generally confirm the results in Frankel, Vegh, and Vuletin (2013). They show that among 104 developing countries in their sample, about 40% to 50% (depending on the de-trending method) followed or switched to countercyclical fiscal policies during the 1990-2010 period. In comparison, among the 14 Caribbean countries, only two to five of them followed the same course during the 1990-2010 period.

There is a number of reasons for such a behavior by developing countries. One explanation is that frictions in the international credit markets prevent developing countries from borrowing in bad times. As a result, developing countries' governments are forced to lower spending during recessions (Gavin and Perotti (1997), Caballero and Krishnamurthy (2004), Mendoza and Oviedo (2006)). Other explanation for pro-cyclical government expenditures rely on political economy reasons which suggest that during good times governments face political pressures and temptations to keep spending high and run fiscal deficits. Lastly, delays in the implementation and execution of fiscal policies in developing economies also contribute to fiscal policy pro-cyclicality in these countries.

Aside from their cyclical properties, government revenues and expenditures are also found to be significantly more volatile in developing countries compared to developed economies. For instance, Male (2010) finds that in a large sample of developed and developing countries, on average, government expenditure is 4.5 times more volatile than output, and government revenue is almost four times more volatile than output. In contrast, in developed countries, the volatilities of government expenditures and revenues are comparable to the volatility of output. Overall, the pro-cyclicality of fiscal policy in developing countries, together with the high volatility of fiscal variables, suggest that in these countries fiscal policy may aggravate economic fluctuations rather than having a stabilizing effect on them. This, in turn, may have a depressing effect on the level of economic activity in the economy, inhibiting factor accumulation, and therefore, economic growth.

## 3. Stylized facts about growth and macroeconomic volatility in the OECS

We start with the statistical analysis of economic growth and business cycles in the member countries of the Organization of Eastern Caribbean States (OECS). We also include Barbados in the empirical analysis given its proximity and similarity to the OECS countries. In particular, we document in detail the growth experience of these countries over the past several decades; the business cycle facts in these economies, such as the volatility of output, consumption, investment, trade balance, and real interest rates; the cyclicality of these variables with output and interest rate, as well as their persistence; and the properties of fiscal policy in these countries, with a particular focus on its cyclical characteristics.

All data are from the International Monetary Fund's *World Economic Outlook* (WEO) database and cover the period 1980-2014 at annual frequency. To transform the data into real terms, all nominal quantities are deflated by the GDP deflator. Interest rate is real lending rate obtained as the difference between the lending rate and the consumer price index (CPI) inflation rate. We also considered an effective interest rate on government debt computed as the ratio of general government interest expenditures and gross debt. The two rates are highly correlated, with the average correlation across countries equal to 0.89. As a result, the stylized facts are very similar

for the two interest rates, with the main difference being the lower average effective interest rate as compared to the lending rate. We choose to proceed with the lending rate, as it better reflects the cost of borrowing to the private firms. While this rate does not capture the cost of borrowing internationally for the domestic firms, the fact that it has very similar dynamics to the interest rate on government debt (both domestic and foreign) gives us some confidence in its appropriateness for our analysis.

We begin by reporting the key properties of the variables of interest. Table 1 presents the GDP growth rates for the OECS countries, the average real interest rate as well as the average investment and government expenditures as a share of GDP. We also report the net foreign asset (NFA) position of the OECS member countries (we will use it later in the calibration). The OECS countries were growing at an average rate of 3% per year over the 1980-2014 period. The average interest rate was at 7.22%, with the lowest average interest rate observed in Barbados at 5.72% and the highest average rate – in Antigua and Barbuda at 8.39%. Investment stood at 27% of GDP on average, while government expenditures at 30% of GDP across this group of countries over our sample period. All OECS countries had positive NFA, with the average NFA-to-GDP ratio equal to 12.6%. Thus, all these countries were net lenders to the rest of the world during 1980-2014, on average.

**Table 1. Averages values for selected key macroeconomics variables: 1980-2014**

| | GDPgrowth | Int rate | Inv/GDP | Gov exp/GDP | NFA/GDP |
|---|---|---|---|---|---|
| | | | | | |
| **Antigua and Barbuda** | 3.23 | 8.39 | 33.73 | 26.35 | 9.16 |
| **Barbados** | 0.84 | 5.72 | 15.63 | 37.13 | 8.61 |
| **Dominica** | 2.71 | 6.94 | 20.20 | 32.34 | 14.82 |
| **Grenada** | 3.37 | 6.98 | 29.87 | 27.65 | 11.20 |
| **St. Kitts and Nevis** | 3.80 | 7.19 | 35.65 | 30.32 | 23.96 |
| **St. Lucia** | 3.52 | 7.94 | 24.85 | 26.24 | 2.60 |
| **St. Vincent and the Grenadines** | 3.50 | 7.34 | 25.70 | 27.79 | 18.07 |
| **Average** | 3.00 | 7.22 | 26.52 | 29.69 | 12.63 |

*Notes*: Int rate is the real interest rate computed as the lending rate minus inflation rate. *Source*: World Economic Outlook.

Next, we turn to the business cycle statistics for the OECS countries. All series (except trade balance, terms of trade and real interest rate) were log-transformed. To obtain the cyclical components of the key variables, they were Hodrick-Prescott (HP) filtered with the smoothing parameter of 100. Table 2 reports the percentage standard deviation of the key variables, as well as the relative standard deviation. It shows that all variables are quite volatile with the average real GDP volatility equal to 3.72%. This is quite high compared to developed economies and even compared to a few other developing countries (see Neumeyer and Perri, 2005, Table 1). The highest GDP volatility is observed in Antigua and Barbuda and in Grenada. Interest rate is also quite volatile in these countries but the magnitudes are similar across them, with the exception of St. Lucia. The volatility of trade balance and terms of trade shows much more dispersion across

the OECS countries, although the main result stands – the OECS countries exhibit very volatile business cycles, even compared to developing economies.

We also report the standard deviation of investment (Inv), government expenditures (Gov exp) and private consumption (Cons) relative to the standard deviation of GDP. As is commonly observed in the business cycles literature, investment is the most volatile variable among the expenditure components of GDP, with the relative volatility in the OECS countries equal to 4.6 on average. This number is comparable to that found for other countries. Government expenditures also exhibit higher volatility than GDP in the OECS countries by a factor of 2.55. This is in line with the findings in Male (2010) for developing countries. In contrast, in developed countries the ratio of volatilities of government expenditure and GDP tends to be closer to 1.

We found that the volatility of consumption in the OECS countries is strikingly high, equal to 2.66 times that of GDP volatility. This is quite high compared to both developing countries and developed economies. The highest consumption volatility is observed in Antigua and Barbuda and St. Kitts and Nevis, while the lowest – in Barbados and Grenada. In all OECS countries the relative volatility of consumption to GDP is well above 1.

**Table 2. Volatility of key macroeconomic variables: 1980-2014**

| | % Standard deviation | | | | % Standard deviation of x | | |
|---|---|---|---|---|---|---|---|
| | | | | | % Standard deviation of GDP | | |
| | **GDP** | **TB/GDP** | **TOT** | **Int rate** | **Inv** | **Gov exp** | **Cons** |
| **Antigua and Barbuda** | 5.38 | 6.98 | 6.76 | 2.87 | 3.42 | 2.64 | 4.56 |
| **Barbados** | 3.56 | 2.31 | 7.95 | 2.28 | 4.82 | 1.22 | 1.06 |
| **Dominica** | 2.49 | 6.17 | 4.03 | 2.90 | 6.88 | 3.96 | 2.82 |
| **Grenada** | 4.28 | 4.61 | 7.24 | 2.72 | 4.19 | 2.36 | 1.64 |
| **St. Kitts and Nevis** | 3.55 | 6.07 | 4.01 | 2.20 | 5.26 | 3.69 | 3.87 |
| **St. Lucia** | 3.63 | 5.04 | 6.20 | 3.23 | 4.07 | 1.46 | 2.50 |
| **St. Vincent and the Grenadines** | 3.11 | 5.32 | 6.04 | 2.63 | 3.33 | 2.50 | 2.17 |
| **average** | 3.72 | 5.21 | 6.03 | 2.69 | 4.57 | 2.55 | 2.66 |

*Notes*: TOT is terms of trade; TB/GDP is exports minus imports over GDP; Int rate is the real interest rate computed as the lending rate minus inflation rate. *Source*: World Economic Outlook.

The examination of the cyclical properties of the key variables reveals important insights. Table 3 reports the correlations between GDP and various macroeconomic aggregates. We notice, for example, that investment and private consumption are pro-cyclical, with the average correlations equal to 0.61 and 0.36, respectively. We also find that government expenditures are pro-cyclical with a correlation coefficient of 0.39. This finding confirms earlier results in the literature that developing countries tend to follow pro-cyclical fiscal policies. In addition, we find that interest rates in the OECS countries are countercyclical – another important result that distinguishes the business cycles in developing countries – with the correlations ranging from -0.55 in St. Lucia to -0.21 in Grenada. Lastly, we show that net exports are countercyclical, in line with the findings for developing economies in other studies.

Finally, we look at the correlation of real interest rates with various macroeconomic variables. The fact that real interest rates are countercyclical with GDP suggests that they may also be negatively correlated with investment, government expenditures, and consumption. Indeed, we find that this is the case for investment, where the correlation with interest rate is equal to -0.29, on average; and for consumption, where the correlation ranged from -0.51 in St. Vincent and the Grenadines to -0.21 in Antigua and Barbuda, with the average of -0.33. The correlation of the interest rate with government expenditures was close to 0, on average, although with a significant spread ranging from -0.23 for St. Vincent and the Grenadines and 0.24 for St. Kitts and Nevis. Our finding that real interest rates are volatile and countercyclical in the OECS countries mirrors the results in Neumeyer and Perri (2005), Uribe and Yue (2006), and others for developing economies.

**Table 3. The correlation of GDP with key macroeconomic variables: 1980-2014**

| | **Correlation of GDP with** | | | | | |
|---|---|---|---|---|---|---|
| | Inv | Gov exp | Cons | TB/GDP | TOT | Int rate |
| **Antigua and Barbuda** | 0.48 | 0.31 | 0.63 | -0.44 | -0.27 | -0.33 |
| **Barbados** | 0.79 | 0.20 | 0.50 | -0.33 | 0.39 | -0.27 |
| **Dominica** | 0.56 | 0.65 | 0.23 | -0.32 | -0.23 | -0.30 |
| **Grenada** | 0.56 | 0.49 | 0.32 | -0.10 | 0.19 | -0.21 |
| **St. Kitts and Nevis** | 0.65 | 0.38 | 0.04 | -0.33 | 0.31 | -0.32 |
| **St. Lucia** | 0.72 | 0.22 | 0.44 | -0.27 | -0.32 | -0.55 |
| **St. Vincent and the Grenadines** | 0.55 | 0.52 | 0.38 | -0.10 | -0.08 | -0.51 |
| **Average** | 0.61 | 0.39 | 0.36 | -0.27 | 0.00 | -0.36 |

*Notes*: TOT is terms of trade; TB/GDP is exports minus imports over GDP; Int rate is the real interest rate computed as the lending rate minus inflation rate. *Source*: World Economic Outlook.

**Table 4. The correlation of interest rates with key macroeconomic variables: 1980-2014**

| | **Correlation of Interest rate with** | | | | | | |
|---|---|---|---|---|---|---|---|
| | GDP | Inv | Gov exp | Cons | TB/GDP | TOT | Effective int rate |
| **Antigua and Barbuda** | -0.33 | -0.30 | 0.04 | -0.21 | -0.08 | 0.00 | 0.79 |
| **Barbados** | -0.27 | -0.21 | -0.17 | -0.40 | 0.39 | 0.11 | 0.93 |
| **Dominica** | -0.30 | -0.50 | -0.18 | -0.22 | 0.72 | 0.43 | 0.87 |
| **Grenada** | -0.21 | -0.01 | 0.01 | -0.35 | -0.06 | 0.04 | 0.92 |
| **St. Kitts and Nevis** | -0.32 | -0.06 | 0.24 | -0.37 | 0.03 | -0.04 | 0.94 |
| **St. Lucia** | -0.55 | -0.53 | 0.02 | -0.27 | 0.31 | 0.14 | 0.86 |
| **St. Vincent and the Grenadines** | -0.51 | -0.43 | -0.23 | -0.51 | 0.40 | 0.37 | 0.92 |
| **Average** | -0.36 | -0.29 | -0.04 | -0.33 | 0.24 | 0.15 | 0.89 |

*Notes*: TOT is terms of trade; TB/GDP is exports minus imports over GDP; Int rate is the real interest rate computed as the lending rate minus inflation rate. *Source*: World Economic Outlook.

Overall, we show that the business cycles in the OECS countries exhibit the properties that are typical of developing countries. In particular, these countries, very much like other developing countries, are characterized by (i) higher volatility of most macroeconomic variables when compared to other more advanced economies as exemplified, for example, by the volatility of the

key variable affecting welfare – consumption – which is above the volatility of output in developing countries, but below output volatility in advanced economies; (ii) countercyclical real interest rates in developing countries as opposed to mildly pro-cyclical or a-cyclical real interest rates in advanced economies; net exports are also found to be much more countercyclical in developing countries relative to the developed economies; and (iii) fiscal policy is pro-cyclical, while it tends to be countercyclical in advanced economies.

## 4. The Model

In this section, we investigate the role played by financial frictions and fiscal policy stance for the transmission of shocks to economic activity in the Eastern Caribbean states by means of a structural model of business cycles. For this purpose, we formalize a model of small open economy with two key features. The first is that domestic financial markets are subject to a friction – firms have to pay a share of the bill for the factors of production before production takes place and revenues are realized. This creates a need for working capital by firms. The second key feature of our model is the presence of fiscal authority. It levies lump-sum taxes and uses the tax revenues to provide public consumption/investment. We allow public expenditures to have different cyclical properties. These two features of the model generate transmission channels through which real interest rates and fiscal policy shocks affect the level of economic activity.

We consider a relatively standard one-good small-open economy that is populated by three types of agents: households, firms, and the government. International financial markets are imperfect, so the only asset traded internationally is a non-contingent real bond. The gross interest rate on bonds is stochastic and equals *R*. Both households and firms participate in the international bond market. Households use them for the risk-sharing purposes, while firms trade in the asset due to the presence of a financial constraint. In particular, they must pay a fraction of the wage bill in advance, before the production takes place, to workers. The government's problem is to balance the budget every period. The two key features that distinguish this model from a standard one-good neoclassical benchmark are the presence of working capital and fiscal policy. We discuss each of them in detail below. We also assume that there is free goods mobility across borders, so that the law of one price applies.

*Firms*

The representative firm combines capital, $k_{t-1}$ and labor, $l_t$ to produce a final good $y_t$ using a constant returns to scale technology:

$$y_t = z_t k_{t-1}^{\alpha}\left[(1+\gamma)^t l_t\right]^{1-\alpha}, \qquad (1)$$

where $z_t$ is the current state of productivity and is stochastic, $\gamma$ is the deterministic growth rate of labor-augmenting technology, and $\alpha > 0$. From the onset, we should note that $z_t$ should be interpreted broader than just technology shocks. In the small open economies like the OECS countries, shocks to $z_t$ may arise due to terms-of-trade shocks, unexpected changes in weather conditions, sectoral shifts, etc.

At the beginning of the period, firms observe shocks for the period and then make production plans. They rent capital and labor. However, firms face a working capital requirement

by which a fraction $\varphi$ of the total wage bill needs to be paid upfront to workers. Since output is only realized at the end of the period, firms finance this payment by borrowing in the world markets at rate $R_{t-1}$. The loan amount along with the interest is paid back next period. Given wages, $w_t$, rental rate on capital, $r_t$, and the interest rate $R_{t-1}$, the firm's problem is to choose labor input $l_t$ and capital input $k_{t-1}$, in order to maximize profits:

$$y_t - [w_t l_t + r_t k_{t-1}] - [R_{t-1} - 1]\varphi w_t l_t \tag{2}$$

subject to the technological constraint (1). The third term in the expression above is the net interest payment by the firm on the borrowed funds.

*Households*

The infinitely-lived representative household receives utility from consuming a (non-storable) good and disutility from supplying labor. She also owns capital and thus is in charge of investment decisions. Households can borrow and lend in the international financial markets using the real bond, however, bond trading is subject to convex bond holding costs. The problem facing the household is

$$\max E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t) \tag{3}$$

where $0 < \beta < 1$ is the subjective discount factor, and $c_t$ is consumption. The budget constraint of the household is

$$c_t + b_t + \kappa(b_t) + x_t \leq w_t l_t + r_t k_{t-1} + R_{t-1} b_{t-1} - T_t \tag{4}$$

for every *t*. In period *t* the household receives proceeds from holding bonds, $R_{t-1} b_{t-1}$ as well as the labor and rental income, pays lump-sum taxes $T_t$ and spends the left-over income on consumption, investment, $x_t$ and bond purchases $b_t$. The household is also responsible for the bond holding cost $\kappa(b_t)$, where $\kappa(.)$ is a convex function.[6]

Investment adds to the current stock of capital and to cover a capital adjustment cost, given by

$$x_t = k_t - (1 - \delta)k_{t-1} + \Phi(k_{t-1}, k_t) \tag{5}$$

These adjustment costs are needed to generate a realistic volatility of investment.

*Government*

The government is comprised of a fiscal authority. Since the OECS countries follow a fixed exchange rate regime, we abstract from the monetary authority in the model, since monetary policy cannot be used to stabilize the economy. The fiscal authority sets government spending

[6] We solve the model by linearizing it around the steady state value. Bond holdings costs are needed to ensure stationarity of bond holdings (see Schmitt-Grohe and Uribe (2003)).

exogenously and finances it through lump-sum taxes. We assume a very simple problem for the government in which the budget is balanced every period:

$$G_t = T_t \tag{6}$$

where $G_t$ is government expenditure in period *t*.

Note that the problem of the government is kept very simple to focus the spotlight on its cyclicality with output. An alternative specification would be to model government expenditure as being substitutable (or complementary) with private consumption and thus affecting the marginal utility of the household. Such a specification would reflect the idea that public goods may substitute (crowd-out) for private consumption, especially when public goods are non-rival such as defense, justice and rule of law; or may complement (crowd-in) private consumption, especially for non-rival public goods such as education, health care, transportation, etc. However, given lack of consensus in the empirical literature on how changes in public consumption affect private consumption, we choose to proceed with the specification in which government consumption does not affect the marginal utility of the household. [7]

*Resource constraint*

By combining the flow constraints for the consumer, the firm, and the government we get the economy's flow resource constraint:

$$\mathrm{b_t = R_{t-1}b_{t-1} + y_t - c_t - x_t - G_t - \kappa(b_t) - (R_{t-1} - 1)\varphi w_t l_t).}$$

Here $\mathrm{tb_t = y_t - c_t - x_t - G_t - \kappa(b_t)}$ is the trade balance, while $\mathrm{CA_t = b_t - (R_{t-1} - 1)b_{t-1}}$ is the current account of the economy.

***Calibration***

*Shocks*

The model economy described above is subject to productivity shocks, $\mathrm{z_t}$; shocks to government expenditures, $\mathrm{G_t}$; and interest rate shocks. From hereon we use $\hat{\mathrm{x}}$ to denote the percentage deviation of variable x from its balanced growth path.

We assume that total factor productivity (TFP) in percent deviations from its balanced growth path follows an AR(1) process:

$$\hat{z}_t = \rho_z \hat{z}_{t-1} + \varepsilon_{z,t}$$

Unfortunately, due to the lack of data on capita stock and employment in the OECS countries, we cannot obtain productivity estimates specific to the OECS countries. Instead we

[7] Empirical evidence on public–private substitutability has been mixed. Aschauer (1985), Bean (1986), Kormendi and Meguire (1995) find evidence for substitutability, while Campbell and Mankiw (1990) find none. Ni (1995) shows that the results are sensitive to model specification. Kuehlwein (1998) looks at disaggregated spending categories and finds evidence of complementarity between private and government consumption. Fiorito and Kollintzas (2004) find evidence for both complementarity and substitutability in 12 European countries depending on the type of goods.

assume that it has the same persistence as the process estimated for the United States annual productivity series. In particular, we use $\rho_z = 0.815$.[8] We assume that innovations to productivity $\varepsilon_{z,t}$ are i.i.d. mean-zero normally distributed. In the counterfactual experiments in which productivity shocks are present we set the volatility of productivity innovations to match the average volatility of GDP in the OECS countries.

We model government spending as an exogenous stochastic process, calibrated to match its properties in the Eastern Caribbean countries. We consider two specifications for government expenditures process – one in which government expenditures are a-cyclical with productivity; and one in which they are pro-cyclical with productivity. In the first case, we assume that government expenditures in percent deviations from their balanced growth path follow an AR(1) process:

$$\widehat{G}_t = \rho_g \widehat{G}_{t-1} + \varepsilon_{g,t} \tag{7}$$

where $\rho_g$ is the autocorrelation coefficient, while $\varepsilon_{g,t}$ are i.i.d. mean zero normally-distributed innovations to $\widehat{G}_t$.

In the specification with pro-cyclical government expenditures we use the idea that government follows a policy rule in which government fiscal expenditures respond to the fundamental shocks in the economy given by the productivity shocks in the model. In particular, we assume the following process for $\widehat{G}_t$:

$$\widehat{G}_t = \rho_p \widehat{G}_{t-1} + \eta_g z_{t-1} + \varepsilon_{P,t}, \tag{8}$$

where $\eta_g$ is a constant capturing how much government spending responds to productivity shocks.

This specification is consistent with the identification assumptions often used in the empirical VAR literature to identify the effects of fiscal shocks on output. In particular, equation (8) implies that shocks to productivity affect government expenditures with a one period lag. At the same time, shocks to government spending can have a contemporaneous effect on current output in the model.[9]

We calibrate the parameters in each specification (7) and (8) to match the persistence and volatility of the government expenditures in the OECS countries. In particular, we target the autocorrelation coefficient of $\widehat{G}_t$ equal to 0.25, and the volatility of $\widehat{G}_t$ relative to output volatility equal to 2.55. In the case of pro-cyclical fiscal rule (8), we have an additional parameter to calibrate, so we also target the correlation between government spending and productivity equal to 0.39 in the OECS data.

Next, we describe the process for the interest rate. We assume that the supply of funds from the international capital market is infinitely elastic, i.e. there is a large mass of international

[8] Note that this value of the autocorrelation coefficient corresponds to 0.95 in quarterly series.

[9] We also considered a specification in which $z_t$ enters contemporaneously in the specification for $G_t$, and found the quantitative results to be similar.

investors who stand ready to lend to households and firms in our model economy at rate *R*. However, lending to the OECS countries is risky, so international lenders demand a risk-premium when making loans to these countries. Thus, we model *R* following Neumeyer and Perri (2005) as consisting of two components – a rate charged for risky assets in the international markets (independent of developing country status), *R**, and a country spread over the risky assets rate paid by borrowers in an OECS country, *D*. Thus, the interest rate faced by the OECS country is $R_t = R_t^* D_t$. Because there is only one international asset in the economy, the interest rate on that asset faces by all agents is the same and equal to $R_t$.

We will calibrate *R** as a U.S. rate for risky assets and model it as a stochastic exogenous process, independent of the fundamentals of the OECS economy:

$$\hat{R}_t^* = \rho_R \hat{R}_{t-1}^* + \varepsilon_{Rt}, \tag{9}$$

where $\rho_R$ is the autocorrelation coefficient, and $\varepsilon_{Rt}$ are i.i.d. mean-zero normal innovations to $\hat{R}_t^*$. In the annual data for the U.S. we find that $\rho_R = 0.4305$ and the standard deviation of $\hat{R}_t^*$ is equal to 1.30%. We calibrate the parameters of equation (9) to match these moments.

In modeling the shocks to risk-premium *D* we consider two possibilities. In the first case, we assume that only exogenous factors (contagion, foreign shocks, etc.) affect the country risk-premium. In this case, the process for $D_t$ is given by a simple AR(1) process with persistence coefficient of $\rho_D$:

$$\hat{D}_t = \rho_D \hat{D}_{t-1} + \varepsilon_{Dt}, \tag{10}$$

where $\rho_D$ is the autocorrelation coefficient and $\varepsilon_{Dt}$ is i.i.d. normal innovations.

In the second approach, we assume that domestic fundamentals determine country risk-premium. We model this in a simple way where country risk is induced by domestic default probability which in turn is a function of domestic productivity shocks. In particular, we use

$$\hat{D}_t = -\eta_D E_t \hat{z}_{t+1} + \varepsilon_{It}, \tag{11}$$

where $\eta_D$ is a constant reflecting the extent to which risk-premium responds to expected productivity shocks; $\varepsilon_{It}$ is i.i.d. normally distributed innovation. In this case, the process for $R_t$ becomes

$$\hat{R}_t = \hat{R}_t^* - \eta_D E_t \hat{z}_{t+1} + \varepsilon_{It} \tag{12}$$

This approach is consistent with the models of default in Eaton and Gersovitz (1981), Arellano (2008) and others. It also corresponds closely to the modeling strategy in Neumeyer and Perri (2005).

Of course, factors other than productivity may influence the country risk-premium in the OECS countries. For instance, risk-premium may also be positively related to changes in government expenditures, where greater spending (or deficits) are accompanied by higher risk-

premium. While this is an interesting extension, here, for the sake of simplicity, we choose to focus solely on productivity as a determinant of country risk-premium.

We choose the parameters $\rho_D$ and the variance of $\varepsilon_{Dt}$ in specification (10) and coefficient $\eta_D$ and the variance of $\varepsilon_{It}$ in specification (11) to generate the same persistence and volatility of $\hat{R}_t$ in the model as in the data for the OECS countries. In particular, we target the average persistence of $\hat{R}_t$ equal to 0.245 and the average standard deviation of $\hat{R}_t$ equal to 2.69% in the data.

*Functional forms and parameters*

In this section we describe the functional forms and parameters chosen in the model economy. The functional forms for the utility function, capital adjustment costs and bond holding costs are borrowed from Neumeyer and Perri (2005) and Mendoza (1991). In particular, the period utility function is

$$\mathrm{u}(\mathrm{c},\mathrm{l}) = \frac{1}{1-\sigma}[\mathrm{c} - \psi(1+\gamma)^{\mathrm{t}}\mathrm{l}^{\nu}]^{1-\sigma}, \quad \nu > 1, \psi > 0. \tag{13}$$

Here $1/\sigma$ is the intertemporal elasticity of substitution, ν-1 is the inverse of the elasticity of labor supply with respect to the real wage. These preferences are well-known from the work of Greenwood, Hercovitz, Huffman (1988) which we will refer to as GHH. These preferences have been widely used in the literature as they provide a better description of consumption and the trade balance for small open economies than alternative specifications. The key feature introduced by GHH preferences is that there is no wealth effect on labor supply.

Following Neumeyer and Perri (2005) we set σ=5 and the curvature of labor ν is set to 1.6. This value is within the range of values used in the literature. For example, Mendoza (1991) uses ν equal to 1.455 for Canada, while Correia et al. (1995) set ν to 1.7 for Portugal.

The rest of the model parameters are set to match the properties of the balanced growth path in the model with the long-run trends in the OECS data over 1980-2014 period. In particular, we set the growth rate γ in the model to replicate the average real GDP growth rate in the OECS of 3% per year. Subjective discount factor β is set to match the average real interest rate in the OECS countries equal to 7.2% per year. Parameter α is set to match the labor income share of 0.6, while depreciation rate δ – to replicate the average investment to output ration in the OECS countries of 26.5%. Parameter ψ in the utility function is set to match an average time spent working of 20% of total time.

We assume that the capital adjustment cost technology is given by

$$\Phi(k_{t-1}, k_t) = \frac{\phi}{2}\left[\frac{\mathrm{k_t} - \mathrm{k_{t-1}}(1+\gamma)}{\mathrm{k_{t-1}}}\right]^2, \tag{14}$$

where $\phi > 0$ is a constant level parameters. This parameter is calibrated to replicate the volatility of investment relative to the volatility of output in our sample, equal to 4.57.

The bond holding costs are assumed to have the following functional form:

$$\kappa(b_t) = \frac{\kappa}{2} y_t \left[\frac{b_t}{y_t} - \bar{b}\right]^2, \tag{15}$$

where κ is a constant level parameter and $\bar{b}$ is the steady state level of bonds-to-GDP ratio. The bond holdings are not uniquely determined in the steady state. So, we set them to replicate the average net foreign asset position of the OECS countries equal to 12.6% of GDP. Parameter κ is set to a very small value sufficient to guarantee the stationarity of bond holdings in the linearized version of the model, but small enough to not have any significant effect on the equilibrium dynamics.

We also ensure that government spending along the balanced growth path is equal to 30% of GDP – its average value in the OECS data. Lastly, following Neumeyer and Perri (2005) we assume that φ is equal to 1. The resulting parameter values are summarized in Table 5.

Once the shock processes and other parameter values are set, we solve the model by linearizing the equations characterizing equilibrium around the steady state and solving the resulting system of linear difference equations.

## 5. Results

In order to understand the effects of financial frictions, pro-cyclical fiscal policy and various shocks on the economy, we now study the properties of the model economy under several scenarios. First, we consider the case of an independent fiscal rule, where government expenditures are independent of the fundamental state of the economy (productivity). In this case we allow for both independent country risk and induced countries risk, i.e. country risk that arises endogenously in response to changes in fundamentals (productivity). In the second case we study the effects of the fiscal policy that is pro-cyclical to the economic conditions. Here we are again interested in the possible interaction between fiscal policy and country risk, so we consider both independent and induced country risk scenarios.

**Table 5. Parameter values**

| | Parameter | Value | |
|---|---|---|---|
| **Preferences** | | | |
| **discount factor** | $\beta$ | 0.9608 | |
| **risk-aversion** | $\sigma$ | 5 | |
| **labor curvature** | $\nu$ | 1.6 | |
| **labor weight** | $\psi$ | 4.932 | |
| | | | |
| **Technology parameters** | | | |
| **productivity growth** | $\gamma$ | 3% | |
| **capital exponent** | $\alpha$ | 0.3568 | |
| **depreciation rate** | $\delta$ | 0.0912 | |
| **wage-in-advance** | $\varphi$ | 1 | |
| **bond holding cost** | $\kappa$ | $10^{-5}$ | |

| | | | |
|---|---|---|---|
| **capital adjustment cost** | $\phi$ | 0.7128 | |
| | | | |
| **Shocks** | | | |
| **Productivity** | | $\rho_z = 0.8145$ | $\sigma(\varepsilon_z)$=varies |
| **government expenditures (independent)** | | $\rho_g$=0.25 | $\sigma(\varepsilon_g)$=3.14% |
| **government expenditures (pro-cyclical)** | | $\rho_P$=-0.0607, $\eta_G$ =0.3 | $\sigma(\varepsilon_P)$=2.75% |
| **international rate** | | $\rho_R$=0.4305 | $\sigma(\varepsilon_R)$=1.46% |
| **country risk (independent)** | | $\rho_D$= 0.1966 | $\sigma(\varepsilon_D)$=2.50% |
| **country risk (induced)** | | $\eta_D$ =0.2748 | $\sigma(\varepsilon_I)$=2.43% |

*Source*: Authors' elaboration.

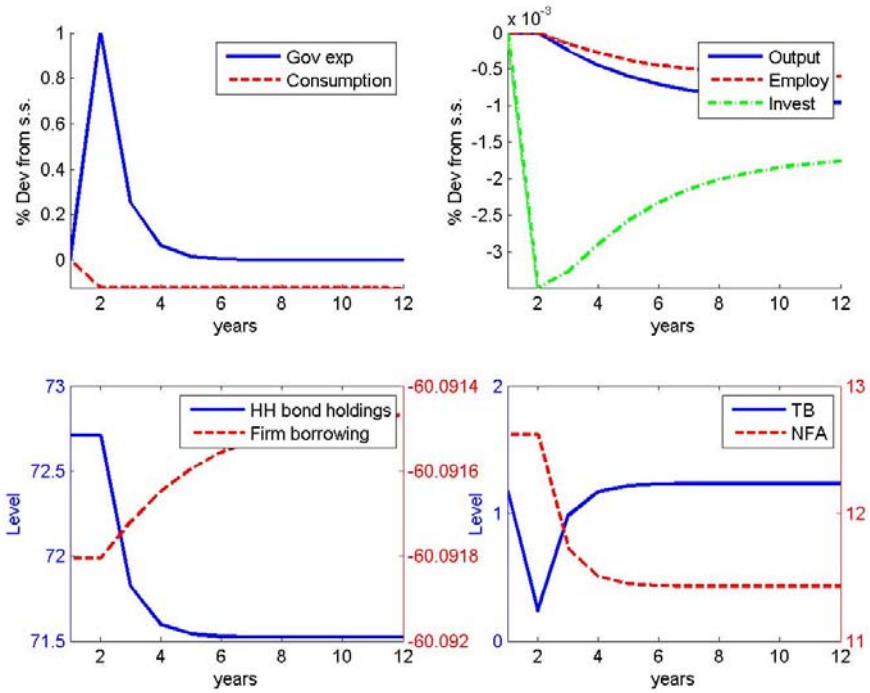
*Responses of the economy to various shocks*

In what follows, we use impulse response analysis to understand the linkages in the model and the effects of various model features. In particular, we study how the key macroeconomic aggregates respond to one-time shocks to productivity, government expenditures and risk-premium.

We start by considering the effects of government spending shocks presented in Figure 1. It shows that an increase in government expenditures has a contractionary effect on the economy, with all macroeconomic aggregates declining following the shock. The largest decrease is experienced by private consumption which falls by 0.05% after a 1% increase in government expenditures. The responses of output, employment and investment, while all negative, are more muted. These dynamics can be understood by looking at how firms and households adjust their borrowing/lending behavior in response to shocks. When government expenditures increase, it causes a decline in households' lifetime income, leading to a fall in consumption. Since the consumption decline is smaller than the fall in households' disposable income due to consumption smoothing, savings must fall as households decrease their bond holdings. Firms, faced with lower demand, cut down on employment and investment, and thus borrow less from the international markets. With lower employment, GDP also declines. Due to increased household borrowing, both trade balance and NFA deteriorate.

The response of the economy to a government spending increase is very similar under the pro-cyclical fiscal policy.

**Figure 1. Impulse responses to a 1% positive shock to government expenditures**




*Notes*: Impulse responses are computed under benchmark parameterization.

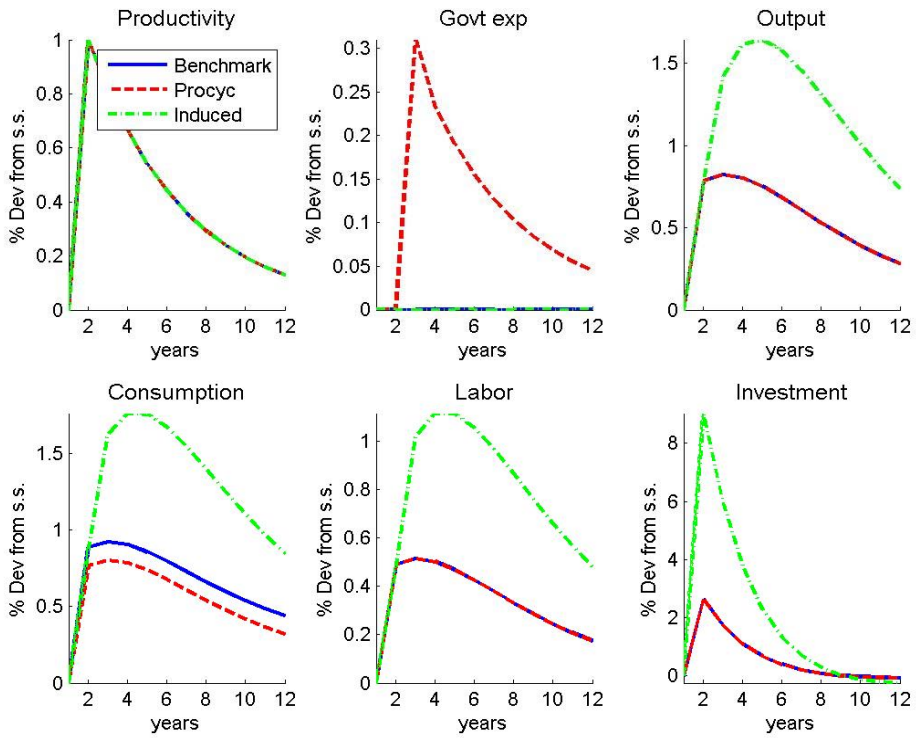
We now consider shocks to productivity. The impulse responses to a 1% positive productivity shocks under independent and pro-cyclical fiscal policy are shown in Figures 2a and 2b. We also include impulse responses under the scenario with induced country risk-premium in the figures. Under the pro-cyclical fiscal policy, an increase in productivity triggers a rise in government expenditures (as given by equation (8)), while government expenditures remain unchanged under an independent fiscal policy (given by equation (7)).

Focusing, first, on the direct effects of productivity shocks, we see that a rise in productivity that is persistent has relatively standard effects – it leads to an expansion in the economy with employment, investment, consumption and output all rising. A higher productivity raises the return to capital and labor, so firms want to increase employment and investment. However, to hire more workers, firms must finance a larger working capital, so firms' borrowing goes up. This can be seen from Figure 2b, which displays impulse responses of agents' asset holdings/borrowing, trade balance and NFA position. Since returns to investment increase following a good productivity shock, households reduce their savings in international bonds and invest more in domestic enterprises. The outcome of these adjustments is that the trade balance worsens and NFA position declines.

Under a pro-cyclical fiscal policy, the adjustments of the economy in response to a positive productivity shock are very similar. The key difference lies in the dynamics of consumption, household savings, and trade balance. When the increase in productivity is accompanied by a rise in government spending (pro-cyclical fiscal policy), the response of household consumption is more muted. This is because an accompanying increase in government expenditures curtails the

rise in the disposable income of the households after productivity improvement. This limits the resources available for consumption and investment. As a result, households must lower their savings by more under the pro-cyclical fiscal policy, leading to a larger deterioration in the trade balance and NFA in the economy. Thus, pro-cyclical fiscal policy acts to curtail the effects of productivity shocks on consumption, by amplifying the effects of these shocks on savings, net exports and NFA.

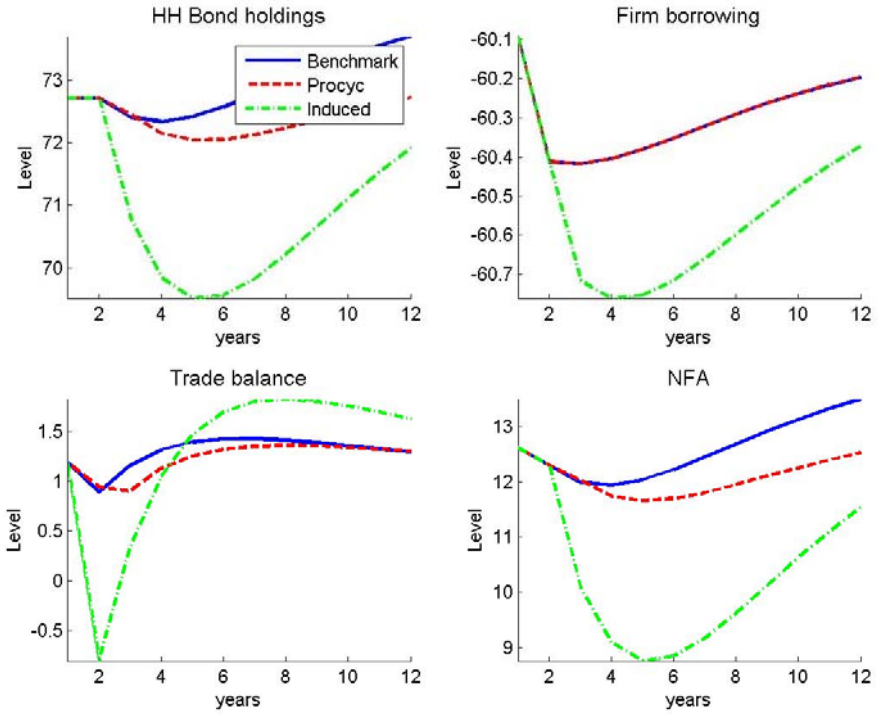
**Figure 2a. Impulse responses after a 1% positive productivity shock: Macro aggregates**




*Notes*: Impulse responses are computed under benchmark parameterization.

Next, we turn to the effects of productivity shocks when they also determine the risk-premium in the economy (i.e. induced risk premium), as given by equation (11). The responses of various variables to a productivity shock in such a case are shown as green dash-dot lines in Figures 2a and 2b. Under this scenario, an increase in productivity has the same effects as described above, except an increase in productivity also triggers a fall in country risk-premium, which in turn provides an additional boost to the economy. Indeed, with induced risk-premium, all macroeconomic aggregates experience a greater expansion relative to the scenario with independent risk-premium. This occurs because lower risk-premium reduces the interest rate faced by domestic agents, encouraging additional borrowing by firms and a greater reduction in savings (bond holdings) by households. As a result, both employment and investment are scaled up significantly. Not surprisingly, the deterioration in NFA position and trade balance (in fact, trade balance goes into deficit) are larger with induced risk-premium. Overall, in the presence of endogenous country risk-premium, the effects of productivity shocks on the economy are amplified.

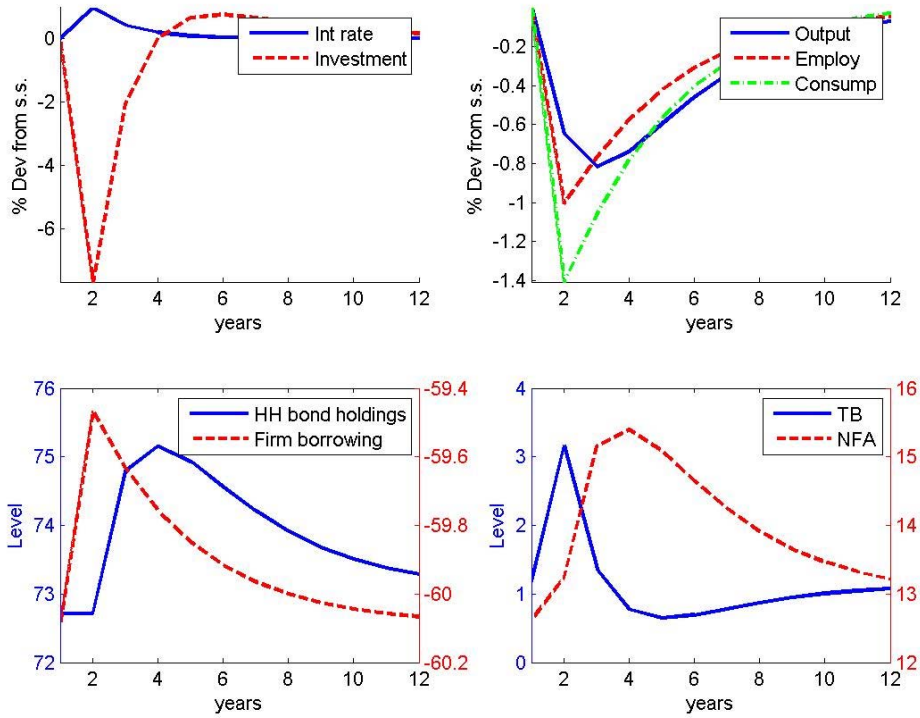
**Figure 2b. Impulse responses after a 1% positive productivity shock: Financial variables**




*Notes*: Impulse responses are computed under benchmark parameterization.

Lastly, we study the effects of a shock to domestic interest rate arising as a consequence of a shock to the international interest rate, the process for which is given by equation (9). Figure 3 presents the responses of key variables. A rise in the international interest rate has a contractionary effect on the economy. Specifically, it triggers an increase in domestic interest rate which raises the cost of borrowing for working capital for domestic firms. Therefore, they reduce borrowing, cut employment, which in turn lowers output. Consumption also declines and this fall exceeds the drop in output. This is an important result of the model as it shows that fluctuations in the interest rate can help account for the high volatility of consumption in the OECS countries. The increase in interest rates also induces higher savings by domestic households, whose bond holdings rise; and discourages investment. As a result, trade balance improves and so does the NFA.

**Figure 3. Impulse responses after a 1% positive shock to international interest rate**




*Notes*: Impulse responses are computed under benchmark parameterization.

*Computational experiments*

We now turn to the evaluation of the contribution of various shocks, financial frictions and fiscal policy to the business cycles of the OECS countries by means of several numerical experiments. In our first experiment we assume that both fiscal policy and country risk-premium are independent of the state of the economy. This version is the benchmark case. In the second experiment we consider the case of independent fiscal policy, but assume that country risk-premium is endogenous to productivity. The third experiment assumes pro-cyclical fiscal policy and independent risk-premium. The last, fourth, experiment studies the case where both fiscal policy and country risk-premium respond to productivity changes. In each case, the standard deviation of productivity innovations, $\sigma_z$, is set so that the volatility of GDP in the model matches the average volatility of GDP in the OECS countries.

In all experiments we simulate the model economy for a random sequence of shocks to productivity, government expenditures, international interest rate and country risk-premium. We then obtain the volatilities and co-movements among the key aggregates from this simulated data and contrast them with the actual data and across various versions of the model. When simulating the model, we treat model series in exactly the same way as the data. In particular, we simulate 45 years of data and remove the first 10 years to reduce the effects of initial conditions. This gives us model series of the same length as in the data. All series, except interest rate and trade balance are log-transformed and HP-filtered with a smoothing parameter of 100. Volatility and co-movement statistics are then computed on each model series and averaged across 1,000 simulations.

**Table 6. Simulated and actual business cycles in the OECS countries: Volatilities**

| | % Standard deviation | | | % Standard deviation of x | | | |
|---|---|---|---|---|---|---|---|
| | | | | % Standard deviation of GDP | | | |
| | GDP | TB/GDP | Int rate | Inv | Gov exp | Cons | Employment |
| OECS data | 3.72 | 5.21 | 2.69 | 4.57 | 2.55 | 2.66 | n/a |
| | | | | | | | |
| **Independent fiscal policy** | | | | | | | |
| **1. Independent country risk** | | | | | | | |
| (a) all shocks | 3.72 | 4.79 | 2.69 | 4.57 | 2.55 | 1.40 | 0.89 |
| (b) no z shocks | 1.81 | 4.46 | 2.69 | 7.09 | 5.25 | 2.03 | 1.44 |
| (c) no G shocks | 3.72 | 3.89 | 2.69 | 4.57 | 0.00 | 1.39 | 0.89 |
| (d) no R*, D shocks | 3.20 | 3.17 | 0.00 | 3.20 | 2.96 | 1.11 | 0.62 |
| | | | | | | | |
| **2. Induced country risk** | 3.72 | 6.55 | 2.69 | 7.74 | 2.55 | 1.41 | 0.94 |
| (d) no R*, D shocks | 1.91 | 2.89 | 0.00 | 3.16 | 4.97 | 1.11 | 0.62 |
| | | | | | | | |
| **Pro-cyclical fiscal policy** | | | | | | | |
| **3. Independent country risk** | | | | | | | |
| (a) all shocks | 3.72 | 4.68 | 2.69 | 4.57 | 2.55 | 1.31 | 0.89 |
| (b) no z shocks | 1.81 | 4.58 | 2.69 | 7.09 | 5.61 | 2.03 | 1.44 |
| (c) no G shocks | 3.72 | 3.89 | 2.69 | 4.57 | 1.02 | 1.31 | 0.89 |
| (d) no R*, D shocks | 3.20 | 2.99 | 0.00 | 3.20 | 2.96 | 0.97 | 0.62 |
| | | | | | | | |
| **4. Induced country risk** | 3.72 | 6.49 | 2.69 | 7.74 | 2.65 | 1.35 | 0.94 |
| (d) no R*, D shocks | 1.91 | 2.89 | 0.00 | 3.16 | 5.15 | 0.95 | 0.62 |

*Source*: Authors' calculations.

We begin by examining Table 6, which presents the results for volatilities. The benchmark model (panel 1.a) replicates the volatilities of the macro variables in the OECS data quite closely. It matches the volatilities of GDP, interest rate, investment, and government spending spot on because these moments were targeted in the calibration. But we did not target the volatility of consumption and trade balance: while the model comes very close to replicating the volatility of TB to GDP ratio, it underpredicts the volatility of consumption in the OECS countries. At the same time, it is important to note that the model is successful in generating consumption that is more volatile than GDP, in line with the data facts for the OECS countries.

Under a pro-cyclical fiscal policy, the model with all shocks (panel 3.a) predicts lower volatility of trade balance and consumption (the rest of the volatilities, again, were targeted in the calibration). The reason for this lower volatility is the counteracting effect that government expenditures have to productivity changes under the pro-cyclical fiscal policy (see impulse responses in Figure 2a).

**Table 7. Simulated and actual business cycles in the OECS countries: Co-movement with GDP**

| | Correlation of GDP with |
|---|---|

| | Inv | Gov exp | Cons | TB/GDP | Int rate | Employment |
|---|---|---|---|---|---|---|
| | | | | | | |
| OECS data | 0.61 | 0.39 | 0.36 | -0.27 | -0.36 | n/a |
| | | | | | | |
| **Independent fiscal policy** | | | | | | |
| **1. Independent country risk** | | | | | | |
| (a) all shocks | 0.69 | 0.00 | 0.93 | -0.28 | -0.42 | 0.90 |
| (b) no z shocks | 0.62 | 0.01 | 0.94 | -0.40 | -0.84 | 0.95 |
| (c) no G shocks | 0.69 | 0.00 | 0.93 | -0.35 | -0.42 | 0.90 |
| (d) no R*, D shocks | 0.84 | 0.00 | 0.99 | -0.17 | 0.00 | 1.00 |
| | | | | | | |
| **2. Induced country risk** | 0.46 | 0.01 | 0.94 | -0.22 | -0.58 | 0.93 |
| (d) no R*, D shocks | 0.84 | -0.00 | 0.99 | -0.11 | -0.02 | 1.00 |
| | | | | | | |
| **Pro-cyclical fiscal policy** | | | | | | |
| **3. Independent country risk** | | | | | | |
| (a) all shocks | 0.69 | 0.20 | 0.91 | -0.38 | -0.42 | 0.90 |
| (b) no z shocks | 0.62 | 0.01 | 0.94 | -0.39 | -0.84 | 0.95 |
| (c) no G shocks | 0.69 | 0.48 | 0.91 | -0.46 | -0.42 | 0.90 |
| (d) no R*, D shocks | 0.84 | 0.23 | 1.00 | -0.34 | 0.00 | 1.00 |
| | | | | | | |
| **4. Induced country risk** | 0.46 | 0.17 | 0.93 | -0.28 | -0.58 | 0.93 |
| (d) no R*, D shocks | 0.84 | 0.14 | 0.99 | -0.21 | -0.00 | 1.00 |

*Source*: Authors' calculations.

Next we consider a scenario in which country risk-premium is endogenous to productivity changes (Panel 2 "Induced country risk"). Here, we calibrated the standard deviation of innovations to all shocks such that we replicate the volatility of GDP, interest rate, and government spending. All other parameters at set to their baseline values given in Table 5. We find that with induced risk-premium, the volatility of all non-targeted variables increases relative to the benchmark scenario. For instance, the percentage standard deviation of investment goes up from 4.57 in the benchmark model with independent risk premium to 7.74 under induced risk premium, i.e. rises by 70%. Similarly, employment volatility goes up by 5.2%, while the volatility of net exports rises by 37%. This is because the effects of productivity shocks on the economy are amplified in the presence of endogenous risk-premium due to the presence of working capital constraint.[10]

Table 7 summarizes the co-movement patterns of various variables with GDP. Here, again, the benchmark model (panel 1.a) performs quite well. It easily reproduces the positive co-movement of consumption and investment with GDP found in the data. More importantly, the

[10] The increase in volatility due to endogenous risk-premium is similar under the pro-cyclical fiscal policy, with the exception that consumption volatility is affected more.

model is able to generate a countercyclical trade balance and real interest rate, with the values of correlations quite similar to those in the OECS data. Under pro-cyclical fiscal policy (panel 3.a), net exports becomes even more countercyclical. Adding induced country risk-premium (panel 2) does not change the basic pattern of correlations, but makes interest rate more countercyclical, while reducing the negative co-movement between trade balance and GDP.

Lastly, Table 8 presents the cyclical properties of key variables with the real interest rate. An important finding in the OECS counties data was that real interest rates are strongly countercyclical with main macroeconomic aggregates. Table 8 shows that the model reproduces this result quite closely. In particular, in the benchmark scenario (panel 1.a), real interest rate commoves negatively with investment, consumption and employment. The correlation with net exports is positive. The signs of the correlations remain unchanged both under a pro-cyclical fiscal policy and with induced country-risk scenario. Also note that the correlation between interest rates and government expenditures is close to zero both in the data and in the model.

Overall, we show that the model does a good job in matching the properties of business cycles in the OECS countries. Several results can be emphasized from the model so far. First, pro-cyclical fiscal policy curtails the effects of productivity shocks in the economy, and reduces the volatility of consumption and net exports. Second, if risk-premium responds to the changes in the economy's fundamentals, the effects of productivity shocks on the economy are amplified through the working capital channel, and therefore the volatility of key macro aggregates rises. This amplification effect would disappear if there was no spillover from productivity to country risk-premium ($\eta_D$=0) or if there was no need for working capital ($\varphi$=0).

We have also isolated the contribution of various shocks to the overall volatility in the economy re-computed volatilities and correlations in the model while sequentially eliminating shocks to productivity, government expenditures, and interest rate shocks (international interest rate and country risk-premium). The results are presented in panels b, c, and d of Tables 6, 7, 8.

Without productivity shocks (panels b of Table 6, 7, 8), volatilities of several variables are significantly reduced relative to the benchmark case with all shocks. For instance, GDP volatility declines from 3.72% when all shocks are present) to 1.81% when productivity shocks are switched off, implying that productivity shocks account for about 51% of GDP volatility in the Eastern Caribbean economies. Volatility of net exports also declines when productivity shocks are eliminated from the simulations, although the decline is more muted. Specifically, productivity shocks account for about 7% of volatility in next exports. In contrast, volatilities of investment, consumption, employment, all rise when productivity shocks are eliminated. Similarly, the negative correlation between trade balance and GDP, and interest rate and GDP become exaggerated without the productivity shocks. All together, these results suggest that these shocks are important in explaining business cycles in the OECS economies.

**Table 8. Simulated and actual business cycles in the OECS countries: Co-movement with interest rate**

| | **Correlation of Interest rate with** | | | | |
|---|---|---|---|---|---|
| | Inv | Gov exp | Cons | TB/GDP | Employment |
| | | | | | |
| OECS data | -0.29 | -0.04 | -0.33 | 0.24 | -0.36 |

| | | | | | |
|---|---|---|---|---|---|
| **Independent fiscal policy** | | | | | |
| **1. Independent country risk** | | | | | |
| (a) all shocks | -0.68 | -0.01 | -0.70 | 0.61 | -0.77 |
| (b) no z shocks | -0.87 | -0.01 | -0.97 | 0.65 | -0.97 |
| (c) no G shocks | -0.68 | 0.00 | -0.70 | 0.75 | -0.77 |
| (d) no R*, D shocks | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | |
| **2. Induced country risk** | -0.41 | -0.01 | -0.81 | 0.36 | -0.84 |
| (d) no R*, D shocks | -0.02 | 0.01 | -0.02 | 0.00 | -0.02 |
| | | | | | |
| **Pro-cyclical fiscal policy** | | | | | |
| **3. Independent country risk** | | | | | |
| (a) all shocks | -0.68 | -0.01 | -0.74 | 0.63 | -0.77 |
| (b) no z shocks | -0.87 | -0.01 | -0.97 | 0.64 | -0.97 |
| (c) no G shocks | -0.68 | -0.01 | -0.74 | 0.75 | -0.77 |
| (d) no R*, D shocks | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | |
| **4. Induced country risk** | -0.41 | -0.03 | -0.83 | 0.37 | -0.84 |
| (d) no R*, D shocks | -0.01 | 0.0 | -0.00 | 0.00 | -0.00 |

*Source*: Authors' calculations.

Given the importance of productivity shocks in the OECS countries, it becomes necessary to better identify the sources of these shocks. As we argued before, the productivity shocks in the model find a broad correspondence to shocks in the data – these include technology shocks, shocks to the terms of trade, unexpected changes in weather conditions, etc.

Panels c) of Tables 6, 7, 8 report the business cycles statistics from simulations where shocks to government expenditures are eliminated. Without government spending shocks, the volatility of trade balance is reduced by 20% (from 4.79% to 3.89%) and the volatility of consumption is also decreased.

Lastly, we simulate the model without interest rate shocks (both to the international interest rate and country risk-premium) and report the resulting statistics in panels d) of Tables 6, 7, 8. Eliminating shock to interest rate lowers the volatility of all variables, except government spending. For instance, the percentage standard deviation of GDP declines from 3.72% to 3.20% -- a 14% reduction; consumption volatility declines by 21%, while employment and investment volatility each decline by about 30%, and the volatility of trade balance drops by 34%. We should note that the majority of this decline in volatilities in accounted for by the absence of risk-premium shocks. For instance, eliminating just the default risk (and allowing for the shocks to the international interest rate) reduces the volatility of GDP by 8%, the volatility of consumption by 15% and employment volatility by 20%.

In the absence of interest rate shocks, the cyclical properties of the key variables are also affected: the co-movement between GDP and consumption, investment and employment all increase above their data counterparts; trade balance becomes less countercyclical than in the data; and of course, the negative correlation between the interest rate and GDP, consumption, and investment disappears. We interpret this result as supportive of the importance of interest rate shocks in explaining the OECS business cycles.

The changes in volatilities and correlations are even more pronounced when we consider the scenario with induced country risk-premium. This case is summarized in panels 2.d) and 4.d) of Tables 6, 7, 8. Eliminating interest rate shocks when risk-premium is determined by domestic fundamentals leads to a 49% reduction in GDP volatility. Again, the majority of this reduction is accounted for by eliminating the shocks to risk-premium. Similarly, without interest rate shocks, consumption volatility in the OECS countries would decline by 21%, employment volatility by 33% and investment volatility by 59%.

Notice that the volatility of GDP declines when either productivity or interest rate shocks are eliminated from the model. In contrast, the volatilities of consumption, investment and employment rise when productivity shocks are absent from the model, while those volatilities decline in the scenario without interest rate shocks. The differences in the behavior of consumption, investment and employment in the two scenarios can be understood through the lens of agents' risk-sharing opportunities in the model. Consider, first, a productivity shock. In response to such a shock, households and firms can borrow/lend in the international markets at a given interest rate, which allows them to smooth out the effects of the shock. The shocks to interest rate are harder to smooth out since they directly affect the cost of borrowing for working capital, and no other mechanisms for risk-sharing are available to the agents. As a result, these shocks make OECS economies more volatile.

We can quantify the importance of the financial channel by considering the case of the model with a smaller value for parameter that determines the size of the working capital requirement – parameter $\varphi$. Table 9 presents the results for volatilities and correlations in the case where only 50% of the labor cost has to be paid in advance ($\varphi$=0.5); and the case in which no labor cost has to be paid in advance ($\varphi$=0). In both cases we keep all other parameters unchanged at their benchmark values given in Table 5. To quantify how the business cycle properties change with $\varphi$, in Table 9 we report volatilities of the key aggregates relative to their respective volatilities under the benchmark model scenario with $\varphi$=1.

Let's focus on the model scenario with independent fiscal policy presented in panel 1 of Table 9 (the results are similar with pro-cyclical fiscal policy). When $\varphi$=1 the model generated volatility of GDP and investment that was very similar to that found in the OECS data. Similarly, it was able to replicate the negative co-movement between GDP and trade balance, and between GDP and the interest rate. When the working capital parameter $\varphi$ is reduced to 0, the volatility of GDP, consumption, employment and government spending, all decline significantly. For instance, GDP volatility is reduced by 14%, while that of consumption by 24%, and employment – by 30%. Similarly, the correlation coefficient between output and interest rate turns from being large and negative to being positive. The same is true for the correlation between consumption and interest

rate. Trade balance also becomes much less countercyclical, but its volatility rises (by around 20% relative to the benchmark case with $\varphi$=1). This is primarily driven by higher volatility of investment.

These changes occur because without the working capital requirement, the negative impact of interest rates on labor demand of firms is eliminated. As a result, it becomes easier for firms to adjust employment and investment in response to productivity shocks. This leads to higher volatility of employment, investment and, therefore, trade balance. At the same time, firms' employment decisions become less sensitive to interest rate shocks when $\varphi$=0, which lowers the volatility of employment in the model. The second effect dominates and employment volatility is reduced with lower $\varphi$. Volatility of investment, however, unambiguously rises.

When $\varphi$=0.5, the same results apply, although the changes in volatilities and correlations are smaller. Importantly, the correlation between GDP and interest rate remains negative at -0.21 when $\varphi$=0.5, and trade balance remains countercyclical. Consumption and investment also commove negatively with the interest rate when $\varphi$ is halved. Thus, only larger values for $\varphi$ are consistent with the business cycles properties of the OECS countries.

**Table 9. Sensitivity analysis**

| | % Standard deviation of x | | | | | | Correlation between | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | % Standard deviation of x, benchmark | | | | | | | | | |
| | GDP | TB/GDP | Inv | Gov exp | Cons | Employ | GDP,R | GDP,TB/GDP | Cons,R | Inv,R |
| | | | | | | | | | | |
| **1. Independent fiscal policy** | | | | | | | | | | |
| **$\varphi$=0.5** | 0.90 | 1.05 | 1.36 | 0.62 | 0.84 | 0.80 | -0.20 | -0.21 | -0.44 | -0.69 |
| **$\varphi$=0** | 0.86 | 1.19 | 1.70 | 0.36 | 0.76 | 0.70 | 0.06 | -0.05 | 0.05 | -0.70 |
| | | | | | | | | | | |
| **2. Pro-cyclical fiscal policy** | | | | | | | | | | |
| **$\varphi$=0.5** | 0.90 | 1.07 | 1.36 | 0.62 | 0.84 | 0.80 | -0.20 | -0.27 | -0.46 | -0.69 |
| **$\varphi$=0** | 0.86 | 1.21 | 1.70 | 0.36 | 0.78 | 0.70 | 0.06 | -0.07 | 0.05 | -0.70 |

*Note*: The table reports the volatility of various aggregates relative to the volatility of the corresponding aggregate under the benchmark parameterization of $\varphi$=1. All other parameters are set to their benchmark values given in Table 5. *Source*: Authors' calculations.

These results suggest a few steps that policy makers in these economies could take to help cushion the effects of the shocks that their economies experience. For instance, the importance of access to international borrowing and lending in smoothing the effects of productivity shocks underscores the importance of greater financial openness for the OECS countries. This greater openness, however, must be accompanied by the development of the domestic financial markets and policies aimed at stabilizing country risk-premium. To the extent that government's pro-cyclical policies contribute to the country risk-premium demanded by international markets, the government can help stabilize the country risk-premium by switching to countercyclical policy rules, and thus reduce the interest rate shocks faced by the private sector. The development of well-functioning domestic financial markets can also contribute positively to reducing the negative

impact of interest rate shocks. For instance, if the working capital requirements are weakened, then the negative impact of interest rates on labor demand is reduced. This, in turn, will lower the fluctuations in economic activity in the OECS countries.

## 6. Conclusion

In this paper we analyzed the business cycle characteristics of the OECS countries. We showed that macroeconomic aggregates in these countries are quite volatile, with consumption exhibiting higher volatility than GDP. We also find that in these economies real interest rates are very volatile and strongly countercyclical with GDP and other macroeconomic aggregates. Similarly, fiscal expenditures also show significant volatility, but are pro-cyclical with GDP.

We developed a model of a small open economy subject to interest rate and fiscal expenditures shocks and introduced a friction into the model – working capital requirement – to capture the under-development of the financial markets in the OECS countries. We find that the model can explain the business cycle facts of the average OECS country very well and show that eliminating fiscal policy shocks reduces the volatility of consumption and trade balance, but will leave the volatility of GDP unchanged. Eliminating shocks to interest rates will reduce the volatility of GDP by 14%, and volatility of consumption by 21%. The majority of this decline in volatility is achieved by eliminating the shocks to risk-premium. In particular, eliminating just the default risk (and allowing for the shocks to the international interest rate) reduces the volatility of GDP by 8% and the volatility of consumption by 15%. An even greater reduction in volatility could be achieved by eliminating the default risk if such risk is endogenous to the economy's fundamentals. In particular, we find that in the model with induced risk-premium, eliminating interest rate shocks would reduce GDP volatility by 49%, again with the majority of this effect accounted for by the risk-premium shocks. Namely, if only risk-premium shocks are eliminated, GDP volatility would decline by 40%.

We also show that domestic financial markets development plays an important role in buffering the effects of interest rate shocks on the economy. Eliminating the working capital constraint, while keeping all shocks in place, would reduce the volatility of GDP, consumption, employment and government spending significantly. For instance, GDP volatility would be reduced by 14%, while that of consumption would decline by 24%.

These results suggest a few directions for designing policies to help reduce the volatility experienced by the OECS economies. First, greater openness to international financial markets is important as it could help the OECS economies to hedge fluctuations in fundamental shocks, such as shocks to technology, terms of trade, and shocks associated to natural hazards. Second, greater openness must be accompanied by improvements in domestic financial markets and government's efforts to stabilize domestic risk-premium. By reducing the frictions in the domestic financial markets, these economies can cushion the negative effects of interest rate shocks on domestic economic activity, and achieve lower volatility. Furthermore, if pro-cyclical government policies induce higher country risk-premium in the international markets, governments of the OECS countries can stabilize their country's risk-premium by switching to countercyclical policies.

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