I. MACROECONOMIC FLUCTUATIONS IN THE EASTERN CARIBBEAN CURRENCY UNION[1]

A. Introduction

1.   **An important area of research in quantitative macroeconomic analysis has been to understand and distinguish between the short- and long-run determinants of fluctuations in macroeconomic time series.** This work has concentrated on documenting the empirical regularities of macroeconomic fluctuations and the determinants of national business cycles. Unfortunately, the bulk of this research has examined macroeconomic fluctuations in developed countries, with little work undertaken on developing countries (see Backus and Kehoe, 1992). Exceptions are Agénor, McDermott and Prasad (2000), Rand and Tarp (2002) and Kaminsky, Reinhart and Végh (2004), who analyze the stylized facts of macroeconomic fluctuations in developing countries. This chapter extends this analysis of macroeconomic fluctuations to the members of the Eastern Caribbean Currency Union.[2]

2.   **Several key questions remain unresolved in the literature.** Do the empirical regularities observed for macroeconomic fluctuations in developed countries differ from those observed for developing countries, and are the regularities broadly similar for countries located in different geographic regions or with different exchange rate regimes? These issues are also central to macroeconomic policymaking, as use of potentially inappropriate conclusions regarding the stylized facts of macroeconomic fluctuations in developing countries can adversely affect the efficacy of stabilization policy (Cashin, 2004).

3.   **This study of business cycle regularities in the eastern Caribbean covers a wide range of macroeconomic series.** These series include annual observations on domestic and world output, inflation, government expenditure and revenue, real interest rates, external assistance, commodity prices, workers' remittances, and current account balances. The relationship between fluctuations in these macroeconomic time series and a key measure of economic activity—gross domestic product—is examined.[3]

4.   **The empirical methodology used in the chapter measures the extent of comovement between economic time series.** In keeping with the literature on the business cycle of developed countries, the results in this chapter are based on unconditional correlations between variables. As noted by Agénor, McDermott and Prasad (2000), such correlations do not imply causation, but do provide information on the type of shocks affecting eastern Caribbean economies and lay the groundwork for more formal economic

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[1] Prepared by Paul Cashin and Ping Wang.

[2] Earlier analyses of Caribbean business cycles include Mamingi (1999), Borda, Manioc and Mantauban (2000), Craigwell and Maurin (2002), and Cashin (2004).

[3] We also analyze the evolution of various measures of per capita incomes in the eastern Caribbean, to ascertain if incomes in the region have converged or diverged in the previous two decades (see the Appendix).

models. In addition, given that many of the macroeconomic time series used in this paper have distinct trend components, the series need to be rendered stationary prior to undertaking statistical analysis. In detrending the data we follow Cashin and Ouliaris (2004) and use the frequency domain filter developed by Corbae, Ouliaris and Phillips (2002).

5.   **The plan of this chapter is as follows.** The data are described in Section B, along with the estimation technique used to ensure stationarity of the data. In Section C the empirical regularities of macroeconomic fluctuations in the ECCU are described, examining the relationship between a set of macroeconomic time series and domestic output, for each of the six Fund members of the ECCU. Section D concludes.

B. Data and Estimation Technique

6.   **Data used in the empirical analysis include series on domestic output, as well as other key macroeconomic variables.** The macroeconomic time series cover the six Fund members of the Eastern Caribbean Currency Union (Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines), and the ECCU as a regional aggregate.[4] The logarithm of annual real GDP (in millions of local currency, base year 1990) is used to measure real output in each country.[5] Data series are annual in frequency, and cover the period 1975 to 2004. All macroeconomic time series are converted into logarithms for the empirical work, except the world real interest rate, inflation rate, inflation tax rate and current account balance. The derivation and description of the data is contained in the Annex.

7.   **In this chapter we examine economic fluctuations at business cycle frequencies.** In doing so, we need to decompose all of our macroeconomic time series into nonstationary (trending) and stationary (cyclical) components, as cross-correlations and other statistical analyses are inappropriate for nonstationary data. To arrive at stationary data, we use the frequency domain (FD) filter of Corbae and Ouliaris (2003) and Corbae, Ouliaris and Phillips (2002). The FD filter is a univariate detrending technique that removes the low-frequency (trend) and high-frequency (irregular) components of the data, leaving behind the business cycle components of the data. Following Cashin (2004), Cashin and Ouliaris

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[4] The ECCU aggregated data on domestic output and the current account balance are taken from the Eastern Caribbean Central Bank. The aggregate ECCU fiscal (expenditures and revenues) data are calculated as the sum of individual country data. Similarly, the aggregate ECCU workers' remittances and overseas development assistance data are the sum of the national data for the six Fund-member ECCU countries. See the Annex for additional details.

[5] The annual national accounts GDP data are taken from the Eastern Caribbean Central Bank, the IMF's *International Financial Statistics* and *World Economic Outlook* databases, and from Fund staff estimates. Information on the statistical features (mean and variability) of detrended real GDP for the eastern Caribbean can also be found in Cashin (2004).

(2004), and Burns and Mitchell's (1946) 'cycle dating rules,' the cyclical component is set at frequencies of between two and eight years.[6][7]

C. Main Features of Macroeconomic Fluctuations

8.   **A key attribute of macroeconomic fluctuations concerns their comovement with domestic output.** The empirical methodology used in the chapter measures the extent of comovement between economic time series. Correlations are between the stationary (cyclical) components of each of two series—typically domestic output and a second macroeconomic time series—with the cyclical components of both series derived using the FD filter.

9.   **We use the correlation coefficient to measure comovement between two macroeconomic time series.** In doing so, we follow Agénor, McDermott and Prasad (2000) in measuring the extent of comovement of time series y_t with real GDP x_t by the magnitude of the cross-correlation coefficient at (annual) lag k, $\rho(k)$, where $k \in \{0, \pm1, \pm2, \pm3\}$. These correlations are between the stationary components of both series (y_t and x_t), with the stationary components derived using the FD filter. In line with the existing literature, we deem a series y_t to be procyclical, countercyclical or acyclical depending on whether the contemporaneous correlation coefficient $\rho(0)$ is positive, negative or not significantly different from zero. In addition, a series y_t is viewed as:

- *strongly contemporaneously correlated* if $\rho(0)$ is $0.36 \leq |\rho(0)| < 1$;

- *weakly contemporaneously correlated* if $\rho(0)$ is $0.18 \leq |\rho(0)| < 0.36$; and

- *contemporaneously uncorrelated* if $\rho(0)$ is $0 \leq |\rho(0)| < 0.18$.[8]

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[6] For data measured at annual frequency, Baxter and King (1999) note that using their band-pass filter on developed country data, researchers should isolate cycles with periodicities of eight years and higher. They point out that since the shortest detectable cycle in a time series using annual data is one that lasts two years, the annual business cycle filter passes components with cycle length between two and eight years. In this case, the band-pass filter is equivalent to a high-pass filter, which removes low frequency (or long cycle) components of greater than eight years, and allows high frequency (or short cycle) components to pass through. That is, the band-pass filter removes the trend components of the data, leaving behind the cycle (or filtered data).

[7] We also checked the robustness of our results using the commonly-used Hodrick-Prescott (1980) filter. Typically, we found a very high correlation between the cyclical components of the data obtained using the Hodrick-Prescott and the FD univariate filters.

[8] Following Agénor, McDermott and Prasad (2000), the approximate standard error of the correlation coefficients, computed under the null hypothesis that the true correlation coefficient is zero, is 0.18 (given T=30).

10.   **Cross-correlations of each macroeconomic variable with output at one- to three-period leads and lags reveal no clear pattern.** In examining the leads and lags in the relationship between (stationary) domestic output and (stationary) macroeconomic time series, we find that for most ECCU countries the correlations peak at or near lag zero. That is, most statistically significant results are found for contemporaneous correlations, which are reported in this chapter. This finding also suggests that macroeconomic fluctuations in the Caribbean are transmitted fairly quickly.

Domestic output and the real sector

11.   **There is a very strong positive association between fluctuations in industrial country output and domestic output in ECCU countries.** This relationship is particularly important for ECCU countries, which have substantial economic links with industrial countries (Cashin, 2004). The contemporaneous correlations between world output and domestic output are strongly positive for most ECCU countries and the ECCU region as a whole (Figure I.1), and indicates that business cycle fluctuations in ECCU countries are highly correlated with business cycle fluctuations in industrial countries. The key likely channels of transmission of cycles from industrial to developing countries include trade in goods and services (Frankel and Rose, 1998), and financial flows (Kose, Prasad and Terrones, 2003).

12.   **There is typically an inverse association between real oil prices and macroeconomic fluctuations in ECCU economies.** We find that there are large and negative contemporaneous correlations of the real oil price and the cyclical component of domestic output (Figure I.1). This is consistent with ECCU countries as large net oil-importing countries—ECCU countries are extremely dependent on imported oil and energy products.

13.   **The contemporaneous correlation between the cyclical component of domestic output and the inflation rate shows evidence of a positive relationship.** This result is consistent with output gap representations of inflation and domestic economic activity, and is also in line with findings for developed countries that inflation is higher in good (above average) times—a form of countercyclical fiscal policy (see Kaminsky, Reinhart and Végh, 2004).[9] Chadha and Prasad (1994) argue that the correlation between inflation and cyclical output is the appropriate correlation for discriminating between demand- and supply-driven models of the business cycle. One explanation for the procyclical behavior of inflation in most ECCU countries is that demand shocks have been an influential determinant of

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[9] Another measure of fiscal policy stance is the inflation tax rate, which is a proxy for the overall tax rate. Similar to the findings for the correlation between the inflation rate and domestic output, the positive contemporaneous correlations between the inflation tax and domestic output indicate a countercyclical government fiscal policy (as more tax revenues are derived in above-average times).

domestic economic fluctuations, which for a given level of aggregate supply, has typically caused aggregate demand and equilibrium prices to move in the same direction.[10]

Domestic output and the fiscal sector

14.   **In this subsection we examine the relationship between fluctuations in economic activity and the fiscal sector.** Examining the relationship between aggregate economic activity and government expenditure and revenue has analytical value from the perspective of business cycle modeling. It is also important from a policy perspective, to ascertain whether government exacerbates or smoothes cycles in economic activity. In so doing we follow Kaminsky, Reinhart and Végh (2004) in defining the cyclicality of fiscal policy in terms of policy instruments rather than outcomes—hence fiscal policy will be determined by government spending and tax rates (as opposed to tax revenues). Under this definition, a countercyclical fiscal policy would be associated with lower (higher) government spending and higher (lower) tax rates in good (bad) economic times.[11]

15.   **Apart from St. Lucia, the positive contemporaneous correlation between domestic output and the cyclical component of central government expenditure is evidence of a largely procyclical role for government expenditure.** This result suggests that ECCU government expenditure tends to reinforce domestic business cycles. This is consistent with Gavin and Perotti (1997), Talvi and Végh (2000) and Kaminsky, Reinhart, and Végh (2004), who find that developing countries typically have a positive correlation between cyclical components of government consumption and output—due largely to credit constraints. This result is also consistent with Rasmussen and Tolosa (2005), who find that while government spending in the ECCU is mildly procyclical, it is much less procyclical than for other developing countries. In contrast, Kaminsky, Reinhart and Végh (2004) find that developed countries tend to have countercyclical or acyclical fiscal policies.[12]

16.   **Contemporaneous correlations between cyclical components of real government revenue and domestic output in ECCU countries are largely positive.** This result is consistent with countercyclical fiscal policy, in the sense of stabilizing the business cycle. In

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[10] In contrast to Chadha and Prasad (1994), we find that the positive correlation between the cyclical component of output and inflation is accompanied by a positive correlation between the cyclical component of output and prices. This is further evidence in support of demand-side shocks driving Caribbean economic fluctuations.

[11] Taxation revenue is composed of the interaction of the tax rate and tax base, where the latter is defined to be high in good times and low in bad times.

[12] An alternative measure of the expenditure stance is central government expenditure (as a share of GDP). Apart from St. Vincent and the Grenadines, the contemporaneous correlations between domestic output and central government expenditure (as a share of GDP) are largely negative. This result is consistent with the findings of Agénor, McDermott and Prasad (2000) for developing countries. However, according to Kaminsky, Reinhart and Végh (2004) this measure could be misleading, since the cyclical stance of government spending (as numerator) may be dominated by the cyclical behavior of output (as denominator).

this sense, Caribbean countries are similar to developed countries, where revenue also tends to exhibit a positive correlation with output (see Kaminsky, Reinhart and Végh, 2004). The negative correlation between revenue and domestic output for St. Kitts and Nevis may reflect the dampening effect on aggregate demand of growing tax revenues (due to rising tax rates).[13]

Domestic output and the external sector

17.   **There is a very strong positive association between world real interest rates and economic fluctuations in ECCU economies.** The strong correlations between (filtered) domestic output in ECCU economies and the world real interest rate are indicative of the influence of industrial country business cycle conditions on domestic fluctuations in ECCU countries. For most ECCU economies, the contemporaneous correlations between domestic output and the world real interest rate are strongly significantly positive. This could reflect the fact that the real interest rate in industrial economies tends to be procyclical and that changes in output in industrial countries, through trade and finance links, have positive spillover effects on output in ECCU economies (see Agénor, McDermott and Prasad, 2000).

18.   **For most ECCU countries, the contemporaneous correlations between (filtered) domestic output and official development assistance flows are largely negative.** These results differ considerably from those of Pallage and Robe (2001), who find the bivariate correlation is overwhelmingly positive for African countries, and typically acyclical for non-African developing countries. Accordingly, an important result is that unlike most other regions, aid flows to eastern Caribbean countries are countercyclical, and appear to assist in smoothing output fluctuations.

19.   **Contemporaneous correlations between the cyclical component of domestic output and workers' remittances are chiefly positive.** This result seems counterintuitive, as one might expect a countercyclical relationship (more remittance flows when the recipient country is in an economic slump) along the lines of the "insurance motive" for remittances derived from micro-level studies (see Docquier and Rapoport, 2004; Mishra, 2005). However, given the strongly procyclical correlation between industrial country and ECCU output cycles, it is not surprising that remittance flows increase when industrial country output rises.

20.   **The contemporaneous association between the current account balance and domestic output is countercyclical for four countries (including the ECCU aggregate), and acyclical for the remainder.** A countercyclical correlation indicates that above-average domestic output is associated with a deteriorating current account balance. A countercyclical

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[13] In contrast, the correlations between central government revenue (as a share of GDP) and cyclical component of domestic output give ambiguous readings. The bivariate correlations are acyclical for two countries and countercyclical for the others, excepting Antigua and Barbuda.

current account correlation is also reflective of largely procyclical borrowing (and foreign direct investment), and an economy which avails itself of foreign saving. This negative association between the current account balance and domestic output for the eastern Caribbean echoes results found for industrial countries (Freund, 2000).

D. Conclusion and Summary of Findings

21.   **Our results have several policy implications.** We briefly summarize here the main findings of the chapter.

- Strongly positive links exist between activity in industrial countries and output fluctuations in ECCU countries, both directly and indirectly through higher world real interest rates. This finding emphasizes the openness of ECCU economies, and the important role that world economic growth plays as a channel of business cycle transmission to the Caribbean.

- Contemporaneous correlations between output and government spending are largely procyclical (as spending rises in good times and contracts in bad times), while correlations between output and government revenue are countercyclical (as revenue moves in the same direction as output).

- Overseas development assistance flows are largely countercyclical, indicating that assistance rises when Caribbean output is in a slump.

- Both domestic output and prices and domestic output and inflation are positively correlated, which is consistent with output gap representations of inflation and domestic economic activity. Real oil prices are negatively associated with domestic output, consistent with the oil-importing status of all ECCU countries.

- Contemporaneous correlations between real current account balances and domestic output are largely negative. This is indicative of procyclical external borrowing (including foreign direct investment) and the lack of borrowing constraints that ECCU countries faced during the period under study.

22.   **In this chapter we have examined the cyclical properties of several important macroeconomic time series for the six Fund members of the Eastern Caribbean Currency Union.** In so doing, we emphasized the patterns of comovement (unconditional correlations) between domestic output and macroeconomic time series, in an attempt to discern some of the "stylized facts" of macroeconomic fluctuations in the Caribbean. We also set out the key differences and similarities between our Caribbean results and those obtained in other studies of business cycle fluctuations in developed and developing countries. It is hoped that in future work, researchers will apply the stylized facts established here in designing more formal, structural models of Caribbean business cycles.

DATA SOURCES

The primary sources of data used in this paper are the International Monetary Fund's *International Financial Statistics (IFS)*, *World Economic Outlook (WEO)*, Eastern Caribbean Central Bank, country authorities and IMF staff's estimates, supplemented by other sources. Data series are in annual frequency and run from 1975 to 2004. All series are converted into logarithms for the empirical work, except the world real interest rate, inflation rate, inflation tax rate and current account balance. All data are available upon request.

Real gross domestic output is obtained from the Eastern Caribbean Central Bank and from IMF staff estimates.

World real output is the gross domestic product (at constant prices) for industrial countries from the *WEO* (series W110NGDP_R).

GDP deflator is from Eastern Caribbean Central Bank.

Real crude oil price in U.S. dollars per barrel is the simple average of three spot prices—dated Brent, West Texas Intermediate, and Dubai Fateh (*IFS*, series 11176RGZLF...), deflated by the manufactured unit export index of industrial countries (*IFS*, series 11074..DZF...).

Inflation (π) is the annual percentage change of consumer price index (CPI), with the CPI index taken from the *WEO* (series W_PCPI).

Inflation tax is defined as $\pi/1+\pi$.

Real central government expenditure is provided by Eastern Caribbean Central Bank and IMF staff, and is deflated by the GDP deflator.

Real central government revenue is the nominal central government revenue retrieved from WEO (series W_GCRG), divided by GDP deflator.

World real interest rate is proxied by the difference between the nominal 6-month euro-dollar rate in London (*IFS*, series 11260D..ZF...) and the rate of inflation in consumer prices in industrial countries (*IFS*, series 11064..XZF...).

Overseas development assistance is total concessional aid (including loans and grants), obtained from the website of Organization for Economic Co-operation and Development (http://www.oecd.org). The GDP deflator is used to convert the series to real terms.

Workers' remittances are defined as the value of monetary transfers sent home from workers abroad for more than one year. The series are obtained from the website of University of California at Davis and the World Bank's *World Development Indicators* for 1986 to 1995, and from country authorities from 1996 onwards. The GDP deflator is used to convert the series to real terms.

Current account balance is taken from *WEO* (series W_BCA) and is deflated by GDP deflator.

We performed the Phillips-Perron unit root tests on cyclical components of all series, derived with the filters employed in this chapter, and confirmed they were all stationary.[14] In addition, we found that unfiltered inflation rates (measured as the annual percentage change of CPI) were not stationary for a few countries in our sample, but filtered inflation rates (which we used in the analysis) were. The results of these unit root tests are not reported, but are available upon request.

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[14] Workers' remittances for Antigua and Barbuda and St. Kitts and Nevis, and broad money and private sector credit for St. Lucia passed the Phillips-Perron test at the 10 percent level of significance. All other series passed at the 5 percent level or lower.

INCOME CONVERGENCE IN THE ECCU

Over the last two decades, economic growth in the countries of the Eastern Caribbean Currency Union (ECCU) has been rather volatile (Rasmussen and Tolosa, 2005). An important question is whether, during this volatile growth process, flows of labor, capital, and remittances have served to equalize per capita incomes across member countries of the ECCU? Following the growth literature, we measure the extent of σ-convergence—that is, we examine whether the dispersion of real per capita incomes across the economies of the ECCU have tended to fall over time, which would indicate that income levels in the rich and poor countries of the ECCU are becoming more similar. In analyzing σ-convergence it is assumed that ECCU countries share the same long-run equilibrium level of per capita income, determined by common technologies and common preferences for saving.

We use three concepts of income in the analysis: gross domestic product (GDP), gross national product (GNP), and gross national disposable income (GNDI). GDP (at market prices) is the sum of gross value-added by all resident producers in the economy, plus any product taxes and less any subsidies not included in the value of the products; GNP is GDP plus net receipts of factor income from abroad (compensation of short-term employees and property income); while GNDI is GNP plus net current transfers from abroad (workers' remittances). As a result, GNDI is the broadest measure of income, as it captures both short-term (compensation of employees) and long-term (worker remittances) transfers, and other types of current transfers (such as official transfers).[15] GNDI thus represents the total income available to residents of an economy for consumption and saving, excluding any foreign borrowing. Given the large numbers of Caribbean emigrants working abroad, it is important to capture the remittances of the Caribbean diaspora in calculating the broadest possible definition of each country's income.

There appears to be little evidence that incomes in initially-poor ECCU countries are converging to (catching up with) those of their initially-rich ECCU counterparts. Appendix Figure I.1 shows the cross-sectional standard deviation of the logarithm of real per capita income (the coefficient of variation), for each of the three definitions of income. We observe that the dispersion rose from about 0.42 (for GDP and GNP) in 1980 to reach about 0.47 by 2003; the dispersion of GNDI rose even further, from 0.35 in 1980 to about 0.47 in 2003. While the dispersion of per capita incomes was broadly stable until the early 1990s, after that time income divergence occurred across the countries of the ECCU. Hence it appears that, contrary to expectation, remittances did not disproportionately flow to the poorer ECCU countries over the period.

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[15] To the extent that official data does not fully capture worker remittances, then GNDI will be an underestimate. GNDI also does not include migrant transfers (defined as capital transfers of migrants), which have been important in some ECCU countries, such as Grenada.

The national paths of per capita GNDI reflect the evolution of these greater income disparities. Appendix Figure I.2 plots the path of per capita GNDI since 1980, with each country's per capita income indexed to be 1980=100. The strong post-1980 growth performance of St. Kitts and Nevis, Grenada, and Antigua and Barbuda is revealed in the data, as is the mediocre growth performance of the Windward Island countries (Dominica, St. Lucia and St. Vincent and the Grenadines).

Appendix Figure I.1. ECCU: Standard Deviations of Real GDP, Real GNP and Real GNDI Per Capita, 1980-2003
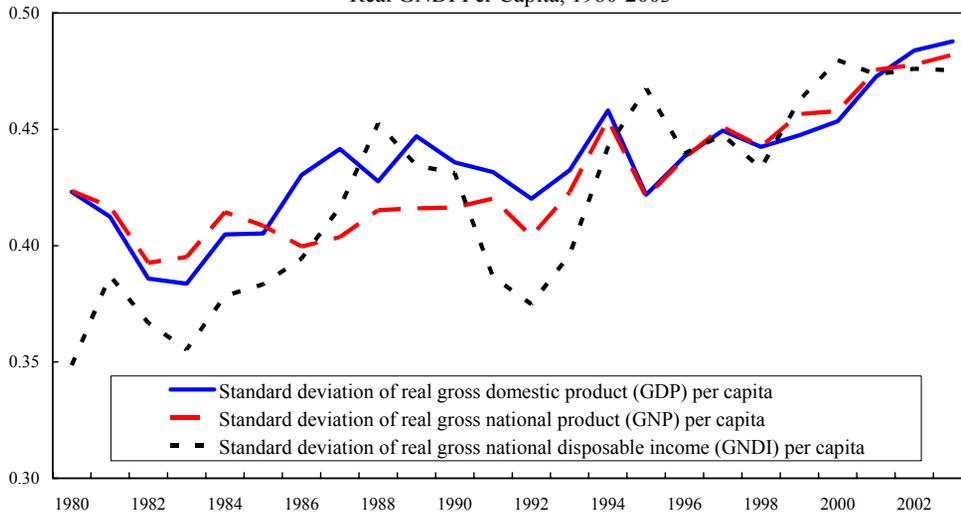
Sources: Eastern Caribbean Central Bank; World Bank, WDI; and Fund staff estimates.
Note: Real GDP, real GNP and real GNDI per capita are in logarithmic form.
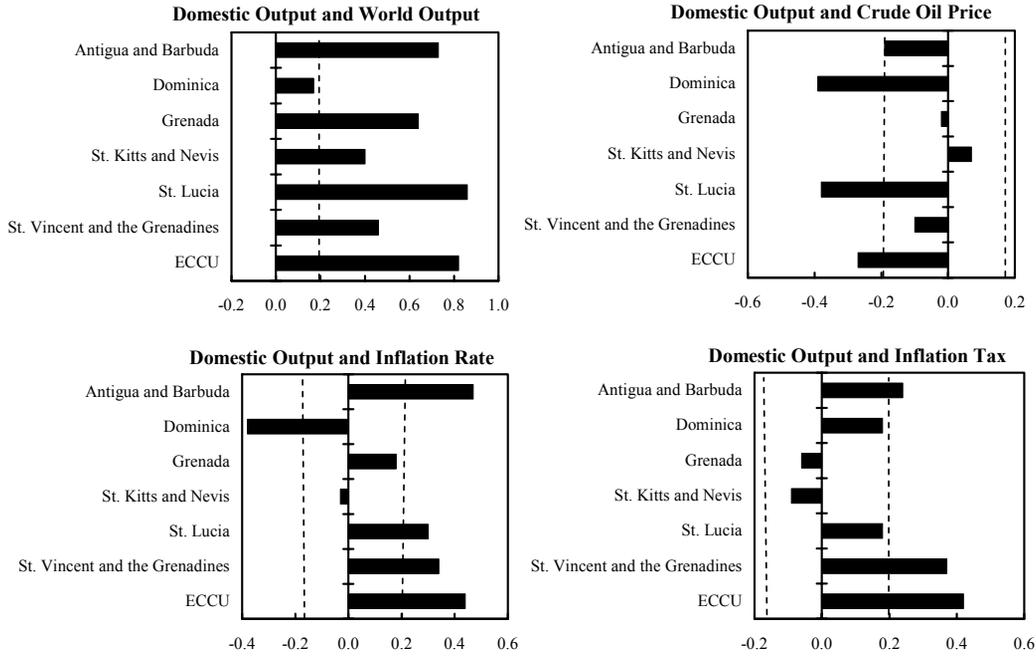
Appendix Figure I.2. ECCU: Real Per Capita Disposable Income, 1980-2003
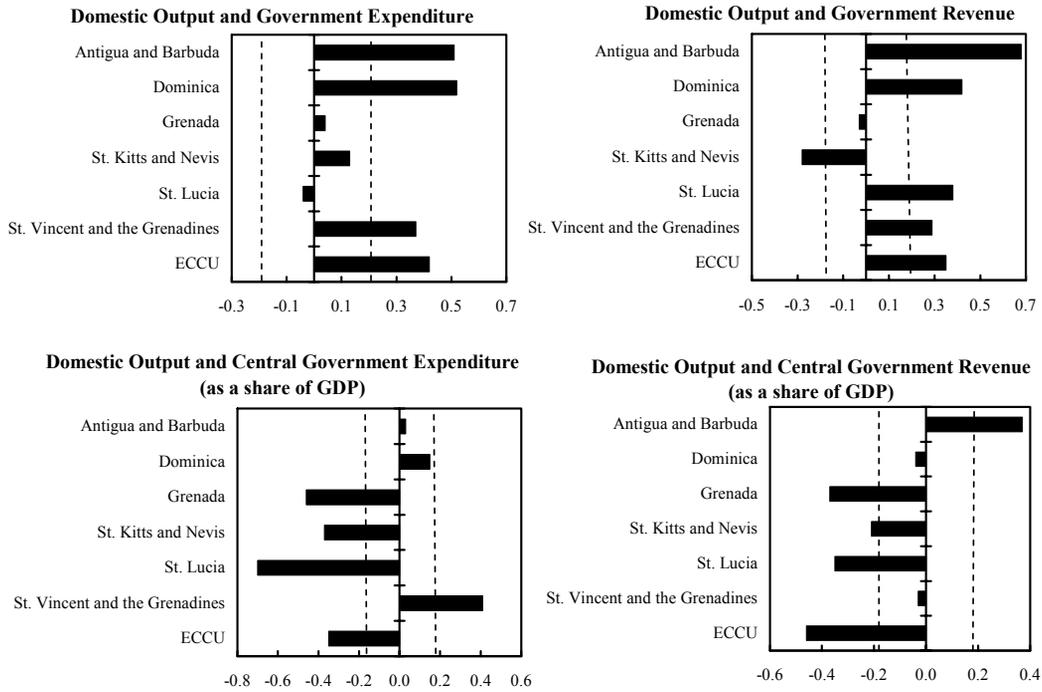(Indices, 1980=100)
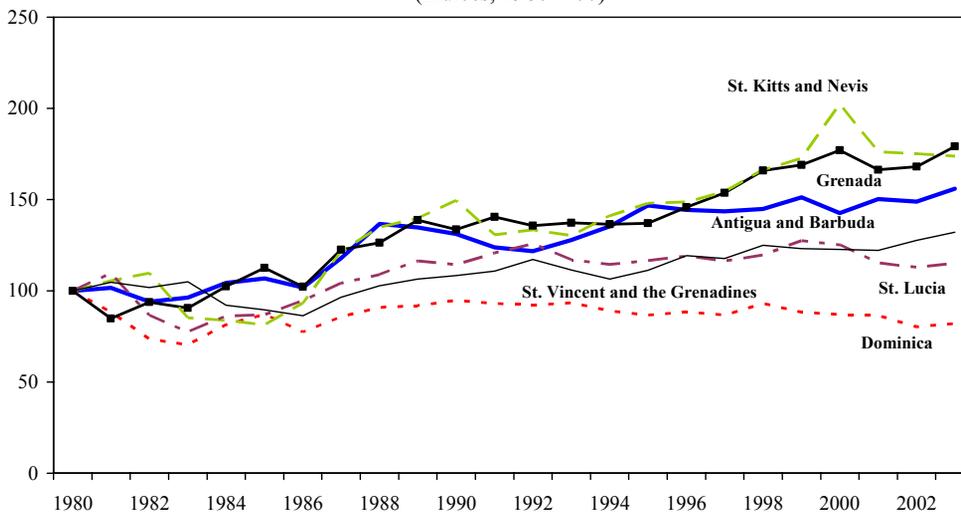
Sources: Eastern Caribbean Central Bank; World Bank, WDI; and Fund staff estimates.
Note: Real gross national disposable income (GNDI) per capita is in logarithmic form.

Figure I.1. Eastern Caribbean Currency Union: Contemporaneous Correlations

Real Sector

Domestic Output and World Output

Domestic Output and Crude Oil Price

Domestic Output and Inflation Rate

Domestic Output and Inflation Tax

Fiscal Sector

Domestic Output and Government Expenditure

Domestic Output and Government Revenue

**Domestic Output and Central Government Expenditure
(as a share of GDP)**

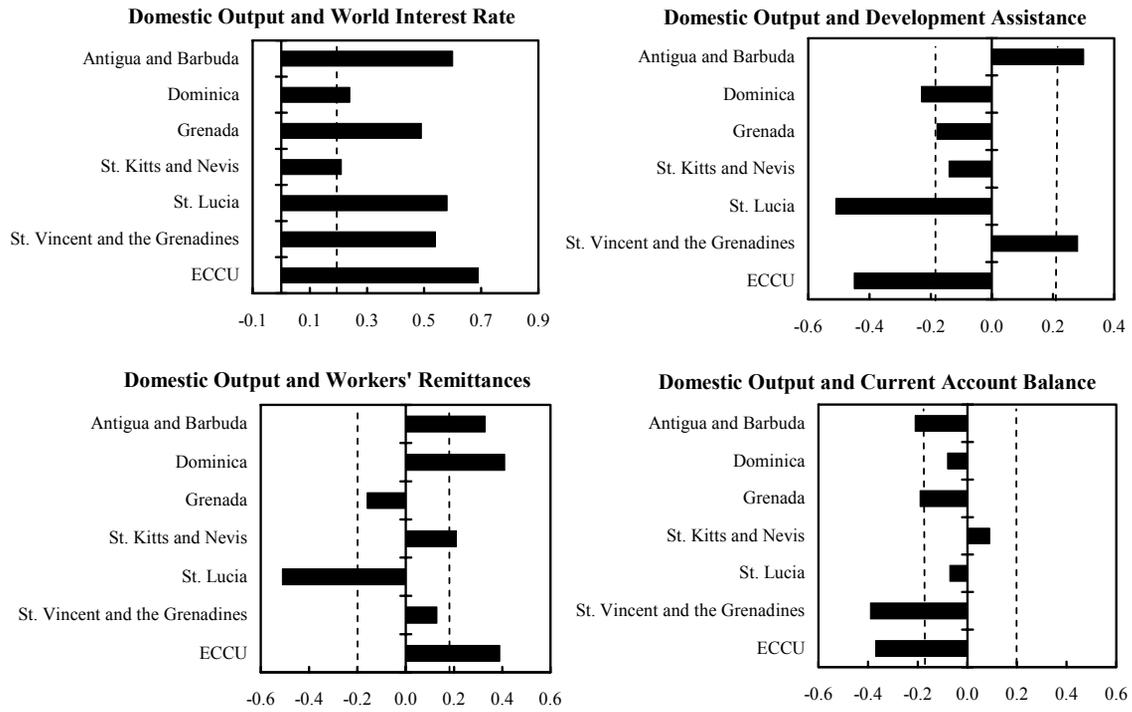**Domestic Output and Central Government Revenue
(as a share of GDP)**

Source: Authors' calculations.
Note: The dashed lines in each figure represent the standard error of the correlation coefficient.

Figure I.1. Eastern Caribbean Currency Union: Contemporaneous Correlations

External Sector

Domestic Output and World Interest Rate

Domestic Output and Development Assistance

Domestic Output and Workers' Remittances

Domestic Output and Current Account Balance

Source: Authors' calculations.
Note: The dashed lines in each figure represent the standard error of the correlation coefficient.

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