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INTERNATIONAL MONETARY FUND

EASTERN CARIBBEAN CURRENCY UNION

SELECTED ISSUES

January 13, 2020

Approved By
Western Hemisphere Department

Prepared by Ding Ding, Alejandro Guerson, Kotaro Ishi, Samira Kalla, Bogdan Lissovolik, Wayne Mitchell, Jan Moeller, Manuel Rosales and Haobin Wang (WHD), Majid Malaika (ITD), and Abdoul Sidibe (University of Montreal)

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FISCAL INTEGRATION FOR THE ECCU[1]

A. Introduction

1. Forming an economic union has been a long-standing policy priority for the Organization of Eastern Caribbean States (OECS). The Revised Treaty of Basseterre, signed by the OECS member countries in June 2010, provided the foundation for deeper economic integration in the region. The Treaty called for the establishment of a single financial and economic space with free movement of goods, people and capital, harmonization of monetary and fiscal policies, and a common approach to trade, health, education, environment, and critical industries such as agriculture, tourism, and energy.

2. On macroeconomic policy harmonization, the common monetary policy represented by the Eastern Caribbean Currency Union (ECCU) has served the region well, but fiscal policy coordination is still in its infancy. The conduct of fiscal policy continues to be in the sole purview of national governments. And despite the fiscal benchmark instituted by the ECCB Monetary Council (a public debt to GDP target of 60 percent by 2030), fiscal performance has varied considerably among the ECCU member countries without any enforcement mechanisms for reaching the regional benchmark.

3. The continued success of the currency union can be solidified by greater fiscal policy integration. The ECCU countries are among the most vulnerable to natural disasters in the world, with an imputed fiscal cost of natural disasters ranging from ½ to 1½ percent of GDP (IMF 2018). These large adverse shocks, combined with frequent fiscal slippages, have led to high public debt across the region, further inhibiting the countries' ability to borrow in the international markets and squeezing fiscal space needed for public investment. As nominal adjustments are not feasible given the currency union arrangement, while fragmented financial system and labor market rigidities further limit market-based regional adjustment mechanisms, individual ECCU countries have struggled to cope with the large adverse shocks with their own buffers. In the absence of effective coordination of fiscal policy, cross-border spillovers from weaker members could undermine confidence and trigger a region-wide crisis. Moreover, collective action failures can occur when national policies generate negative externalities and create pressures for other countries to follow suit, resulting in a "race to the bottom" especially in the areas of tax incentives and the Citizenship-by-Investment (CBI) programs.

4. Against the growing intensity of external shocks, country-level fiscal policies remain as the most important policy lever. As detailed in IMF (2018), an effective fiscal policy framework should center around two building blocks: (i) resilient and credible country-specific fiscal responsibility frameworks supported by strong fiscal institutions, and (ii) specific ex-ante mechanisms to deal with natural disasters with investment in resilient infrastructure and adequate

[1] Prepared by Ding Ding, Alejandro Guerson, Samira Kalla, Bogdan Lissovolik, Jan Moeller, Manuel Rosales and Abdoul Sidibe.

insurance layering. The latter ranges from self-insurance based on national saving funds to contingent financing arrangements in the event of particularly large shocks. Implementation of these two blocks would have significant benefits in terms of supporting economic growth. However, these fiscal policy improvements require determined implementation and fiscal space and capacity, which the ECCU countries lack in the absence of further concessional financing. This progress would be bolstered by comprehensive country-specific disaster resilience strategies—currently being piloted in Dominica and Grenada—that provide a roadmap for strengthening resilience and facilitating donor coordination and support.

5. Regional fiscal policy coordination could usefully supplement national policies in dealing with adverse shocks. Such coordination can potentially create fiscal and policy space along several dimensions. First, it can mitigate the disadvantage of the individual ECCU countries' small size, including by pooling capacity and resources. Second, regional coordination can correct for sub-optimality in the current interactions of the individual ECCU members, for example when these engage in excessive competition with each other to the detriment of the whole union. Third, to the extent there are asymmetries in the ECCU countries' economic structure, these could be leveraged for better risk-sharing through improved policy responses. However, the benefits from regional coordination should be matched by improved national fiscal policies, which are crucial to maintain confidence. To this end, implementation steps would require careful sequencing. The subsequent analysis is focused on identifying and quantifying the benefits of fiscal integration.

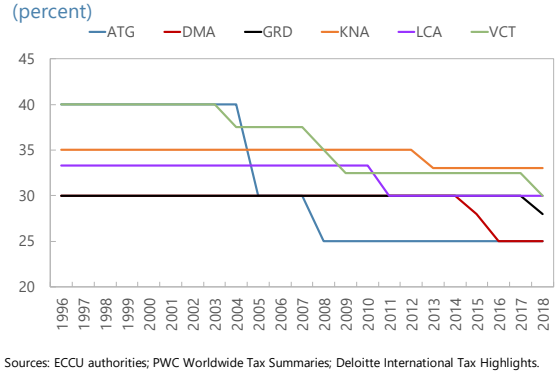
6. Internationally, fiscal integration takes many forms, depending on the interconnectedness of member economies and their willingness to give up fiscal autonomy. The more interconnected member economies are, the greater is the case for a more centralized adjustment mechanism to share risks and limit harmful competition, especially if fiscal governance and market discipline are weak at the national level. Many fiscal federations, such as the U.S. and Canada, rely on centralized revenue and spending arrangements (e.g., central-local fiscal transfer mechanisms and central government spending on social safety nets), while allowing self-imposed fiscal rule at the sub-national level to signal local government creditworthiness to the market. At the other extreme, where bailouts at the sub-national level are expected, a center-based budget constraint is often needed to safeguard fiscal discipline, often at the expense of local government fiscal autonomy. At the national level, however, a bigger role for a supranational mechanism could raise difficult questions about political and democratic accountability for individual sovereigns. As the European experience shows, coordinating fiscal policy in a monetary union can be very challenging, not least because cross-border fiscal oversight and transfers could raise difficult political issues (IMF 2013).

B. The Impact of Tax Incentives

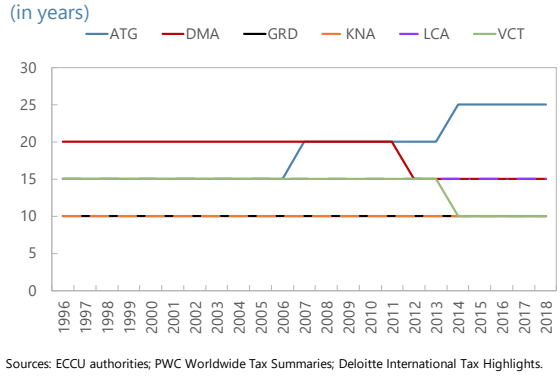
7. Tax incentives are popular tools for the tourism-dependent Caribbean economies to attract FDI. Amid intensified competition for the regional tourism market, the ECCU countries have increased their uses of tax incentive measures in recent years, including through longer tax holidays and loss carry-forward years, higher investment tax allowances, and lower statutory corporate

income tax (CIT) rates (Figure 1). Generous tax concessions are also granted at customs for import duties, VAT, and excise taxes. Such incentives are typically not rules-based (or clearly specified in the tax code) or coordinated across the ECCU countries.

Figure 1. Change of Tax Policies in the ECCU Countries



Sources: ECCU authorities; PWC Worldwide Tax Summaries; Deloitte International Tax Highlights.



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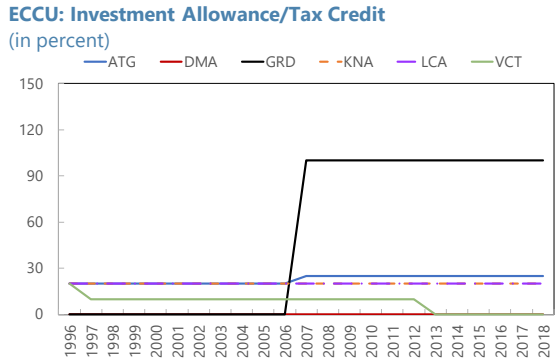

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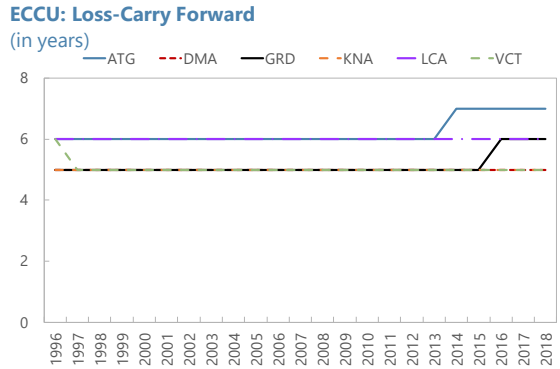


Sources: ECCU authorities; PWC Worldwide Tax Summaries; Deloitte International Tax Highlights.

8. The pervasive use of tax incentives leads to a harmful "race to the bottom" and entails large fiscal costs (Figure 2). As countries feel compelled to offer incentives packages to investors out of the fear that otherwise potential investment would move to a competing destination in the region, they may obtain immediate gain from these actions, but losses from the impact of adverse consequences may collectively cause damage to all involved and constrain governments' ability to finance much needed human and physical capital (Otker 2014). Indeed, staff's estimation indicates large fiscal costs for the ECCU countries. The estimation includes the foregone revenue at customs and the foregone CIT revenues based on the below three approaches.

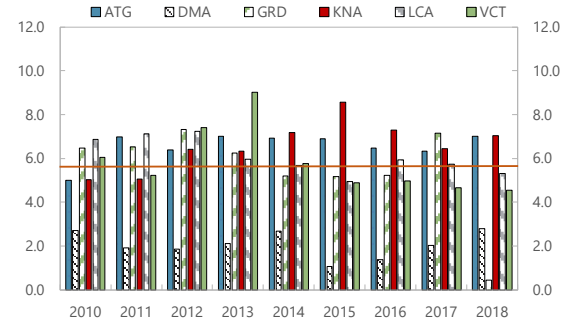
- **Based on CIT returns.** Under this approach, the foregone revenue is estimated by applying the standard CIT rate to the taxable profits of the companies benefiting from tax holidays minus the actual collection of CIT revenue. Normally, this approach may lead to underestimation of the foregone revenue due to the underreporting of profits and tax returns.

- **Based on VAT returns.** The foregone revenue is estimated as the difference between the actual CIT yield and the potential, which is estimated as the product of the statutory rate and the CIT

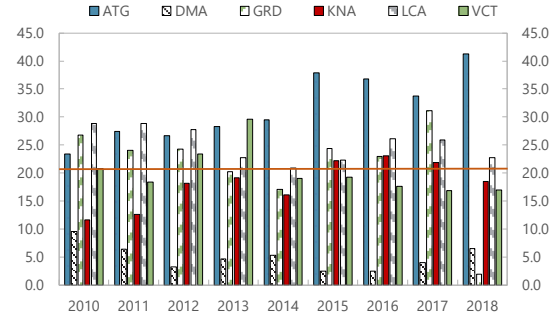
base calculated as a quarter[6] of the difference between total sales and total purchases in the VAT returns.

- **Based on sector specific value-added data from national accounts.** Like the above VAT returns approach, the potential CIT base is calculated as one-fourth of the value added for the economic sectors benefiting from tax incentives from national accounts.

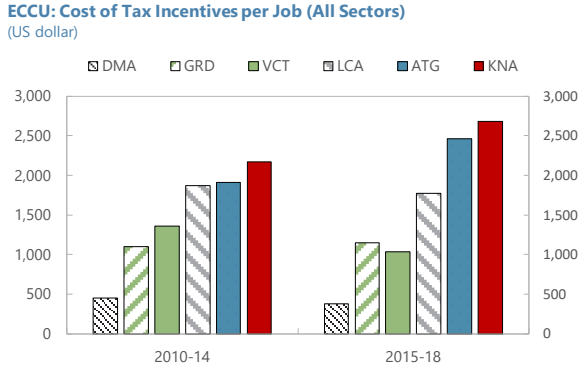
Figure 2. The Fiscal Costs of Tax Incentives



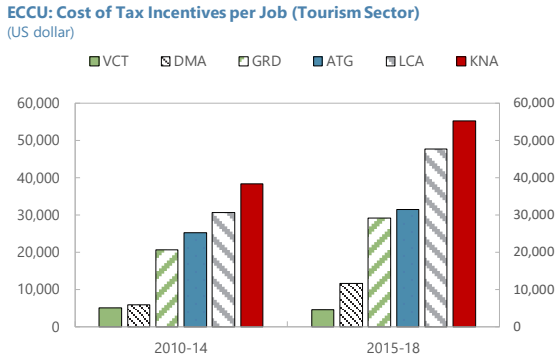
Sources: ECCU's Ministries of Finance and IMF staff calcualtions.



Sources: ECCU Ministries of Finance



Sources: ECCU Ministries of Finances, ECCU Social Security Boards, and IMF staff calculations.



Sources: ECCU Ministries of Finances, ECCU Social Security Boards, and IMF staff calculations.

9. The total foregone revenue is estimated to have averaged 5.8 percent of GDP in 2010–18 in the ECCU region, or 21 percent of total tax revenue.[2] These results are broadly in line with previous studies (e.g., Chai and Goyal 2008). They are also in line with the estimation of other tourism-based Caribbean economies such as Barbados and Jamaica (IMF 2017). Measured against employment, the cost of tax incentives is equivalent to as high as $2,500 per job in the formal sector.

[2] Due to data gaps in CIT returns, the results presented here are the foregone revenue of CIT based on the sector specific value-added approach as well as the foregone revenue at customs, which reflects concessions associated to indirect taxes and fees/charges waived by the governments when qualified beneficiaries import goods into these economies, including import duties, excise taxes, and VAT.

10. Despite the large fiscal costs, the benefits of tax incentives appear to be marginal. Empirical analysis for a sample of eleven tourism-based Caribbean countries (including the six independent states in the ECCU) suggests that tax incentives have some positive impact on the tourism sector. For instance, a decline in the CIT rate is associated with an increase in the number of hotel rooms (controlling for other macro-level factors) in a panel regression with country fixed effects, and an increase in the foregone revenue by 1 million EC dollars is associated with an increase in the number of hotel rooms by 0.2 percent in a pooled OLS regression. But tax incentives do not seem to have an impact on overall FDI, GDP growth or employment (Table 1, Appendix I Table 1-4). The analysis also shows that FDI to the Caribbean is positively correlated with the stock of public infrastructure when countries experience natural disaster shocks, indicating a policy tradeoff between granting tax incentives and raising revenue to finance infrastructure investment.

Table 1. ECCU: The Effect of Tax Incentives on FDI

	Dependent Variable: FDI						
	Estimation Method Specifications			**Fixed Effect Panel**			**GMM**
Tax policy variables	CIT rate	0.006	0.001	-0.001	0.006	0.028	0.016*
	Tax holiday		-0.042*				-0.091***
	Investment allowance rate			-0.002			-0.006**
	Tax competition index				-0.004		
	Foregone revenue					-0.001*	0.000
Other control variables	Public consumption	-0.055	-0.088**	-0.063	-0.055	-0.087**	-0.200***
	REER	0.002	0.002	0.007	0.002	0.009	0.020***
	US PPPGDP	0.591**	0.547**	0.725**	0.590**	0.884***	0.976***
	Number of flights (lag)	0.028**	0.029**	0.045	0.027**	0.038	0.006
	Infra. stock (lag)	-0.14	-0.098	-0.376	-0.139	0.01	-0.538**
	Infra. stock (lag) interacted w/ natural disaster dummy	0.054*	0.054*	0.086*	0.054*	0.043	0.073***
	Constant	-0.111	0.838	1.035	-0.104	-2.805	2.659
	Observations	140	140	102	140	96	81
	Number of countries	10	10	10	10	10	10
	R-squared	0.565	0.576	0.504	0.565	0.445	

Source: IMF staff calculations.
Note: the tax complettion index measuires the number of tax incentive changes withina year.

C. The Case for Coordination of CBI Programs

11. The competition among the ECCU countries to attract foreign investment through the CBI programs has intensified in recent years, exemplifying another race to the bottom in the region.[3] Several countries have reduced the price and requirements for investment to increase demand for applications. For example, Dominica amended its CBI requirements in end-2016, lowering the fee for the real estate investment option to expand hotel construction. St. Lucia substantially eased the conditions for access by reducing the cost to generate more revenue and enhance the program's competitiveness. Antigua and Barbuda reduced the overall price nearly by half in late 2017. St. Kitts and Nevis rolled out a Hurricane Relief Fund (HRF) in early 2018, lowering the price for donations to the development fund and allowing family members to come for free, to make the program more competitive and support real estate developers.

12. A regional approach to manage CBI programs is therefore needed to sustain the programs' long-term viability and their contributions to public finance. In the short term, protection of the programs' financial integrity offers an initial rationale for collective action, including to dispel concerns relating to the tax rate on offshore income and residency period and other aspects of transparency standards to lower perceptions of abuse of CBI programs. In March 2019, the ECCU launched an initiative to harmonize CBI programs' due diligence processes. Implementation of this initiative could help the region-wide sustainability of the revenue flows and support financial stability. In the medium term, the following analysis suggests a case for exploring CBI program coordination on pricing and the use of quotas to support these revenues over time.

13. In theory the competition can be thought of as a Bertrand price competition where countries use the required CBI investment as a strategic variable, which is perceived by foreign applicants as the price for citizenship. The conventional wisdom is that price competition leads competitors to a suboptimal outcome and policy coordination could improve their joint outcome (Deneckere and Davidson 1985). If countries are identical, then countries' revenue from CBI programs could improve either through a minimum price or (equivalently) by an appropriate cap on the number of new citizens per country. However, if countries face asymmetric demands for their CBI programs, a minimum price and a maximum quantity quota will have different effects. We show in this section that a combination of price and quantity instruments can generate the Pareto efficient outcome for member countries.

14. The intuition can be illustrated by a simple example with linear CBI demand with respect to prices. We consider n countries that can be classified into two groups: the low-demand countries (L) and the high-demand countries (H), depending on, for instance, the freedom of travel associated with their respective citizenships. Countries are assumed to be identical within each category, with the former facing less demand than the latter but with symmetric elasticities with

[3] For the background of CBIs, see Xu et al (2015).

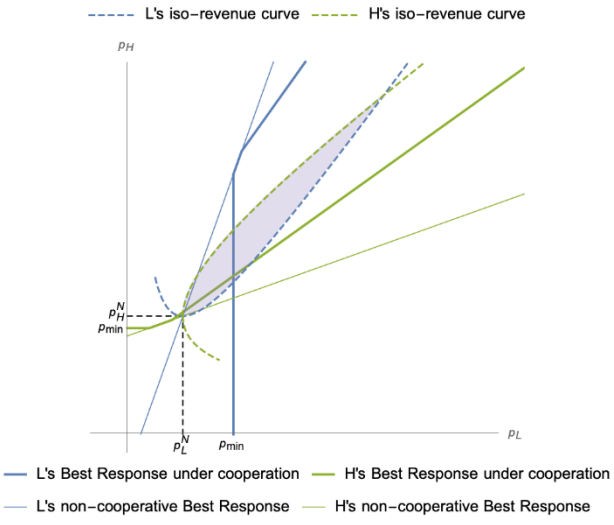
respect to prices and producing CBI at an identical constant marginal cost. As in Deneckere and Davidson (1985), we assume that demand functions can be expressed in the following linear form

$$q_i^j\left(\tilde{\tilde{p}}\right) = v_i - p_i^j - \delta\left(p_i^j - \overline{p}\right)$$

where $q_i^j\left(\tilde{\tilde{p}}\right)$ is the demand to the j-th i-type country with $i \in \{L, H\}$ and $j \in \{1,2,\ldots,n_i\}$, $\delta > 0$ is a substitutability parameter, $\overline{p}$ is the average price level in the economy and $v_H > v_L$. We assume v_L to be large enough so that, $q_i^j\left(\tilde{\tilde{p}}\right)$ is always positive. In a *Non-Cooperative Equilibrium* (p_L^N and p_H^N in Figure 4), the *H*-type countries charge a higher price and grant a greater number of new citizenships than the *L*-type countries do. Therefore, while imposing a minimum price would be more biding to the *L*s, a maximum quota limit on new citizenships would be more restrictive to the *H*s.

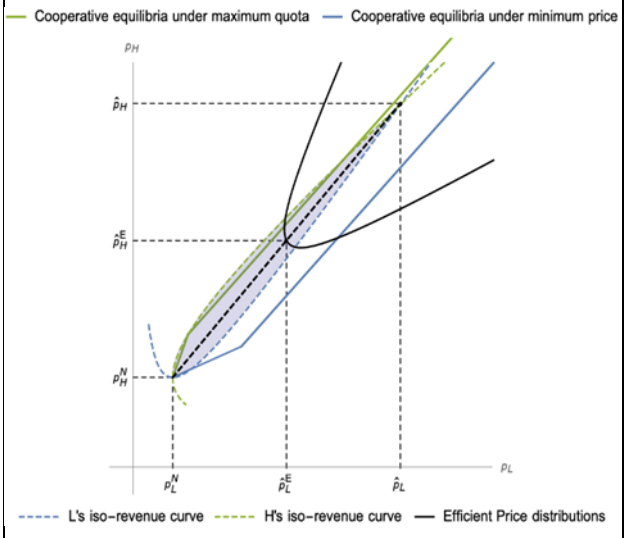
15. Pareto improvement can be achieved from a Non-Cooperative Equilibrium to a cooperative one. The *Cooperative Equilibrium* prices are determined by the intersection of the best response functions of L-types and H-types under cooperation. In Figure 3, the dashed blue (green) line represents the iso-revenue curve for L-types (H-types) that corresponds to their *Non-Cooperative Equilibrium* revenue level. Any point located above the dashed blue line (to right of the dashed green line) represents a combination of prices that can generate a higher CBI revenue for the L-types (H-types) than the one produced by the *Non-Cooperative Equilibrium*. Therefore, the shaded area of the graph represents the sets of prices that represent a revenue improvement for both sets of countries from the non-cooperative scenario. In Figure 3, the equilibrium prices under a minimum price and a maximum quota are higher for *L*s and *H*s than their respective non-cooperative prices, p_L^N and p_H^N.

Figure 3. Pareto Improvement of the Non-Cooperative Equilibrium



Source: IMF Staff calculations.

Figure 4. Efficient Pareto Improvement of the Non-Cooperative Equilibrium



Source: IMF Staff calculations.

16. Moreover, it can be shown that a combination of the price and quantity instruments could allow countries to reach a Pareto-efficient outcome. The intuition is as follow:

- Because the minimum price is always binding for the type-*L* countries (but not always the type-*H* countries), the marginal revenue from increasing the minimum price is always higher for the *H*-type, that is, an additional increase in the minimum price generates more revenue for the *H*-type countries than for the *L*-type countries. When the minimum price becomes high enough its marginal benefit turns negative for the *L*-type countries but remains positive for the *H*-type countries.

- Because the Pareto efficiency is achieved when the revenue generated in the *H*-type countries due to an additional unit to the minimum price is equal to the resulting loss of revenue for the *L*-type countries, this Pareto-efficient outcome may not dominate the non-cooperation equilibrium outcome (similarly for the maximum quota as the single requirement). Only a combination of both the minimum price and the maximum quota could ensure a "fair" distribution of the additional revenue from cooperation and, if chosen appropriately, the combination always guarantees an efficient outcome that is more profitable to both types compared to the non-cooperative equilibrium.[4] To illustrate the intuition, notice that any point that lay between the blue line and the green line in Figure 4 can be achieved by setting a combination of a minimum price and a maximum quota. The green line always passes above $(\hat{p}_L, \hat{p}_H)$ because otherwise, there would exist a maximum quota level for which type-*H* countries would earn more revenue as compared to their revenue in a non-cooperative equilibrium while type-*L* countries would earn less, which is impossible. Analogously, the blue line always lay below $(\hat{p}_L, \hat{p}_H)$·

- Because the set of efficient price distributions (black line on the graph) always passes through the shaded area (representing feasible Pareto improvements of the *non-cooperative equilibrium*), it always exists an efficient distribution of prices profitable to all types that lay between the green line and the blue line. Therefore, the right combination of a minimum price and a maximum quota would guarantee an efficient outcome that is more beneficial to both types of country than the non-cooperative equilibrium.

17. The combination of price and quantity instruments has proved effective in the context of cross-country policy coordination. Several countries in the Pacific have been coordinating on revenues from selling fishing rights to foreign companies under the Party to the Nauru Agreement (PNA). The Agreement, through the so-called Vessel Day Scheme, sets limits on the number of fishing days that can be auctioned off by each member country during a calendar year, as well as a minimum benchmark fee for a fishing day. The Scheme has led to increased revenue for its parties through the licensing fees, decreased catch to ensure sustainable fishing, and leveraged the PNA to be a stronger international negotiator than the parties would be individually (Bernadett, 2014).

[4] See Ding et al (2019) for details.

D. A Regional Stabilization Fund for the ECCU in the Longer Term

18. This section quantifies the economic benefits and costs from establishing a regional stabilization fund (RSF). To demonstrate the scope for risk-sharing, we establish empirically that macro-fiscal shocks across ECCU countries are imperfectly correlated. As a result, a RSF would need to be only half as large as the sum of individuals country saving funds (SFs) while providing a similar degree of insurance. With the SFs/RSF designed to incentivize less procyclical fiscal policies, we show that average public investment over the cycle would be increased at the expense of current spending. We document that such spending reallocation leads to substantial increases in output, employment, and wages, once the general equilibrium response of the private sector is accounted for. Finally, we incorporate opportunity costs for setting up and maintaining the RSF and demonstrate that the benefits from cross-country risk-sharing are likely to outweigh opportunity costs.

19. The RSF would help smooth pro-cyclical government consumption and investment. Government spending in ECCU countries has been procyclical, reflecting political economy incentives for spending and financing constraints. Increases in government revenue during booms relieve cash-flow constraints and lead to increases in government consumption. During recessions, when revenue is low, government consumption, mainly wages and transfers, are rigid under social and political constraints. As a result, public investment is crowded out during recessions. The saving-disbursement rules used in this paper assume that a share of the pro-cyclical increase of government consumption in good times is saved in a SF, and the savings are disbursed to sustain public investment execution during recessions, thereby contributing to output stabilization and to over-the-cycle increase in public investment.

20. The need for self-insurance in the form of SF/RSF can be motivated by financing constraints and political economy factors. ECCU countries are not integrated to global financial markets. The bulk of financing remains external, mostly in the form of official multilateral and bilateral loans, which are typically project-based, and therefore disbursements are subject to administrative and processing lags and execution progress which do not necessarily align with fiscal policy cyclical management needs. This implies inability to access financing during low states of the cycle matching timing and amount commensurate with cyclical stabilization objectives, particularly given the shallowness of the domestic financial markets.[5] Also, and critically, the vulnerability to potentially catastrophic natural disasters requires immediate availability of financing for rehabilitation and reconstruction—available insurance instruments are insufficient and/or expensive.[6]

[5] The regional Securities Market has limited depth, and bonds issued regionally are seldom traded locally or internationally.

[6] The Caribbean Catastrophe Risk Insurance Facility (CCRIF) has been a valuable instrument to finance disaster recovery, but extensive coverage is costly due to high reinsurance cost in international markets, resulting in under-insurance.

The Size of the RSF: A Monte-Carlo Analysis

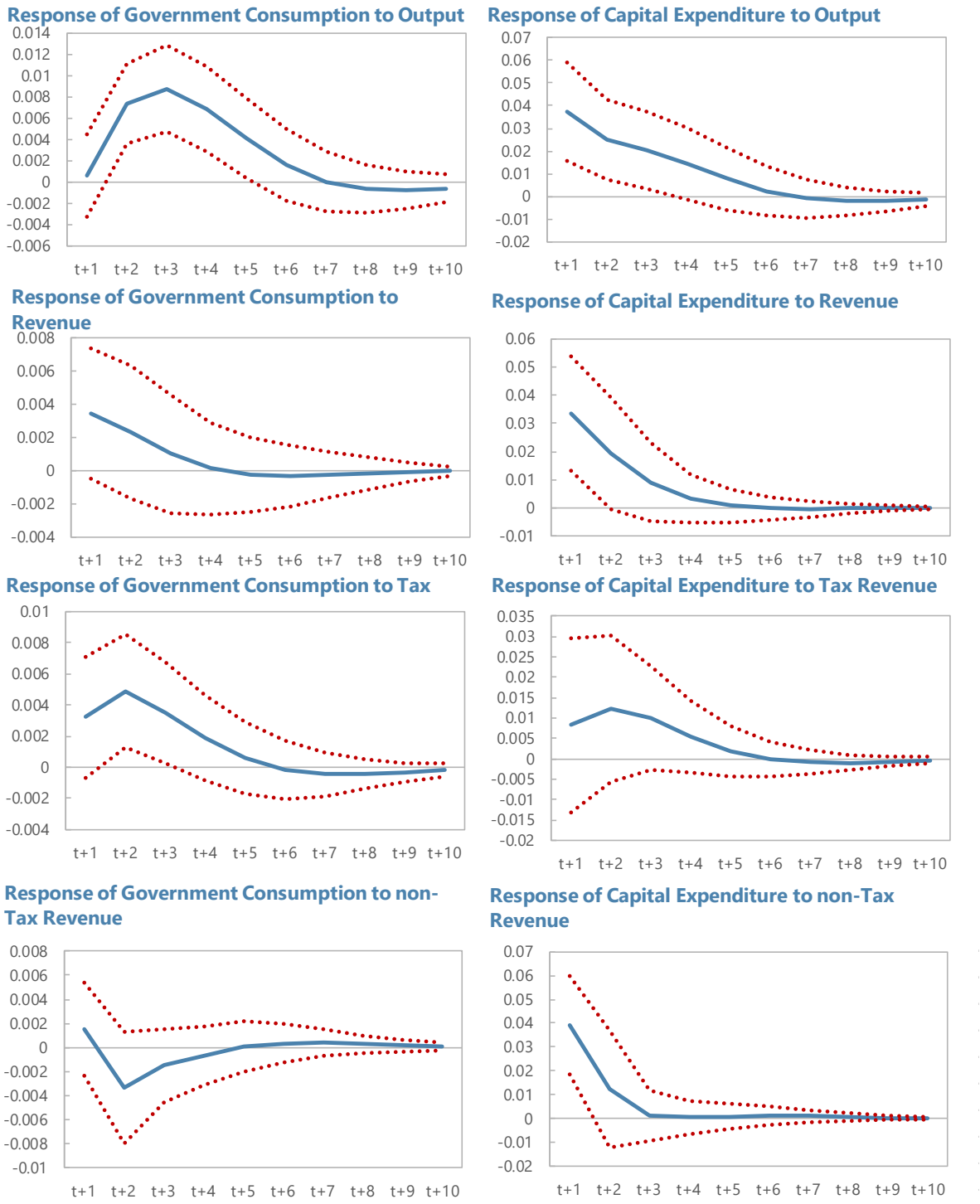
21. We use a Monte-Carlo experiment to simulate output and government revenue and expenditure cyclical fluctuations. The starting point is estimation of empirical models for each country that mimic bussiness cycles fluctuations in historical data series. To this end, VAR models have been estimated for each country including five endogenous varaiables: cyclical fluctuations of output, tax and non-tax revenue, and recurrent and capital expenditure. The models therefore capture cyclical depth, persistence and co-movement across series as observed historically, and allow identification of the joint distribution of macroeconomic shocks. The latter has then been used to run two Monte-Carlo experiments consisting of 1000 simulations, each including off-sample projections of the five endogenous variables (see Appendix II for technical details).

22. Government spending in ECCU countries has been procyclical. Impulse-response analysis with the estimated fiscal models indicate that government consumption, as measured by current primary spending, and public investment increase when output and revenue are high. Figure 5 shows impulse-response functions (IRFs) from the VAR estimates in previous sections for the regional aggregation of output, revenue and expenditure (Appendix II shows the results for individual countries). Therefore, the region could achieve higher welfare with smoother intertemporal public spending.[7]

23. Current spending procyclicality crowds-out public investment over-the-cycle. The increase of recurrent spending during cyclical booms when government revenue is high and its downward rigidity under political economy constraints de-facto reduces fiscal space for investment in low states of the cycle, especially under limited access to financing. In addition, the results also point to significant cyclical co-movement across ECCU countries: the regional aggregation maintains the procyclical patterns albeit with less pronounced cycles, indicating also the presence of offsetting cyclical asymmetries across countries. This is explained by differences in timing and exposure to shocks (including natural disasters), economic structure (i.e. size of tourism and agriculture sectors), and CBI program revenue size and volatility.

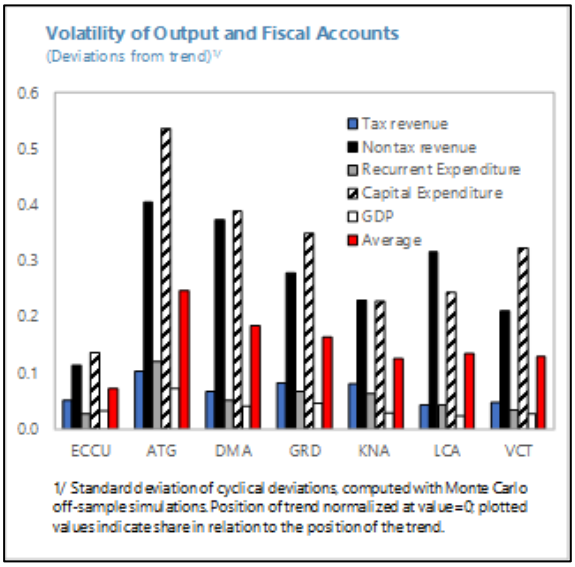
[7] A-cyclical spending if fiscal multipliers are zero, or counter-cyclical for positive multipliers. Alichi et.al. (2018) show small island states positive revenue and spending fiscal multipliers in general equilibrium calibration for a prototypical Caribbean economy.

Figure 5. Procyclicality of Public Expenditure in the ECCU



Source: Staff calculations based on country authorities data.

24. The procyclical fiscal policies and offsetting cyclical asymmetries provide a basis for welfare-enhancing SFs at the individual and regional levels. The text chart shows that the ECCU aggregate displays lower cyclical volatility of government revenue and expenditure, especially for non-tax revenue and capital expenditure. The simulations assume governments save a share of the revenue gap above trend into a SF. This results in an accumulation of savings during booms and a build-up of assets. During recessions, when public investment typically declines, it is assumed that government tap into the SF to finance a share of the predicted decline of capital expenditure below trend –the size of the investment gap share is calibrated to ensure that SF stock is stable over time, for a given probability of depletion to be set by governments according to risk tolerance.[8]



25. An RSF enables significant savings from risk pooling. The simulations indicate that the size of an RSF is about ½ of the size of the sum of individual countries' SFs for the same saving and withdrawal flows. For example, for a probability of SF depletion at 1 percent and share of "excess consumption" saving of 1, the estimated RSF is about 5 percent of regional GDP, while the sum of individual countries' SF adds to near 10 percent (text table).[9]

Size Requirement of Regional and Individual Country Stabilization Funds
(In percent of Regional GDP)

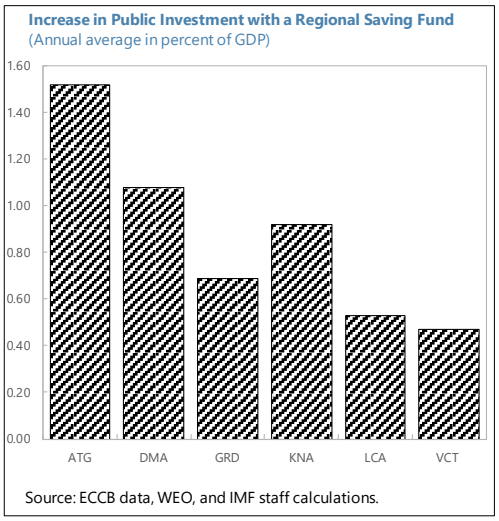
	Prob. Depletion = 0.1		Prob. Depletion = 0.05		Prob. Depletion = 0.01		Prob. Depletion = 0.001	
	Country	Regional 1/	Country	Regional 1/	Country	Regional 1/	Country	Regional 1/
Antigua and Barbuda	1.79	0.90	2.69	1.33	4.75	2.29	6.83	3.12
Dominica	0.34	0.17	0.49	0.24	0.71	0.34	0.90	0.41
Grenada	0.39	0.20	0.56	0.28	0.93	0.45	1.35	0.62
St. Kitts and Nevis	0.46	0.23	0.66	0.33	1.09	0.53	1.55	0.71
St. Lucia	0.59	0.30	0.90	0.44	1.55	0.75	2.13	0.97
St Vincent andf the Grenadin	0.23	0.11	0.32	0.16	0.52	0.25	0.71	0.32
ECCU	**3.79**	**1.90**	**5.63**	**2.78**	**9.55**	**4.61**	**13.46**	**6.15**

Source: ECCB data, WEO, and IMF staff calculations.
1/ Stochastic simulations for targeted probabilities of Stabilization Fund depletion.

[8] The long-term expected stability of the SF stock as a percent of GDP ensures that the saving fund is efficient and sustainable. A perpetual expected increase in the SF by setting the investment share is set "low" would be inefficient; a sustained expected decline of the SF by setting the investment share too large would lead to depletion and unsustainability.

[9] The contributions of the individual countries to the regional SF are calculated based on the shares of each country in the sum of the individual-country SFs—thus accounting for cross-country differences in size and cyclical volatility as measured by depth and length of output and fiscal cycles.

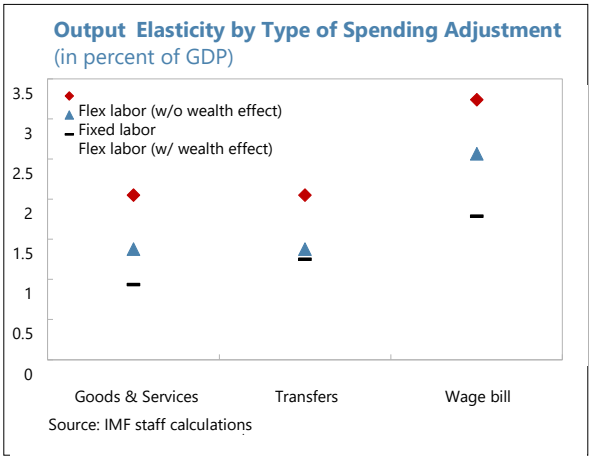
26. All countries benefit from risk pooling under the specified saving-investment rules used in the simulations. This is concluded from the observation that the size of estimated saving funds for the individual countries is in all cases larger than the allotted shares under the regional pooling (see text table). Notice that the smaller RSF remains sufficient for the same level of saving-investment flows each of the countries would have on an individual basis. This is achieved by way of implicit cross-country transfers as a result of the cyclical asymmetries.



The General Equilibrium Impact of the RSF

27. The assumed reallocation from government consumption to investment over the cycle results in a significant increase in public investment. For example, under a RSF with depletion probability of 0.01, ECCU countries would increase public investment in the range of 0.5–1.5 percent of GDP per year on average (text chart). Aside from the direct investment stimulus a sizable boost to output can also be expected from crowding-in of private investment and employment. To assess this channel quantitatively the empirical analysis is complemented by a calibrated general equilibrium model in which elasticities of output with respect to public investment are derived.

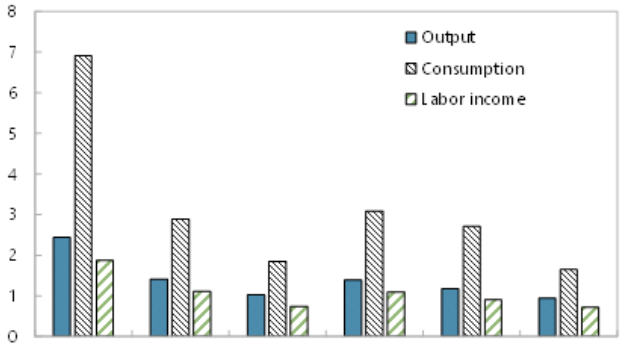
28. The model features a collection of small-open economies (islands) with limited factor mobility (Appendix III). Each economy is populated by households, firms, and a government, and goods trade takes place between each island and world markets, but not within the region. Firms in each country produce output with a constant return technology in which country-specific public capital enters as an externality to productivity. The extent to which private investment and employment are crowded in depends not only on household preferences but also on the way the government implements the reduction in current spending. In the model the government can lower either transfer payments, purchases of goods and services, or the wage bill, with different implications for overall resources and the strength of wealth effects.



29. Output elasticities are generally higher when the government reduces transfers or reduces the wage bill. The elasticities are derived by comparing steady states of the baseline economy with an economy in which the average ECCU government reduces current and increases capital expenditure by 1 percent of GDP. The output response to the expenditure reshuffling depends not only on the

extent of crowding in of private investment (as determined by the production function), but also on the households' labor supply response (as determined by the preference specification) and the type of current spending that the government chooses to reduce (see text chart). Clearly, not all reductions in current spending are alike, with cuts to public sector employment delivering the largest output response since workers are reallocated to more productive private sector activity. Ranging between 0.9 and 2.1, the output elasticities for reductions in transfers and goods and services are still sizable.[10] It is important to note that unlike in much of the literature on government spending multipliers the elasticities reflect permanent increases in output levels from a change in the spending composition, not from a change in the level of total spending.

General Equilibrium Impact from Additional Investment
(change in percent relative to steady state)



Sources: ECCB data, WEO, and IMF Staff calculations.

30. The boost from greater public investment to output, consumption, employment, and wages is substantial. Using the increase of investment by country (from the RSF simulations above) and assuming a weighted adjustment of current spending[11] as well as fixed labor supply, the level increases in GDP range between 0.9 percent for St. Vincent to 2.4 percent for Antigua. The level increases in consumption are even larger, in part because the reduction in purchases of government services frees up domestic resources for consumption purposes.

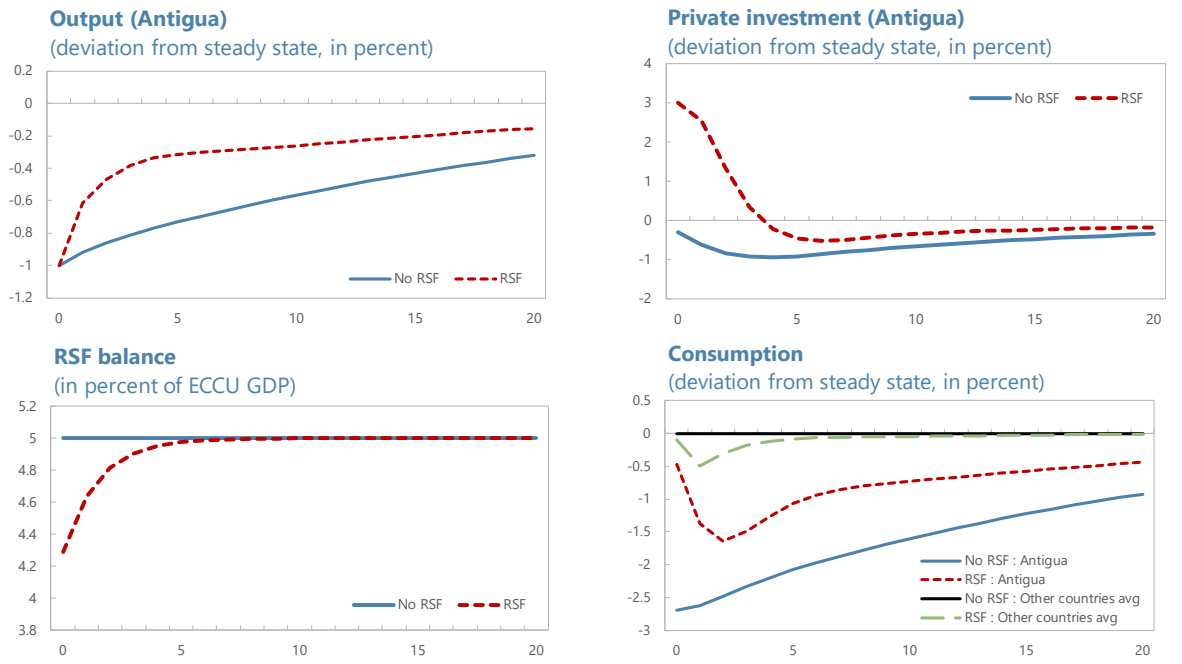
31. For a full picture of the RSF's economic benefits its contribution to cross-country consumption risk-sharing needs to be quantified. As shown above, using the RSF as a device to incentivize less procyclical fiscal policies and thus greater public investment over the cycle comes with its own economic benefits. The core economic function of the RSF, however, consists in macroeconomic stabilization in the face of country-level shocks by allowing greater consumption risk-sharing. To quantify the stabilization benefits a dynamic, multi-country version of the general equilibrium model is calibrated to the ECCU economies. While the RSF can provide support against various shocks, the exercise below uses natural disaster shocks as both the incidence of such shocks and the resulting damages can be readily observed. It is assumed that following a natural disaster event the RSF makes a one-time transfer to the affected country allowing it to rebuild 50 percent of the destroyed public capital stock at once. A key underlying assumption of the exercise is that countries cannot implement such stabilization on their own, for instance, by quickly issuing debt on financial markets.

[10] A reduction in government purchases of goods and services increases domestic resources available for private consumption. Under separable preferences this increase in wealth reduces households' incentives for supplying labor.

[11] The reduction in current spending is implemented via lower purchases of goods and services (weight of 0.5), transfers (weight of 0.3), and public employment (weight of 0.2).

32. Disbursement from the RSF help stabilize the consumption path and speed up the recovery significantly. The illustration of a natural disaster shock in Antigua and Barbuda, assuming total damages of 10 percent of GDP with two-thirds thereof borne by the public sector, shows that support from the RSF can be critical in speeding up the recovery. The contraction in output (top left of Figure 6) is reduced not only directly through quicker reconstruction of public capital, but also indirectly through crowding-in private investment post-disaster (top right). The fall of consumption in the affected country is much reduced by RSF support, especially on impact but also in the long run (bottom right). Consumption in unaffected countries falls slightly under the RSF as these countries are assumed to help recapitalize the fund. The fund, whose size is calibrated to 5 percent of ECCU GDP, maintains ample resources following the disbursement and is recapitalized within five years (bottom left).

Figure 6. Illustration of Stabilization with RSF—Natural Disaster Shock in Antigua and Barbuda

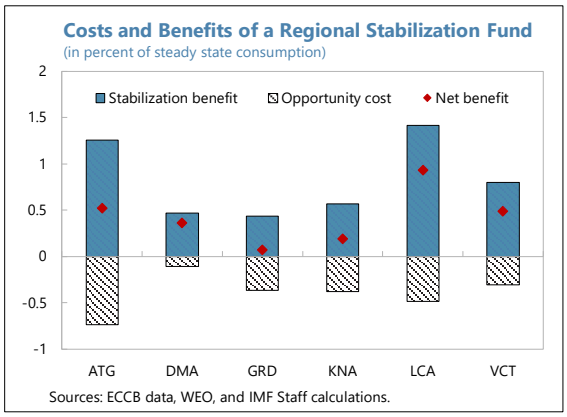


Source: IMF staff calculations.

33. While the RSF can provide valuable stabilization of output and consumption these benefits need to be weighed against the opportunity costs for maintaining the fund. Setting up and maintaining a stabilization fund is costly since countries have alternative uses for their funds, such as paying down debt or investing in resilience building. The general equilibrium model serves as a suitable analytical framework to comprehensively assess opportunity costs since it allows incorporating the effects of distortionary taxation on capital accumulation. Specifically, it is assumed that countries set up the stabilization fund by borrowing domestically and defray the associated debt-servicing cost by increasing non-distortionary consumption taxes and distortionary capital

taxes in equal measure.[12] Long-run stabilization benefits are computed from a stochastic simulation of the dynamic model, assuming that countries are hit independently by natural disaster shocks with an average annual loss of 1 percent of GDP.[13]

34. The analysis indicates that stabilization benefits are likely to outweigh opportunity costs. With the RSF supporting quicker post-disaster recoveries consumption in each country would be higher over the long-run and the drag from higher distortionary does not offset these benefits. Opportunity costs could be even lower if the RSF was capitalized to a greater extent by non-distortionary taxes, e.g., a carbon tax, or if countries could access grants. Also, the utility gains from consumption stabilization are likely to be underestimated since the model captures only the change in consumption levels and not the lower consumption volatility brought about by the RSF.



The Guiding Principles of a RSF

35. The size and scope of the regional fund ultimately depends on social and political preferences in the ECCU. In the above section we focus on the economic case for the fund, assuming that an ECCU-wide agreement could be reached on the extent of desired risk-sharing and the degree to which the fiscal autonomy is retained. Nonetheless, some guiding principles of the fund are needed to frame the discussions and inform the design of policy scenarios in the rest of the paper.

Objective and Scope

36. Improving macroeconomic stabilization through effective risk-sharing should be the main objective of the regional fund. Stabilization can be achieved by providing transfers to finance public expenditure including capital/reconstruction investment when countries experience negative shocks such as natural disasters. While other objectives may be pursued in tandem, care should be taken not to inadvertently undermine the fund's stabilization power by assigning it additional functions.

37. The fund is only intended to address temporary shocks that are unrelated over time and are not consistently positive or negative, to avoid the risk of being a permanent transfer scheme from one country to another. The design of the fund should incorporate a framework to monitor the

[12] Since RSF assets are assumed to be invested at the world risk-free rate, the effective cost of funds is the difference between domestic and foreign interest rates.

[13] The annual probability of a shock hitting a country is 0.1 and resulting damages are 10 percent of GDP.

shocks and envision periodic and transparent re-assessments of the operating rules should there be a need to correct any perception of sustained subsidization.

Governance Framework

38. A strong governance framework is needed to mitigate the risks of moral hazard, especially given the fiscal stability challenges in the ECCU. The framework should entail the following elements.

- **Financing with fiscal resources** of the RSF's operations would be performed by all governments through national fiscal accounts. The RSF should envision no involvement of the ECCB in order to protect its reserve position and the integrity of its quasi currency board arrangement.

- **Transparency** should be fully implemented. The RSF's operations should be transparently recorded in fiscal accounts. Clear saving and investment rules should be applied to address risks of misappropriation and clarify sovereign ownership and each sovereign's net asset position vis-à-vis the RSF.

- **Country-level fiscal responsibility frameworks** underpinned by the regional debt target would be essential complements that ensure that member countries do not use the regional fund as a bail-out mechanism. Each country's medium-term fiscal frameworks should be subject to peer review. Compliance with the frameworks, underpinned by improved PFM procedures, should be a criterion for sanctions and for determining access to the fund. Conversely, adopting a regional fund could be supportive of fiscal sustainability because (i) it limits increase in recurrent spending in good times; (ii) it protects fiscal space for public investment which supports growth; (iii) insures a more cost-effective response to shocks, and (iv) it reduces public debt dispersion outcomes.

- **Triggers** for disbursement should be objective, transparent and automatic to help prevent disputes. In theory, the output gap would be the best candidate for a cyclically sensitive trigger. But, in reality the output gap is un-observable, and estimates are often revised dramatically, making it a poor candidate for a trigger that has to operate in real time. Significant natural disasters and/or large declines in GDP growth could therefore be alternative triggers.

- The fund should be managed by a **supranational agency** whose powers are granted by all countries' acts of parliament that has the authority to (i) objectively assess the damage from shocks and reporting standards; (ii) impose and enforce rules on resource allocations and compliance and penalties for noncompliance; and (iii) build capacity in key areas (asset-liability management). Fiscal and financial transparency would be a key guiding principle and the key (realistic) requirements would need to be worked out. Principles for effective decision-making mechanisms could also be considered (consensus voting versus qualified majority or reverse qualified majority voting).

Modality

39. The modality of the fund should reflect the political economic characteristics of the region.

- **Caps on transfers and contributions.** Given the political economy in the region, member countries' access to the fund may be capped by its accumulated savings for a set period of time, say, 10 years; contributions can be capped as well to avoid better-performing countries becoming net contributors for an extended period of time. Alternatively, inflows to the pooled fund could be governed by actuarial mechanisms that ensure that there is no sustained subsidization of countries for key types of shocks (e.g., CCRIF's probabilistic models of natural disasters could be used for determining actuarially neutral contributions and size of payouts).

- **A rainy-day fund with transfers.** The primary function of the fund—stabilizing macroeconomic shocks—can be assumed by the contribution-transfer arrangement of a typical rainy-day fund. The fund could initially set very prudent limits on transfers beyond each country's own contributions and gradually expand them in line with the progress in reinforcing institutional arrangements, including oversight and sanctions.

- **Voluntary lending options.** Each country could be allowed to lend voluntarily beyond the transfer caps, at mutually agreeable interest rates and maturities between borrowers and lenders. This could help scale up fund re-allocation within the region in the event of very large shocks and at the same time incentivize the use of windfall-like resources such as CBI inflows for dealing with the key shocks.

Sequencing and Timing

40. The implementation of the RSF should be carefully sequenced. At a first stage, countries could begin reallocating funds to the RSF but retain very prudent limits on transfers to other countries. This would allow them to test the key elements of the framework and assess its quantitative and institutional parameters, including exposure to risks and the fiscal oversight framework, without imperiling own resources. In parallel, the countries could be upgrading their national fiscal frameworks and making them more transparent. At a next stage, they could gradually relax the transfer limits as the institutional and sanctions mechanisms are set up and gain credibility. Finally, a topping up of transfers through voluntary lending could be considered. Given the complexity of the multi-stage operation and significant time needed for building regional and upgrading national institutions, the RSF could only be realistically implemented over the long term.

Costs and Challenges

41. An implementation of the RSF could involve various risks and challenges. At an early stage, the beginning of operations would require a strong insitutional framework underpinned by an ECCU-wide consensus. However, such a consensus may be slow to materialize due to asymmetries in

the positions of member states. In this case, any benefits from the RSF would be slow to materialize while the costs, in terms of administrative expenses and uncertainty, could be substantial.

42. Another set of risks would be related to the possible difficulties in enforcing the framework's rules among sovereign states. This could potentially include: (i) non-observance of the payment or re-payment commitments by member countries; (ii) inapproriate use of funds received (for example, their use for current spending instead of supporting public investment); (iii) disagreements about the size and nature of shocks; and (iv) potential legal challenges arising from the differences in the interpretation of the framework or gaps in the rules. Moreover, potential tensions over the operation of the RSF could spill over to other areas and affect broader ECCU collaboration. Finally, risk of moral hazard would be a substantial consideration and the framework's enforcement and sanctions mechanisms should be carefully designed to minimize those.

E. Conclusions

43. Regional fiscal policy coordination can usefully supplement national policies to improve the ECCU countries' responses to shocks. In the short term, a key priority would be to create fiscal space to both reduce public debt and build resilient infrastructure and insurance buffers for natural disasters. The analysis in this note shows there is scope for substantial potential of raising revenues already in the immediate future. In the longer term, as the targeted buffers grow in size, maintaining them exclusively at national levels would be increasingly costly, and regional pooling arrangements could be used to improve the cost and effectiveness characteristics of the associated policy interventions.

44. Regional coordination of tax incentives could help raise significant revenue without adversely affecting incentives to invest. Updated estimates of tax expenditures—which reflect extreme concessions that the countries grant as part of the regional "race to the bottom"—remain very large, even considering that only a portion of those amounts could realistically be recoverable. At the same time, empirical analysis does not detect a significant link between tax incentives and investment or other macroeconomic variables. Moreover, the current trend towards minimum global taxation is likely to further mute the impact of extreme tax incentives on attracting investment. In practice, such exemptions vary in effectiveness and often introduce sizable distortions favoring some sectors over others without a clear rationale. Accordingly, our analysis shows there is scope for tangibly improving tax incentives and rebalancing them toward those that are more effective, while using higher revenues to attract investment also through better infrastructure. Regional coordination could significantly support and accelerate those processes.

45. Similarly, coordination of CBI programs could raise additional public resources. The ECCU countries' already-initiated coordination on financial integrity issues should aim to dispel concerns relating to the tax rate on offshore income and residency period and other aspects of transparency standards to lower perceptions of abuse of CBI programs. A successful implementation of such coordination could support sustainability of these revenues as well as financial stability. In the longer term, there may be scope for coordinating more ambitiously on other CBI program parameters such as prices and quotas.

46. Over the long term, a regional saving-investment fund can be a useful tool for the ECCU economies to build resilience against key shocks. Compared to the self-insurance funds, a regional saving-investment fund can be more cost-effective, requiring only ½ of the resources compared to the sum of individual countries' funds for the same stabilization effect. The RSF would save resources during booms to contain pro-cyclical government consumption and invest the proceeds during recessions when public investment would typically be cut, it also leads to higher public investment, increasing growth. The RSF could also support the pooling of scarce institutional capacity in the region. However, it requires a strong supranational institutional framework. The tradeoff between achieving effective risk-sharing in the region and retaining fiscal autonomy implies that the regional fund should be a complement, not a substitute, to country-level resilience buffers.

47. The success of regional coordination of fiscal policy elements would require strong preconditions, at both national and regional levels, a solid governance framework, and careful sequencing. With respect to tax incentives and the CBI revenues, this would entail transparent accounting and judicious and efficient use of higher revenues primarily for building resilience. With respect to the RSF, strong governance pre-requisites would be particularly important and would realistically take significant time before the RSF could be fully operational. Countries' willingness to participate would likely depend on the fiscal sustainability prospects of other countries, as needed to ensure availability of funds in bad times from the contributions of other members. A strong governance framework would likely be necessary to assess fiscal sustainability, and a transparent methodology for the assessment of revenue and spending positions, possibly with support of independent institutions. It would also require an accounting mechanism for the net-credit appropriation of the pooled funds by each member, and decisions on specific access rules—i.e. whether members would be allowed to become net-debtors of the RSF. Regional initiatives establishing minimum common standards for the Medium-term Fiscal Frameworks and fiscal responsibility frameworks would be valuable supporting institutions at the national level.[14]

48. The above analysis has focused on assessing the economic potential of selected regional coordination initiatives without pre-judging the political realities. Implementation of some of these proposals would entail substantial political will on the part of sovereign countries, and it is likely that the process would be subject to debates, delays, or failures to reach consensus. And even with potential political agreements to move forward on some of the issues, further analysis or tailored technical assistance may be needed to refine institutional details in line with the evolving circumstances and preferences.

[14] Grenada has a fiscal rule entrenched in legislation; other ECCU countries have expressed commitment to adopt fiscal rules with signature of a Memorandum of understanding by all ministers of finance in their role as members of the Eastern Caribbean Central Bank Monetary Council.

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Appendix I. Estimating the Impact of Tax Incentives for the ECCU Countries

Data

1. The sample includes annual data from 1996 to 2018 for ten tourism-based Caribbean countries: the six independent ECCU countries, The Bahamas, Barbados, Dominican Republic and Jamaica. The macroeconomic indicators were collected from the World Bank and the IMF's World Economic Outlook (WEO) and other internal databases. The source of the data on natural disasters is The Emergency Events Database (EM-DAT) (see Table 3 for details). The main variables of interest are the CIT rate as well as other tax incentive measures. We also construct a tax competition index to measure the number of tax incentive changes on an annual basis (1 for the loosening of a tax incentive measure). In order to capture the overall impact of different tax incentives, we also include the estimated foregone revenue.

2. Our control variables include a set of domestic and external indicators. Public consumption, defined as the sum of compensation to employees and purchases of goods and services, serves as a proxy for the underlying fiscal position. The Real Effective Exchange Rate (REER) and real US PPP GDP indicate the potential role of competitiveness and push factors, respectively. Moreover, we also include the number of airlifts and the stock of infrastructure as potential factors indicating the attractiveness of the country for foreign investors. Finally, we include a dummy variable for the occurrence of natural disasters.

Methodology

3. We follow the specification in Klemm and Van Parys (2009). Specifically, we estimate the following dynamic panel model:

$$FDI_{it} = \delta FDI_{it-1} + Tax_{it}\gamma + X_{it}\beta + \mu_t + \varepsilon_{it}$$

where FDI_{it} is the dependent variable, Tax_{it} is a vector of the tax variables described in Table 1; X_{it} is a vector of control variables; μ_t are country fixed effects; and ε_{it} is independently and identically distributed error term. Subscripts i and t indicate the country and time period, respectively. The same specification is used to estimate the effect of tax incentives on the number of hotel rooms instead of FDI. Furthermore, to ensure a normal distribution of the data, FDI, the number of hotel rooms, infrastructure and U.S. PPP GDP underwent natural logarithmic transformation, whereas government consumption is expressed as percent of GDP.

4. The model specified above uses one-way fixed effect estimator to limit selection bias. The individual country fixed effect accounts for country heterogeneity, including factors such as the country's business environment. To avoid overfitting the regressions, we do not apply the time fixed effect. Instead, we include potential time-varying common factors, such as the occurrence of natural disasters, among the control variables. The model is estimated using country Fixed Effect (FE) and

System Generalized Methods of Moments IV (IV-GMM). We begin by estimating a dynamic FE panel model and then use System IV-GMM estimation techniques to address potential endogeneity concerns. Nevertheless, the small sample size makes FE estimations preferable and more reliable, therefore the discussion in the following section focuses on the FE estimation results while reporting the GMM results indicatively.

Results

5. While the CIT rate is expected to be negatively related to FDI, tax incentives should support FDI in theory. To the extent public consumption provides an indication about the underlying fiscal position, we expect it to be negatively associated with FDI, i.e. an increase in public consumption is ceteris paribus interpreted as a deterioration in the fiscal outlook by foreign investors. In line with the literature, REER is expected to be negatively associated with FDI as real appreciation indicates a loss in competitiveness. At the same time, an increase in real US PPP GDP would stimulate foreign investment in the region. Similarly, improved attractiveness of the region, indicated by better air access (higher number of flights) and a higher stock of infrastructure, would lead to an increase in FDI. Finally, the interaction of infrastructure and the natural disaster dummy is expected to have a positive relationship with FDI.

6. Table 1, in the main text, shows the effect of a change in CIT rates and tax incentives on overall FDI. Columns 1–5 show the baseline FE regression results, with each column using a different tax incentive indicator while the CIT rate is included in each specification. Column 5 indicates the IV-GMM results. Neither the CIT rate nor tax incentives are significant either statistically or economically, suggesting that they do not have material impact on attracting FDI.

7. In terms of other control variables, public consumption is statistically significant and negatively associated with FDI across all specifications. As explained above, to the extent an increase in public consumption leads to a worsening of the fiscal balance, this could negatively affect foreign investors' perception of risk and thus their investment decisions. While REER does not seem to be a significant driver of FDI, the coefficients of the number of flights and U.S. PPP GDP are positive and statistically significant. Infrastructure is significant only when interacted with the natural disaster dummy. The positive coefficient, however, indicates that raising revenue to finance infrastructure investment might be a more efficient way to attract FDI than granting tax incentives.

8. We then estimate the model using the number of hotel rooms as a proxy for FDI, given the fact that investments in the tourism-based Caribbean countries are concentrated in the tourism sector (Appendix Table 1). In contrast with the baseline results, there are mixed results regarding the role of tax incentives. For example, the CIT rate is negatively associated with the number of hotel rooms (and statistically significant when controlling for investment allowance rate), suggesting that lower taxes may have some positive impact on investment in the tourism sector. In a pooled OLS regression, we also found that an increase in the foregone revenue by 1 million EC dollars is associated with an increase in the number of hotel rooms by 0.2 percent for the ECCU countries (Appendix Table 2). Finally, we also find that tax incentive measures do not seem to have an impact

on overall FDI, GDP growth, or employment for the tourism dependent Caribbean economies (Appendix Table 3 and 4).

Appendix I. Table 1. ECCU: The Effect of Tax Incentives on the Number of Hotel Rooms (Panel Regression)

Dependent Variable: The Number of Hotel Rooms						
Estimation Method Specifications			Fixed Effect Panel			GMM
Tax policy variables						
CIT rate (lag)	-0.006	-0.006	-0.013**	-0.006	-0.009	0.006
Tax holiday (lag)		-0.004				-0.074***
Investment allowance rate (lag)			-0.003*			-0.002
Tax competition index (lag)				0.027		
Foregone revenue (lag)					0.000	0.001**
Other control variables						
Public consumption	0.006	0.004	0.018*	0.006	0.010	-0.072***
REER	0	0	-0.002	0	0.001	-0.001
US PPPGDP	0.129**	0.129**	0.197***	0.131**	0.258***	0.387**
Number of flights (lag)	0.003	0.003	-0.005	0.003	-0.011	-0.070
Infra. stock (lag 2)	0.113***	0.116***	0.110**	0.110***	0.073	-0.214*
Infra. stock (lag 2) interacted w/ natural disaster dummy	-0.012	-0.012	-0.027*	-0.013	-0.017	0.000
Constant	6.733***	6.813***	6.542***	6.695***	5.693***	4.015
Observations	135	135	101	135	93	80
Number of countries	10	10	10	10	10	10
R-squared	0.54	0.317	0.319	0.468	0.327	

Source: IMF staff calculations.
Note: the tax complettion index measuires the number of tax incentive changes withina year.

Appendix I. Table 2. ECCU: The Effect of Tax Incentives on the Number of Hotel Rooms (OLS Regression)

	Dependent Variable: The Number of Hotel Rooms				
	Estimation Method Specification		OLS		
Tax policy variables					
	CIT rate (lag)	-0.017***	0.000	0.027***	0.001	0.031**
	Tax holiday (lag)		0.007			
	Investment allowance rate (lag)			0.002		
	Tax competition index (lag)				0.170**	
	Foregone revenue (lag)					0.002***
Other control variables						
	Public consumption	-0.064***	-0.124***	-0.173***	-0.124***	-0.134***
	REER	0.001	0.008	0.01	0.011*	0.015
	US PPPGDP	-0.181*	-0.062	-0.065	-0.049	0.276
	Number of flights (lag)	0.033***	0.041***	0.050***	0.041***	0.085***
	Infra. stock (lag 2)	0.275***	0.189***	0.115***	0.181***	-0.16
	Infra. stock (lag 2) interacted w/ natural disaster dummy	-0.02	-0.041	0.074	-0.046	0.016
	Constant	8.068***	7.599***	7.831***	7.359***	6.510***
	Observations	135	135	101	135	93
	Number of countries	10	10	10	10	6
	R-squared	0.882	0.894	0.843	0.899	0.639

Source: IMF staff calculations.
Note: the tax complettion index measuires the number of tax incentive changes withina year.

Appendix I. Table 3. ECCU: The Effect of Tax Incentives on Growth

	Dependent Variable: Overall GDP				
	Estimation Method	Fixed Effect Panel			
Tax policy	CIT rate	0.005***	0.004***	0.003**	0.004**
	Tax holiday		-0.001		
	Investment allowance rate			0.000	
	Foregone revenue				0.000
Other control variables	Public consumption	-0.014***	-0.015***	-0.010***	-0.009**
	REER	0.000	0.000	0.000	-0.002**
	US PPPGDP	0.067***	0.067***	0.116***	0.108***
	Number of flights (lag)	-0.001	-0.001	-0.002	-0.001
	Infra. stock (lag)	0.022*	0.019	0.009	0.026
	Infra. stock (lag) interacted w/ natural disaster dummy	0.003	0.003	0.004	0.007**
	Constant	1.135***	1.103***	1.708***	1.956***
	Observations	160	157	115	96
	Number of countries	11	11	11	6
	R-squared	0.935	0.935	0.921	0.911

Source: IMF staff calculations.

Appendix I. Table 4. ECCU: The Effect of Tax Incentives on Employment

	Dependent Variable: Total Employment			
	Estimation Method	Fixed Effect Panel		
Tax policy	CIT rate	0.004***	0.005***	0.003*	0.005**
	Tax holiday		0.002		
	Investment allowance rate			0.000	
	Foregone revenue				0.000
Other control variables	Public consumption	-0.007**	-0.006*	-0.004	-0.005
	REER	0.000	0.000	-0.001	-0.001
	US PPPGDP	0.074***	0.080***	0.095***	0.104**
	Number of flights (lag)	0.000	0.000	-0.001	-0.004
	Infra. stock (lag)	0.026*	0.023	0.040*	0.018
	Infra. stock (lag) interacted w/ natural disaster dummy	-0.001	-0.001	0.000	0.001
	Constant	2.841***	2.862***	3.844***	2.947***
	Observations	150	147	105	86
	Number of countries	11	11	11	6
	R-squared	0.82	0.83	0.76	0.79

Source: IMF staff calculations.

Appendix II. Calculation of Country and Regional Stabilization Funds

1. The first step is to estimate an empirical model for each country to capture the joint cyclical variations of output and government revenue and expenditure. To this end, an unrestricted Vector Auto-regression Model (VAR) is estimated for each country.

$$X_t = \gamma_0 + \sum_{k=1}^{p} \gamma_k X_{t-k} + \epsilon_t$$

where X_t is a vector of endogenous variables including the cyclical components of GDP; tax revenue; non-tax revenue; current primary expenditures; and capital expenditures; *p-1* is the number of distributed lags, for data sample spanning 1990–2018. The endogenous variables are expressed as a share of each indicators' trend,[1]

$$\hat{x}_{it} = x_{it}/x_{it}^{trend}; \hat{x}_{it} \in X_t.$$

$\epsilon_t \sim N(0, \Omega)$ is the vector of residuals, with variance-covariance matrix Ω characterizing the joint statistical properties of the contemporaneous disturbances of the endogenous variables, and γ_k is the vector of coefficients.

2. The second step is to run a Monte-Carlo experiment. This involves generating a large number of simulations using the estimated model above. The simulations use a sequence of random vectors $\hat{\epsilon}_{t+1}, \dots, \hat{\epsilon}_T$ such that $\forall\, \tau \in [t+1, T], \epsilon_\tau = W v_\tau$, where $v_\tau \sim N(0,1)$, and W is such that $\Omega = W'W$ where W is the Choleski factorization of Ω. The estimated VAR is then used to generate 1000 forecasts X_τ for each country with the randomly-generated shocks $\epsilon_\tau, \tau = t+1, \dots, T$.[2] The simulations consist of vector sequences of the five endogenous variables in the model, each affected by simulated random shocks of statistical distribution as estimated sequences of vector residuals. In this way, the simulations mimic historical volatility, persistence, and co-movement in the sample data. The results are then used to compute probability density functions for each of the five endogenous variables in each year projected, for the period 2019-2030.

3. The simulations in deviations from trend are then transformed as a percent of GDP. To that end, a deterministic trend is projected for each variable, assuming each and all trends grow at the same constant rate starting from the end point of the estimated trend in the sample period, that is

$$x_{it+l} = \hat{x}_{it+l} x_{it+l}^{trend} \quad \text{with} \quad x_{it+l}^{trend} = x_{it}(1+g)^{l-t}; l = 0, \dots, T;$$

[1] The cyclical components of GDP are estimated using the Hodrick-Prescott filter on 1990–2018 annual data. All variables expressed in real terms using the GDP deflator.

[2] Notice that the results are not sensitive to the ordering of the variables in the VAR, as the stochastic simulation results are shaped per the variance-covariance matrix of reduced-form errors Ω, which is unique.

where g is the potential growth rate assumption. After all endogenous variables are expressed in real-term levels, they can be calculated percent of GDP by dividing each of the fiscal indicator projections by the GDP projection in each of the vector simulations. In order to ensure revenue and expenditure indicators as a percent of GDP are consistent with the data, the starting points of the trend projections are set at constant prices of the last year of the sample, 2018.[3]

4. The third step is to specify the saving and investment flows vis-à-vis the SF. Savings S_t in year *t* are assumed to take the form of a share of current primary expenditures *above* trend, that is $S_t = \sigma\,[G_t - G_t^{trend}]$ if $G_t - G_t^{trend} > 0$, $S_t = 0$ otherwise, where G_t is current primary expenditure computed in the simulations. Specified in this way, governments are assumed to reduce the extent of pro-cyclical public consumption (expenditure booms are positivelly correlated with output and revenue booms in the data and thus in the simulations). Public investment I_t in year *t* is assumed to take the form of a share of government investment *below* trend, that is $I_t = \varphi\,[X_t - X_t^{trend}]$ if $X_t - X_t^{trend} < 0$, $I_t = 0$ otherwise, where X_t is government investment budget execution. Saving in the stabilization fund is therefore used to finance public investment above the level that would have been predicted in the simulation. This results in stabilization of government consumption and smoothing of public investment, and also in an increase in public investment over-the-cycle. The stabilization fund stock, denoted SF_t, evolves according to $SF_{t+1} = (1 + i_t)\,SF_t + (S_t - I_t)$, where i_t is the interest rate on savings from year *t* to *t+1*.[4]

5. The fourth step is to compute public debt dynamics in each random simulation with the debt accumulation identity

$$D_{t+l+1} = (1 + i_{t+l+1})D_{t+l} - PB_{t+l} + (S_t - I_t);\;\; D_{t+l} > 0;\;\; l = 0, \dots, T\,;$$

where D_{t+l+l} is the stock of public debt in year *t+l+1*, and PB_t is the primary balance in the revenue and primary expenditure simulations. The implicit interest rate i_t is calculated as the ratio of interest expenditures in year *t* divided by public debt stock in *t-1*. Notice this results in stochastic debt simulations that take into account saving and investment flows vis-à-vis the SF.

6. The solution is obtained by finding the SF expected withdrawal for investment equal to the saving flows to ensure the sustainability of the SF. This is done by solving for the share of government ivestment $\varphi \in [0,1]$ that meets the transversality condition $E_t[SF_{T+N}/\,Y_{T+N}] = SF_T/\,Y_T$, where E_t is the expectations operator, *Y* is GDP, *T* is the last year of the sample data, and *N* is the number of years for which the SF is to remain with positive saving. The transversality condition requires the SF to remain stable in expected terms, thereby ensuring the SF sustainability without inefficient perpetual acummulation of resources (φ is set "low" resulting in more public investment can be afforded with availavle resources in the SF), or a declining trajectory in expected (φ is set "high" with too much public investment that end up depleting the SF). Also, *N* needs to be set large

[3] It is therefore implicitly assumed that the deflators of GDP and the remaining fiscal variables change at the same rate in the projections.

[4] The simulations assume that is the SF is depleted, investment financing flows to the budget are constrained by the amount of remaining resources in the SF.

enough to cover complete boom-bust cycles in the simulations. The solution for φ is pinned down by setting a SF probability of depletion π at a terminal time horizon *T+N*. (σ, π, N) are therefore parametric government choices that governments would set according to risk aversion preferences, as measured in terms of the probability of SF depletion.

7. The size of the RSF is calculated following the procedure above with aggregated output, revenue and expenditure data of all countries. By construction, aggregation results in revenue and expenditure cycles that are lower than the sum of the individual countries' cycles—equality would require perfect correlation of cyclical deviations accrosss countries, an unlikelly possibility. This means the aggregated simulation will yield a RSF that is necessarilly smaller that the sum of individual countries' SFs. Notice that the RSF would suffice to allow each country to benefit from the same saving-investment flows than having individual SFs by virtue of implicit cross-country financing flows.

8. The simulation framework also allows specification of structural fiscal consolidation, important to govern the expected trajectory of public debt. To this end, the projected trends used in the simulations of revenue and expenditures can be shifted up or down at any siulated year to internalize permanent fiscal policy innovations. In this way, public debt simulations can be calibrated to ensure fiscal sustainability. This is important to provide incentives for participation—countries are unlikelly to be willing to participate in a regional SF with pooled resources if other members confront fiscal sustainability challenges which can compromise their ability to contribute their share of savings.

Appendix III. Details on the Dynamic General Equilibrium Model

1. Model description. The general model is a real, dynamic, general equilibrium model representing a region with N countries and limited factor mobility. Each country $i \in \{1, \dots, N\}$ is modeled as a small open economy that takes as given the world interest rate (R_t^*). Households supply labor domestically and decide over consumption ($C_{i,t}$), investment into domestic private capital ($I_{i,t}$), and savings into domestic bonds ($B_{i,t}$) and international bonds ($B_{i,t}^{h*}$), with the corresponding interest rates denoted as R_t and R_t^{h*}, respectively. Household preferences may be either separable or non-separable over consumption and labor, with η denoting the labor supply elasticity. Firms produce output with a constant returns technology into which country-specific public capital $Z_{i,t-1}$ enters as an externality (similar to productivity):

$$Y_{i,} = Z_{i,t-1}^{\psi} K_{i,t-1}^{\alpha_i} L_{i,t}^{1-\alpha_i}$$

There is trade in final goods between each country and world markets, but not within the region. Specifically, some of country i's output (denoted as $\mathcal{X}_{i,t}$) is exported to world markets while domestic consumption and investment (both private and public) are assumed to be Leontief composites with a share ϕ_i of imported world output. Portfolio adjustment costs are introduced to pin down the household's asset allocation outside of steady state. Also, there are adjustment costs to the flow of private investment to allow for smooth dynamics of the capital stock.

2. Government. The government in each country collects taxes on consumption and capital returns. Total spending is the sum of interest expenses, public investment ($X_{i,t}$), and current primary spending, which comprises purchases of goods and services (or government consumption) $G_{i,t}$, transfers ($T_{i,t}$), and the government wage bill. The overall fiscal deficit—which takes into account payouts from the regional stabilization fund as well as net recapitalization payments to the fund—is financed via issuance of either domestic debt ($B_{i,t}$) or foreign debt ($B_{i,t}^{g*}$), with the interest rate on foreign debt denoted as R_t^{g*}.

3. Regional Stabilization Fund (RSF). With regional markets for output, capital, and labor closed the RSF is the only link between countries in the region (and the only available tool for consumption risk-sharing). If hit by a natural disaster, the affected country receives a transfer $SavOut_{i,t}$ from the fund to rebuild a share κ of the destroyed public capital. The net recapitalization payments $SavIn_{i,t}$ reflect the necessary payments to replenish the fund net of interest revenue of the fund,

$$SavIn_{i,t} = (1 - \rho_{Sav}) w_{i,t} \left(\overline{Sav} - R_{t-1}^* Sav_{t-1} \right) + \rho_{Sav} \overline{SavIn_i}$$

where ρ_{Sav} regulates the speed of recapitalization, $w_{i,t}$ are weights determining the countries' shares for recapitalization, and idle funds of the RSF are assumed to be invested at the international risk-free rate. Notice that if the fund was fully capitalized in the previous period, $Sav_{t-1} = \overline{Sav}$, governments would receive a payment from the RSF ($SavIn_{i,t} < 0$). The law of motion for the RSF balance then writes as follows:

$$Sav_t = R^*_{t-1} Sav_{t-1} + \sum_{i=1}^{N} \left(SavIn_{i,t} - SavOut_{i,t}\right).$$

4. Resource constraint and equilibrium. Combining the household budget constraint with the government budget constraint yields the country i's resource constraint. Note that payouts from the RSF do not have a net impact on the resource constraint since public investment increases by the same amount.

$$Y_{i,t} + P^{\mathcal{M}}_{i,t}\mathcal{M}_{i,t} + \sum_{m=g,h} B^{m*}_{i,t} + SavOut_{i,t} = C_{i,t} + I_{i,t} + X_{i,t} + G_{i,t} + P^{\mathcal{X}}_{i,t}\mathcal{X}_{i,t} + \sum_{m=g,h} R^{m*}_{t-1} B^{m*}_{i,t-1} + SavIn_{i,t},$$

where total imports $\mathcal{M}_{i,t}$ are the sum of imported inputs for consumption and investment of both the private and public sector, $\mathcal{M}_{i,t} = \phi_i\left(C_{i,t} + I_{i,t} + G_{i,t} + X_{i,t}\right)$, and $P^{\mathcal{M}}_{i,t}$ and $P^{\mathcal{X}}_{i,t}$ denote the prices of imports and exports, respectively. Given the exogenous process for the world interest rate, etc., the equilibrium is defined as sequences of prices and quantities such that the optimality conditions of household and firms are satisfied and markets for output, capital, bonds, and labor clear.

5. Calibration. The model is calibrated at annual frequency with the world risk free rate $\overline{R}^*$ set to 2 percent. Depreciation rates for private and public capital are set to 0.081 and 0.035, respectively (see IMF (2015)). The elasticity of output with respect to public capital, ψ, is set to 0.05, which is at the lower end of the elasticities used in IMF (2017).[1] Table 1 lists the steady state targets for the calibration, computed as sample averages over 2014 to 2018. Interest rates on domestic and foreign debt are implicit interest rates inferred from fiscal accounts. Public sector employment is inferred from fiscal account data on wages and salaries assuming that public sector wages are set 15 percent above the private sector. External debt of households ($\overline{B}^{h*}_i$) is assumed to be zero in steady state. Note that by no arbitrage the steady state interest rate on external households' debt ($\overline{R}^{h*}_t$) is equal to the interest rate on domestic bonds ($\overline{R}_t$). The tax on capital returns is set to 20 percent and the consumption tax is used to balance the government's budget constraint, resulting in implicit tax rates ranging between 9 and 21 percent (averaging 14 percent across ECCU countries). The size of the RSF is set to 5 percent of ECCU GDP, with recapitalization parameter ρ_{Sav} set to 0.5, and replacement parameter κ set to 0.5.

6. Impact of greater public investment. To quantify the impact of expenditure reshuffling on output (and other variables) the equations characterizing the steady state equilibrium are differentiated to derive elasticities of output with respect to public capital, $\frac{dY}{\overline{Y}} / \frac{dZ}{\overline{Z}}$. Elasticities are derived for the case of separable period utility,

$$U\left(C_{i,t}, L_{i,t}\right) = \log C_{i,t} - \chi_i L^{1+\eta^{-1}}_{i,t}(1+\eta^{-1})^{-1},$$

[1] Given that ψ is a key determinant for the elasticity of output with respect to public capital and considering that it is hard to pin down empirically, a conservative choice for this parameter seems prudent. Buffie et al. (2012) and Marto et al. (2017) assume a value for the return on public capital to back out ψ, arriving at values of 0.17 and 0.031, respectively. However, with the return on public capital itself being unobserved in practice, there is considerable uncertainty around these numbers.

and non-separable utility (with no wealth effects on labor supply),

$$U(C_{i,t}, L_{i,t}) = \log(C_{i,t} - \chi_i L_{i,t}^{1+\eta^{-1}}(1+\eta^{-1})^{-1}).$$

Elasticities primarily depend on the degree of crowding-in of private capital (determined by the shift of the capital demand schedule via capital share α_i and the elasticity parameter ψ) and the impact of a shift of labor demand on equilibrium employment (as determined by the slope of labor supply via parameter η). The type of adjustment in current spending can also have substantial impact on the shift of the labor supply schedule via wealth effects and reallocation effects. For example, reductions in purchases of goods and services enter the economy's resource constraint (unlike government transfers) and with greater availability of resources for domestic final use the labor supply schedule shifts leftward (under separable preferences). Also, a reduction of the government wage bill, if implemented via a reduction the number of public sector employees, leads effective labor supply to the private sector to shift rightwards (reallocation of workers from the public to the private sector).

7. Opportunity costs. To obtain an expression for the opportunity costs of a stabilization fund, expressed in terms of steady state consumption, the equations characterizing the steady state equilibrium are again differentiated. It is assumed that a fund of 5 percent of GDP is capitalized through issuance of domestic government debt and associated interest costs are financed by raising one of the two tax instruments (or a combination thereof). If the tax on capital returns is raised the capital demand schedule shifts to the left, leading to a decline in equilibrium private investment, output, and consumption. Opportunity costs are derived assuming fixed labor supply ($\eta = 0$), such that wealth effects on labor supply play no role. As such, the change in the consumption tax does not have any impact on equilibrium output. For the exercise in the main text, it is assumed that half of the debt-servicing cost for the fund is raised through the distortionary tax on capital returns.

8. Stabilization benefits. While the impact of greater public investment and opportunity costs are evaluated country-by-country in steady state, quantifying the benefits from macroeconomic stabilization requires simulating the full multi-country model. Natural disaster shocks are used to illustrate the stabilization benefits as these shocks are most relevant to countries in the region and also support from RSF can be conditioned on an event that is easily observable. Assuming that natural disaster shocks are uncorrelated across countries the model with RSF is simulated over a long horizon and average consumption for each country is recorded. The model is then rerun without any RSF disbursements following natural disasters, i.e., $\kappa = 0$, and stabilization benefits for each country are defined as the percentage difference in consumption levels.

Appendix III. Table 1. ECCU: Empirical targets for calibration

	Antigua	Dominica	Grenada	St. Kitts	St. Lucia	St. Vincent	ECCU 4/
				(in percent of ECCU GDP)			
Output	22.1	8.4	16.4	14.0	27.0	12.1	100.0
				(in percent)			
Interest rates							
Domestic government 1/	6.0	4.7	4.5	4.5	6.6	5.7	5.3
External government	3.0	2.4	3.5	1.9	4.5	2.4	3.0
				(in percent of GDP)			
Debt							
Domestic government	42.3	12.6	24.5	34.2	31.5	26.0	28.4
External government	30.6	46.2	54.1	21.8	31.4	38.7	37.1
Fiscal accounts							
Public investment 2/	5.3	7.0	5.4	5.8	3.8	4.6	5.3
Goods and services	3.8	8.9	3.6	6.8	4.0	3.5	5.0
Transfers	7.5	7.1	4.2	5.9	6.0	7.0	6.3
Wage bill	8.8	10.9	8.4	11.7	8.1	12.5	10.1
Trade							
Exports	56.2	37.8	35.7	41.0	47.2	34.3	42.0
Imports	63.9	55.5	53.0	42.1	54.5	54.9	54.0
Private investment 3/	20.0	17.5	20.0	22.5	17.5	20.0	19.6

Source: IMF staff calculations based on data from country authorities.
1/ Adjustments for Antigua, Grenada, and St. Kitts.
2/ Adjustments for Antigua and Dominica.
3/ Estimates based on FDI data and measures of the private capital stock.
4/ Average across ECCU countries.

A CENTRAL BANK DIGITAL CURRENCY IN THE ECCU[1]

A. Introduction

1. The Eastern Caribbean Central Bank (ECCB) is actively exploring the possibility of issuing the digital version of the EC dollar (DXCD).[2] On March 12, 2019, the ECCB announced that it would pilot a central bank digital currency, using a distributed ledger technology (DLT) in the Eastern Caribbean Currency Union (ECCU).[3] The ECCB conducts this pilot project in partnership with a Barbados-based fintech company, Bitt Inc. The pilot consists of two phases: (i) development and testing (March 2019-February 2020); and (ii) rollout and implementation in Antigua and Barbuda, Grenada, Saint Lucia, and St. Kitts and Nevis (April-September 2020).

2. The ECCB hopes that new technologies will help overcome long-standing challenges. Costs of cash services (e.g., transportation, storage, and security) are high, and so are credit or debit card fees, putting constraints on economic growth potential. The ECCB has tried to improve the efficiency of their payment systems, but progress has been slower than expected. Lack of economies of scale (small population size and limited growth opportunities) has, in part, discouraged private banks from investing in payment systems. Against this backdrop, the ECCB hopes that the new DLT-based digital currency would provide a solution. In particular, the ECCB expects that the adoption of digital currency would reduce demand for cash (by half over time) and improve the efficiency of the retail payment system. See Box 1 for motivations for considering a central bank digital currency in other economies.

3. This chapter discusses challenges in modernizing payment systems in the ECCU and explores different aspects of introducing a central bank digital currency in the ECCU. Section II summarizes the key characteristics of the retail payment system in the ECCU. Section III discusses key challenges for issuing central bank digital currency and how the ECCB is tacking these issues in the design of its digital currency, and Section IV concludes.

[1] Prepared by Kotaro Ishi, Haobin Wang, and Wayne Mitchell (all WHD), and Majid Malaika (ITD).

[2] A central bank digital currency is defined as a widely accessible digital form of fiat money that could be used as legal tender. Like cash, it is a central bank liability, denominated in the same unit of account as the legal tender, and is part of the monetary base.

[3] In the same month, the Central Bank of The Bahamas also announced that it selected a blockchain startup to design and implement a digital currency pilot project, "Project Sand Dollar," for The Bahamas. The People's Bank of China is also reportedly researching and testing its digital yuan.

B. Retail Payment System Landscape in the ECCU

Extensive Use of Cash and Checks, and Underutilized Electronic Payments

4. Cash and checks are the most commonly used means of payments in the ECCU.[4] The average amount of cash holding per capita is about US$900 in the ECCU, compared to US$200-US$450 in other regions (Figure 1 top left). Among ECCU economies, there are also wide differences with about US$400 in St. Vincent and the Grenadines (the lowest) and US$1,800 in Montserrat (the highest, Figure 1, top right). In addition, the World Bank's Global Payment Systems Survey suggests the extensive use of checks: the value of checks in the ECCU totaled over 160 percent of GDP, much higher than any other regions on average (Figure 1, middle left).

Box 1. Motivation for Considering a Central Bank Digital Currency around the World[1]

Globally, there is no universal case for adopting a central bank digital currency. Although many central banks are actively studying central bank digital currencies, most central banks are proceeding with caution (BIS, 2019). The case for a central bank digital currency is viewed even weaker in countries that already offer 24/7 fast payments services, including cheap and immediate settlement of funds. In such cases, mobile (and online) payment operators could compete with a central bank digital currency on convenience and speed of payment settlement. In fact, many central banks are not seeing the value of issuing a central bank digital currency (Carstens, 2019).

Nonetheless, some central banks are considering the issuance of a central bank digital currency for a variety of reasons. Especially, it appears that the announcement of Libra has surged interests on central bank digital currency in the world. In some advanced economies, the falling use of cash is motivating the study of a central bank digital currency as an alternative, robust, and convenient payment method (e.g., Sweden), as well as the potential to have negative interest rates. A central bank digital currency could also facilitate contestability of the payment market and reduce the chances of a few large providers dominating the market. In emerging and developing economies, the focus is more on improving operational and cost efficiency. In some economies with underdeveloped financial systems and many unbanked citizens, a central bank digital currency is seen as a means to improve financial inclusion and support digitalization. Other reasons for considering central bank digital currency include enhancing financial integrity (as non-anonymous central bank digital currency could enhance the monitoring of transactions).

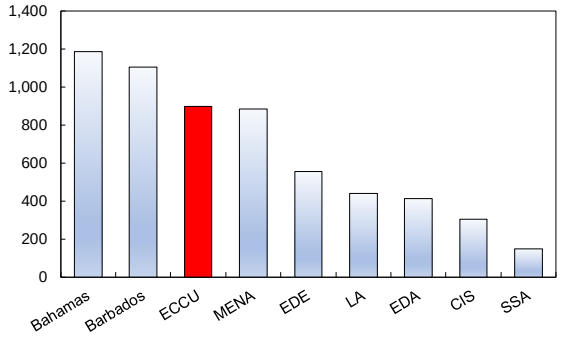
[1] This box draws mainly from "IMF Policy Paper: Fintech The Experience So Far," June 28, 2019, International Monetary Fund.

[4] Cash is held not only as a means of payment but also as a store of value. Given the anonymity of cash transactions, it is difficult to estimate the use of cash solely as a means of payment. The amount of cash withdrawals at ATMs can be used as a proxy. Such data, however, are not publicly available for most of the sample economies.

Figure 1. Cash, Checks, Cards, and Transfers

Cash in Circulation Per Capita, 2016-18 Average

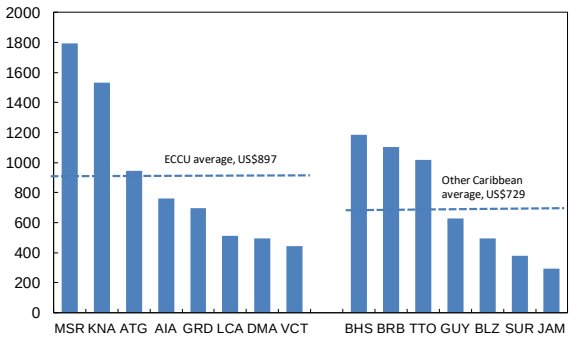
(In US dollar, regional average)



Source: IMF International Financial Statistics and WEO database.

Caribbean: Cash in Circulation per Capita

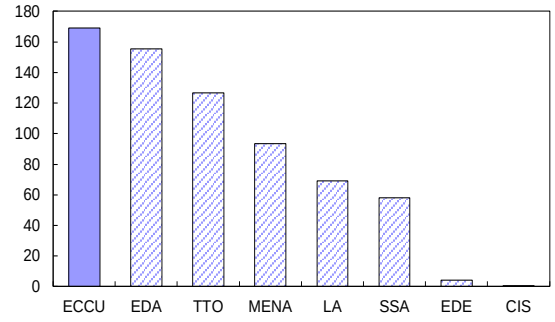
(In US dollar)



Source: IMF International Financial Statistics and WEO database.

Use of Checks in Value, 2015

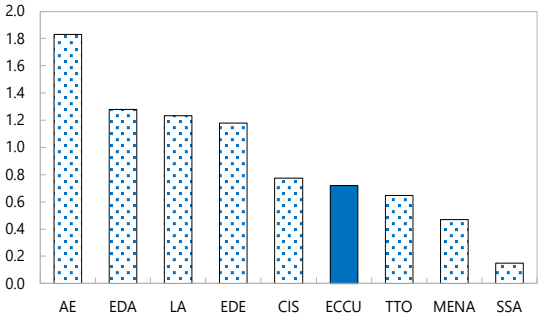
(Percent of GDP)



Source: WB Global Payment Systems Survey, 2015
Note. Other Caribbean (OC) includes Dominican Rep. and Trinidad and Tobago.

Number of Credit and Debit Cards Per Person, 2015

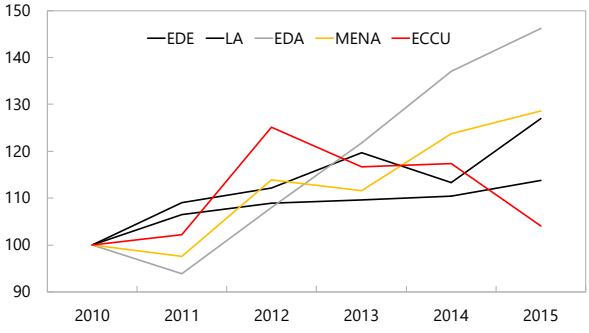
(Per person; regional average)



Source: WB Global Payment Systems Survey, 2015
Note. Other Caribbean (OC) include Dominican .Rep. and Trinidad and Tobago.

Number of Credit and Debit Cards Per Person

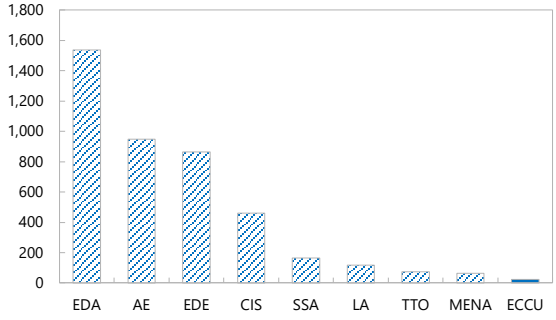
(Per person; regional average; 2010=100)



Source: World Bank Global Payment Systems Survey

Bank Credit Transfer in Value, 2015

(Percent of GDP)



Source: WB Global Payment Systems Survey, 2015
Note. Other Caribbean (OC) includes Dominican Rep. and Trinidad and Tobago.

5. Cash is expensive to issue and handle. For the ECCB, the costs include the importation, transportation, and distribution of cash, including insurance and security related expenses. Geographical fragmentation in the ECCU poses logistical challenges in distributing cash (the ECCU consists of eight economies, and some of them consist of multiple inhabited islands). The ECCB spent EC$8.4 million in 2018 on cash services,[5] equivalent to US$ 4.9 per capita or about 12 percent of its net interest income. Although comparing cash service costs across central banks is difficult as each central bank has different schemes of producing and distributing cash, the costs of cash appear to be much higher in the ECCB and Central Bank of The Bahamas than other central banks. Similarly, the private sector (including financial institutions, businesses, and households) also bear both monetary and non-monetary costs.[6]

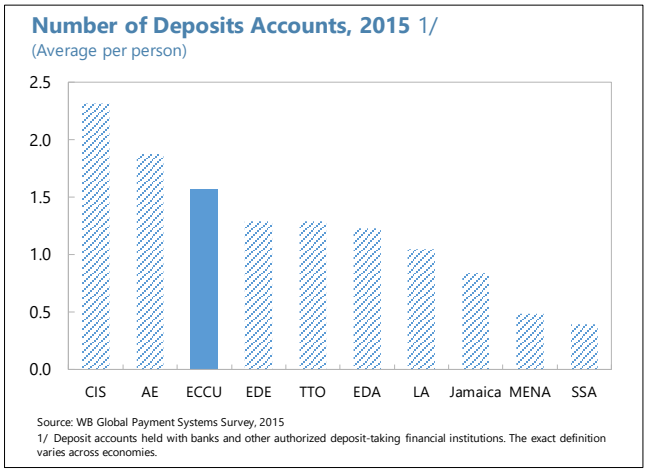
Selected Central Banks: Annual Expenses Related to Banknotes 1/

		Local currency in million	Percent of GDP	Per capita in US dollar	Percent of net interest income	Memo: Population in million
Eastern Caribbean Central Bank	Mar. 2019	8.4	0.042	4.9	11.9	0.6
The Central Bank of The Bahamas	Dec. 2018	1.8	0.014	4.8	4.4	0.4
Bank of Canada	Dec. 2018	53.4	0.002	1.1	3.2	37.0
Central Bank of Chile	Dec. 2018	17,394	0.009	1.3	4.5	18.5
Bank of Israel	Dec. 2018	81.4	0.006	2.4	1.3	8.9

Sources: for ECCB, 2019 Annual Report; for CBB, Bank of Canada, and Central Bank of Chile, 2018 Annual Report for respective central banks; and for Bank of Israel, "Report of the Team to Examine the Issue of Central Bank Digital Currencies, Bank of Israel, November 2018.

1/ The expense includes the cost of printing, storing, and distributing banknotes (mostly recurrent). The exact definition, however, varies across central banks.

6. In contrast, the use of electronic payments remains low. This is somewhat puzzling given that access to deposit accounts is reasonably high with each person holding more than 1.5 accounts on average (text chart). The World Bank's Global Payment Systems Survey suggests that the number of credit and debit cards per person is less than 0.8 in the ECCU, much lower than other regions at a similar development level (Figure 1, middle right). In fact, growth in the number of credit and debit cards in the ECCU was stagnant during 2010–15 (the latest available data), whereas in the other regions, cardholders increased steadily (Figure 1, bottom left). Credit transfers through the banking system are a safe and convenient method to transfer money, but usage is quite low in the ECCU region Figure 1, bottom right).



7. The relatively high cost of electronic payments, as well as the lack of a wide range of mobile payment services, partly explains the low usage of electronic payments. First, credit card transactions are typically charged at a rate of 5 percent (or more) to merchants, compared to

[5] Excludes distribution costs (which are not published).

[6] Due to the lack of data, it is difficult to estimate the social costs of cash in the ECCU.

1–3 percent (in the U.S. and the U.K.).[7] In most products, cardholders also need to pay annual membership fees (ranging from US$40 to US$170). Fees for wire transfers in the ECCU are generally less than U.S. banks but are comparable to U.S. credit unions (outgoing transfers) or higher (incoming transfers). In comparison with banks in Europe (where faster payments are available), fees in the ECCU are significantly higher (Table 1). Second, the range of mobile banking services is limited in the ECCU, except for a few banks.

Table 1. ECCU: Bank Wire and Credit Fees [1/]
(In US dollars)

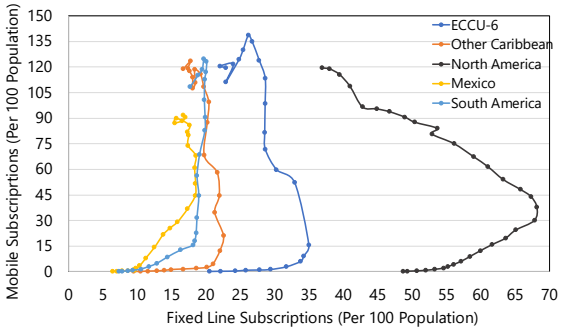
	Credit card fees			Wire transfer fees				Accounts maintenance fee
	Annual fees	POS transaction fees incurred by: 2/		Domestic/regional		International		
		Banks	Merchants	Incoming	Outgoing	Incoming	Outgoing	
ECCU 1/	40-170	About 1.1-2.1 % per transaction	About 4-5 % or more per transaction	9.0	16.0	9.0	32.9	Typically US$ 2.7-9.3 per month
U.S.								
Selected major banks 3/	Many are free	...	Generally 1.7-3.5% per transaction	13.0	29.0	16.0	49.0	Mostly free
Selected credit unions 4/	Many are free	...		0.5	22.0	0.5	40.1	Mostly free
U.K.								
Selected major banks 5/	Many are free	...	Generally 1-3% per transaction	Faster payments, free		0-10	0-40	Mostly free
Memorandum items:								
Per capita GDP (US$ '000)				ECCU 11.8	U.S. 62.9	U.K. 42.6		

Sources: For ECCU data, ECCB "Commercial Banks Fees and Charts"; ECCB, "Overview of the ECCB's Fintech Pilot," November 28, 2018; for the U.S., "mybanker.com" and Prakash, P., 2019, "Credit Card Processing Fees: The Complete Guide"; and for the U.K., "moneyadviceservice.com," gilmore, X., 2019, "Credit Card Processing Fees," and "cardswitcher.co.uk."

1/ As of end 2017. For wire transaction fees, the average of all banks (reported) in each country.
2/ Not strictly comparable as credit card fees vary depending on plans (e.g., transaction fees, flat fees, and incidental fees). Excludes other fess (e.g., POS terminal rental fees).
3/ The sample includes 18 banks.
4/ The sample includes 10 credit unions.
5/ The sample includes 5 banks.

8. Another puzzle is that technology is available but underutilized. As elsewhere in other developing and emerging economies, mobile phones have allowed the ECCU to "leapfrog" technologically. In the early 2000s, the spread of the fixed line phone was about 35 per 100 persons in the ECCU, higher than in Latin America (below 20 per 100 persons), but much lower than in North America (nearly 70 per 100 persons). The use of mobile phones has since started growing fast and, subscriptions have

Evidence of Leapfrogging: 1985-2017



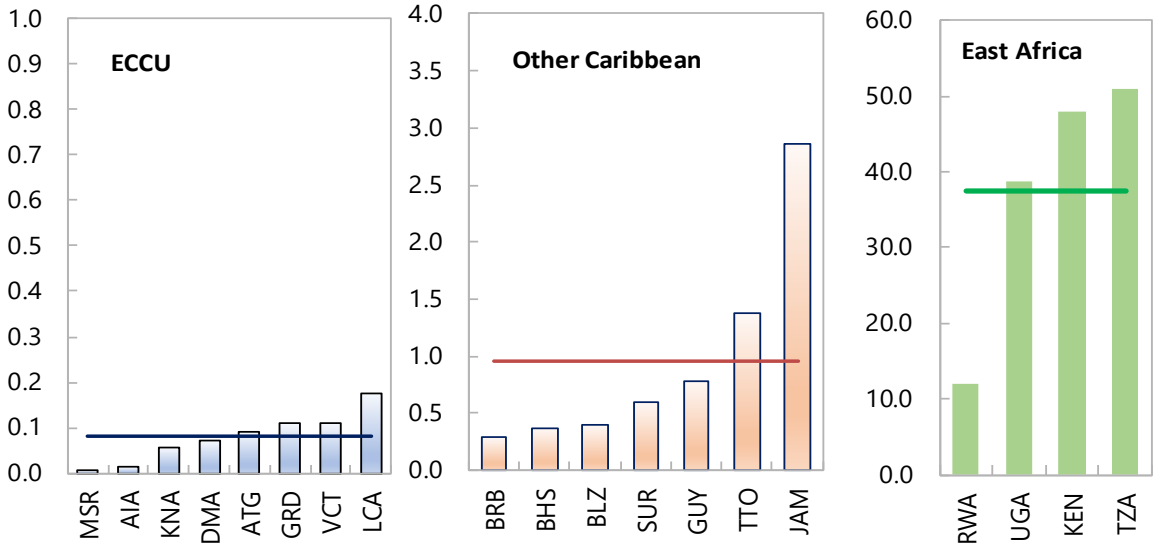
Sources: World Bank Database and IMF Staff Estimates

[7] Only some merchants with significant volumes charge lower fees (as low as 1.5 percent), while in other cases, merchants pay rental fees for point-of-sale machines, up to 5 percent of the transaction value.

reached 120 per 100 persons today. Nonetheless, the development of non-bank private e-payment services has lagged behind: only a handful of e-payment services (e.g., CaribePay and JAD Cash in St. Kitts and Nevis) have emerged over the past few years, with the limited scope and scale of their activities.

9. A couple of factors explain, at least in part, why the ECCU lags behind other regions in developing payment services. First, the lack of economies of scale. The ECCU economy is very small, with a population averaging less than 0.1 million in each member economy. This compares with about 1 million in other Caribbean economies (where various electric payment services are provided by banks and non-banks) and 40 million in East African economies (which are known for M-Pesa's success). Second, there is no legal and regulatory framework specifically for mobile wallet services, which has also contributed to deterring payment service developments.

Figure 2. ECCU: Population
(million)



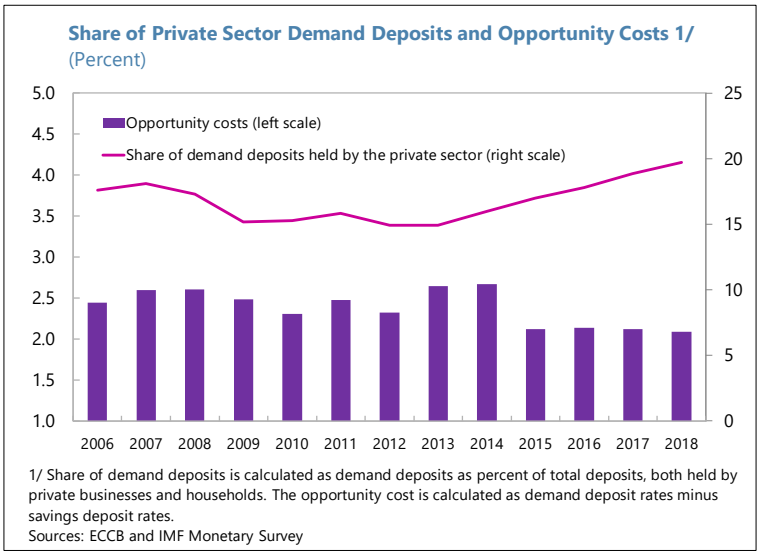
Source: IMF WEO

C. Key Challenges for Issuing Central Bank Digital Currency

10. Against this backdrop, the ECCB views the DXCD as an option to modernize the payment system. The main objectives include reducing the use of cash and check by half, improve the efficiency of the retail payment system, stimulate the competition in payment industry, thereby supporting economic activity and growth (see Appendix I).

11. Central bank digital currency, however, could bring a number of new challenges. Given that the ECCB has a fixed exchange rate regime, monetary policy implications of a central bank digital currency would be limited. Rather, key challenges that warrant careful considerations would include risks to financial intermediation, financial integrity, and cybersecurity (see for example, BIS 2018 and Mancini Griffoli 2018).

- ***Financial disintermediation risk could arise, if the central bank digital currency is designed as a close substitute to bank deposits***. A central bank digital currency that bears interest and can be used for a relatively large amount of transactions and be allowed to hold a sizable amount for saving purposes could attract many users, due to its convenience, speed, and cheapness. This approach could, however, expose banks to funding risk, since ECCU banks rely heavily on deposit funding (over 90 percent of total liabilities) and pay only negligible interest on demand deposits (about 0-0.1 percent). Absent deposit insurance, a central bank digital currency would directly compete with bank deposits (see Box 2). There seems to be negative correlation between the opportunity cost of holding demand deposits (calculated as saving deposit rates minus demand deposit rates) and the share of demand deposits in total deposits, held by the private sector.



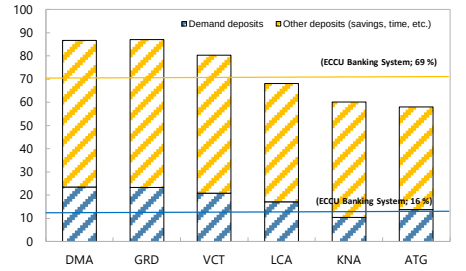
- ***Financial integrity risk*** could arise, if the central bank digital currency allows for anonymous and/or large-value transactions. The introduction of central bank digital currency could also raise operational questions. For example, to what extent, would the central bank need to be involved in customer due diligence process? And would the central bank have resources and skills to monitor illicit activity and ensure compliance?

- ***Cybersecurity*** is one of the most important operational challenges for central banks and the financial industry more generally (BIS 2018). Cyber-threats, such as malware, and fraud are risks for nearly every payment, clearing, and settlement system. They pose a particular challenge for a central bank digital currency, which is exposed to many participants and points of attack. Moreover, the potential effect of fraud could be more significant with a digital currency, in particular if the system lacks the proper and modern safeguarding, detection, and prevention controls.

Box 2. Possible Competition between a Central Bank Digital Currency and Bank Deposits

ECCU banks rely heavily on retail deposits as a source of funding. For the banking system as a whole, the deposit funding ratio (defined as the ratio of total customer deposits to total liabilities including equity) amounts to about 69 percent. The share of demand deposits (which pay only negligible interest and thus would most likely face competition with the ECCB's digital currency) is about 16 percent of total liabilities, about a half of which are held by households and private businesses, equivalent to 5-20 percent of total liabilities.

Dependence on Demand Deposit Funding, 2018
(Demand depost as a percent of total liabilities)



Sources: Eastern Caribbean Cetral Bank

A central bank digital currency would replace cash but also potentially bank deposits. It is default risk-free and cheap, whereas bank deposits are riskier (without deposit insurance) and expensive. If a central bank digital currency replaces a portion of cash, it would not affect banks' balance sheets. However, it could replace a portion of bank deposits, affecting banks' funding. This could happen when interest rates are low (thus the opportunity cost of holding a central bank digital currency is small) or a confident shock arises in the banking system.

What Would Happen if CBDC Competes with Bank Deposits?

Case A: CBDC and cash are substitute

ECCB		Banks/Credit Unions		Households	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
	Cash: -EC$100 CBDC: + EC$100	No change		Cash: -EC$100 CBDC: + EC$100	

Case B: CBDC and demand deposits (DD) are substitute

ECCB		Banks/Credit Unions		Households	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
	RM: -EC$100 CBDC: + EC$100	RM: -EC$100	DD: -EC$100	DD: -EC$100 CBDC: + EC$100	

We estimate simple deposit demand functions to gauge the responsiveness of demand deposits to interest rates. The dependent variable is real demand deposits held by private businesses and households (logarithm), and the independent variables are real GDP (logarithm) and opportunity costs. We also test a global financial crisis dummy to see if it affected deposits. The dataset covers six ECCU economies in 2006–18 (annual data). We employ three estimation methods, OLS, fixed effects, and Seemingly Unrelated Regression (because error terms may be correlated across countries).

Estimating Deposit Demand Functions

Dependent variable	Real business demand deposits (logarithm)				Real household demand deposits (logarithm)			
	OLS	FE	SUR	OLS	OLS	FE	SUR	OLS
RGDP (logarithm)	1.20 (0.08) **	2.33 (0.39) **	1.20 (0.06) **	1.21 (0.08) **	1.26 (0.10) **	1.26 (0.26) **	1.26 (0.06) **	1.26 (0.10) **
Opportunity cost	-0.21 (0.08) **	-0.22 (0.09) *	-0.21 (0.09) *	-0.20 (0.10) *	-0.46 (0.10) **	0.02 (0.06)	-0.46 (0.13) **	-0.49 (0.10) **
2008 GFC dummy	...	...	...	-0.13 (0.11)	...	...	...	0.21 (0.13)
Constant	3.21 (0.63) **	-5.34 (3.06)	3.21 (0.41) **	3.17 (0.63) **	2.95 (0.77) **	3.62 (2.06)	2.95 (0.46) **	3.01 (0.77) **
R-squared	0.76	0.82	0.76	0.76	0.71	0.94	0.71	0.72
S.E. of regression	0.25	0.22	0.25	0.25	0.25	0.15	0.31	0.31
Cross section	6	6	6	6	6	6	6	6
Observations	78	78	78	78	78	78	78	78

Source: The authors' estimates.
Note: Standard errors parentheses with ** and * indicating significance level at 1 percent and 5 percent, respectively.

The regression results confirm negative correlation between the opportunity cost and real demand deposits (text table). The coefficients on the opportunity cost are consistently negative and significant (except for the fixed effects model for households). The coefficient on the dummy variable is negative, implying a negative association between real deposit demand and a shock, but the results are not statistically significant. These results imply that with a decline in the opportunity cost, people could shift funds to a default risk free central bank digital currency, away from bank demand deposits. This said, currently, there is ample liquidity in the financial system, providing a cushion to liquidity shocks.

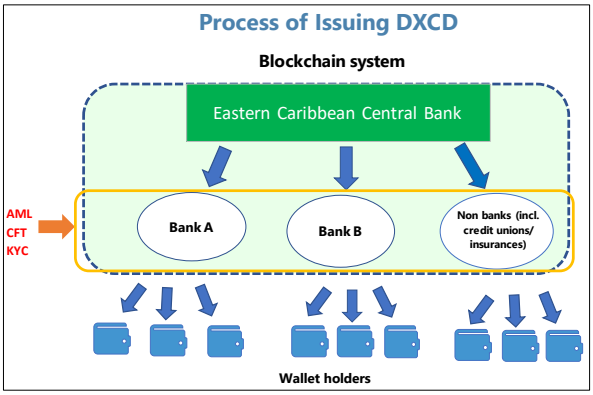
ECCB Approach

12. In considering these challenges, the ECCB plans to embed several safeguard measures in the design of its DXCD. The digital currency pilot project would be conducted under the supervision of the ECCB and within a controlled environment (Box 3).

Box 3. The Key Design Aspects of the ECCB Digital Currency for the Pilot[1]

General scheme. The ECCB will have the sole authority to issue and redeem the digital currency and will be able to fully control its supply. The ECCB will preserve a "two-tier system" to fully utilize the comparative advantage of (i) the private sector to interact with customers and carry out the relevant AML/CFT requirements, including the necessary customer due diligence measures; and (ii) the central bank to provide trust and manage the DXCD scheme in line with its payment system policies. About 15 financial institutions in four ECCU member economies (Antigua and Barbuda, Grenada, St. Kitts and Nevis, and St. Lucia) will participate in the pilot. The digital currency can be used for financial transactions including peer-to-peer, business-to-business, and business-to-customer. The size of its holding and transaction values per wallet is limited, with no interest accrued and no use for foreign exchange transactions. The ECCB has no intention to eliminate the use of physical cash, because it has its own convenience.

Process of issuing digital currency. Financial institutions request DXCD from the ECCB. In response, the ECCB sends DXCD to them using the DLT system. Then, financial institutions in turn distribute DXCD to their clients upon their request in exchange for deposits or cash.[2]



Access to transaction data:

- The ECCB can observe each transaction data (but anonymously) and the outstanding stock of DXCD in each digital wallet. The ECCB does not see detailed information about DXCD transactions (e.g., the identity/name of payers and payees and the purpose of transaction).
- Financial institutions can fully observe the identity of payers and payees and the purpose of transaction (e.g., the goods or services payers bought from payees), if either payers or payees are their own customers. They are responsible for maintaining its own clients' database.

Who Can See What Information?

	Transaction data related to clients of:		
	Bank A	Bank B	Nonbank A
ECCB	**Only anonymous transaction data**		
Bank A	**Full data related to transaction of own customers 1/**		
Bank B		**Full data related to transaction of own customers1/**	
Nonbank A			**Full data related to transaction of own customers1/**

1/ All data including identity of payers and payees involved in transactions.

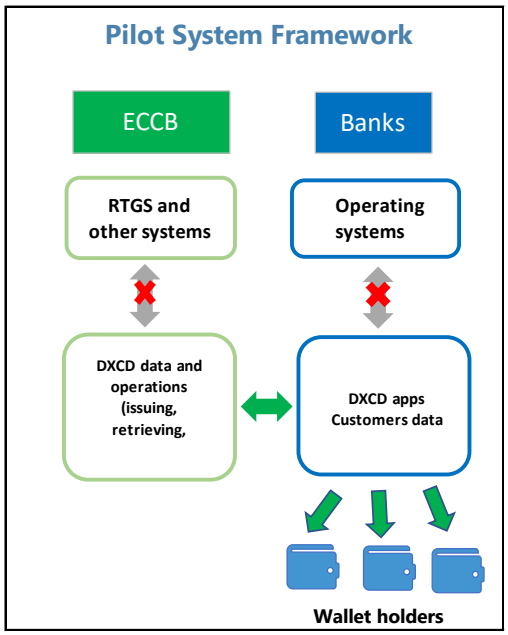
[1] Based on the information staff obtained during the mission. The ECCB was still developing the design of the DXCD.

[2] This scheme implies that clients do not have direct access to central bank accounts.

13. To mitigate financial intermediation risks, the digital currency is designed as a small value retail payment instrument. The ECCB plans to set limits to DXCD holding and transaction values, taking into account the current practice for cash (e.g., ATM withdrawal limits, debit card

transaction limits, online and mobile banking transaction limits) as well as AML/CFT regulations.[8] In addition, to discourage the use of DXCD for saving purposes, ECCB's digital currency will not bear interest. Financial institutions would also be allowed to control the amounts of digital currency depositors can exchange for deposit accounts, which would help their liquidity management.

14. The ECCB is also planning to introduce several features to mitigate financial integrity risk. The imposition of limits on the size of transactions (as discussed above) would help minimize financial integrity risks. In addition, the use of DLT technology is expected to facilitate effective identity authentication and tracking of payments and transfers. Furthermore, the ECCB will preserve a "two-tier system" in distributing digital currencies, similar to the current cash distribution arrangement. This set up would help utilize private sector's skills to interact with customers and carry out the relevant AML/CFT requirements, including the necessary customer due diligence measures, thereby reducing ECCB's operational burden. Individual financial institutions would have access to information pertaining to their clients' transactions and have the obligation and responsibility to monitor the legitimacy of each transaction and maintain their clients' database. The ECCB is not expected to be directly involved in monitoring individual transactions. Instead, its main role is to supervise financial institutions to ensure that they are compliant with the AML/CFT regulatory framework.



15. To mitigate cybersecurity risks, the planned pilot is limited in the scope of system integration. Most importantly, the digital currency system is not planned to be linked to the ECCB's core payment systems (such as the RTGS), banks' operating systems, and the Automated Clearing House. This is intentional and a prudent approach given (not fully known) risks entailed in the digital currency system. This, however, means that after the pilot, another round of testing will be needed, most importantly to assess risks and vulnerabilities after connecting the digital currency system to the other payment and operating systems at the ECCB and financial institutions.

The Role of the Pilot

16. While several safeguard measures are embedded in the design of ECCB's digital currency, it could still expose the ECCB and the financial system to various financial and operational risks. The ECCB is among the first central banks in the world to experiment central bank digital currency using DLT technology. A central bank digital currency is a new form of money, and the knowledge and experience on how it affects the financial system is limited. In addition, DLT

[8] At the time of the ECCU consultation, the authorities had not determined the exact size of such limits.

technology is relatively untested, and even the private sector is in the early phase of developing and applying this technology for commercial use.

17. In this context, the pilot will provide the opportunity to examine these risks and assess policy gaps. More specifically:

- ***Financial intermediation.*** Ample excess liquidity in the system would mitigate possible financial disintermediation risk. However, the effects of the DXCD on the choice of payment instruments and financial institutions' funding are uncertain, especially under stress. Accordingly, the ECCB and the national supervisors should closely coordinate on analyzing the liquidity and funding conditions of each bank and credit union, including through liquidity stress testing.

- ***Financial integrity.*** The current AML/CFT framework will be broadly maintained, as the regulated financial institutions continue to take the key role in ensuring AML/CFT compliance. To fully reap the benefits of the new technology and address new risks, AML/CFT operational guidelines and regulations need to be thoroughly reviewed and may need upgrading to cover the new digital territory.

- ***Cybersecurity.*** The ECCB could be exposed to operational and financial risks from malfunctioning of the digital applications, platforms, or infrastructure, due to cyberattacks. The ECCB is identifying cybersecurity threats and exploring risk mitigation measures, which is an important pre-requisite to the DXCD. Areas for further considerations would include:

    - Developing proactive cybersecurity IT operation within the ECCB, for example by instituting a "real-time 24/7" monitoring system to prevent, detect, and recover from cybersecurity breaches. This function will be essential for ECCB's digital currency ecosystem to maintain a high-level assurance of the network, systems, data, and applications security.

    - Further strengthening the ECCB's IT operational resiliency (which includes IT asset, control, change and vulnerability management) and security testing activities before deploying new systems and applications.

    - Further improving third party and cloud risk management.

    - Allocating more supervisory resources for ensuring robust cyber security policy and practice at financial institutions.

- ***Data and privacy governance.*** The data and privacy governance frameworks should be established to ensure that sensitive financial or personal data is protected.

D. Conclusions

18. The ECCB's move to pilot digital currency reflects its dissatisfaction over the slow progress in payment system modernization. Due to the limited economies of scale, the private sector may not be able to fully exert its potential on its own, either by providing e-money or mobile

payment services at a low cost. The case in the ECCU contrasts with the case in a larger economy where a central bank digital currency could be viewed as redundant as the private sector already plays an important role in retail payments (see Macini-Griffoli etc. 2018, and Barontini and Holdenby, 2019).

19. The digital currency pilot project, launched by the ECCB, should proceed cautiously, as planned. Safeguard measures embedded in the design of the digital currency would help mitigate risks, but risks pertaining to central bank digital currency and DLT have yet to be fully understood. After the pilot, the ECCB is planning to thoroughly review its results. More work may be warranted, especially to further test the digital currency system, strengthen cybersecurity and AML/CFT operations, and update legal and regulatory frameworks. The authorities are also encouraged to conduct a comprehensive cost and benefit analysis of the new digital currency ecosystem

20. Note that central bank digital currency alone would not solve the problem. To minimize the risk of financial disintermediation, central bank digital currency should be designed as a means of payment for small value transactions. A small-scale central bank digital currency, however, would be unlikely to serve the business needs of small and medium-sized enterprise, as they need fast and cheap payment methods for larger value transactions. Accordingly, in tandem with their efforts to pilot DXCD, the authorities have to continue their efforts to modernize payment systems based on bank deposits.

21. Indeed, along with the digital currency pilot, the authorities should continue efforts to improve the traditional payment system. The pilot project is part of the ECCB's broader initiative to promote a digital economy and modernize the payment systems. By 2025, the ECCB aims to increase the use of credit cards by 50 percent, debit cards by 40 percent, and electronic transfers by 60 percent. Acknowledging that the lack of legislation has deterred the development of FinTech and non-bank payment services, the authorities are planning to review their legal and regulatory frameworks.[9] In addition, accelerating the ongoing e-government reform would lead to greater use of electronic payments for government services (e.g., transfer programs and pension), which would help increase electric transaction volumes, thereby reducing unit costs for banks and their payment service fees.[10]

[9] The Payment System Act, a key legislation governing payments, was passed in various member economies between 2008 and 2010. It can be viewed as outdated since the law does not reflect the rapid technological developments over the past decade. In addition, there is no specific legislation to accommodate the new type of payment system providers using e-wallets.

[10] In most of the ECCU economies, Ministries of Finance use a centralized, fully automated government financial management system. However, due to weaknesses in payments infrastructure, they still need to print and hand deliver paper checks to execute spending.

Appendix I. Estimating Relationships Between Digital Payments and Productivity Growth

1. A digital payment technology may contribute to economic growth and productivity by reducing friction in payments. We explore a statistical relationship between labor productivity and digital payments by estimating the following model:

$$Log\_LP_{it} = \beta_0 + \beta_1 D_{t>2014} + \beta_2 D_{DP} + \beta_3 D_{t\geq 2014} D_{DP} + \beta_4 X_{it} + \mu_i + \varepsilon_{it}$$

where i and t denote country and time, respectively; μ_i denotes an unobserved fixed effect capturing time-invariable heterogeneity across countries; and $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$ is a white-noise error term. The dataset covers 96 countries for the sample period from 2000 to 2017 (annual).

2. The dependent variable, Log_LP_{it}, is the logarithm of labor productivity in a country. Explanatory variables are: $D_{t\geq 2014}$, time dummy which is one if year t is greater than 2014; D_{DP}, digital payment penetration dummy which is one if an increase in digital payment penetration is greater than certain thresholds between 2014 and 2017; X_{it}, control variables including human capital index and R&D expenditure. For the threshold for D_{DP}, we choose low (below 25 percentile of the sample), median (50 percentile), or high (above 75 percentile).

3. The setup is similar to the difference-in-difference estimator. We take this approach due to the limitations of the data: the data for digital payments are available only for 2014 and 2017. The intuition of this approach is as follows. The increase in the digital payment penetration from 2014 to 2017 can be considered a "natural experiment." We test whether countries with a large increase in digital payments are associated with higher labor productivity. The interaction term $D_{t\geq 2014} D_{DP}$ is equal to one if a country is categorized as a high digital payment penetration country in 2014–17. Our main interest is β_3, difference in difference coefficient.

4. The results suggest that countries experiencing rapid growth in digital-payment penetration are associated with higher labor productivity (Appendix 1 Table 1). The estimated coefficients on the interaction term, β_3, are positive in Model 1 and Model 2 but not significant. This interaction term in Model 3, however, is positive and significant, implying that those countries experiencing a large increase in digital-payment penetration are associated with higher labor productivity in 2014–17.

Appendix I Table 1. Difference in Difference Regressions 1/

Dependent variable: log labor productivity

Extent of digital payment penetration	Model 1 (Low)	Model 2 (Median)	Model 3 (High)
Log human capital index	2.591***	2.636***	2.622***
	(0.137)	(0.137)	(0.136)
Log R&D expenditure	0.0519***	0.0537***	0.0530***
	(0.0168)	(0.0169)	(0.0168)
Time dummy (t>2014 = 1)	0.0266	0.0406***	0.0371***
	(0.0190)	(0.0149)	(0.0129)
Digital payment penetration dummy	-0.307**	-0.0158	-0.221
	(0.127)	(0.116)	(0.146)
Time dummy * country dummy	0.0351	0.0163	**0.0609****
	(0.0220)	(0.0205)	**(0.0258)**
Observations	1,012	1,012	1,012
Number of country	96	96	96
Sample period	2000-2017	2000-2017	2000-2017
Change in digital payment per population b/w 2013 and 2017	<25 percentile	= 50 percentile	> 75 percentile

1/ Constant and control variables are not reported in this table. Standard errors are reported in parentheses with *** indicating significance level at1 percent, ** at 5 percent, and * at 10 percent.

Data Description

- **Labor productivity.** Calculated as real GDP at chained PPPs (in 2011 US dollars) divided by total employment. Data source, University of Groningen Penn World Table.
- **Digital payment penetration.** Calculated as the proportion of population having made or received digital payments over the past year. The data are available for 119 economies, but we remove outliers by truncating the top and bottom 5 percent of the dataset based on labor productivity. Data source, the World Bank's Global Findex database.
- **Human capital index.** Calculated as the contributions of health and education to the productivity of the next generation of workers. The index measures the amount of human capital (health and education) that a child born today can expect to acquire by age 18, relative to the

benchmark of full health and complete education. Ranging between 0 and 1, the index takes the value 1 only if a child born today can expect to achieve full health and complete her education potential. Data source, World Bank Development Indicators.

- **R&D expenditure.** Gross domestic expenditures on research and development (R&D) as a share of GDP. They include both capital and current expenditures in business enterprise, government, higher education and private non-profit. R&D covers basic research, applied research, and experimental development. Data source, World Bank Development Indicators.

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