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Research Article

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Abstract

This paper explores the potential growth of Central America and the Dominican Republic after the 2008-2009 crisis to shed light on their 2020 pre-pandemic macroeconomic vulnerability and to ascertain that the observed path is deviating more than before from its potential. Using Hodrick-Prescott filter by constrained minimization, production function, regime-switching models, and Bayesian model averaging, the main findings suggest a pre-pandemic regional slowdown. By country, there are mixed results. This scenario was not only driven by international factors but by particularities; on the one hand, statistical models show higher potential growth, and, in a less favorable context, the region would be closer to the structural performance; on the other hand, individual factors are hindering potential growth.

Resumen

El documento explora el crecimiento potencial de Centroamérica y la República Dominicana luego de la crisis 2008-2009 para dar idea de su vulnerabilidad macroeconómica previo a la pandemia de 2020 y para comprobar si la senda observada se desvía de su potencial más que antes. Usando el filtro Hodrick-Prescott por minimización restringida, los modelos de función de producción,

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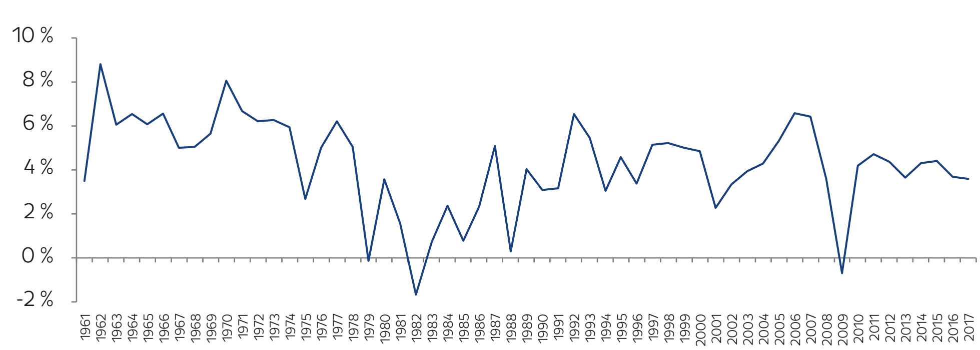
de cambio de régimen, y el promedio bayesiano de modelos, los principales hallazgos sugieren una ralentización regional del crecimiento pre-pandemia. Los resultados son mixtos por país. Este escenario no solo está influenciado por factores internacionales sino por particularidades; por un lado, los modelos estadísticos muestran un crecimiento potencial mayor y, en un contexto menos favorable, la región estaría más cercana al desempeño estructural; por el otro lado, los factores individuales limitan el crecimiento potencial.

Introduction

Developed economies have shown a sluggish recovery after the 2008-2009 crisis. First, they set historically low monetary policy rates (such as the effective federal fund rates of the United States, which was below 0,25 % between 2009 and 2015), significantly limiting the policy scope. The commodity prices were also at relatively low levels; therefore, less sensitive to adjustments. Then, the total world trade contracted more than 7 % on average during 2015-2016, followed by a gradual recovery pace that turned back during 2018. This scenario occurred in a context with significant debt accumulation and a low propensity for real investment (Prat and Solera, 2017). This behavior might reveal the onset of structural lower aggregate demand and reduced recovery capacity, raising doubts about the growth prospects worldwide. So a couple of issues emerge: Was there a pre-pandemic slowdown? Are we facing secular stagnation?[1]

This paper aims at understanding whether the economic growth of Central America[2] and the Dominican Republic (CADR) was compromised before the 2020 pandemic. Looking for robustness, I apply different statistical and structural methodologies to estimate the potential growth of these countries, shedding light on its pattern over time to verify if the actual growth was deviating from its potential more than before. As mentioned by Manzano and Maldonado (2016), CADR countries not only had to deal with the 2008-2009 crisis but they have also been suffering external shocks during the last decades, significantly increasing their macroeconomic vulnerability. They are small economies, highly dependent on foreign trade, and, in most cases, remittances. Figure 1 shows the average real growth of CADR since the sixties, while Figure 2 indicates how these countries depend on the international scenario. The context makes it difficult to rule out a slowdown in the region even before the pandemic.

Figure 1. CADR: Real Growth

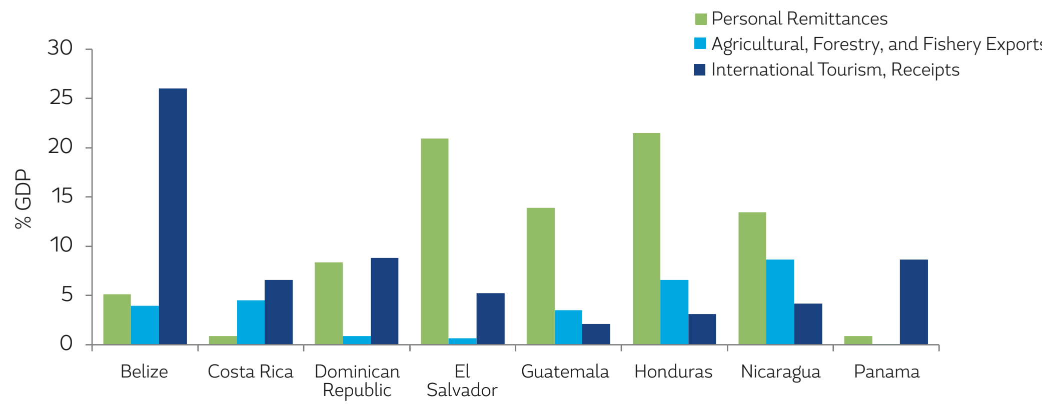


Source: Penn World Table 9.0.

[1] The term secular stagnation was first employed by Alvin Hansen in 1934 in the Great Depression and, later on, elaborated in Hansen (1938). After World War II, the concept fell into oblivion, but it was "rediscovered" by Summers (2013).

[2] Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

Figure 2. Linkages to the International Dynamic, 2018



Source: U.N. Comtrade, and World Bank.

In this field, a new normal describes a constant state of weak demand with few and unusual episodes of full employment, a context in which countries might reach a lower potential growth rate than before or even a negative natural rate. It is understood not only as of the need for having negative real interest rates to equal out savings with investment under full employment but as the difficulty of achieving financial stability and a high potential growth rate through conventional monetary policy.

This setup centered its attention on developed countries, as drivers of global economic effects, and comes up recently as a topic for debate (Summers, 2013 and 2014; Krugman, 2014; Fernald, 2015; Bernanke, 2015a and 2015b; Eichengreen, 2015; Gordon, 2015; Caballero and Farhi, 2018; Di Bucchianico, 2020). Nevertheless, the inherent dynamics of emerging countries and their remarkable dependence on external factors makes it possible to consider it a worldwide phenomenon.

CADR has boasted a higher growth rate than the rest of Latin America. In 2015, they had favorable expectations based on both the slow but gradual recovery of the United States (leading trading partner) and better terms of trade with low oil prices.[3] However, this favorable context was not fully recognized and is now changing. The Federal Reserve of the United States gradually increased its interest rates from ultra-low (near zero) to historically normal levels. At the same time, the oil prices showed signs of recovery during 2016 and most of 2018. Also, developed countries seem to be facing weak demand and less historical growth, a macroeconomic situation deepened by the recent pandemic (Davies, 2020).

The potential growth is an unobserved variable; thus, there is no precise method to estimate it. Miller (2003) reminds us that particular characteristics feature each country, and each method has its advantages and disadvantages, lending uncertainty to these estimations. One way to deal with this concern is to follow different approaches (Cotis, Elmeskov, and Mourougane, 2004). Looking for robustness and using annual data, I herein estimate the potential growth of CADR countries using two main approaches:

- Statistical, with full/recurrent use of statistical tools or filters. Three methods are applied: i) Hodrick-Prescott filter (HP) by constrained minimization, following both the variability of the acceleration of the trend relative to the variability of cyclical component, and the variability of the acceleration in the

[3] For example, see Manzano and Maldonado (2016) and Prat and Solera (2017).

trend component; ii) Production function (PF), using a standard Cobb-Douglas with skill-adjusted labor (human capital); and, iii) Regime-switching model (SM) based on three growth scenarios: recession or moderate, sustainable, and overheated.

- Structural, using a Bayesian model averaging over panel data to produce robust country-structure variable specifications and test the significance of country effects on the pre-pandemic period. This process is based on several variables falling into six categories: growth theories (usually considered in theoretical models); convergence; educational system; economic openness; institutional quality; and economic structure.

The contribution of this paper is threefold. Firstly, CADR countries have no recent estimations of potential growth and output gaps using historical data and following different methodologies throughout statistical and structural approaches. Johnson (2013) comes up with an applied effort estimating potential output for these countries, but only using production function, switching, and state-space methods. Also, Johnson (2013) excludes Belize from the sample and does not consider historical data. Besides, in this paper, I use an unbalanced panel with 39 high-income, 52 medium-income, and 11 low-income countries, as well as 40 variables to test robust determinants of potential growth using a Bayesian model averaging. This panel differs from studies such as Lanzafame et al. (2016), in which at most 70 countries are included (leaving aside most of the Central American countries) considering 34 possible determinants. The use of different methodologies allows to gain robustness and widen the analysis of potential growth. In fact, contrasting all the outputs, this paper confirms that statistical models show a higher potential growth for CADR countries, signaling that the region would be closer to structural growth in a less favorable context.

Secondly, this analysis allows us to verify if particularities might be structurally limiting potential growth. Following structural models, I confirm the presence of country-specific vulnerabilities and find positive and negative fixed effects statistically significant for each country of CADR, revealing a scenario not only featured by exogenous factors but by individual results. Nevertheless, this approach faces at least one limitation, it accounts for particularities and allows to conclude their presence, but it does not identify the specific determinants and constraints per country that might be causing dissimilarities. In this sense, exploring and identifying heterogeneities in potential growth drivers could be valuable for further research.

Thirdly, this paper is an applied effort to understand better the vulnerability of the economic growth of CADR countries before the global pandemic shock. Moreover, I identify an aggregate slowdown experienced by CADR before the shock, with mixed country results. Most countries show a relative deacceleration of observed and potential growth and pre-pandemic macroeconomic conditions hindering their recent shock response. This situation deserves to be highlighted. The economic impacts of the pandemic on the region might be deepening the already aggregate slowdown of the potential growth.

This paper is organized as follows: In the next section, I describe each of the statistical methods; the third section exposes the Bayesian model averaging approach; the fourth section reviews the main results; and the fifth section comprises the conclusions.

2. Statistical Approaches

This section focuses on describing the methodologies that use full/recurrent statistical tools over annual data for each country.[4]

2.1. Hodrick-Prescott Filter by Constrained Minimization.

The HP filter decomposes a time series (y_t) into a trend (y_t^*) and a cyclical component. The sum of squared deviations from the series' trend is minimized, penalizing changes in its acceleration through a smoothing parameter λ. Equation (1) shows the conventional HP filter.

$$\min_{\{y_t^*\}_{t=1}^{T}} \left[\sum_{t=1}^{T} (y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1} \left((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right)^2 \right] \text{ where } \lambda > 0 \tag{1}$$

This filter involves a clear problem: arbitrariness in the selection of λ. The value depends on the frequency of the series. Researchers usually adopt Hodrick and Prescott's setup (in their 1980 analysis on the United States), that is, to use λ=100 for annual data, λ=1600 for quarterly data, and λ=14400 for monthly data. Nevertheless, the properties of economic cycles differ among countries. Hence, the use of such values does not guarantee reliable and consistent results. As an alternative, I follow two assumptions from Marcet and Ravn (2004) to calculate two optimal λ by country, making them comparable with the traditional standard values. In this case, Equation (2) identifies the objective function to minimize:

$$\min_{\{y_t^*\}_{t=1}^{T}} \sum_{t=1}^{T} (y_t - y_t^*)^2 \tag{2}$$

Firstly, I assume larger variability of the growth rate in countries with a more volatile cyclical component (some countries might have larger deviations from a linear trend than others). This procedure (also called *V* methodology) considers the variability of the acceleration of the trend relative to the variability of the cyclical component. The idea is to minimize Equation (1) subject to Equation (3) in which the relative variability must be at most equal to a positive constant *V*:

$$\frac{\sum_{t=2}^{T-1} \left((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right)^2}{\sum_{t=1}^{T} (y_t - y_t^*)^2} \leq V \tag{3}$$

Secondly, the trend's growth might have the same variability across countries (similar deviation between the actual trend and a linear trend). Therefore, this procedure (also called *W* methodology) focuses on the variability of the acceleration in the trend component of each country. In this case, Equation (1) is minimized subject to Equation (4), where the variability of the acceleration trend adjusted by T-2 observations is limited at the top by a positive constant *W*:

$$\frac{\sum_{t=2}^{T-1} \left((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right)^2}{T - 2} \leq W \tag{4}$$

[4] Table A1 shows the beginning of the sample at its best for each country by methodology.

V and W are not chosen arbitrarily, I calculate the components of the standard HP filter as calculated for the United States and the respective restrictions. In this sense, the results are conditional to the United States scenario (λ=100) as sample reference but country-specific in the output. I apply the filter to the real GDP logarithm with those parameters and its differences approximate the potential growth. By restriction, Table 1 presents the results of the optimal λ.

Table 1. Optimal Smoothing Parameter

Optimal λ	Belize	Costa Rica	Dominican Republic	El Salvador	Guatemala	Honduras	Nicaragua	Panama
V	152	143	108	226	247	100	191	120
W	740	260	420	1500	420	58.5	8857	740

Using these parameters would have the immediate advantage of better-adjusted calculations, and they represent new reference values for future research for CADR countries.

The data comes from Penn World Table 9.0 (PWT) and the World Economic Outlook (International Monetary Fund, April 2018). The latter allows us to extend the final range of the series to 2023, reducing the bias generated by sample endpoints, where the cycle component is underestimated.

2.2. Production Function.

Following Sosa, Tsounta, and Kim (2013) I assume a standard Cobb-Douglas production function with skill-adjusted labor (human capital) and constant returns to scale for each country, as in Equation (5):

$$Y_t = A_t K_t^{\alpha} (L_t h_t)^{1-\alpha} \tag{5}$$

The real output (Y_t) is determined by the technological progress (A_t, calculated as residual), a capital factor (K_t), and a labor factor (L_t) skill-adjusted by a human capital index (h_t). In this case, α_t is a country-specific output elasticity to capital (averaging the values from PWT 9.0).

The capital factor is calculated in two stages, assuming an economy with balanced growth in t=0, the initial value of the capital factor (T_0) comes from Equation (6):

$$K_0 = \frac{I_0}{(1+g)(1+n) - (1-\delta_t)} \tag{6}$$

I_0 is the average weight of real investment over GDP from t=0 to t=4 multiplied by the initial GDP, minimizing the impact of future fluctuations. The parameters are the following: the technological progress growth (g) is a constant for all countries that equals 1,53 % (assumed by Ferreira, Pessôa, and Veloso 2012, in their analysis about the evolution of total factor productivity in Latin America); the population growth rate (n) is country-specific, averaging the sample growth rate of the population until 2014 and assuming medium-fertility variant of the population in 2015-2023 (taken from the United Nations World Population Prospects); and a time-varying depreciation rate (δ_t) from PWT 9.0.

For K_t, where t>0, I consider the perpetual inventory method to approximate capital stock at full capacity (Equation (7)):

$$K_t = (1 - \delta_t)K_{t-1} + I_t \tag{7}$$

The labor factor is measured on the basis of the number of workers. Following Bils and Klenow (2000), h_t is calculated as in Equation (8). In this case, Barro and Lee (2013) have estimations of the total years of schooling (s, using linear interpolation whenever missing values). The parameters θ and ψ equal 0.188 and 0.368, respectively (Fernández-Arias, 2014).

$$h_t = e^{\frac{\theta}{1-\psi}s^{1-\psi}} \tag{8}$$

Finally, the potential real GDP is obtained from Equation (9), that is, calculating the exponential values of the linearized function. Except for the capital, each factor represents the respective trends using the standard HP filter.[5]

$$Y_t^* = e^{\ln(A_t)_{\lambda=100} + \alpha\ln(K_t) + (1-\alpha)(\ln(L_t)_{\lambda=100} - \ln(h_t)_{\lambda=100})} \tag{9}$$

2.3. Regime-Switching.

The real GDP growth rate might have experienced significant breaks while moving across different growth paths or regimes. In this case, three growth regimes are taken into account: recession (or moderate growth), sustainable (potential path), overheated. No permanent shocks are considered, which means that neither recession nor economic over-heating represents an absorbing state.

The regime-switching model follows an iterative procedure. A set of stationary processes (stable variance-covariance matrix), represented with different probability density functions, generates a time series (y_t), allowing variability on a given number of scenarios.[6] Then, an expectation-maximization (EM) algorithm is applied to find the most likely estimators of parameters.[7] $\forall$ scenario = j =1,2,3, this procedure is carried out through Equations (10), (11) and (12):

Estimated growth $(\hat{\theta}_j)$:

$$\frac{\sum_{t=1}^{T} y_t P\left(s_t = j \middle| \Psi_{t-1}; \hat{\Gamma}^{k-1}\right)}{\sum_{t=1}^{T} P\left(s_t = j \middle| \Psi_{t-1}; \hat{\Gamma}^{k-1}\right)} \tag{10}$$

Estimated volatility $(\hat{\sigma}_j^2)$:

$$\frac{\sum_{t=1}^{T} \left(y_t - \hat{\theta}_j\right)^2 P\left(s_t = j \middle| \Psi_{t-1}; \hat{\Gamma}^{k-1}\right)}{\sum_{t=1}^{T} P(\quad s_t = j| \quad)} \tag{11}$$

[5] For more details, see Johnson (2013). I assume λ=100 rather than the optimal λ from Table 1 to ensure the use of different methodologies. The series are extended to 2023 with data from the World Economic Outlook (International Monetary Fund, April 2018), and I use one-step averaging results to prevent the sample endpoint bias.

[6] For more details, see Kim and Nelson (1999) and Johnson (2013).

[7] See Hamilton (1990, 1991).

Unconditional probability $(\hat{\pi}_j)$:

$$\frac{1}{T}\sum_{t=1}^{T} P\left(s_t = j \middle| \Psi_{t-1}; \hat{\Gamma}^{k-1}\right) \tag{12}$$

With $P(s_t = j|\Psi_{t-1}; \hat{\Gamma}) = \frac{\hat{\pi}_j f(y_t \mid s_t=j;\, \Psi_{t-1}; \hat{\Gamma})}{f(y_t \mid \Psi_{t-1}; \hat{\Gamma})}$, the normal density function is expressed as f, a random variable generated from the distribution function is s_t, the number of iterations is k, and Γ is the parameter vector (set of conditional information). Table 2 shows the outcomes for each scenario in our unbalanced panel.

Table 2. Convergence Results (%)

Country	Growth			Standard Deviations			Unconditional Probability		
	Recession or Moderate	Sustainable	Overheating	Recession or Moderate	Sustainable	Overheating	Recession or Moderate	Sustainable	Overheating
Belize	2.2	4.9	9.2	1.8	0.2	2.5	60.2	20.0	19.9
Costa Rica	2.3	4.9	7.9	5.4	2.5	5.1	10.7	77.3	12.0
Dominican Republic	-7.9	5.4	18.0	3.3	3.4	0.5	2.5	94.7	2.8
El Salvador	-6.1	2.1	4.4	2.5	0.3	2.4	5.8	29.9	64.4
Guatemala	2.2	3.9	7.5	2.8	0.9	1.4	25.6	62.9	11.5
Honduras	-1.1	4.2	4.9	3.6	1.6	0.8	12.6	67.5	20.0
Nicaragua	-2.6	3.4	12.9	12.9	2.7	0.6	10.8	81.6	7.6
Panama	1.6	5.6	11.8	9.2	2.9	6.8	4.6	90.3	5.1
CADR*	-1.2	4.3	9.6	5.2	1.8	2.5	16.6	65.5	17.9

Note: *simple average from the unbalanced panel results.

3. Structural Approach

An unbalanced panel with sample spaces is constructed with 102 countries (39 high-income, 52 medium-income, and 11 low-income), spanning the period from 1961 to 2017 (at most). A total of 40 variables are used, including real GDP growth (dependent variable). The classification of the variables into six categories is based on Lanzafame et al. (2016).[8]

I follow the Bayesian model averaging (BMA) to extract robust determinants and use them as covariates in future regressions of potential growth. A priori, each variable is transformed through forward orthogonal deviations (FOD), proposed by Arellano and Bover (1995). In this case, I subtract the mean of the remaining future observations available in the sample from each of the first T-1 observations. Given a variable x_{it} (country i), the transformation comes from Equation (13):

$$x_{it}^{\perp} = \sqrt{\frac{T-t}{T-t+1}}\left[x_{it} - \frac{x_{it+1} + \cdots + x_{iT}}{T-t}\right] \tag{13}$$

[8] Table A2 shows the summary.

This transformation has the advantage of avoiding serial correlation as well as removing unobserved individual effects, and it could be used on data with sample spaces.[9] After the data transformation, I apply the general BMA framework (Equation (14)):

$$y_{it} = \mu_i + [\gamma_F^T \quad \gamma_A^T]\begin{bmatrix} X_{it}^F \\ X_{it}^A \end{bmatrix} + [\beta_F^T \quad \beta_A^T]\begin{bmatrix} W_{it}^F \\ W_{it}^A \end{bmatrix} + \epsilon_{it} \tag{14}$$

Where y_{it} is the real GDP growth,[10] μ_i is the fixed effect for the country i (the FOD transformation captures this effect), γ_F^T and β_F^T are the coefficient vectors of the focal variables of respective size $1 \times n_1$ and $1 \times n_2$, γ_A^T and β_A^T are the coefficient vectors of auxiliary variables of respective size $1 \times (N_1 - n_1)$ and $1 \times (N_2 - n_2)$, X_{it}^F and W_{it}^F are the vectors of the focal variables of respective size $n_1 \times 1$ and $n_2 \times 2$, X_{it}^A and W_{it}^A are the vectors of auxiliary variables of respective size $(N_1 - n_1) \times 1$ and $(N_2 - n_2) \times 1$, where $\epsilon_{it} \sim i.i.d.(0, \sigma_\epsilon^2)$.[11] The number of auxiliary variables determines the size of the model space (number of non-null subsets of auxiliary variables). If $N_1 + N_2 = N$ variables of which $n_1 + n_2 = n$ are focal, then 2^{N-n} model space, which could exponentially reduce the combination of models to be estimated in the presence of many auxiliary variables.

To simplify, following Harrod (1939) and Domar (1946), potential growth is defined based on the sum of workforce growth and labor productivity rates. In this case, the working-age population trend is a focal variable and is a proxy for workforce growth. In contrast, the rest of the variables will affect labor productivity growth. Assuming that the 38 remaining regressors are auxiliary, the model space would be 2^{38}=274.9 billion models.[12] Hence, it is necessary to reduce that space number.

Under this idea, I combine results from a bivariate correlation matrix with an in-depth revision of the categories to find theoretical similarities in variables, reducing the auxiliary variables to 25.[13] Then, a first Bayesian model averaging is applied (BMA 1), in order to consider the rest of the variables discarded and looking for consistency in results, I run a second Bayesian model averaging (BMA 2).

BMA 1 and BMA 2 are performed in four stages to avoid multicollinearity. Following Barbieri, M. M., & Berger, J. O. (2004), the use of posterior inclusion probability (PIP) allows us to identify the robustness of the variables, where a PIP ≥ 0.5 means robustly correlated, and 0.5>PIP ≥ 0.25 is marginally robust. If PIP is lesser than 0.25, the associated variable is discarded. Every next run starts with at least marginal robust variables from the previous run.[14]

[9] See Leamer and Heckman (2001).

[10] Lanzafame et al. (2016) use potential growth as the variable of interest, after estimating it using a state-space model. Here, the dependent variable is the observed real GDP growth, and its estimation will give us the smoothed result (potential growth).

[11] Focal variables are those that will always appear in all specifications of the model in the BMA (model space); conversely, auxiliary variables are not fixed, so they may not appear in all the possible combinations in the model space.

[12] Considering current regular processors, computationally, it might take more than four continuous years to generate an output.

[13] 2^{25} = 33.55 million models or approximately five continuous hours of computational processing.

[14] Table A3 and Table A4 show the results of these stages for each model.

Table 3 shows the results with the respective robust variables. As expected, they are statistically significant, explaining changes in the GDP growth.[15] The technological gap with the United States (through the capture of productivity gains from technology transfers) and the labor force growth are important to increase the GDP growth. All the variables related to institutional quality show a positive relationship with economic growth. The economic structure robustly expressed in the employment absorption from the agriculture sector and the economic openness has an important positive effect on these countries. And, the real exchange rate seems to be negatively related to economic growth. The smoothed fitted values of these models represent the potential real GDP growth from this approach.

Table 3. Estimation of the Real GDP growth

Variable	BMA 1		BMA 2	
	(1)	(2)	(1)	(2)
Trend of Working Age Population Growth	0.4836*** (0.0650)	0.5199*** (0.1220)	0.4660*** (0.0526)	0.7409*** (0.0919)
Technological Gap with the U.S. (lagged)	0.0371*** (0.0057)	0.0943*** (0.0178)		0.0322*** (0.0058)
Legal Structure	0.5141*** (0.0828)	1.0257*** (0.1938)		
Employment in Agriculture (lagged)	0.0240*** (0.0062)	0.2032*** (0.0340)		
Size of Government	0.1463** (0.0723)	0.5800*** (0.1516)		
Political Stability		1.2534*** (0.3462)		
Real Exchange Rate (lagged)			-2.9171*** (0.2623)	-3.4143*** (0.3294)
Openness (lagged)			0.0073*** (0.002)	0.0265*** (0.0041)
Constant	-3.7265*** (0.8562)	-23.094*** (2.7399)	3.7394*** (0.2024)	-0.8125 (0.9326)
R-squared	0.1508	0.3824	0.0668	0.1489
Observations	1631	1373	4556	4353
Country Fixed Effects	No	Yes	No	Yes

Note: Significant at *10, **5, ***1 %. Standard errors in ( ).

[15] The missed variables in the regressions with no fixed effects indicate their lack of significance. It is to remember that the FOD transformation already removes the unobserved individual effects.

4. Results

4.1. Statistical Approaches.

Each methodology comprises the entire available sample, but it is not always possible to use the same sample size across all the methods. Therefore, I explicitly weight each country's average by its sample size. Table 4 shows the average potential growth estimated from the statistical models.

Table 4. Potential Real GDP Growth, by Statistical Approaches (%)

Country	Observed (Overall)	Modified Hodrick-Prescott Filter		Production Function	Regime Switching	Weighted Average
		V	W			
Belize	4.4 (3.3)	4.4 (1.3)	4.3 (1.0)	4.5 (1.9)	4.9 (0.2)	4.5 (1.0)
Costa Rica	5.1 (3.7)	5.0 (1.4)	5.0 (1.3)	5.0 (1.6)	4.9 (2.5)	5.0 (1.7)
Dominican Republic	5.4 (4.7)	5.4 (1.2)	5.4 (1.0)	5.4 (1.5)	5.4 (3.4)	5.4 (1.8)
El Salvador	3.2 3.4	3.1 1.7	3.2 1.2	1.9 2.0	2.1 0.3	2.6 1.2
Guatemala	3.9 (2.3)	3.9 (1.1)	3.9 (1.0)	3.9 (1.7)	3.9 (0.9)	3.9 (1.2)
Honduras	3.7 (4.2)	3.7 (0.8)	3.7 (0.7)	3.8 (1.0)	4.2 (1.5)	3.8 (1.0)
Nicaragua	3.4 (6.2)	3.1 (2.9)	2.7 (1.3)	2.1 (2.4)	3.4 (2.7)	2.9 (2.3)
Panama	5.7 (4.3)	5.7 (1.6)	5.8 (1.3)	5.2 (1.9)	5.6 (2.9)	5.6 (1.9)
CADR*	4.4 (4.0)	4.3 (1.5)	4.2 (1.1)	4.0 (1.8)	4.3 (1.8)	4.2 (1.5)

Note: *simple average from the unbalanced panel results. Standard deviation in ( ).

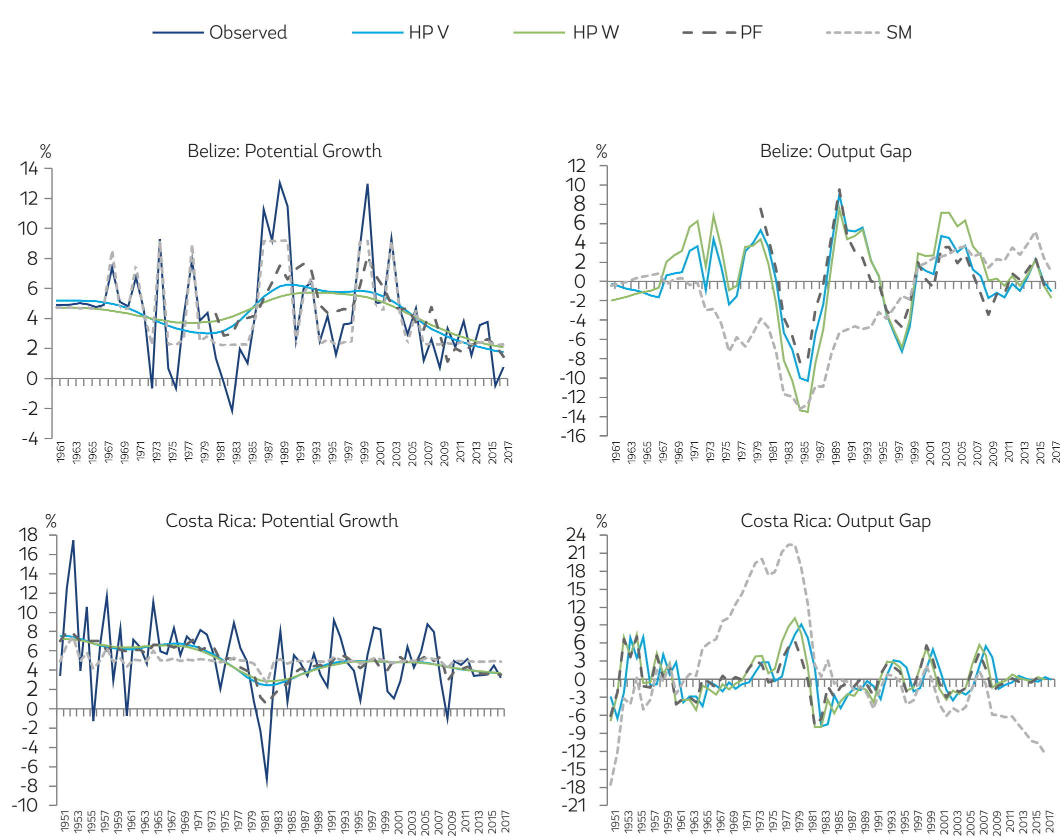
Most of the results are similar within each country across the methodologies. However, El Salvador, Nicaragua, and Panama are countries with relevant differences in their results, mostly in the production function estimation. As expected, that model reveals less potential growth in these three countries than other approaches. Among all the CADR countries, those three show the main difference regarding their sample while applying the production function. This situation implies that while the potential growth of these three countries might be lower if the sample gets reduced favoring more recent years, the sample size might impact the estimation, which justifies the use of different methodologies.

In all cases, the countries averaged an observed growth similar or slightly higher than their potential. On average, CADR should have grown by 4,2 % to fulfill its potential but was rising above that in the pre-pandemic period (4,4 %). Nevertheless, regarding potential growth, there are mixed results. Belize (4,5 %), Costa Rica (5 %), the Dominican Republic (5,4 %), and Panama (5,6 %) were pushing up the potential growth of the region and could be considered with less vulnerable macroeconomic conditions than recorded before the 2020 pandemic. The other countries were facing potential growth below the regional average. For example, El Salvador reveals the region's lower potential growth, 2,6 %, likely being the most macroeconomic vulnerable country to address the pandemic relative to its historical performance.

Figure 3 presents the evolution of the potential real GDP growth and the output gap by country following each of the statistical methodologies described. All the methodologies show similar patterns but different volatilities.[16] Also, every country reveals a reduction of the output gaps since the mid-1990s/2000s. In this case, I highlight the regime-switching model results, which in most of the countries show a significant gap with smooth convergence. This model carries on acumulative process while generating the estimation. Using a large sample may be spreading the output gap over the potential growth. Nevertheless, this approach filters the gap cycle from unsustainable events in the recursive process, leading to capture with more precision the sustainable growth, thus the convergence to lower gaps after higher ones tend to be smoothed.[17]

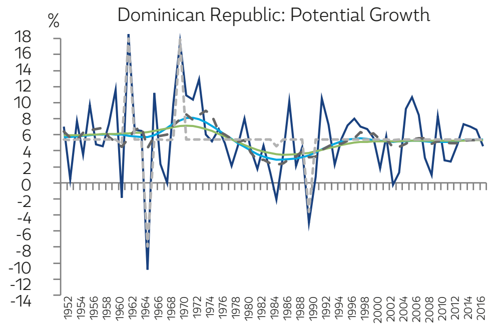
Finally, almost every country seems to expose a reduction in the variability of potential growth in recent pre-pandemic years; moreover, it is clear that the region has been facing stable/lower potential growth over time.

Figure 3. Potential Growth and Output Gap, by Statistical Approaches



[16] Costa Rica, the Dominican Republic, Nicaragua, and Panama, have a higher standard deviation on average than the rest of the countries (see Table 4).

[17] See, for example, Johnson (2013).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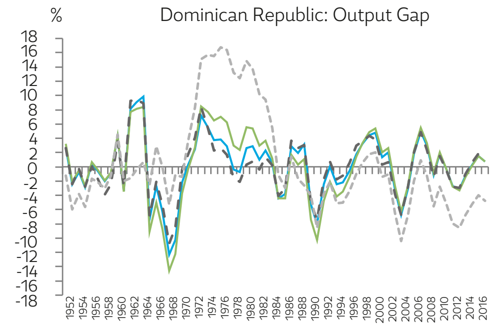
Dominican Republic: Potential Growth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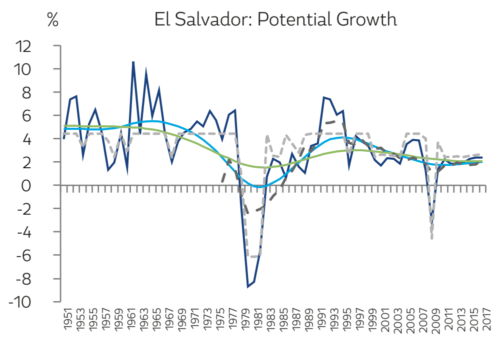
Dominican Republic: Output Gap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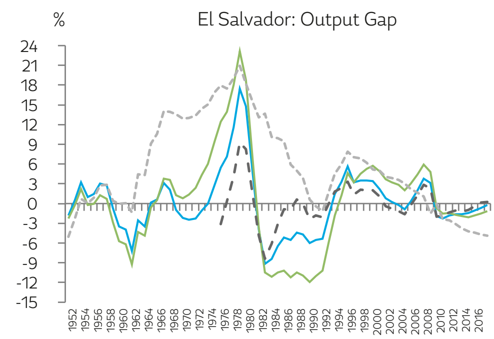
El Salvador: Potential Growth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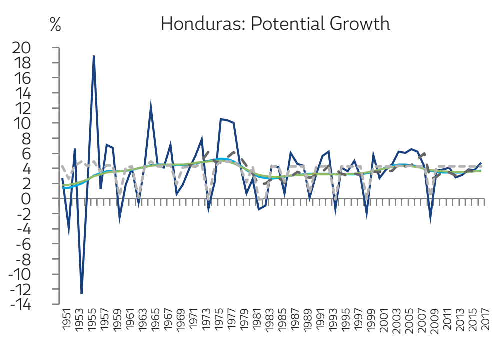
El Salvador: Output Gap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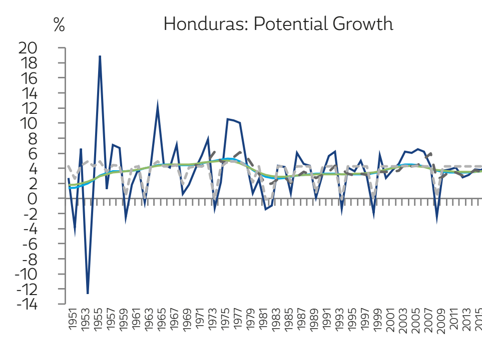
Honduras: Potential Growth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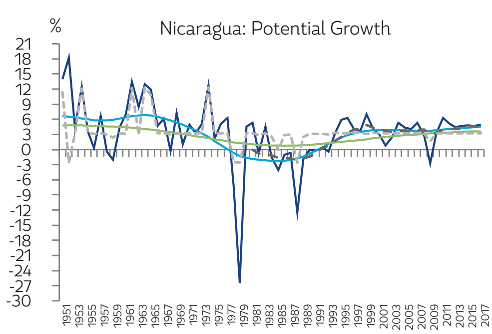
Honduras: Potential Growth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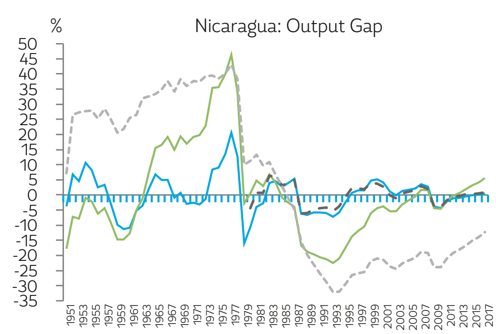
Nicaragua: Potential Growth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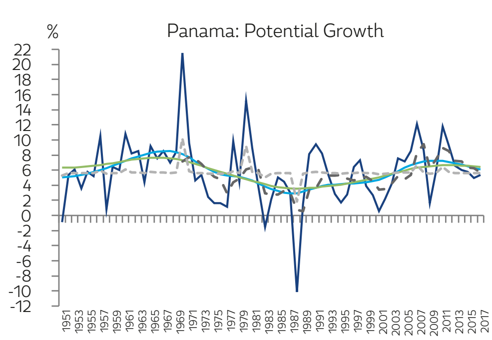
Nicaragua: Output Gap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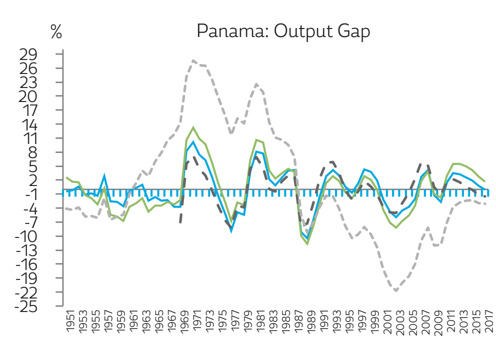
Panama: Potential Growth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Panama: Output Gap

4.2. Structural Approach

Table 5 shows the average potential growth results between 2002 and 2017. During the 2000s, CADR is growing slightly above its potential growth (4,1 % of observed growth versus 4,0 %). At the country level, there are mixed results. Two groups are identified: Belize, El Salvador, Guatemala, and Honduras growing below their potential; and Costa Rica, the Dominican Republic, Nicaragua, and Panama exhibiting rates above their potential. But there are differences in the fixed effects, except for the Dominican Republic and Panama, the structural particularities seem to be negatively affecting the countries' potential growth performance, leading them to a pre-pandemic slowdown and a higher macroeconomic vulnerability.

Table 5. Potential Real GDP Growth, by Structural Approach (%)

Country	Observed (2002-2017)	BMA 1		BMA 2		Weighted Average	Net Fixed Effect
		No Effects	Country Effects	No Effects	Country Effects		
Belize	3.1 (2.3)	5.1 (0.8)	3.6 (2.2)	4.5 (0.2)	4.6 (0.3)	4.4 (0.9)	-
Costa Rica	4.4 (2.3)	4.7 (0.3)	4.2 (0.6)	3.5 (0.7)	3.6 (1.0)	4.0 (0.6)	-
Dominican Republic	5.2 (3.2)	3.5 (0.4)	4.8 (0.5)	3.6 (0.5)	4.1 (0.8)	4.0 (0.6)	+
El Salvador	2.0 (1.6)	4.0 (0.5)	1.7 (0.9)	2.7 (0.6)	1.7 (0.7)	2.5 (0.7)	-
Guatemala	3.5 (1.3)	4.9 (0.3)	3.4 (0.7)	4.3 (0.4)	3.9 (0.6)	4.1 (0.5)	-
Honduras	4.1 (2.1)	5.3 (0.3)	4.3 (0.5)	4.8 (0.4)	4.4 (0.7)	4.7 (0.5)	-
Nicaragua	3.8 (2.2)	4.8 (0.2)	3.5 (0.5)	4.3 (0.3)	2.3 (0.4)	3.7 (0.4)	-
Panama	6.7 (2.9)	4.0 (0.2)	6.8 (0.7)	4.2 (0.3)	3.9 (0.5)	4.7 (0.4)	+
CADR*	4.1 (2.2)	4.5 (0.4)	4.0 (0.8)	4.0 (0.4)	3.6 (0.6)	4.0 (0.6)	

Note: *simple average.

Figure 4. Potential Growth and Output Gap by Structural Approach

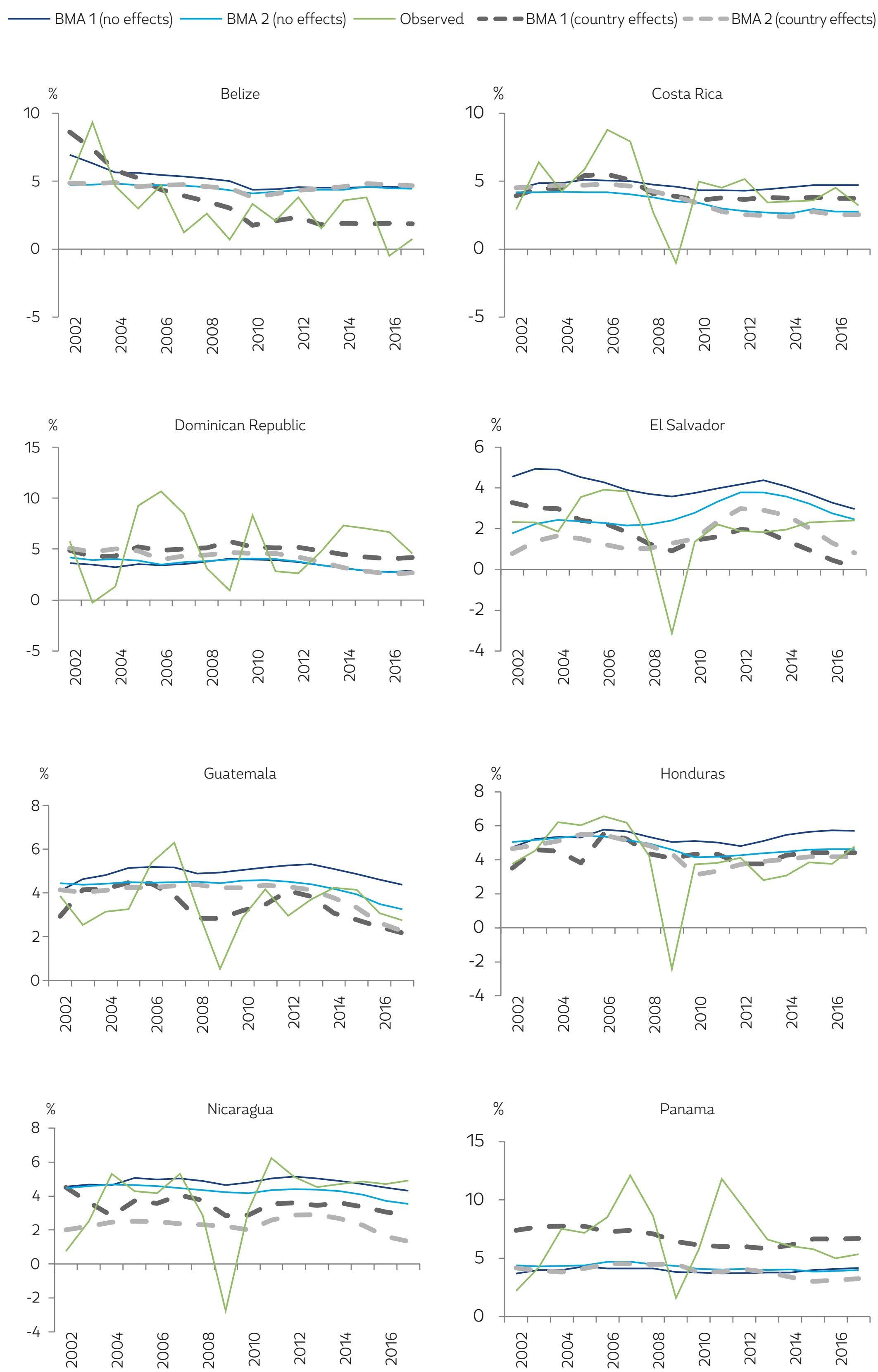


Figure 4 shows some dissimilarities between the results from both BMAs. For all countries, the results from the BMA 1 seem to fit better to the sample than those from BMA 2.[18] In this case, the economic structure and institutional quality of the countries seem to capture to a better degree the evolution of the potential growth. In general, CADR has been facing stable/lower potential growth.

By BMA, there is a gap between the models with no fixed effects and individual effects, which correlate with the data presented in Table 5. Nevertheless, that gap is not the same for all countries. Independent of the model, El Salvador, Guatemala, and Nicaragua show higher gaps than the rest, having a more vulnerable macroeconomic scenario than the other countries to face the 2020 pandemic.

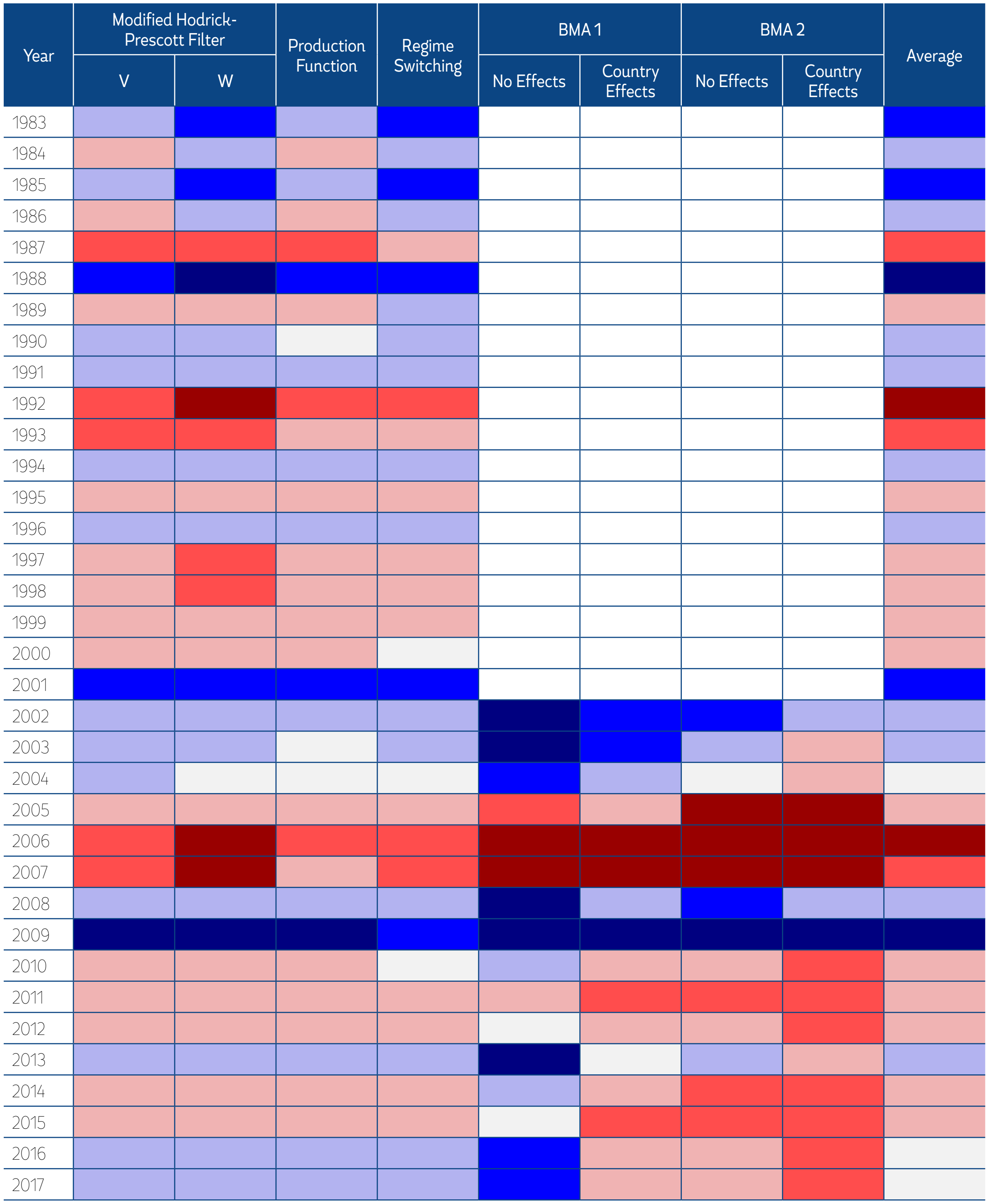
4.3. What Could Explain the Adverse Effects?

Overall, the statistical results place the potential historical growth of CADR at 4,2 %. Comparing the structural results, with and without country effects, the potential growth since 2002 is lower (3,8 % and 4,3 %, respectively). On average, throughout all the results, the potential growth is 4,1 % for CADR. Table 6 shows a heat map denoting the gap between the observed growth and its potential by approach, and Figure 5 shows how the potential performance of CADR is below its historical.

Table 6. CADR: Heat Map

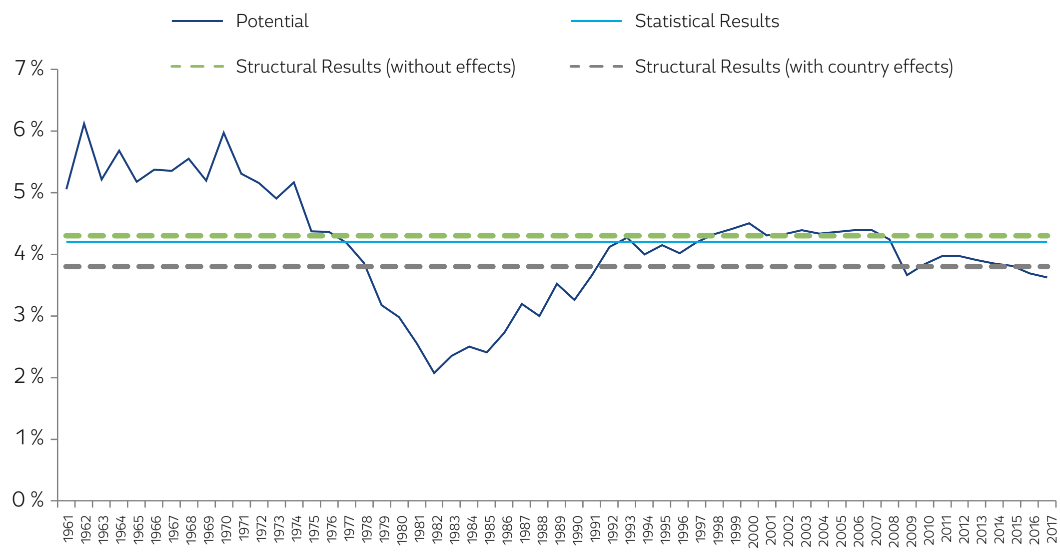
Year	Modified Hodrick-Prescott Filter		Production Function	Regime Switching	BMA 1		BMA 2		Average
	V	W			No Effects	Country Effects	No Effects	Country Effects	
1961									
1962									
1963									
1964									
1965									
1966									
1967									
1968									
1969									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									

[18] This is as expected given the R-squared values in Table 3.



Note: Light to darker blue represents an observed growth slightly, one standard deviation, and two standard deviation below from its potential, respectively. Light to darker red represents an observed growth slightly, one standard deviation, and two standard deviation above from its potential, respectively. Light gray shows coincidence.

Figure 5. CADR: Potential Growth



Source: Own estimations.

It is not possible to rule out a pre-pandemic new normal in CADR, this slowdown is evident since the 2008-2009 crisis, the outcomes from the statistical and structural approaches underscore two pre-pandemic stylized facts. On the one hand, the statistical methods show higher potential growth than structural models, indicating both a favorable context that CADR experienced and that the region would be closer to structural growth during a less favorable environment. On the other hand, most of the individual effects are negative: Therefore, in recent years these particularities seem to be making potential growth lower than it should be.

This approach accounts for particularities and allows concluding their presence; nevertheless, it does not identify specific determinants per country that might be causing dissimilarities in growth. Some researchers have attempted a growth diagnostic framework to identify binding constraints in the region, as shown below.

For Central American countries, Guasch, Rojas-Suárez, and Gonzales (2012) identify innovation, knowledge transfers, infrastructure or logistics, education or human capital, and crime or weak governance as critical areas to improve. Martin (2015) suggests that the high cost of capital, the anti-export bias,[19] and the poor road and port infrastructure are limiting the growth of Belize. For Costa Rica, Beverinotti et al. (2014) find that infrastructure, scarcity of skilled labor in strategic areas, inadequate production linkages of small/medium companies with transnationals (free trade zones), and the fiscal deficit are constraining the economic growth. Also, Inchauste, Morena, and Stein (2009) and Asocio para el Crecimiento (APC, 2011) conclude that coordination problems between investment-promoting agencies, business training institutions, universities and the private sector, as well as crime and violence issues and low productivity in the tradable goods sector are restricting the growth in El Salvador. Sánchez, Scott, and López (2016) show how socioeconomic fragmentation, limited job opportunities, problematic human capital accumulation, limited capacity for provision of public goods, and occurrence of natural disasters are harming the growth of Guatemala (a performance widely shared with El Salvador, Honduras, and Nicaragua).

[19] More incentives to the domestic market than to the export sector.

On the other hand, studies focused on productivity in the region (Schipke and Desruelle, 2007, and Sosa, Tsounta, and Kim, 2013) conclude that the productivity levels have not been sufficient to drive more growth.[20] Table 7 summarizes some constraints of economic growth exposed in recent literature.

Table 7. Main Particularities Suggested by Authors

	Infrastructure	Human Capital	Crime and Violence	Exposure to Natural Disasters	Provision of Public Goods	Costs of Investment	Productivity
Central America: Guasch, Rojas-Suárez, and Gonzales (2012)	X	X	X				
Belize: Martin (2015)	X					X	
Costa Rica: Beverinotti et al. (2014)	X	X				X	
El Salvador: Inchauste, Morena and Stein (2009), and APC (2011)		X	X			X	X
Guatemala: Sánchez, Scott and López (2016)		X		X	X		

Conclusion

Central America and the Dominican Republic have been experiencing a decline in potential growth. Statistical and structural approaches (Hodrick-Prescott filter by constrained minimization, production function, regime-switching models, and Bayesian model averaging) confirm the aggregate slowdown. This context could be understood as a pre-pandemic economic new normal in the region. Nevertheless, the findings suggest mixed results by country.

Most countries show a relative deacceleration of observed and potential growth and pre-pandemic macroeconomic conditions hindering their recent shock response. This situation constitutes another issue to highlight; the economic effects of the pandemic on the region could deepen the aggregate slowdown of the potential growth.

I identify at least two stylized facts: firstly, statistical models show higher potential growth signaling that in a less favorable context, the region would be closer to the structural growth; secondly, it is essential to consider particularities that might be structurally limiting potential growth. The approaches in this paper account for specificities and allow to conclude their presence, still, these methodologies do not identify specific determinants per country that might be constraining and causing dissimilarities in growth. This concern is an open gap that valuable further research should explore and fill in.

[20] For Honduras, Quijada and Sierra (2014) get the same conclusion. See Prat and Solera (2017).

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Appendix

Table A1. Sample (Initial Year)

Country	Modified Hodrick-Prescott Filter		Production Function	Regimen Switching
	V	W		
Belize	1960	1960	1980	1960
Costa Rica	1950	1950	1950	1950
Dominican Republic	1951	1951	1951	1951
El Salvador	1950	1950	1975	1950
Guatemala	1950	1950	1950	1950
Honduras	1950	1950	1970	1950
Nicaragua	1950	1950	1980	1950
Panama	1950	1950	1969	1950

Table A2. Summary of Variables

Category	Description	Mean	Standard Deviation	Min.	Max.
Dependent	• Real GDP growth (%). World Bank	3.9	4.8	-50.2	35.2
Growth Theory (from theoretical models)	• Technological gap with the United States. Constructed as one minus the ratio between the country's labor productivity in relation to that of the U.S., multiplied by 100. Labor productivity represented by real GDP per worker. Calculated with data from PWT 9.0	61.4	48.2	-945.3	98.8
	• Capital-labor ratio growth (%). Calculated with data from PWT 9.0	2.8	4.3	-20.6	45.5
	• Human capital growth (%). PWT 9.0	0.9	0.7	-2.4	5.8
	• Growth trend of the working age population (%). Obtained by applying the Corbae-Ouliaris filter, with parameters for annual data, on the log of the working age population after which the log-difference rate was approximated. Calculated based on data of the World Bank.	1.9	1.6	-2.6	20
	• Patent grants (number). Proxy for investment in research and development. WIPO	7187	27018	1	300678
Convergence	• Initial GDP per capita by decade (dollars/person). Using real 2010 GDP and the total population. World Bank	11055.6	15613.9	171.3	115003.2
Educational System	• Public spending on education (% GDP). UNESCO	4.5	1.9	0.8	44.3
	• Gross enrollment ratio, primary (%). UNESCO and calculations based on data from INIDE (Nicaragua)	99.5	17.2	15	165.6
	• Gross enrollment ratio, secondary (%). UNESCO and calculations based on data from INIDE and CNU (Nicaragua)	69.2	32.5	1.4	164.8
	• Gross enrollment ratio, tertiary (%). UNESCO and calculations based on data of INIDE and EMNV (Nicaragua)	27	23.2	0.1	110.3
	• Pupil-teacher ratio, primary. UNESCO	27.9	12.6	8.9	87.5
	• Pupil-teacher ratio, secondary. UNESCO	18.2	7.3	6.9	70.4
	• Average schooling of the population over 15 years, total (years). Barro and Lee (2013) and calculations from linear interpolation	6.7	3.1	0.2	13.6

Category	Description	Mean	Standard Deviation	Min.	Max.
Economic Openness	• Overall globalization (index, 1-100=maximum). KOF Globalization Index	52	18.6	11.7	92.6
	• Economic globalization (index, 1-100=maximum). KOF Globalization Index	52.1	19.2	9.1	97.1
	• Political globalization (index, 1-100=maximum). KOF Globalization Index	62.6	22.1	6.6	98.4
	• Integration (% GDP). Calculated on the sum of total stocks of external assets and liabilities. Lane and Milesi-Ferretti (2007) and author's calculations as of 2010 using IMF BOP/IIP and WEO	190.2	407.7	5.3	7866.5
	• Integration through foreign direct investment (% GDP). Calculated on the sum of total stocks of assets and liabilities in foreign direct investment. Lane and Milesi-Ferretti (2007) and author's calculations as of 2010 using IMF BOP/IIP and WEO	43.3	190.4	-14.6	5394.3
	• Integration through portfolio equity (% GDP). Calculated based on the sum of stocks of portfolio equity assets and liabilities. Lane and Milesi-Ferretti (2007) and calculations as of 2010 using IMF BOP/IIP and WEO	17.6	84.9	0	2051.2
	• Capital account openness (normalized index, 0-1=no restrictions). Chinn and Ito (2006)	0.49	0.37	0	1
	• Openness (% GDP). World Bank	67	37.7	5	251.1
	• Real exchange rate (index, 2011=1 for United States). Approximated by price levels in real GDP at current purchasing power parity, in millions of 2011 dollars. Values greater than one indicate that the currency value is higher (appreciation) than indicated due to purchasing power parity. PWT 9.0	0.4	0.29	0.02	3.11
Institutional Quality	• Perception of corruption (index, 0-100=low). Transparency International	47.5	22.3	3.3	100
	• Government effectiveness (index, -2.5-2.5=maximum). World Bank	0.28	0.93	-1.73	2.36
	• Size of government (index, 0-10=greater freedom). Economic Freedom of the World - Fraser Institute	6.12	1.48	0.65	9.54
	• Labor market rigidity (index, 0-3.5=more rigid worker protection laws). Campos and Nugent (2012) was used up to 2004; between 2005-2009 data of World Bank-Doing Business was normalized to bring it to the scale of 0-3.5 (with the minimum-maximum methodology); from 2010 the last available calculated data was used (given little variance in the indicator)	1.51	0.62	0	3.5
	• Legal structure (index, 0-10=greater freedom). Economic Freedom of the World - Fraser Institute	5.8	1.7	1.2	9.6
	• Political stability (index, -2.5-2.5=maximum). World Bank	-0.02	0.89	-2.81	1.66
	• Labor market regulation (index, 0-10=greater freedom). Economic Freedom of the World - Fraser Institute	6	1.5	1.8	9.3
	• Regulatory quality (index, -2.5-2.5=maximum). World Bank	0.29	0.89	-2.21	2.08
	• Voice of accountability (index, -2.5-2.5=maximum). World Bank	0.18	0.93	-1.86	1.83

Category	Description	Mean	Standard Deviation	Min.	Max.
Economic structure	• Employment in agriculture (% total employment). ILO - Trends Econometrics Models (Oct. 2013) and World Bank	25.8	23.3	0.1	92.2
	• Employment in industry (% total employment). ILO - Trends Econometrics Models (Oct. 2013) and World Bank	22.7	8.6	2	47.5
	• Employment in services (% total employment). ILO - Trends Econometrics Models (Oct. 2013) and World Bank	51.4	17.8	5.7	83.7
	• Bulk commodities (% Exports of goods). Author's calculations based on Comtrade data (using SITC Rev. 1)	10.3	18.2	0	97.9
	• Fuel and mining products (% exports of goods). Author's calculations based on Comtrade data (using SITC Rev. 1: 27, 28, 3, 68)	20.7	25.7	0	99.8
	• Raw material (% exports of goods). Author's calculations based on Comtrade data (using SITC Rev. 1: 21, 23-26, 29)	5.8	8.4	0	61.6
	• Raw material plus fuel and mining products (% exports of goods). Author's calculations based on Comtrade data (using SITC Rev. 1: 21, 23-29, 3, 68)	26.4	25.8	0	99.8
	• Youth-to-adult ratio of unemployment rate. ILO - Trends Econometrics Models (Oct. 2013)	3	1.5	0.5	13.1

Note: Light to darker gray highlights the variables considered in the BMA 1, BMA 2, or both reductions, respectively. Excepting the convergence variable, the working-age population trend component, and variables associated with institutional factors, the one-period lagged is used to address potential problems of endogeneity.

Table A3. Posterior Inclusion Probability, by Stage in BMA 1

Variable	Initial Run	Intermediate Run 1	Intermediate Run 2	Final Run
Trend of Working Age Population Growth	1.00	1.00	1.00	1.00
Technological Gap with the U.S. (lagged)	0.63	1.00	1.00	1.00
Legal Structure	0.84	1.00	1.00	1.00
Employment in Agriculture (lagged)	0.25	0.98	1.00	1.00
Size of Government	0.65	0.99	0.99	0.97
Political Stability	0.97	1.00	0.99	0.92
Capital-Labor Ratio Growth (lagged)	0.45	0.31	0.35	
Political Globalization (lagged)	0.51	0.54	0.32	
Bulk Commodities (lagged)	0.91	0.38	0.03	
Raw Materials (lagged)	0.36	0.07		
Gross Enrollment Ratio, Tertiary (lagged)	0.94	0.04		
Initial GDP per capita by Decade	0.98	0.03		
Employment in Industry (lagged)	0.31	0.03		
Openness (lagged)	0.18			
Economic Globalization (lagged)	0.12			
Capital Account Openness (lagged)	0.11			

Variable	Initial Run	Intermediate Run 1	Intermediate Run 2	Final Run
Regulatory Quality	0.09			
Gross Enrollment Ratio, Secondary (lagged)	0.08			
Integration (lagged)	0.07			
Fuel and Mining Products (lagged)	0.07			
Gross Enrollment Ratio, Primary (lagged)	0.06			
Labor Market Rigidity	0.05			
Human Capital Growth (lagged)	0.04			
Patent Grants (lagged)	0.04			
Public Spending on Education (lagged)	0.04			
Pupil-Teacher Ratio, Secondary (lagged)	0.04			
Model Space	33554432	4096	256	32
Focal Variables	1	1	1	1
Auxiliary Variables	25	12	8	5

Note: Robust (PIP ≥ 0.5), marginally robust (0.5 > PIP ≥ 0.25), and non-robust (PIP < 0.25).

Table A4. Posterior Inclusion Probability, by Stage in BMA 2

Variable	Initial Run	Intermediate Run 1	Intermediate Run 2	Final Run
Trend of Working Age Population Growth	1.00	1.00	1.00	1.00
Technological Gap with the U.S. (lagged)	1.00	1.00	1.00	1.00
Real Exchange Rate (lagged)	1.00	1.00	1.00	1.00
Openness (lagged)	0.09	0.13	0.10	1.00
Perception of Corruption	0.08	0.16	0.13	
Initial GDP per capita by Decade	1.00	0.30	0.03	
Integration through Portfolio Equity (lagged)	0.36	0.21	0.03	
Capital-Labor Ratio Growth (lagged)	0.13	0.13	0.02	
Voice of Accountability	0.11	0.11		
Youth-to-Adult Ratio of Unemployment Rate (lagged)	0.06	0.08		
Labor Market Rigidity	0.07	0.05		
Labor Market Regulations	0.06	0.05		
Human Capital Growth (lagged)	0.15	0.03		
Bulk Commodities (lagged)	0.79	0.03		
Gross Enrollment Ratio, Primary (lagged)	0.05			

Variable	Initial Run	Intermediate Run 1	Intermediate Run 2	Final Run
Gross Enrollment Ratio, Tertiary (lagged)	0.05			
Average Years of Schooling (lagged)	0.05			
Employment in Industry (lagged)	0.05			
Employment in Services (lagged)	0.05			
Patent Grants (lagged)	0.04			
Gross Enrollment Ratio, Secondary (lagged)	0.04			
Pupil-Teacher Ratio, Primary (lagged)	0.04			
Overall Globalization (lagged)	0.04			
Integration through Foreign Direct Investment (lagged)	0.04			
Government Effectiveness	0.04			
Raw Materials and Fuels and Mining Products (lagged)	0.04			
Model Space	33554432	8192	128	8
Focal Variables	1	1	1	1
Auxiliary Variables	25	13	7	3

Note: Robust (PIP ≥ 0.5), marginally robust (0.5 > PIP ≥ 0.25), and non-robust (PIP < 0.25).