

# Digital economy and technology in the service of the region's development

Economic report on Central America  
and the Dominican Republic

## Coordinators

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# Foreword

The global economy has entered a cyclical downturn. Nonetheless, the region of Central America, Panama and the Dominican Republic has shown relative resilience. The region has benefited from moderate economic growth in its main trading partner, the United States, significant inflows of remittances, increased foreign direct investment and a low international oil price, contributing to low inflation and therefore greater consumption.

The economic outlook, however, is not without risks. Prominent among these are uncertainty about US economic performance and the toughening of US immigration policy, as well as international trade tensions.

In this context of lower growth and uncertainty in the face of external risks, several countries of the region have little fiscal space to implement a countercyclical policy. Other countries, moreover, already need to make fiscal adjustments after a period of economic growth in which public deficits and debt widened.

In view of these issues, and given the priority of improving the population's living conditions, there is a need to find efficiencies in public and private sector operations that could be affected in the present circumstances. With regard to the private sector, these operations include tax collection and the provision of public services. As regards the private sector, they include remittances.

For these reasons, I hereby submit a report that focuses on finding efficiencies in these areas, to which end technology plays a very important role.

The report describes tools to improve the targeting of spending, and to save time and public resources by using new techniques to draw up poverty maps, and maps for productive and social infrastructure, among other uses. It also describes the revenue potential of the digital economy in the region, as well as its characteristics and challenges from a tax standpoint. Finally, it examines the experience of an inter-central bank payments system for remittances in terms of its outcomes in lowering commissions, maximizing the resources received by beneficiaries, and contributing to the proper operation of the local exchange market.

I am pleased to say that the matters identified herein, though they may be disconnected from other complex challenges facing the countries of the region, are priorities in the current circumstances. Moreover, they have the capacity to bring about substantial change in how things are done in each of those countries or, to put it more colloquially, to “move the needle.”

**VERÓNICA ZAVALA**

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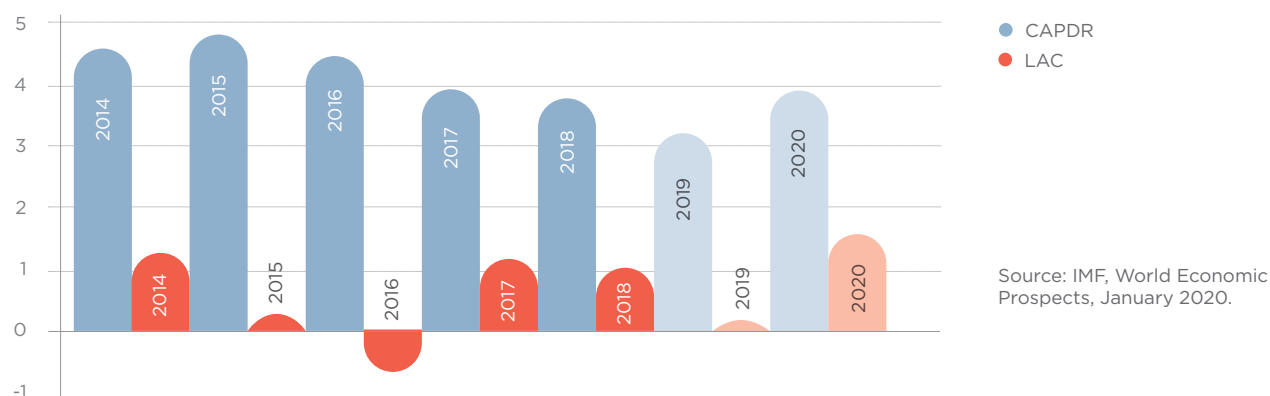
# 1

## The economic environment of Central America and Dominican Republic

The CAPDR region (Central America, Panama and the Dominican Republic) has displayed resilience in an adverse external environment marked by a global downturn in which world economic growth for 2019 is estimated at barely 3 percent. This is the lowest rate since 2009, when the subprime crisis arose. The International Monetary Fund estimates that the economy of the CAPDR region will grow by 3.2 percent in 2019 and 3.9 percent in 2020 (in 2018 it grew by 3.8 percent). The region will therefore continue to grow far above the average for Latin America and the Caribbean (an estimated 0.1 percent and 1.6 percent for 2019 and 2020, respectively), and even above the rate for the global economy (an estimated 3.3 percent for 2020).

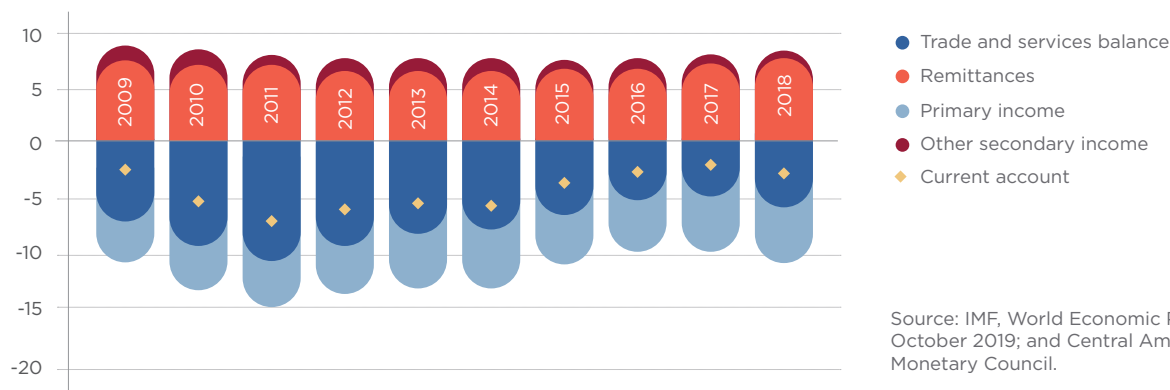
**Figure 1.1** GDP Growth Rate

Annual percentage change



**Figure 1.2** Components of the CAPDR Current Account

Percentage of GDP



Several factors underlie the region's relative resilience. On the one hand, moderate growth in the United States (an estimated 2.3 percent for 2019 and 2.0 percent for 2020) and the positive performance of the Hispanic labor market in the United States (a 4.1 percent unemployment rate in October 2019) support the region's exports and the family remittances it receives. Net remittances to the region grew by 8 percent year-on-year in the first half of 2019, having already grown by 12 percent in 2018.

Remittances, therefore, have substantially reduced the current account deficit.

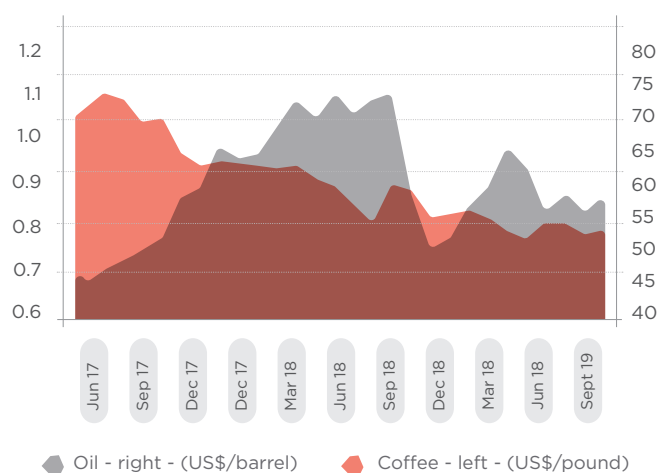
On the other hand, domestic consumption benefits not only from remittances but also from low inflation (2.6 percent year-on-year in September 2019) and a cut in domestic interest rates. The central banks of Costa Rica and the Dominican Republic cut the monetary rate this year by 200 and 100 basis points, respectively, while Guatemala has kept its monetary rate historically low at 2.75 percent.

Another factor underpinning resilience in the region has been the flow of net foreign direct investment (FDI), which grew by 7 percent year-on-year in the first half of 2019.<sup>1</sup> Historically, FDI has helped finance these countries' current account deficits and has averaged 4.1 percent of regional GDP in the past five years.

Finally, it is important to note that the region's terms of trade with the rest of the world were better in 2019 than in the previous year. In particular, the international price of energy products increased in 2018. These products comprise a significant share of imports (the price of a barrel of WTI oil grew by 23 percent in the first half of that year), while the international price of various export products fell. Coffee is notable among the latter products because it accounts for a substantial proportion of the region's exports and its price fell by 12 percent in the year because of a larger world supply. By contrast, the oil price remained low in 2019, partially offsetting the decline in the coffee price. It is worth noting that the international prices of other products that account for a significant share of exports—such as bananas and sugar—have remained stable, while the international price of corn, an important import product, has risen modestly.

**Figure 1.3** International Prices

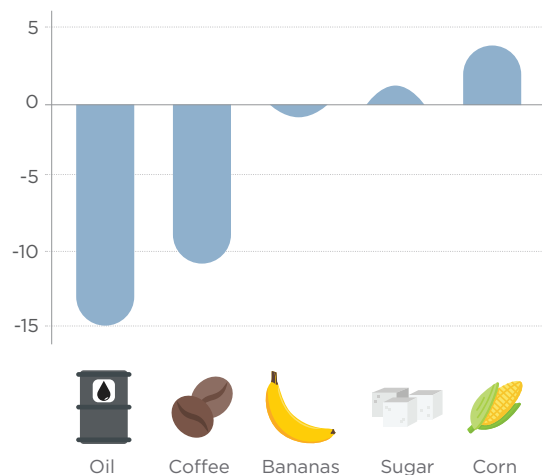
US\$ per unit of measure



Source: St. Louis Federal Reserve on the basis of IMF data.  
Note: oil refers to West Texas Intermediate (WTI).

**Figure 1.4** Annual Change in the International Price in 2019

Percentage change in the January-September average



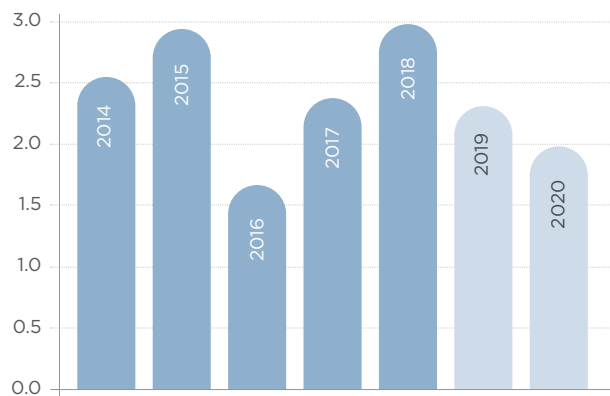
Percentage change in the January-September average

1. Excepting Nicaragua, because of the unavailability of data.

The outlook of growth is not disconnected from the various global risks. Prominent among the factors that could have negative effects on the region are a slowdown in the US economy, a toughening of immigration policies in the United States and other countries in the region, unfavorable developments in the region's terms of trade with the rest of the world, and an increase in global trade tensions. The latter would reduce external demand and lower the international price of various products that are important for the region's exports.

**Figure 1.5** GDP Growth in the United States

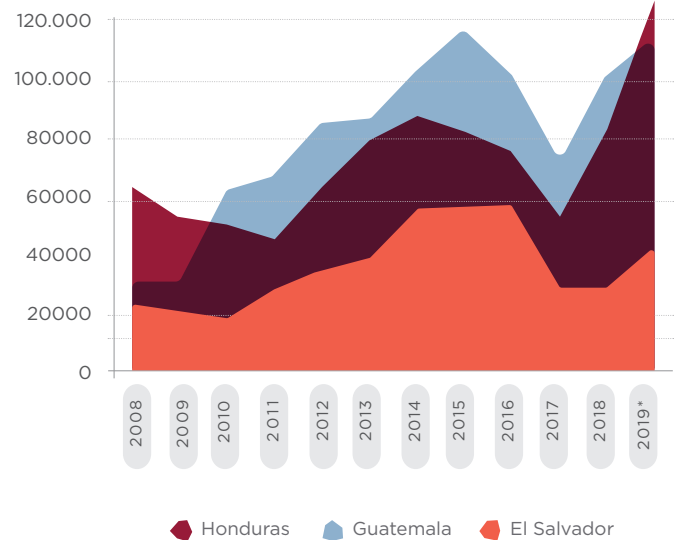
Annual percentage change



Source: IMF, World Economic Prospects, January 2020.

**Figure 1.6** Number of deportations

Persons



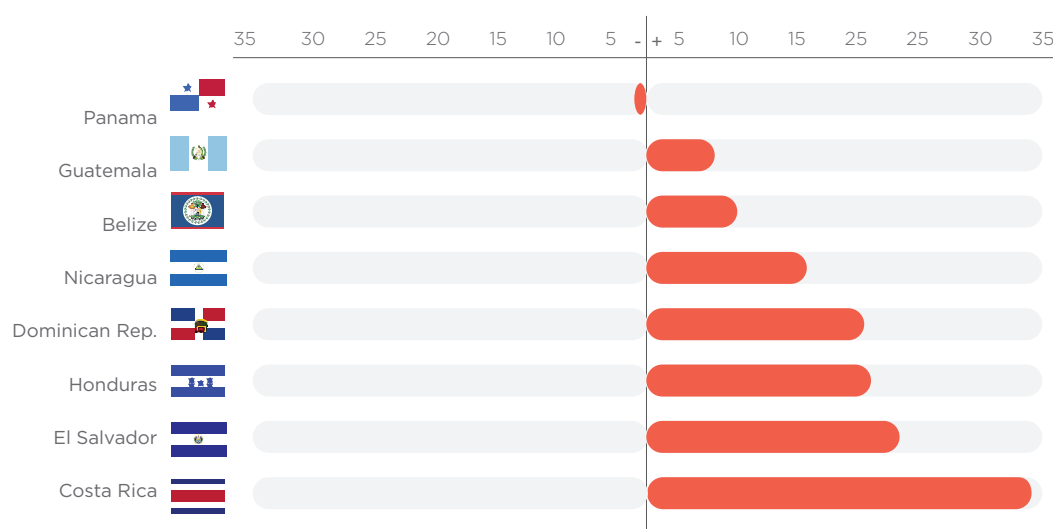
Source: Northern Triangle Information Management Initiative. \*Annualized on the basis of third-quarter data.

With regard to the toughening of immigration policies, it is important to note that this could lead to a greater number of deportations. Remittances might therefore increase in the short term, given the greater prospect that senders might be deported, but in the medium term they could decline.

In this context of downturn and uncertainty in the face of external risks, most countries of the region have limited fiscal space to implement countercyclical measures, though the capacity to do so varies among them. Several of them, moreover, face the challenge of reducing their fiscal deficits and public debt after a period of expansion in a benign (and now waning) environment of economic growth. In these circumstances, and at a time of a latent increase in global risk aversion, it is very important to maintain sound economic fundamentals in order to avoid a deterioration in the countries' financial conditions. To that end, one of the most pressing matters is to strengthen the fiscal position. It is positive that some countries of the region have monetary policy space to support economic activity in a context of low inflation and anchored expectations of inflation.

**Figure 1.7** Public Debt: Difference between 2019 and 2008

Percentage of GDP



Source: IMF, World Economic Perspectives, October 2019.

Given the budget constraint and the need to provide public services and development opportunities in order to improve the wellbeing of the region's population, it is important to seek other alternatives. One of these is to increase the efficiency of operations in the public and productive sectors that might be affected in this environment. Technology can be a very useful tool in increasing efficiency. The following chapters therefore analyze how technology creates efficiencies and offers opportunities to the region, especially in two areas that, as mentioned above, face complex circumstances: public finances and remittances. With respect to public finances, efficiency can be sought in both revenue and expenditure. As regards revenue, the analysis below discusses how to exploit the revenue potential of the digital economy. Most particularly, it estimates revenues from the digital economy in CAPDR, describes its characteristics from a fiscal perspective, and presents the challenges posed by the main taxes and the experience of levying them in various countries.

As regards public spending, this report explores tools to improve its targeting and efficiency, particularly with respect to the targeting and provision of public services, as well as to reduce costs and save time. The issues analyzed include drawing up poverty maps, public investment, social infrastructure and housing deficits, among other matters, with particular attention to the countries of the region.

With regard to remittances, the report presents the experience of a system of international transfers between central banks as a tool to maximize the amount of resources available for beneficiaries and to aid the proper functioning of the exchange market.



In short, although the region faces substantial structural challenges, it also faces challenges posed by current circumstances. These arise from global changes such as the toughening of immigration policies, the digital economy, and fewer public resources because of the weaker cycle stemming from trade tensions. This report focuses precisely on these latter challenges, to which it proposes solutions that could be a source of transformation in these fields.

# 2

## Technology to improve the efficiency of public and spending and service provision



In a context of less fiscal space in the Latin American and Caribbean countries, technology use is increasingly advocated as a viable means of saving fiscal resources and making public spending and service provision more efficient. The use of big data, such as cell phone traffic and satellite images, supports efforts towards this goal in two ways:

**it significantly reduces the expense and time required to produce analyses of income distribution at the national and subnational levels**

**it enables social programs to be targeted better, and allows public services to be provided to the geographic areas that need them most.**

### Reducing the time and costs involved in income analysis through survey

It is very costly to produce reliable and regular poverty estimates at the national and subnational levels. Kilic et al. (2017) estimate that the direct cost of interviewing a household in Latin America is US\$ 105, although in countries like Guatemala it can be as high as US\$ 134 per interviewed household. Added to this are the administrative costs of producing a survey, which average US\$ 613,000. Taking into account the direct costs and the average administrative costs in the region, it costs US\$ 2 million to produce an income survey in a medium-sized country. In addition to the cost associated with conducting surveys, the data collection period can be long. Collecting data for an income or expenditure survey, for example, can take up to 12 months (World Bank, 2017).

Conducting frequent and reliable surveys is therefore prohibitive for many countries in the region, precisely because of the cost and time involved in producing them. Fifty-seven countries, for example, produced one or no poverty estimate between 2002 and 2011 (Serajuddin et al., 2015). This causes persistent “information gaps” in the poverty statistics, despite the efforts of governments and international agencies to increase data production. Partly because of the high cost, poorer countries usually have the worst poverty statistics. They are not collected often enough to underpin policies properly; nor do they cover wider geographic areas than necessary with a view to tackling pockets of poverty, which are often isolated from the areas covered by the survey (Serajuddin et al. 2015).

In response to the high cost and the limited technical capacity to produce these surveys, many researchers have proposed using big data to generate poverty statistics at the subnational level, by means of poverty maps that use cell phone traffic (Blumenstock et al., 2015) or satellite images (Jean et al., 2016; Engstrom et al., 2017). These methods, however, used to depend on the acquisition of high-resolution satellite images (very high-resolution satellite images—defined as a pixel size of less than 50 centimeters—can cost up to US\$ 20 per square kilometer) or databases of cell phone traffic owned by telephone companies, which did not used to have wide coverage in developing countries. For a statistical agency in the region that does not have US\$ 2 million to conduct a survey, the alternative of acquiring expensive databases, such as high-resolution satellite images, was also not a viable option.

## How can technology help reduce these costs?



In recent years, technological advances have made it much cheaper to access the big data analyses used to measure income, such as satellite imagery, cell phone metadata, including call detail records (CDRs), and data gathered by web portals such as Facebook, Twitter and Wikipedia.

As regards satellite images, there is broader access to free, medium-resolution imagery that can be used for analysis. This is the case of the Sentinel-2 sensor, consisting of two satellites operated by the European Space Agency, which have been used by the IDB to build poverty maps in Belize. That experience is described in more detail below.

Additionally, open source methods can now be used to combine free satellite images and survey data with machine learning models. The process consists of extracting characteristics correlated with the income level of local areas from the satellite images, such as the physical features of a neighborhood (the material used to build the houses, for example, the height of the buildings, or the quality of the roads), combined with time-series information on rainfall patterns or observed patterns of vegetation in the year before the survey. Once these images are processed, advanced machine learning models are used to predict household income using the characteristics obtained from satellite images, as well as from the surveys or censuses available in the country.

The use of satellite images has some advantages over traditional surveys. First, satellite images capture nationwide information, whereas surveys can exclude remote parts of the territory. Second, satellite data can capture important income-related information that is not apparent in traditional surveys, such as drought conditions



in remote agricultural areas. This is particularly important for Latin American and Caribbean countries, where poverty is more severe in rural areas that depend on agriculture. Finally, the granularity of satellite-image estimates is increasing, making it possible to capture changes in income-related variables more precisely and more often.

With regard to analysis using cell phone metadata, coverage was confined to the developed world until a few years ago but, as it has become more affordable, even the most remote areas now have access to mobile telephony; many households have made the transition from fixed to mobile telephony. The same is true of information on web portals, the use of which continues to expand in developing countries.

Cell phone calls and telephone data use have been shown to be closely correlated with the population's income. It should also be noted that variables such as subscription type (for example, whether telephones are postpaid or prepaid) and per-user spending (average billing per user, for instance) can predict changes in the income trend and reflect the impact of shocks on household income. If these variables are combined with machine learning models, changes in household income can be calculated. In addition to their broad national coverage, CDRs have the advantage (relative to satellite images) of providing information on intrahousehold dynamics and measuring household behavior in real time.

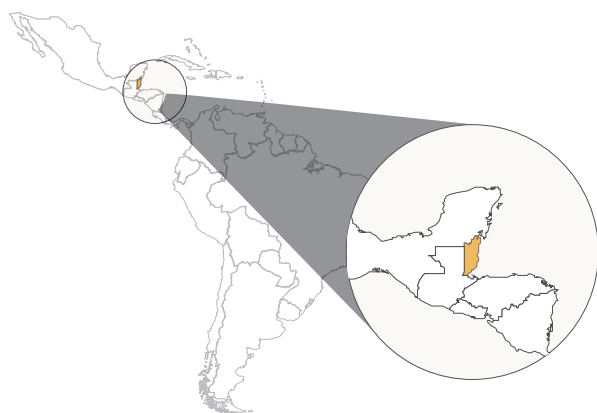
In both cases, these methods have revolutionized poverty-mapping methodologies, entailed a significant reduction in costs, and overcome the challenge of data availability. Despite this, translating these big data measurements (whether they come from satellite images, cell phone towers or online behavior) into poverty statistics is not easy. Often, this requires the use of machine learning techniques to transform the big data into identifiable characteristics, and to develop robust mapping between the variables derived from big data and poverty measurement (Harding and Hersh, 2018). This means that, even if the costs of the inputs to produce the poverty maps are zero, there is a fixed cost associated with developing the models and the data processing. That cost tends to decrease over time.

It is worth mentioning that there are several data portals such as DigitalGlobe's GBDX and Planet's PlanetScope. These automate some of the data processing tasks and thereby facilitate access to this kind of analysis.

International organizations such as the IDB have been using these technologies and familiarizing decision-makers with them, so as to expand the range of tools available to increase the efficiency of public policies. The following section describes some applications in the countries of the CAPDR region.

**Satellite images**  
have revolutionized  
poverty-mapping  
**methodologies**

## Poverty maps with satellite imagery and cell phone calls: the cases of Belize and Guatemala



BELIZE



Belize is an excellent example of a country in which big data and machine learning are powerful tools to create low-cost poverty maps. Belize's last nationwide poverty diagnostic was conducted in 2009, when the national poverty rate stood at 41.3 percent. The subnational poverty estimates of 2009 were carried out solely at the district level. Although Belize conducts a labor force survey every six months, there are no income or consumption surveys available in the country, and no subnational estimates have been available since 2009.

Belize's last nationwide poverty diagnostic was conducted in 2009, when the national poverty rate stood at

**41,3%**

In 2019, therefore, the IDB, together with academics from Georgetown and Chapman Universities and with the Statistical Institute of Belize, launched a project to create poverty maps using satellite images. The project's main feature is that it used free satellite images from the Sentinel-2 sensor, which is operated by the European Space Agency, and MODIS (Moderate Resolution Imaging Spectroradiometer), which is owned by the National Aeronautics and Space Administration (NASA). Both satellites offer global coverage and frequent overflights. The Sentinel-2 sensor, for example, observes the Earth's entire land mass every five days, while MODIS provides images of the entire land mass twice a day.

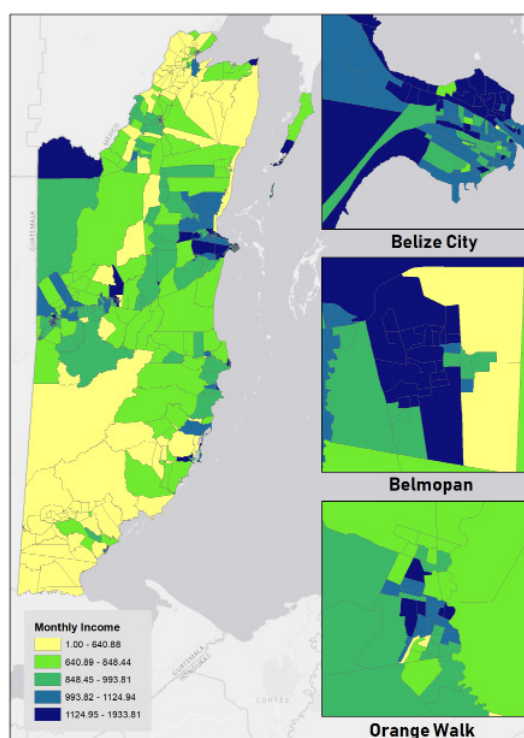
Once the relevant features are extracted from these images, the project follows the small area estimation method that combines information from two periods of the labor force survey (which covers only part of the territory) with the 2009 census. Four machine learning models are then used: Ridge, Elastic Net, Random Forests, and Extreme Gradient Boosted Trees, as well as a fifth model that combines the other four. The aim is to find correlations between the satellite images and the census data, and to predict household income. Poverty maps are thereby estimated at the level of enumeration districts (EDs), whose boundaries are smaller than those of the districts. These include 423 spatial characteristics and 203 time-series characteristics derived from the sensors, with 37 survey variables.

The model's accuracy is assessed by means of both the data used to estimate the models (that is, the training data) and the data used to validate the model (the test data). The model's accuracy with data that are not used to estimate the model (out-of-sample) has to be assessed in order to ensure that the models eventually built are representative at the country level. The results of this study indicate that the models explain 90 percent of the variation in the EDs' income in the training data and 55 percent in the validation data.



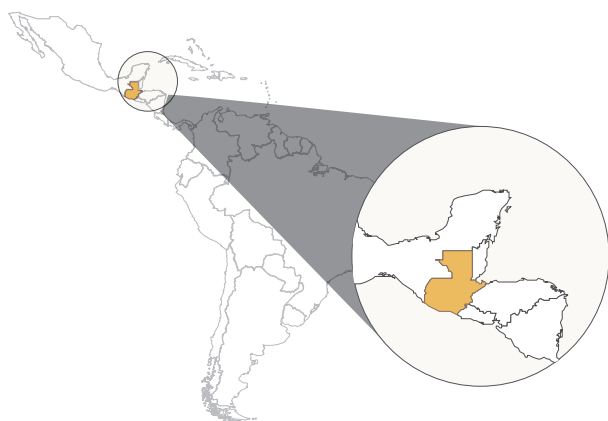
The results show relative poverty in Belize at the ED level, the poorest districts being Corozal in the north and Toledo in the south (see Figure 2.1). In the most recent poverty map published by the government of Belize in 2009, the districts with the highest poverty rates were Corozal, Orange Walk, Stann Creek, and Toledo. Comparing the updated map and the 2009 map, a significant reduction in poverty is apparent for the districts of Orange Walk and Stann Creek. Given that the new poverty map has a higher resolution than the 2009 map, and since the results are shown at the ED level and not just at the district level, the map indicates a wide diversity in poverty at the district level.

**Figure 2.1**  
Income Estimates for Belize  
at the ED Level of the  
Combined Model



Source: Hersh et al. (2019).

This project shows that using satellite imagery to build poverty maps works in Belize and is cheaper than traditional methods. This approach can easily be used in other countries. The countries that could benefit most are those with significant rural populations, where traditional surveys might not be capturing variations in income. To some extent, poverty maps produced using satellite images and surveys serve as substitutes. For countries that conduct income surveys often, the benefit of producing poverty maps with satellite images is less than for countries that conduct them infrequently.



## GUATEMALA



Guatemala is another Central American country that offers an excellent example of the limits of traditional data collection. Although a census was held in Guatemala in 2018, the previous population and housing census dated from 2002 and, before the census, all national data on poverty were derived from only four household surveys conducted in the past 25 years. Conducting these surveys entails significant costs. The 2014 ENCOVI (Encuesta

Nacional de Condiciones de Vida) household survey, covering 11,500 households, cost about US\$ 2 million and took approximately two years to complete. In 2017, therefore, the World Bank decided to carry out the first analysis of poverty maps in the country using CDRs.

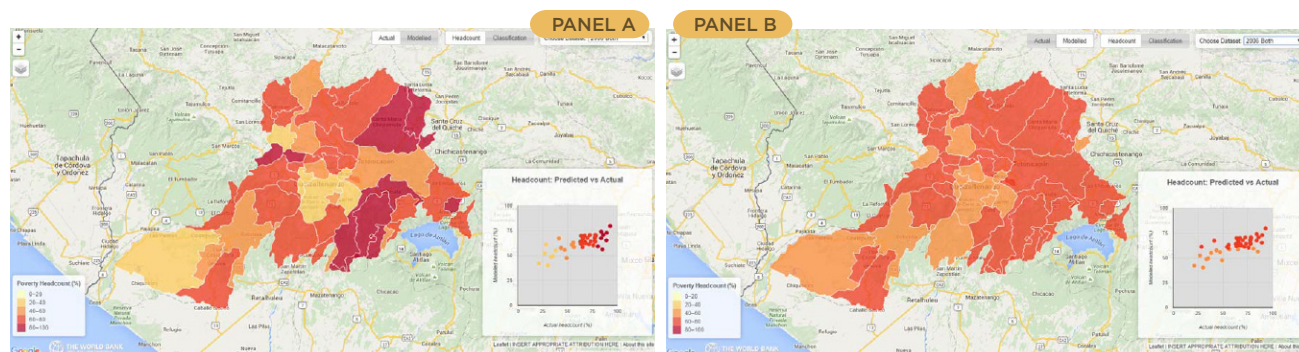
The main results of the poverty mapping revealed that the analyses carried out with CDRs could predict poverty in Guatemala. In all the models used, CDR analysis consistently predicted poverty rates at the municipal level (see Figure 2.2). In the best model, for instance, 76 percent of the variation in poverty rates at the municipal level could be explained by cell phone data for 2013. Another important result of the study was that CDRs predicted urban and total poverty more accurately than rural poverty. CDR data could account for only 25 percent of the variation in rural poverty. This outcome contrasts with the Belize study, in which poverty maps devised from satellite imagery improved rural poverty estimates. The study offers two possible reasons for this:

CDRs predicted urban and total poverty more accurately than rural poverty.

1. cell phone penetration rates in urban areas tend to be higher, and CDR-based analyses therefore model poverty more robustly in urban areas

2. urban areas tend to have more cellular antennas per square kilometer, resulting in smaller polygons. The bigger polygons in rural areas tend to reduce the granularity of the data and to aggregate behaviors, weakening the algorithm's predictive power.

**Figure 2.2** Observed Poverty Rates (Panel A) and Poverty Rates Estimated by CDR Analysis (Panel B) for the Municipalities Included in the Exercise



Source: Hernández et al. (2017).

**CDR analysis can add value** by providing very frequent updates and complementary information

One of the matters highlighted by the study is that, although this was the first such analysis in Guatemala and was designed mainly to test the validity of various methods, a more comprehensive exercise would only require a small fraction of the time, funding, and human resources needed for a traditional census or survey. Moreover, the authors emphasize that these costs would probably be even lower in later iterations of CDR analysis, because methodological innovation and testing would be replaced by the routine implementation of established techniques. In contrast to ENCOVI's cost of US\$2 million, the CDR analysis amounted to US\$ 100,000 and most of the spending was related to developing the logarithm, which is a fixed cost.

CDR analysis cannot completely replace conventional research methods, but it can increase their value by providing very frequent updates and complementary information. Furthermore, if it can be shown that CDR analysis provides sufficiently accurate inferences to allow countries a little more time between traditional surveys, this could be a net saving for the national research budget.

## Better targeting of public spending and service provision



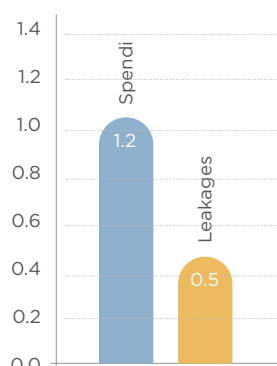
### Public spending inefficiencies in Latin America and the Caribbean

According to Izquierdo et al. (2018), about 30 percent of public spending in Latin America and the Caribbean (US\$ 700 billion) is for transfers, including social programs, conditional cash transfers (CCTs) and non-contributory pensions (NCPs), subsidies to businesses (mainly energy subsidies) and contributory pensions. This is the largest expenditure item in the region.

Unfortunately, because of errors, fraud and corruption, much of this spending does not reach the people who need it, lessening the economic efficiency of the

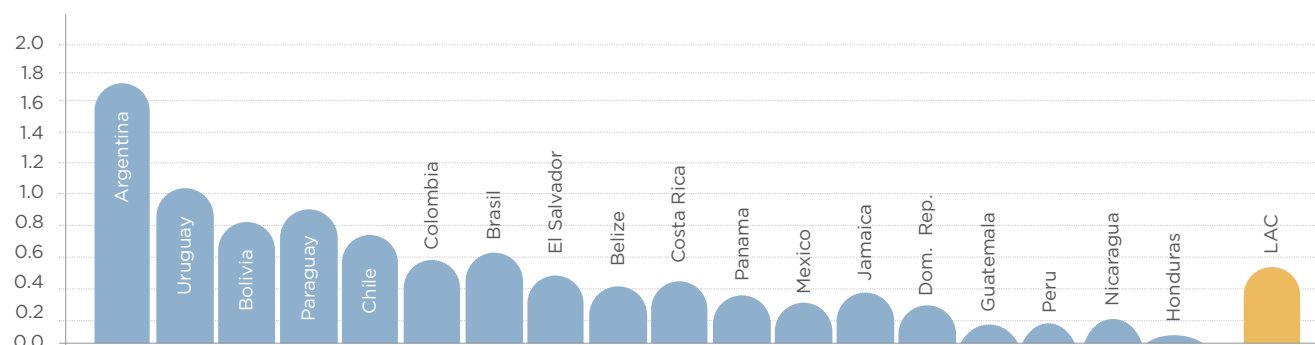
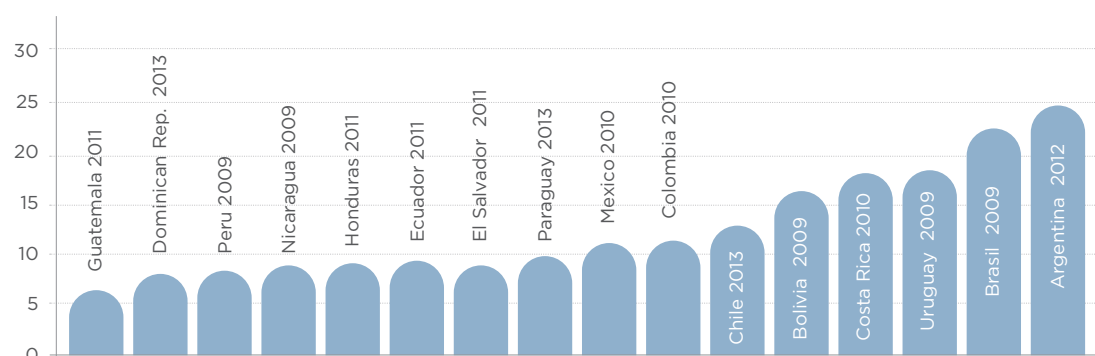
**Figure 2.3**

Average Spending on Social Programs and Leakages in LAC (% of GDP)



interventions. Targeting errors, which result in some of the funds reaching people who are not poor or do not need the program, can arise for two main reasons: (i) inadequate program design, such as not using appropriate indicators to identify poor beneficiaries; and (ii) inadequate program implementation, whereby eligibility decisions diverge from the rules of the program. In social protection programs, such as pensions or unemployment benefits, mistakes are less important.

Within social programs, CCTs and NCPs are the two main expenditures. According to this study, in the sample of 18 countries, these expenditures accounted for 1.2 percent of GDP in 2015. A little less than half of this spending, however, amounting to 0.5 percent of GDP, is received by non-poor families (Figure 2.3). Leakage tends to be lower in Central American countries, averaging 0.27 percent of GDP, and higher in South American countries, averaging 0.86 percent of GDP (Figure 2.4). As Figure 2.5 shows, however, social spending in South America is considerably higher than in Central America.

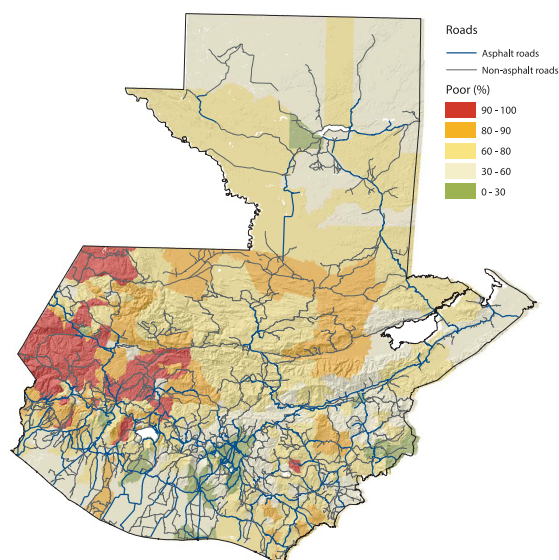
**Figure 2.4** Leakages in Targeted Spending on Social Programs (% of GDP)**Figure 2.5** Total Social Spending (% of GDP)

Source: Izquierdo et al. (2018).

The use of poverty maps for government planning and resource allocation is not a new concept for Latin America and the Caribbean. As early as 2002, Henninger and Snel brought together 14 case studies from countries in Africa, Asia and Latin America, reporting their use in a wide range of geographical and institutional settings. For example, Guatemala used poverty maps to restructure the Public System of National Investment, with a view to improving the geographic targeting of US\$ 576 million in social spending during fiscal year 2002.

The World Bank used these poverty maps to develop the country's roadbuilding strategy and thereby guide the US\$ 100 million investment. In that exercise, overlaying poverty maps with highway data showed that poverty in Guatemala was highly correlated with the lack of roads, resulting in significantly longer travel times and lack of access to basic services (Figure 2.6). Panama used poverty maps to help target US\$ 150 million of Social Investment Fund expenditures between 1997 and 2001. In that case, the poverty estimates were used to target investments in schools, health centers and roads in the country's poorest districts.

**Figure 2.6**  
Overlaying Poverty  
Maps and Road  
Data in Guatemala



Source: Henninger and Snel (2002).

**Technology** has made it possible for these maps to be **updated often and at a lower cost**

So then, if governments have been using these maps for a long time, what has the technology changed? Technology has made it possible for these maps to be updated often and at lower cost, covering the whole country and increasing the granularity of the measurements. Without these technologies, the maps are usually based on population censuses that cover the entire country but that eventually become obsolete before the next census takes place.

Moreover, producing maps using technology can be key to increasing the effectiveness of poverty reduction programs. These include not only direct or conditional transfer programs, but any fiscal policy that has poverty reduction as its goal. Because the success of these programs and policies lies in directing efforts towards the poorest areas of the country, their effectiveness depends on accurate information about



the location of poor areas and households. Poverty maps in Belize illustrate how technology can improve this targeting. In Belize, the models substantially improve the accuracy of income estimates for the poorest households when they include variables from satellite imagery and not just from surveys. This indicates great potential for identifying the poorest households among poor households. This ability to distinguish the poorest households accurately is critical to the effective targeting of poverty interventions.

Poverty maps developed with technology, therefore, can help improve the design of the sample framework on which basis the means tests are applied, thus ensuring that the poorest areas of the country are not excluded from the direct transfer system (Bah et al., 2018). For example, the standard method of allocating direct transfers involves a proxy means test, in which household characteristics are used to rate the household's poverty status in the absence of a consumption survey (Grosh and Baker, 1995). If the areas where the means test is applied are better defined, resource efficiency can be increased and fiscal resources can be saved.

Additionally, the effectiveness of these transfers depends on the speed with which the resources reach households in the event of a negative shock to the households' income (Bazzi et al., 2015). Because these negative shocks can be varied, up-to-date poverty maps can significantly help increase the effectiveness of the targeting.

Another benefit of producing frequently updated poverty maps is ensuring that information about the geographic location of lower-income areas is transferred to upper levels of government and public policymakers, as well as to all those involved in the implementation of development projects in the country. This is essential if one of the goals of fiscal policy is to reduce poverty, such as centralized transfers to support the building of schools in poor neighborhoods, or infrastructure that enables those schools to connect to the internet.

These maps are even more useful in view of the decisions that must be taken at different levels of government in a country. Local representatives, for example, can come to know which areas are the poorest in their political constituency and can design programs to tackle poverty or increase public services, using local resources efficiently. This subnational poverty information, however, might not be transferred properly to local levels of government.

If poverty maps are updated frequently, the relative effectiveness of efforts to combat poverty and provide public services can be measured. Such measurement can help improve the efficiency of fiscal spending and increase its effectiveness. This is because the costs of these policies are generally known but accurate measures of income at the subnational level are needed to assess the programs' benefits, since aggregate statistics can hide many factors unrelated to the anti-poverty policies implemented in the country.

As we will see in the next section's examples, big data methods such as information from satellite images, combined with census and survey variables, are not confined to measuring poverty. These methods can be extended widely, and can be used in an array of fields such as the planning of housing and telecommunications infrastructure, or even devising strategies to reduce crime.

Frequently **updating of poverty maps** ensures that information about the geographic location of lower-income areas **is transferred to policymakers**



## Applications for better resource allocation and public service provision: housing in Guyana, telecommunications infrastructure in Honduras, and crime in El Salvador

### HOUSING IN GUYANA

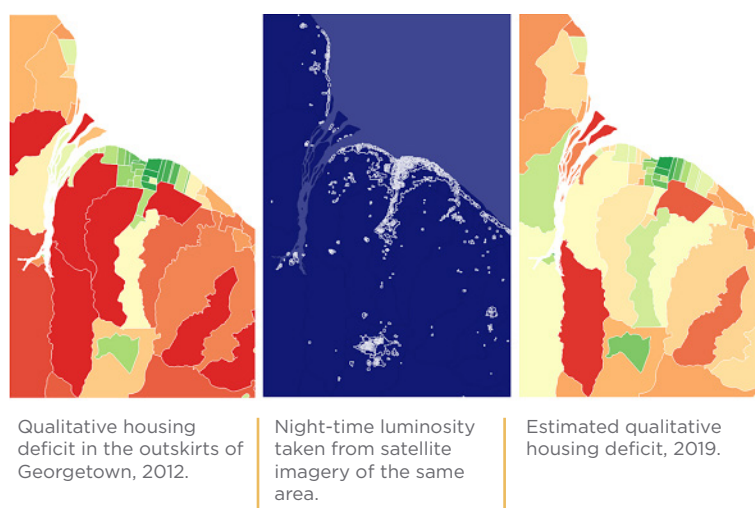


The IDB has developed various tools to calculate the housing deficit in Guyana and design an urban strategy by using satellite images and census data. With regard to the former point, the aim is to have detailed information on housing needs, which so far has not been available.

The lack of information on housing needs leads to “blind” planning and to errors such as building houses far from places where there are jobs and services—when the problem probably would have been solved if the residents had received a subsidy to make improvements in the relatively better-located homes where they already lived.

The housing deficit estimator that was created uses a methodology based on a similar exercise conducted by Colombia’s Department of Statistics, which wanted to numerically standardize the quantitative and qualitative national housing deficit by the smallest available administrative division. Applying it to Guyana, one of the findings is that the qualitative housing needs that have to be tackled (low-durability materials, lack of access to services, and so on) are much more pressing than quantitative needs (the availability of any kind of housing). Finally, applying the housing deficit estimator that uses night-time satellite images as an approximation of the urban environment and infrastructure, qualitative housing needs are estimated in years when census data are not available (see Figure 2.7).

**Figure 2.7**  
Housing Deficit  
Estimator in Guyana



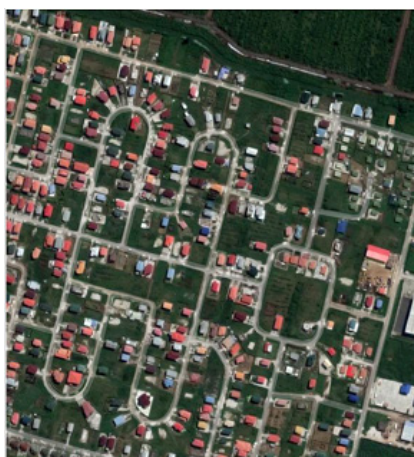
Source: IDB (2019a).

Guyana's urban planning is also being supported by the creation of a model to detect buildings. Urban planners often lack current digital maps of existing buildings and structures. The building detection model can automatically generate a basic map of buildings from satellite images, enabling planners to create detailed digital files of remote and hard-to-reach areas, such as Guyana's hinterland. As well as creating a map of existing structures, urban planning and housing agencies can use the model's outputs to estimate population size, neighborhood density or access to resources, as a basis for extrapolating household-level information. Moreover, these estimates can help in tackling subsequent tasks, such as measuring and detecting unplanned or informal urban growth, and informing planned interventions and the provision of urban ecosystem services to such areas.

The model, which uses automatic learning techniques for basic categorization, was calibrated on data from Paramaribo (Suriname), Georgetown (Guyana) and Belize City (Belize). These cities have similar climates, vegetation, architectural styles and urban patterns (see Figure 2.8 for an example of the resulting map).

**Figure 2.8**  
Building Detection  
Model in Guyana

Source: IDB (2019a).



Regular satellite image.



the building detection model colors the buildings it has identified



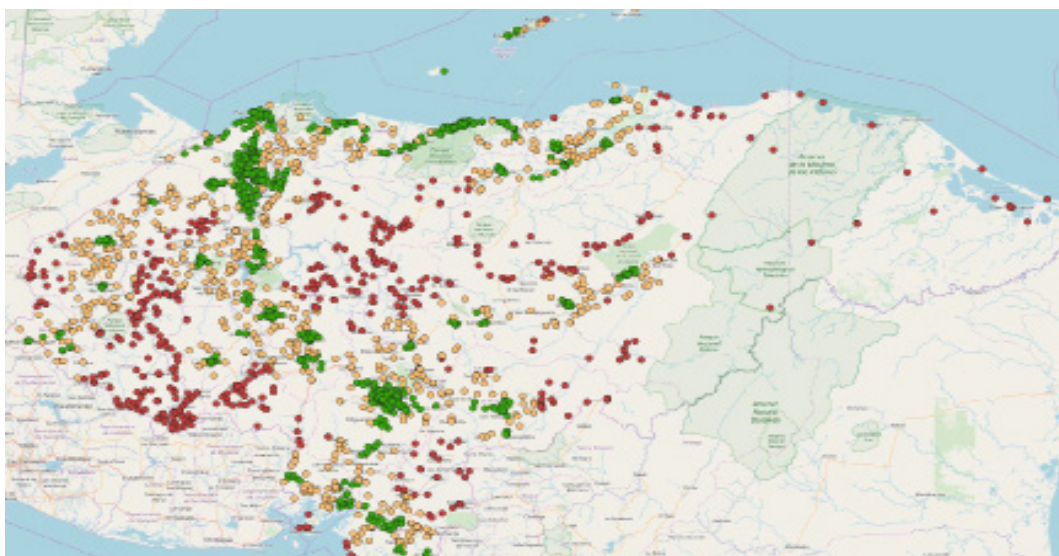
#### TELECOMMUNICATIONS INFRASTRUCTURE IN HONDURAS

In order to analyze broadband information and communications technology infrastructure services in Honduras, an analysis of the broadband market was carried out by developing municipal-level maps: in this case, maps on the 3G and 4G broadband coverage of the country's main providers, TIGO and Claro. The analysis includes a study of market shares per mobile operator and the prices of broadband services. Later,

using penetration data, a calculation was made of traffic demand from households, SMEs, and public institutions, including schools, health centers, community squares and municipal offices. This exercise yields demand estimates up to 2023 for each body at the municipal level.

The satellite images with the country's broadband coverage can be cross-referenced with georeferenced information from the entities included in the analysis. In this case, it is particularly important to cross-reference with schools, health centers, community squares and municipal offices. The results of the analysis for Honduras can help the government and policymakers in devising investment strategies. For example, 58 percent of the country's schools are more than 5 kilometers from the fiber network, so connection to the high-speed network is not possible without a preceding operation (see Figure 2.9). As with the schools, 64 percent of squares and parks are more than 5 kilometers away from the fiber network.

**Figure 2.9**  
Georeferenced  
Information on the  
Distance between  
Schools and the  
Fiber Optic Network



Source: IDB (2019a).

58% of schools are more than 5 km from the fiber network, so connection to the high-speed network is not possible without a preceding operation.

- Schools less than 5 km from the fiber network.
- Schools between 5 and 20 km from the fiber network.
- Schools more than 20 km from the fiber network

## CRIME IN EL SALVADOR

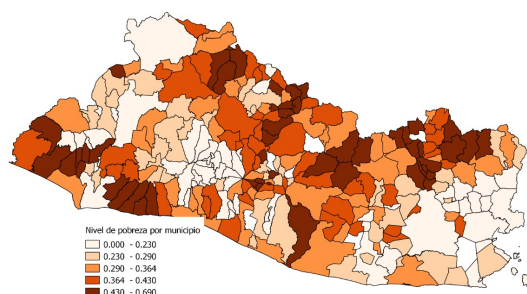


The IDB is making efforts to gain a better understanding about relationship between crime and violence indicators and indicators of social and business development. By combining Machine Learning methods with household surveys, the bank managed to update poverty estimates at the municipal level, which used to rely on a 12-year-old data. This project develops poverty maps for El Salvador from the Stacking model that combines predictions from multiple models, which adds value to the prediction.<sup>2</sup>

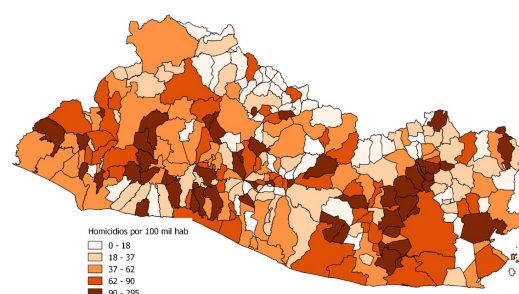
Once the poverty maps are produced, they are overlaid with homicide maps drawn up from official registry databases. Subsequently, layers of social indicators are added with varying degrees of granularity that allow to explore the correlations between homicide and poverty information, with education variables in schools and costs related to violence such as spending on security and extortion, as well as other multidimensional indicators. The results of this project are expected to be used to outline better crime policies at the geographical level.

**Figure 2.10**

Poverty Rate by Municipality

**Figure 2.11**

Homicide Rate by Municipality



Source: Abrego et al. (2019).

2. Specifically, the model used in this project brings together four different machine learning models: Gradient Boosting Machine, Generalized Linear Model, Extremely Randomized Trees, and Distributed Random Forest.



# 3

## Opportunities for taxing the digital economy





# 1 Introduction



There is no generally accepted definition of the digital economy, but there is no doubt that it occupies an increasingly important place in countries' economic life. E-commerce, intermediation services, online advertising and other digital activities are growing much faster than the traditional economy (OECD, 2015; European Commission, 2018). The region is not immune to these trends. Currently, in Central America, Panama and the Dominican Republic (CAPDR), revenues from the digital economy amount to more than US\$ 20 billion and account for 6.2 percent of GDP (it is 9 percent in the OECD).<sup>3</sup> It is growing at 14 percent a year, far above total consumption (1.8 percent), and the number of users is expanding at a rate close to 7.5 percent a year. Guatemala has the region's highest share of total revenues at 26 percent, followed by the Dominican Republic (22 percent) and Costa Rica (18 percent).

In these countries, financial technology (fintech) is the main source of revenue from digital services at more than US\$ 11 billion (56 percent of the total), followed by e-commerce (16 percent), online travel reservations (12 percent) and online mobility services (8 percent).<sup>4</sup> Audiovisual media (music, video, and so on) is the sector of the digital economy with the highest number of users in CAPDR (45 million people, or three quarters of the total population), followed by fintech and e-commerce (24 million users each; 40 percent of the population). Not only is the digital economy already an important part of the economy, but its significance will increase even more in the future. Companies such as Netflix, Amazon, Uber and Airbnb, to name just a few, already have a substantial presence in the region.

3. Figures calculated on the basis of data on the Statista website. Among the most important activities, this includes e-commerce, digital services, intermediation services, online advertising and fintech industries.

4. In the OECD, the main sectors in terms of revenues are fintech and e-commerce, which account for 58 percent and 19 percent of total revenues, respectively.



The digital economy presents opportunities and challenges in many areas, including taxation. It is important to highlight these opportunities, for two reasons. First, as mentioned earlier, the digital economy is growing at very high rates and those rates will increasingly offer scope for taxation, for a widening of the tax bases. Second, in the current circumstances, when public revenues are growing less than in the past, the digital economy may provide an opportunity to increase fiscal space. Conversely, to disregard the tax possibilities offered by the digital economy would entail losing resources that the region badly needs. As we shall see below, moreover, devising appropriate taxation for the digital economy is essential to ensuring healthy competition between companies.

Realizing the tax opportunities offered by the digital economy, however, requires that a number of challenges be addressed. The digital economy's consequences for taxation are important not only because of their growing role in the productive apparatus, but also because they entail qualitative changes. Because of the digital economy's very characteristics, traditional taxation rules are of limited use in this context and need to be rethought. Those consequences are related, first, to two key aspects of the architecture of international corporate income tax: the allocation of taxing rights and the increasing problems of tax base erosion.

**The Digital economy**  
makes traditional  
taxation rules of  
limited use

There are also implications for taxing personal income. The boundaries between various income categories become blurred (subordinate employment, professional activity, capital income) and, consequently, so too does their tax treatment. Problems also arise with regard to indirect taxation, requiring changes to traditional tax rules—essentially, the VAT exemption for the cross-border sale of low-value goods. The justification for this measure loses meaning with the rise of e-commerce and the application of the origin principle in services trade.

Second, the digital economy's challenges for taxation affect not only how the taxes are designed but also their administration. The latter issue, for example, includes the need for information from intermediaries located outside the corresponding jurisdiction, or the collaboration of platforms when ensuring the payment of taxes. Finally, failure to address these challenges not only means losing an additional source of tax revenue, but may also create circumstances in which companies are not competing on a level playing field for tax purposes. This is most evident, for instance, in e-commerce, where traditional domestic suppliers may be disadvantaged relative to online vendors.

The international community is therefore seeking multilateral solutions to these challenges in the OECD framework. Business income is the area in which it is most difficult to reach consensus, whereas the differences on VAT are much smaller. In the meantime, several countries have begun implementing measures, some of them controversial and others that are bearing much fruit. There have already been experiences in the region as well. All of this is presented in the following pages. Specifically, the second section is devoted to the matter of taxing business income, the third section to personal income, and the fourth to VAT.

## 2 Challenges in corporate income tax



Because of the digital economy's very characteristics, which distinguish it from more traditional sectors, its implications for taxation are qualitative and require a rethinking of current tax rules. Three of these characteristics are particularly noteworthy:

### A. VALUE CREATION

In the digital economy, users can become input providers rather than mere customers, essentially through three channels: their own data (search engines, social networks); generated content (social networks, video platforms); and network externalities (reservation websites, or sites for transport and accommodation intermediation, where the usefulness for users depends not only on their own consumption but also that of others). Users deliver these inputs free of charge in exchange for a series of services (access to social networks, search engines and so on), thereby helping to generate supply (unlike mere customers, who only create demand). Value is being created in this transaction between a company and its input suppliers (users), although it would seem not, given that the transactions appear to be free. This does not happen in the traditional economy, where transactions are monetary. As will be seen below, this possible shift in value creation by firms in the digital economy has significant implications for international tax rules, and is one of the main points of debate.<sup>5</sup>

### B. SCALE WITHOUT MASS

Some companies operating in the digital economy can have a strong presence as a supplier in a given market without necessarily having a physical presence.

5. See, for example, OECD (2018), Olbert and Spengel (2019), and IMF (2019).

### C. INTELLECTUAL PROPERTY

Although not unique to the digital economy, intellectual property is far more important here than in more traditional sectors.

In practice, these three characteristics have implications for two key aspects of the international architecture of corporate income tax: (i) the allocation of taxing rights and their enforcement; and (ii) growing problems of base erosion and profit shifting (BEPS).<sup>6</sup> With regard to the allocation of taxing rights, the first major challenge is to define “permanent establishment” (PE), which is crucial if a country is to have the right to tax a company’s income. According to the standards set out in double taxation agreements, a company’s profits are taxed in its country of residence unless it is a PE, in which case the profits can also be taxed in the country where they originate. A company is usually regarded as a PE if it has a sufficient level of activity in the country, which normally requires a certain physical presence through a fixed place of business or a dependent agent. Mere marketing endeavors are not enough, much less data collection or other activities associated with the digital economy. Some facilities, such as warehouses (which are so important in e-commerce), have been specifically excluded from consideration of PE.

These rules, therefore, are designed for the traditional economy, where significant economic presence is associated with physical presence. The change in this area would therefore come from a new definition of PE linked to digital presence (this has been termed “virtual” PE), which would introduce new variables upon the acquisition of PE status (such as the number of users of a website). Another important matter is the figure of dependent agents, as opposed to commission agents. The former are allowed to conclude contracts on behalf of companies but the latter are not, which prevents them from being regarded as a PE. In the digital economy this figure has been abused. In reality they negotiate contracts that are later signed in another jurisdiction with barely no change to the original. Similarly, it seems necessary to reconsider ancillary services (such as storage), which are not considered as a PE by international standards because they barely contribute to value creation in the traditional economy, though they are key in e-commerce.

Related to the above is withholding for passive income (dividends, interest, royalties). National laws and conventions often allow exceptions so that these revenues may be taxed according to rules of origin (residence of the taxpayer, place where the asset is used). In the digital economy, however, they enter a hazy area as regards the distinction between royalties, technical services or profits. Doubts arise as to whether cloud computing refers to payments and therefore forms part of the provider company’s profits, or whether it involves renting out digital space, which the agreements characterize as royalties. Something similar happens with the acquisition of 3-D printing licenses or the use of software.

6. BEPS problems refer to strategies that transnational companies use to exploit current legal options and divert profits to low-tax jurisdictions, thereby minimizing payment of taxes. This is part of what is popularly known as “fiscal engineering” and entails a substantial loss of tax revenues for countries. It also creates problems of competition between companies, since large multinationals are more likely to benefit from such strategies than smaller firms operating at the national level. To address these BEPS problems, the OECD launched an initiative to devise strategies with the aim of tackling such practices.

## The Digital economy

is a hazy area as regards the distinction between royalties, technical services or profits

As for the risks of BEPS, digitalization aggravates some traditional problems and poses new challenges. The BEPS report itself on Action 1 (challenges of digitalization; OECD 2015) and the report on Action 3 (OECD 2015b) acknowledge that it is particularly important to prevent the artificial avoidance of PE status and to strengthen the rules on intragroup operations between companies located in different jurisdictions. The aim is to minimize the risk that intragroup transactions might be used to artificially divert profits to low-tax countries. It is important to bear in mind that even where there is a PE, it is easy to shift income to low-tax jurisdictions through intangible assets. One example is a patent whose ownership is granted to a group company located in a low-tax country; that company receives payments for use of the patent from other group companies located in higher-tax countries. Using this approach, the group's profits will tend to be concentrated in the company located in the low-tax country, thereby minimizing total tax payments. This problem arises in other sectors but it is even more serious in the digital economy, where there is a substantial presence of intangible assets that are very easy to relocate and very hard to value. At the same time, the ease with which companies in the digital economy can locate these key (intangible) resources creates an incentive to use bridging companies in countries with a good treaty network (treaty shopping).

All these challenges have led the international community to seek consensus on tax rules. It is precisely in the area of business income tax that agreement is most necessary, and at the same time most complicated to reach. This is because, on the one hand, there are divergent interests between countries; and, on the other, because of the differences between experts. This search for an agreement is being pursued in the OECD framework on two major issues: the allocation of taxing rights and BEPS-related matters. The issue was raised in the aforementioned BEPS Report on Action 1, "Challenges of the Digital Economy" (OECD, 2015). Later, following a mandate from the G20, another report (OECD, 2018) identified three characteristics that are often apparent in highly digitized businesses, as well as their implications for the territorial allocation of profits and linking rules: the aforementioned scale without mass, the marked presence of intangibles, and the involvement of data and users. In 2019, two new reports were published (OECD, 2019a and 2019b), and the definitive report reflecting the international agreement reached (if one is reached) is expected by the end of 2020.

Most particularly, in the 2015 report, the Task Force on the Digital Economy analyzed three avenues for direct corporate taxation: (i) a new linking rule based on significant economic presence; (ii) withholding taxes on certain digital transactions; and (iii) an equalization levy to even out taxation between domestic and foreign companies when they have a significant economic presence. None of these options was definitively recommended, but the prospect arose that countries could include them in their legislation as safeguards against BEPS problems, provided that they respected the international agreements and conventions signed. The October 2019 report (OECD, 2019b) recognized the need to look ahead to the approach underlying work on the 2020 agreement. This approach should be based on four elements. The first is the scope. It is recommended that this be confined to highly digitized and consumer-oriented businesses. The second is a new nexus rule, which would be based not on physical presence but on sales. The third element is a geographic profit-allocation rule that includes some formula for allocation by jurisdiction. The final element is a mechanism that increases certainty for administrations and taxpayers. In essence, the OECD proposal recognizes the need to change the traditional rules and to

The OCDE recognizes **the need to change the traditional rules** and to take account of virtual users, **when allocating the rights to tax companies in the digital economy**

take account of users, not just physical presence, when allocating the rights to tax companies in the digital economy.

In the meantime, some countries have begun to apply provisional measures. These are basically of three types: (i) a digital services levy; (ii) the redefinition of PE and/or measures to avoid tax base erosion; and (iii) an equalization levy (rate per payment for digital services). The first of these are generally taxes on gross income rather than taxes on profits, since the latter are incompatible with the commitments made in double taxation agreements, although the former may create problems with the WTO because of their potential discriminatory effect on local companies. One of the most significant and controversial initiatives in this area has been that of the European Commission (EC), although in the end it has been put into abeyance. Pending agreement in the OECD and the redefinition of PE, the EC made a provisional proposal for a digital services tax (DST) (European Commission, 2018). On the one hand, this would tax advertising on digital platforms and the delivery of user data collected on those platforms; on the other hand, it would tax intermediation services that allow users to provide goods and services to each other. The tax is not levied on the value of the goods or services sold, nor on the digital content (films, music, text), but on the intermediation service. A rate of 3 percent was set on the gross revenue (excluding VAT) obtained from providing these services. It is applicable to companies with taxable earnings of more than € 750 million worldwide and more than € 50 million in the European Union. These revenues would be allocated among European countries according to the number of users and the number of times an advertisement appears.

An important difference between this proposal and the OECD approach is that while the OECD has avoided distinguishing between digital and non-digital industries (because of the difficulty of doing so), the EC initiative does make such a distinction (ring fencing). There has been criticism, however, that this distinction cannot be made, especially as ever more traditional sectors (such as the automotive or supermarket sectors) are earning income through digital services. It is argued, moreover, that the DST is supposedly designed for activities in which users play a large part in value creation, but it is not clear why this is so for some services and not for others that are excluded from the tax (streaming content services).

It has been criticized for other reasons, too:

- 1 Potentially it could create double taxation and legal uncertainty
- 2 It could be distortionary, because it can cause a cascade effect
- 3 It is potentially very damaging to businesses that do not yet make a profit (since it applies to revenues)
- 4 It can entail entry barriers
- 5 It can raise little in revenue relative to its administrative costs
- 6 It is potentially incompatible with trade regulation

As regards this latter point, note that part of the difficulty in reaching international consensus is the divergence of interests among countries.



In the end this proposal was not approved by the European countries, which left the matter for the OECD, although they pointed out that it could be taken up again in 2021 if there were no agreement. France, however, has moved in this direction after recently approving the Digital Services Tax, popularly known as the GAFA tax (Google, Amazon, Facebook, Apple). This is a provisional tax—until an international agreement is reached—that applies to companies whose revenues from the taxable activities exceed € 750 million worldwide and € 25 million in France. These are digital services in which French users play a key role in creating value, especially: (i) intermediation services (not the sale of the products themselves); and (ii) advertising on a digital interface based on data collected from the users themselves, as well as the management and sale of user data. The basis of the tax is annual income from these activities weighted by the importance of the French market over the company's world total, and the rate is 3 percent. The United States has called this initiative discriminatory against US companies and has announced that it could take countervailing measures.

As regards the second group of provisional measures (redefinition of PEs and/or measures to prevent tax base erosion), several countries have begun to reconsider the definitions and criteria of PEs in order to adapt them to the digital world. This is the case of Israel, for example, which regards economic presence as significant on the basis of certain parameters: contracts concluded online, services used by Israeli customers, or a website focused on the Israeli market. Similarly, Slovakia expanded its definition of fixed place of business in 2017 in order to cover certain online platform activities (transport and lodging intermediation services).

It should be kept in mind, however, that the possibility of doing this is conditioned by the country's international agreements, since there could be resort to those agreements if the redefinition of PE breaches them.

Other countries have chosen to introduce special schemes to deal with the diversion of multinationals' profits in the digital economy, such as the Diverted Profits Tax (DPT) in the United Kingdom and Australia, or the Base Erosion Anti-Abuse Tax (BEAT) and the Tax on Global Intangible Low-Taxed Income (GILTI) in the United States. They are not specifically targeted at digital businesses but, given the characteristics of the sector, they have a significant impact on such firms. In particular, DPTs are a dissuasive complement to anti-abuse rules related to regulations on profit attribution, PE and transfer pricing. They seek to establish a dialogue over a given time period between the administration and the company, during which the latter is encouraged to reconsider its tax strategies and operations. For example, Australia's Multinational Anti-Avoidance Law (MAAL) reinforces the integrity of the PE rules in Australia by applying them to non-resident companies that belong to large multinationals and engage in strategies to provide goods and services remotely to Australian clients, thus artificially avoiding being regarded as PEs. In the United States, GILTI is a tax aimed at securing a minimum taxation of groups that conduct operations between

companies in different jurisdictions, while BEAT sets a limit on the erosion of the tax base.

With respect to the third group of provisional measures, some countries—such as India, Italy, Chile, Uruguay and Hungary—have opted for an equalization levy on the provision of some digital services made by non-residents for residents. To some extent they are similar to DSTs, with the difference that they do not, in principle, focus on activities in which user participation is crucial. In Italy, for example, there is a 3 percent levy on taxable transactions net of VAT for digital services delivered electronically, while Uruguay makes a distinction between two types of digital services. One is audiovisual production, distribution and intermediation through digital media. Payments are considered Uruguayan-source income for the tax on non-resident income, provided that the user is in Uruguay (by means of an IP address or a billing address, or is paid by an electronic means that is managed from Uruguay). Digital intermediation activities are regarded as Uruguayan-source activities and are subject to taxation at 100 percent if both the service provider and user are in Uruguay, and at 50 percent if only one of them is in the country.

### 3 Personal income



The digital economy also has significant implications for personal income tax and social security. Sometimes (as with transportation or delivery activities) the category changes from wage-earner to self-employed, altering the worker's status and therefore the taxes to be applied. The boundaries between the various income categories become blurred (subordinate employment, professional activity or capital

## The digital economy

incomes for some recipients, avoiding control by tax administrators

income) and, consequently, so too does their tax treatment. An interesting case is the recent law passed in California, whereby those working for transportation, distribution and other intermediation companies like Uber and Lyft—hereto regarded as self-employed—are now compulsorily employed. This has significant regulatory and fiscal consequences in areas such as taxation, minimum wage, overtime and so on.

At the same time, tax obligations are generated for both the recipient of the income (self-declaration) and the payer (withholding), and are sometimes unknown and/or difficult to enforce. Some activities in the digital economy (such as rentals) entail sporadic income for recipients and are difficult for tax administrations to control. Without the collaboration of the corresponding platform, it is difficult to know the income received by users of the sharing economy. The information that the platforms hold is crucial for the administrations, but the ability to acquire it may be limited if the platforms are in another jurisdiction. It is therefore crucial to secure the collaboration of the platforms, as well as to foster tax education.

There are several examples in this regard. The Canada Revenue Agency (CRA) has added information to its website on income and VAT obligations related to revenues derived from the sharing economy, while France requires P2P platforms to provide users with information on their tax and social security obligations. In Denmark, there is an initiative to grant tax benefits on renting real estate, cars and boats if the platform declares all income. Estonia has reached an agreement with Uber to share information with the tax administration; a similar development in Finland is related to rentals and crowdfunding; and taxi services are similarly collaborating in Mexico and Ecuador. Italy has introduced an optional tax scheme for short-stay rentals of not more than 30 days, amounting to 21 percent of gross income, rather than including the income in the personal income tax base.

In short, it is very important to secure the collaboration of the platforms and, sometimes, to have simplified methods of taxation.

## 4 VAT. Going deeper into the destination principle



In VAT, the destination principle applies to cross-border transactions. Hence the tax is imposed in the country where the buyer is located because, if it were applied in the country of origin, competition would be distorted for tax reasons and suppliers from lower-rate countries would have a clear advantage. With trade in goods, the basic exception to this rule has traditionally been low-value goods bought by consumers. Given the cost that controlling them entails for the customs authorities, it has been preferable to keep them exempt at destination by establishing the threshold countries below which the exemption applies.

With the growth of e-commerce, this exemption for the sale of low-value goods has become a problem. This is not only because of the revenue foregone by the state, but also because of the unfair competition involved, since the goods sold domestically are indeed taxed. It therefore seems desirable to eliminate this exemption. This might not be feasible, however, because it would overburden customs services in their oversight functions. Removing the exemption for low-value goods therefore requires the involvement of online trading platforms and other players, such as couriers or the postal service. Simplified registration methods also seem to be necessary, because suppliers may be in another jurisdiction with neither the incentive nor know-how to levy VAT at destination (OECD, 2018).

In precisely this connection, in 2021 the European Union will eliminate the exemption on the import of goods valued at less than € 22. Large e-commerce portals, moreover, will be responsible for collecting VAT on goods sold by companies outside the EU to consumers within the EU, all this through a simplified registration mechanism. Australia and Switzerland have also removed the threshold.

Theoretically, the destination principle should also apply to trade in services. To make this possible, however, consumers would have to self-assess their obligations, which is why most systems tax at source. With the marked increase in electronic services trade, this has become an increasingly important issue. Taxing at source prevents fraud in B2C services, but provides an incentive to relocate in order to offer services from low-tax jurisdictions. More and more countries, therefore, are also shifting B2C services to destination, with obligations to register, collect and remit the tax online. This is what the OECD itself recommends (OECD, 2015), along with a simplified registration method for non-residents. It is also crucial, however, to induce the collaboration of foreign providers, since they are difficult to monitor because they are from another jurisdiction. Experience shows that large platforms often collaborate if it is made easy for them to do so. In addition to the EU, countries such as Australia, Argentina, Chile, Colombia, Costa Rica and Uruguay have begun to apply the destination principle to digital services, including music and video downloads, apps, games and e-books, with the provider being responsible for registration and settlement. Mexico is in the process of applying a similar measure.

In Latin America, Colombia requires foreign companies providing digital services to register in the Single Tax Registry (RUT) in order to declare and pay VAT, with the option of a withholding tax regime by issuers of the means of payment. In Uruguay, audiovisual content transmission services and intermediation in multilateral platforms supplied from abroad were included in the VAT system in 2017, being taxed at the general VAT rate of 22 percent. Unlike in Colombia, the tax cannot be paid through credit or debit card withholding mechanisms; rather, non-resident providers must pay it. Costa Rica and Paraguay have also included VAT on digital services, mainly through withholdings on means of payment. Table 3.1 shows the estimated revenue impact of including digital services in VAT.

**Table 3.1** Estimate of Potential Revenue from VAT on Digital Services in Some Countries of Latin America (US\$ millions)

	Argentina	Bolivia	Brasil	Chile	Colombia	Costa Rica	Ecuador	Mexico	Peru	Uruguay
Rate	21.00	13.00	9.25	19.00	16.00	13.00	12.00	16.00	18.00	22.00
Revenue	86.4	4.9	153.9	38.9	52.6	5.1	11.2	176.9	34.6	7.5

Source: ECLAC (2019).

In Mexico, the Ministry of Finance and Public Credit's 2020 Draft Expenditures Budget included measures to improve revenues from VAT and income tax on digital services. The measures (withholdings) will vary depending on whether the services to be taxed are matters of intermediation or provision. For the former (such as food delivery services, transportation or room rentals), the proposal is that legal entities—the intermediation platform—should withhold both taxes whether they reside in Mexico or not. For the latter, the proposal is that in digital services involving access to or the downloading of films, images, video, text and data storage, among others,



VAT is not the  
**end of the  
problem of  
indirectly  
taxing** the digital  
economy

where the end user is the importer of the service, the provider should withhold VAT from the user (16 percent). This measure is to come into force in April 2020. If digital service providers do not register as taxpayers with the Ministry of Finance and Public Credit, their connection to public telecommunications network operators could be suspended.

Despite these challenges that the digital economy poses for VAT, it should be noted that there is much more international consensus in this area. The OECD has pointed out the importance of applying the destination principle to the electronic provision of goods and services, and of working with online trading platforms. It might be appropriate that the latter be made responsible for collecting and delivering the tax jointly with the final supplier of the good, so as not to burden the platforms with undue liability.

To conclude, it should be recalled that VAT is not the end of the problem of indirectly taxing the digital economy. There are effects on other taxes, such as with online gaming, where it is also desirable to establish a registry of operators that are obliged to withhold taxes and their income (Díaz de Sarraalde, 2018).

### Box 3.1

#### Belize's experience in the tourism sector

Tourism has become the main engine of the Belizean economy. Its share of GDP currently exceeds 40 percent, it has a considerable carry-over effect on other activities, and it is the country's main source of foreign exchange. In recent years, home-sharing through digital platforms has been growing at a substantial rate. It is estimated that visitors who use this type of supply now account for about 7 percent of the total and the share is increasing. Home-sharing has made a significant contribution to the increase in the total stock of accommodation available in Belize, and to a wider variety of sites for tourism. Nonetheless, tax treatment is radically different between traditional establishments (hotels) and the new supply of private accommodation through digital platforms.

The former are subject to a 9 percent tourism tax (instead of the 12.5 percent general sales tax) on the price charged for the stay, as well as 25 percent business income tax. In practice the latter are subject to neither tax, though the law makes provision for this obligation.<sup>7</sup> This differential tax treatment clearly highlights the two issues we have been pointing out throughout this chapter:

- 1 The potential source of revenue offered by the digital economy
- 2 The distortions of competition that are created if taxation in that economy is not properly addressed.

7. Compliance in paying both taxes is very low because home-sharing establishments fall below the minimum income threshold for paying income tax (BZ\$ 75,000 a year), and because most of them are not registered with the Belize Tourism Board, which is responsible for collecting the tourism tax.

In May 2017, therefore, representatives of the Belize Tourism Industry Association (BTIA) began a dialogue with the Airbnb platform about the opportunities and challenges that home-sharing was posing to the country's tourism sector, including regulatory and tax issues. Since then, several possibilities have been suggested to improve taxation in the sector.

In the case of indirect taxes, it would be a matter of extending the practical application of the tourism tax to home-share accommodation, and (given the difficulty and compliance costs for the owners if they were responsible for processing and remitting the tax) tasking the corresponding platform with retaining it and delivering it to the Belizean authorities. With regard to the tax on profits, again, given how complicated it would be for owners to become legal entities for the purposes of the tax, as well as to comply with the obligations arising therefrom, it seems more appropriate to opt for a simplified regime or to use withholding mechanisms at the platform's expense, possibly at a rate below 25 percent. Discussions and negotiations are continuing, but it is estimated that the Belizean authorities could receive about US\$ 2 million by extending the tourism tax to home-sharing, and about US\$ 4 million by taxing the rental income earned by owners.

As mentioned, although the home-sharing sector is legally obliged to pay the tourism tax, most owners are unaware of this obligation. According to reports from the Belize Tourism Board (BTB), which is responsible for collecting this tax, the rate of compliance is very low in practice. This led the government to launch the "Did You Know?" campaign in September 2019, with a view to alerting owners of their obligation to register with BTB before advertising in any digital media, and to comply with the tax. This campaign will run until March 2020, so its outcomes in terms of registration and payment of the tourism tax are not yet available.

## 5 Conclusion



The digital economy could be an increasingly important source of taxation. If countries are to take advantage of this opportunity, however, they have to address a series of challenges. The digital economy's very characteristics (value creation, scale without mass, the importance of intellectual property) not only accentuate some of the pre-existing problems related to other sectors (associated with tax base erosion), but also make it necessary to rethink some of the traditional standards of taxation. Some of the most significant areas where traditional rules are in question in the digital economy include the definitions of permanent establishment set out in the agreements and the concept of passive income in business income tax; the separation between income sources (wage-earners versus self-employed) in personal income; and exceptions to the destination principle in VAT. All this, moreover, not only affects how taxes are designed but also has significant implications for the tax administration. Moreover, it has a substantial impact on fair competition in the markets, creating situations in which some companies may be at a clear disadvantage relative to others purely for tax reasons.

Hence the need for international consensus on this matter, because without agreement it will be very difficult to tackle these challenges properly, especially in the area of corporate income tax. The international community hopes to reach this consensus within the OECD in late 2020. This will make it easier to design tax systems that are adapted to the new circumstances introduced by the digital economy, and will also facilitate the necessary collaboration between companies and tax administrations. Conversely, a lack of agreement would have harmful consequences such as the loss of tax revenues, unfair competition between companies, international tensions arising from the adoption of unilateral measures, and problems of tax justice among taxpayers. The high speed of the digital economy, moreover, makes it increasingly necessary to reach an agreement satisfactory to all.

**The high speed of the digital economy** makes it increasingly necessary to reach an agreement satisfactory to all

There is much greater consensus in the area of indirect taxation, and measures geared to taxing digital services at destination are being adopted by a growing number of countries, including some in the region. The rest have an opportunity to make progress in this area and achieve a stronger and fairer tax system.



## 4

Remittances and  
innovative payment  
systems



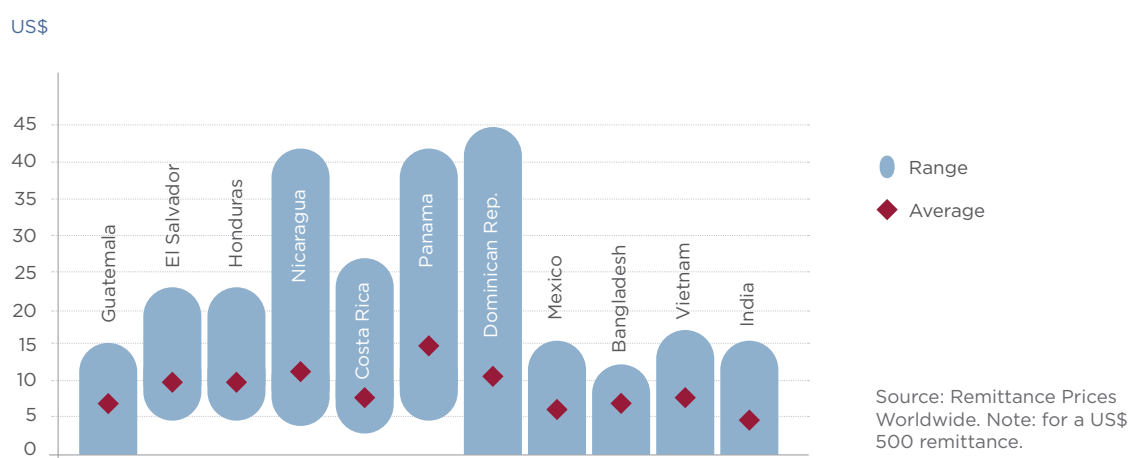
Remittances comprise one of the leading flows of external resources to CAPDR. They are an important source of income for the low-income population<sup>8</sup> and they help to reduce poverty (Adams and Page, 2005; Inter-American Development Bank, 2007; Hobbs and Jameson, 2012). In El Salvador and Honduras, remittances accounted for about 20 percent of GDP in 2018, while in Guatemala, Nicaragua and the Dominican Republic they provided between 8 percent and 12 percent of GDP.

Although remittances confer substantial benefits, managing the inflows also poses a challenge in view of their magnitude relative to the scale of economic activity in some countries. Most particularly, such significant inflows can cause exchange-rate volatility and temporary exchange-rate appreciation that could undermine the export sector's competitiveness—a phenomenon often referred to as “Dutch disease” (Acosta et al., 2009; Amuedo, 2004). For that reason, some central banks intervene in the local exchange market (on the basis of rules or in a discretionary manner) to support its liquidity and proper functioning.

It is worth considering that large remittance flows should be temporary. As time passes, remittances should decline for various reasons, such as a tougher immigration policy in the United States, or the fact that migrants reduce the amount they send as their time outside their home countries goes by and when their residence status is legal, among other causes (Abuelafia, 2018). Remittance flows could also alter in the short term as a result of changes in the economic cycle of the sector in which migrants are concentrated in the destination country, or because of shifts in the migrants' behavior. In view of this, temporarily high remittance flows would harm the competitiveness of the tradable sector.

In the countries of the region, there is still scope to reduce the commission and improve the exchange rate applied to remittance transfers. The average fee for sending remittances from the United States to countries in the region is higher than that recorded in Mexico and several Asian countries. The same applies to the exchange-rate margin applied to remittances. In general, moreover, there is a greater spread in both the commission and the exchange-rate margin for the CAPDR countries.

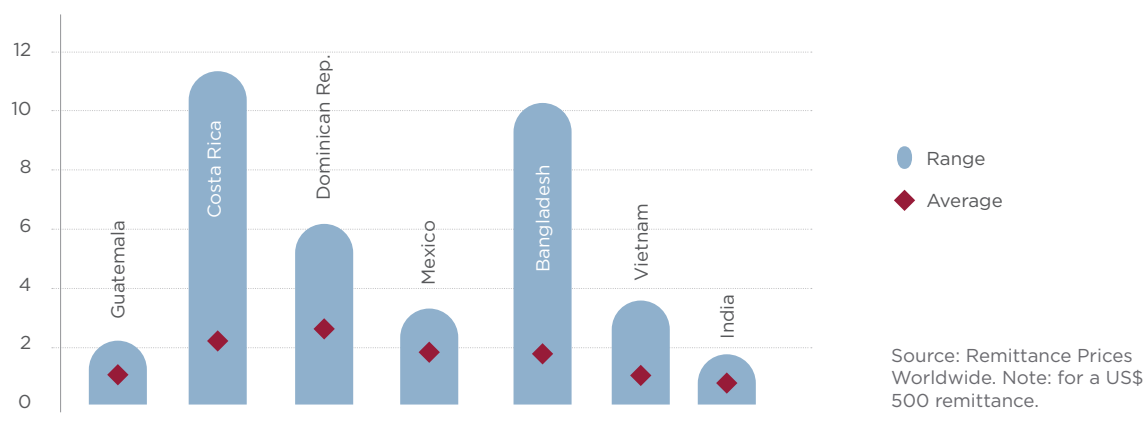
**Figure 4.1** Commission on Sending Remittances from the United States



8. According to Keller and Rouse (2016), 88 percent of remittance-recipient households in Guatemala were in poverty or at risk of falling into poverty. In 2014, remittances accounted for 44 percent of those households' income.

**Figure 4.2** Exchange Rate Margin on Sending Remittances from the United States

Percentage difference between the market reference and the amount charged



For these reasons, and given the sudden toughening of immigration policy in the United States and other countries of the region, it is useful to explore alternatives that help maximize the benefits of remittances, so as to increase the amounts that the beneficiaries receive and improve the operation of the local exchange market. The use of technology and new international transfer systems could be helpful in this regard. In particular, thought could be given to a system of remittance transfers between central banks.

A system of remittance transfers between the central banks of sending and recipient countries would make it possible to (i) use their technology to reduce commissions and improve the exchange rate applied to remittances, thereby increasing the amount that beneficiaries would receive; and (ii) ensure that some of the external flows arriving in the recipient country's central bank do not enter the exchange market directly, thus avoiding volatility and some short-term appreciation pressure in the market. These resources would go directly to the central bank and could have various uses, such as paying the public sector external debt or accumulating international reserves, among others. Additionally, this would obviate the need for some of the central bank's interventions in the exchange market.

Moreover, there is emerging technology that allows transfers between central banks and that is worth exploring for these purposes. Take, for example, the transfer between the Bank of Canada and the Monetary Authority of Singapore, which uses blockchain technology and the central banks' digital currencies to make international payments cheaper, faster and safer.<sup>9</sup>

It is important to mention that the Federal Reserve (Fed) already has a cross-border payments system called FedGlobal ACH Payments. In the countries of the region, it connects with the Bank of Mexico (Banxico) and with Panama.<sup>10</sup> The countries of the region also have a regional payments scheme known as the Payments Interconnection System (SIPA), which is operated by central banks. This allows customers of financial institutions that are members of the system to make electronic transfers of funds in US dollars between countries in the region.

9. Press release, available at: <https://www.mas.gov.sg/news/media-releases/2019/central-banks-of-canada-and-singapore-conduct-successful-experiment-for-cross-border-payments>.

10. The countries in which this system is used to make transfers are available at: <https://www.frb services.org/financial-services/ach/fedglobal/index.html>.

The payments system between the Fed and a local central bank usually works as follows: initially, an automated clearing house (ACH) is set up to link the electronic payments systems of various financial institutions among the countries in question. Customers, in this case migrants living in the United States, must have an account at the financial institution from which the remittance is sent.<sup>11</sup> The financial institution sends the remittance to the Fed, a process that takes one business day. The Fed sends the payment orders and dollars to the local central bank and, if necessary, the latter converts them from dollars to the local currency on the next business day, records the transaction in the country's financial system, and makes the transfer to the beneficiaries' accounts or to another institution that makes cash payments.

### Commissions and exchange rates applied to remittances



We conducted a case study to understand the impact of implementing a remittance payments system between central banks with regard to the commission charged and the exchange rate applied to remittance transfers in the market as a whole: specifically, we analyzed the implementation of such a system between the Fed and the Bank of Mexico in the 2000s.

The program was created in the context of the US-Mexico “Partners for Prosperity” (P4P) plan announced in September 2001 in Washington, DC. This sought to promote economic and social development through institutional improvements, training public sector personnel, and bringing about convergence between the public and private sectors toward best institutional practices. The action plan aimed

11. Note that this is not normally a constraint on access to the financial system, since migrants can open a bank account in a simple way using national identity documents or consular records.

### The action plan has three goals:

**1. Ensure** greater access to credit

**2. improve** cross-border communication between institutions

**3. Foster** private investment in infrastructure and development projects

to meet three overall goals (Bakker, 2015): ensure greater access to credit; improve cross-border communication between institutions; and foster private investment in infrastructure and development projects. With respect to remittances, the plan's components included reducing the costs of sending them through financial institutions and increasing investment in the construction of buildings or houses for Mexican migrants (through cross-border loans and mortgages).

As a result, in 2003 Banxico and the Fed linked the two countries' electronic payments systems through an automated clearing house. In October of that year, the Fed began promoting the transfer service among US financial institutions under the name "FedACH International Mexico Service." The first transfers were US government payments to retired citizens living in Mexico. From 2004 onwards, payments through the US banking system were included. Thereafter, the Fed and Banxico launched a series of information campaigns to induce the inclusion of more banks and credit unions in the service. In July 2005, the two central banks formally launched the "Directo a México" (DaM) campaign to promote FedACH benefits among financial institutions and among the migrant community. According to Bakker (2015: 164), the promotional materials presented the system as a "safe, fast, low-cost and convenient service to transfer funds to Mexico." Elena Whisler, who worked on promoting the DaM program at the Federal Reserve in Atlanta, maintains that the main goal of the program was "to reduce the cost of sending payments to Mexico" and "one of the benefits ... is that more money could be transferred to Mexico into an account" (in Bakker, 2015: 165).

It is worth mentioning that the Federal Reserve had been charging the financial institution in the United States US\$ 0.67 per transaction for the use of the service (those institutions are free to set their commission with the customer). As regards the central bank of Mexico, it receives the funds from the Fed and exchanges them for local currency, using the interbank market exchange rate and charging a commission of 0.21 percent on that for the service.

Operational Scheme of the Directo a México System



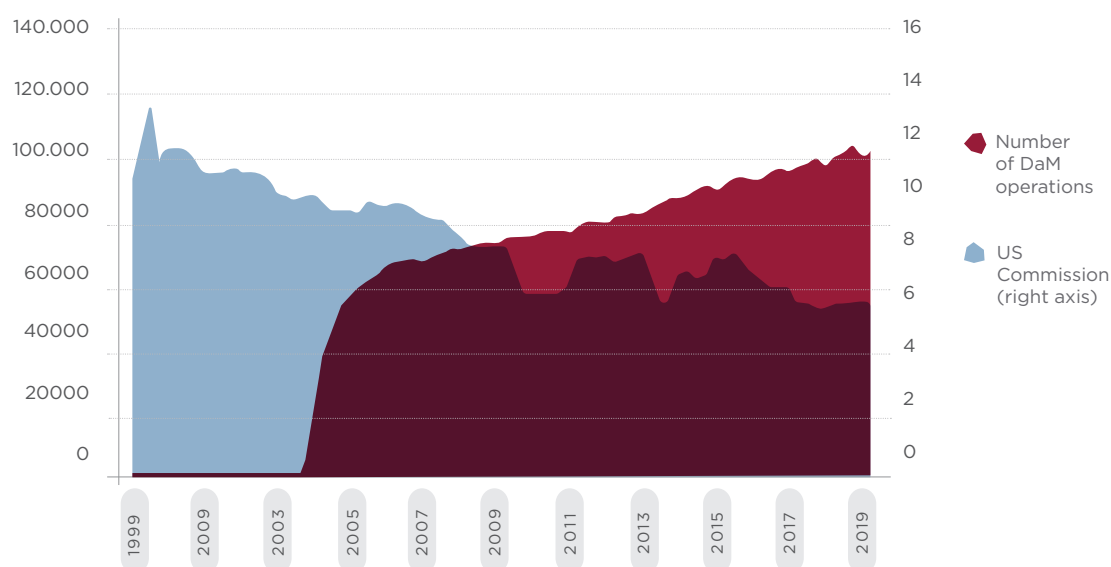
Source: prepared by the author on the basis of information from [directoamexico.com](http://directoamexico.com).



The migrants point out that one of DaM's main drawbacks was the obligation to open an account in Mexico in the public bank Bansefi (now called Banco del Bienestar). This arrangement was somewhat inconvenient, since the account would be in the name of a beneficiary living in Mexico who was often unable to provide the necessary documentation. To tackle this problem, in April 2010 the “cash pickup” option was introduced to allow beneficiaries with official identification to collect money at branches of the state firm Telecomm-Telégrafos, which has branches in remittance-recipient areas.

The number of remittance operations transferred through DaM has grown consistently since the system was introduced, albeit at a relatively low rate (7.7 percent a year in the number of transfers in the past 14 years; and 3.5 percent in the past five years). The number of operations carried out through this system is therefore low relative to the number of transfers made, accounting for just 0.5 percent of the total. As regards the number of remittances sent, the system accounts for about 1 percent of the total. The number of operations effected through the system increased from an average of 11,000 a month in its first year to 40,000 a month in 2018. Over the same period, the amount transferred rose from an average of US\$ 4 million a month to US\$ 26 million a month by 2018. The average commission charged throughout the US market for sending remittances to Mexico has trended downwards (see Figure 4.3).

**Figure 4.3** Number of Operations in the System and Commission on Sending Remittances from the United States



Source: author's calculations on the basis of information from Profeco and Bank of Mexico. Note: refers to the average commission in nine cities with the highest concentration of migrants where the DaM program operates. They are: Chicago, Dallas, Houston, Indianapolis, Los Angeles, Miami, New York, Sacramento and San Jose. For a US\$ 300 remittance.

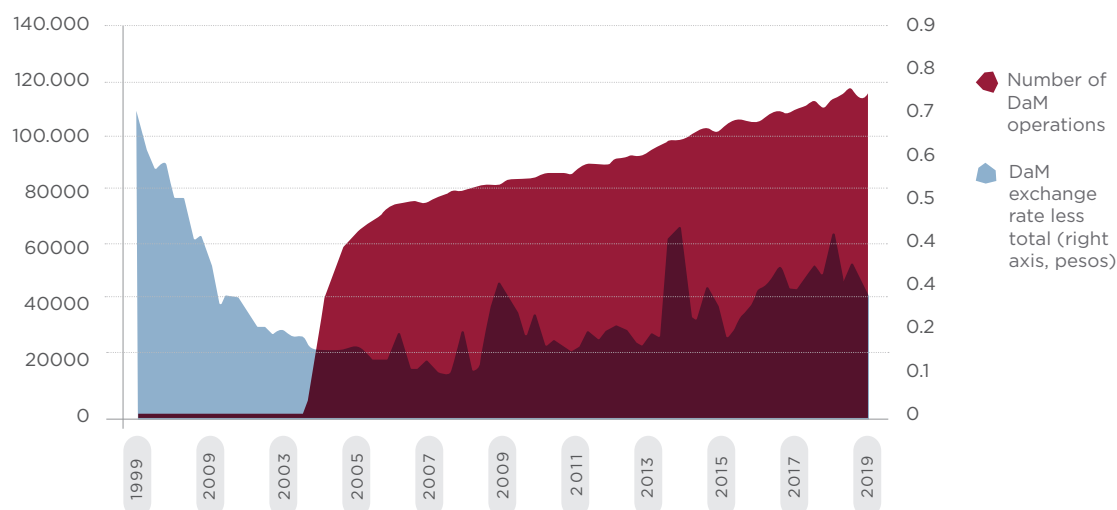
Statistical tests indicate that implementation of the international payments system between the central banks of the United States and Mexico brought about a fall in the commission charged for remittances to Mexico. Specifically, a Granger causality test and Breitung and Candelon's spectral Granger causality test (2006) were conducted. These suggest that both the number and amount of DaM operations determine the cost of the commission, and the relationship between them is clearer with a seven-month lag.<sup>12</sup>

Moreover, statistical tests of structural change (Wald tests) showed that in July 2006 (a year after the DaM campaign was launched), the series covering the average commission for remittances began to behave differently than it had previously and was marked by lower rates. In short, the evidence shows that the payments system had a spillover effect on the rest of the remittance transfer market by inducing lower commissions.

As regards the exchange rate applied to remittance transfers, the DaM rate is more favorable for the beneficiary than the market average. This system's more favorable exchange rate is evident in the difference between the (interbank) FIX rate that DaM uses, adjusted by the 0.21 percent commission charged by the Bank of Mexico (as of October 2003, the year when its operations began to be recorded) and the average exchange rate applied to remittances from Mexican migrants in the United States.

Figure 4.4 illustrates this difference. Closer to zero, on average the market is paying an exchange rate that is close to the interbank (wholesale) rate, which is better for the beneficiary. Between 1999 and 2007 there was a decline of about 0.6 pesos. In other words, in that period this differential's annual average fell from 0.67 pesos per dollar to 0.12, on average, and then rose to 0.37 pesos per dollar on average in 2018.

**Figure 4.4** Number of Operations in the System and DaM Exchange Rate Less Total Remittances



12. See López-Marmolejo and Ventosa-Santaularia (2019) for the technical details of the findings presented in this section.

The statistical evidence suggests that the system's entry into force helped reduce the exchange-rate differential between the average market rate for remittances from the United States to Mexico and the interbank rate. Specifically, the number (and amount) of DaM transactions “Granger-causes” the exchange rate for remittances from the United States relative to the wholesale rate, with a lag of between two and 11 months.

In sum, the program was successful in reducing commissions and offering a more favorable exchange rate to remittance beneficiaries. The increase in the exchange-rate differential that the system offers relative to the wholesale price seems to suggest that the system has lost influence over this variable in recent years

### Impact on the volatility and level of the exchange rate in the economy



Implementation of this system can also affect the exchange market, because remittances are a source of significant inflows from overseas to the region's economies.

The payments system could contribute to a depreciation in the local exchange rate, for a number of reasons:

- 1 fewer dollars available in the local exchange market because the central bank captures dollars through the system
- 2 the system's use of a market exchange rate (usually the interbank rate plus a very small commission), which would be higher (more depreciated) than the rate that a bank or company would have reason

- 3 to offer to the sender of a remittance, with a view to maximizing profits (less local currency per dollar)
- 4 competitive pressure that creates better exchange rates for beneficiaries (more local currency per dollar).

The following method was used to estimate the scale of the effect of taking a portion of the remittances out of the local exchange market through this system: given that the payments system obviates central bank interventions in the exchange market to mitigate appreciation of the local currency in the face of an abrupt increase in remittances, the effect on the exchange rate is estimated indirectly, seeking to isolate the effect of the interventions (so as to estimate their absence). These foreign currency purchase interventions in the exchange market increase international reserves, which are used as proxies for the interventions, given the data constraints. The determinants of the (real) exchange rate were estimated using a panel model for Latin American countries in the period 1980–2018. On the one hand, net remittance flows were found to have a statistically significant effect on the real exchange rate. On the other, interventions (reserves) have a positive effect on the exchange rate, consistent with the central bank's demand for foreign exchange. The volume of remittances would continue to reach the economy and support private consumption, but it would be in local currency and would require fewer interventions. According to the estimation coefficient, implementation of a payments system that captures, say, 1 percent of GDP in remittances, thereby avoiding a 10 percent rise in interventions (increase in reserves)—for instance, if reserves went from 10 percent to 11 percent of GDP—would cause the real exchange rate to be further depreciated by 0.7 percent. To this we should add the additional effect exerted by competitive pressure, which is not estimated in detail here (microeconomic data would be needed), but Mexico's experience is a useful reference.

Hence a payments system that helps mitigate the abrupt flow of remittances in the local exchange market would affect the real exchange rate. At the same time, there is econometric evidence that remittance flows also increase the volatility of the nominal exchange rate. The annex presents the econometric estimation for both exercises.<sup>13</sup>

In short, the payments system under consideration would confer significant benefits on the population of remittance-recipient countries by: (i) increasing the beneficiaries' disposable income as a result of smaller commissions and a better exchange rate; (ii) causing less exchange-rate volatility and a somewhat more depreciated exchange rate that fosters the competitiveness of the export sector (less Dutch disease); and (iii) requiring fewer central bank interventions in the local exchange market, especially discretionary interventions that might be necessary at times of abrupt increases in remittances.

Recently, financial technology (fintech) companies have been set up to offer online cross-border money transfers. Some of these companies have grown fast and have helped bring greater transparency to commissions, as well as more competitive

13. See López-Marmolejo et al. (2019) for further detail of the econometric models and the results described.

exchange rates—especially when the transfers are account-to-account transactions, where the interbank market exchange rate is reached. These new players thereby complement the market and stimulate competition. On the other hand, their scope could be limited among some population groups because, among other things, the sender must have access to telecommunications, possess a passport or legal residence documents, and have substantial financial knowledge, as well as bank accounts or bank cards in the country where the resources originate. It is important to work on reducing these barriers. Similarly, steps could be taken to assess whether a payments system such as the one described here might serve as a complementary platform for this type of company.



# Annex

## Panel model of the real exchange rate

The database covers almost 30 years over the period 1980–2018, and the countries of Latin America and the Caribbean for which data are available. The model's underlying specification is based on the general equilibrium model of Farhi and Gabaix (2015), from which a closed solution of the exchange rate is obtained, wherein the nominal exchange rate depends on bilateral differentials of productivity, prices, and interest rates. Other variables that are important in the region, such as remittances and reserves, are added to the foregoing variables.

The analysis of macroeconomic panel data regards the cross-sectional units as being exposed to the influence of statistical structures that create interdependence among them, giving rise to “cross-sectional dependence.” In the economic literature, one possibility for treating panels with cross-sectional dependence is as follows:

Consider the following heterogeneous panel data model

$$Y_{it} = \alpha'_i d_t + \beta'_i \chi_{it} + e_{it}, \quad (1)$$

where  $d_t$  is a vector  $N \times 1$  of common observable effects that may include deterministic factors,  $\chi_{it}$  is a vector  $K \times 1$  of individual and specific observable regressors of the  $i$ th cross-sectional unit in time  $t$ .  $e_{it}$ , are random disturbances that have the following common factor structure

$$e_{it} = \gamma_{i1} f_{1t} + \dots + \gamma_{im} f_{mt} + \epsilon_{it} \equiv \Gamma_i' F_t + \epsilon_{it}, \quad (2)$$

in which  $F_t = (f_{1t}, \dots, f_{mt})'$  is an  $m$ -dimensional vector of common unobservable factors, and  $\Gamma_i = (\gamma_{i1}, \dots, \gamma_{im})'$  is the  $m \times 1$  vector of the loads associated with those factors.

When the regressors,  $\chi_{it}$ , in equation (1) are strictly exogenous, the panel model can be consistently and efficiently estimated via GLS based on the factor structure of equation (2). When working with macroeconomic panels, however, it is quite possible that this factor structure is correlated with the observable factors  $d_{it}$ , as well as with the  $\chi_{it}$  regressors. Because of the foregoing, we used the following specification, which makes it possible to generalize the model a little more:

$$x_{it} = A_i' d_t + \Gamma_i' F_t + v_{it} \quad (3)$$

where  $A_i$  and  $\Gamma_i$  are  $N \times K$  and  $m \times K$  matrices of the loads of observable and unobservable factors, and  $V_{it}$  is the idiosyncratic component of  $X_{it}$  and they are distributed independently of the common factors  $F_t$  and errors  $\epsilon_{jt}$ , for all  $i, j, t$  and  $t'$ .

In this case, we followed the methodology proposed by Pesaran (2006), who suggests using a cross-sectional average of the observed variables as proxy variables of the non-observable common factors. The estimation method is termed common correlated effects (CCE) and has been widely used in the empirical literature due to

the ease of the estimation procedure, mainly because it does not require knowledge of the number of common factors  $m$  to be considered. The CCE method has been studied in the literature to enable long-memory processes (Ergemen and Velasco, 2017) and unit-root processes (Kapetanios et al., 2011), whose procedures are used in this analysis because of the potential persistence of some variables.

DEPENDIENT VARIABLE Log(real exchange rate)				
	Model 1	Model 2	Model 3	Model 4
<b>Log (GDP of the country / GDP of USA)</b>	-0.644***	-0.631***	-0.621***	-0.902***
	(0.032)	(0.034)	(0.037)	(0.037)
<b>Remittances / GDP</b>		-5.947***	-9.373***	-3.53***
		(0.548)	(0.494)	(0.603)
<b>Log (reserves / GDP)</b>			0.025	0.067***
			(0.014)	(0.012)
<b>Log (public debt / GDP)</b>				0.162***
				(0.024)
<b>Trend</b>	0.002**	-0.004**	0.004**	-0.0001*
<b>Constant</b>	0.509	2.301***	2.509***	1.403**
<b>Observations</b>	644	605	605	514
Notes: *p<0.1; **p<0.05; ***p<0.01 Parentheses represent robust Newey-West standard deviations.				

## Exchange rate volatility model

We model the Realized Volatility (RV) of the nominal exchange rate defined as follows:

$$RV_t = \sqrt{\sum_{i=1}^t (p_i - p_{i-1})^2}$$

Where  $p_i - p_{i-1}$  is the return in a time interval and  $p_i$  is the logarithm of the exchange rate. In this case, the time period is one day ( $i$ ) and the realized volatility is calculated for each month ( $t$ ). Thus, RV is the variation of the “return” for the exchange rate and is commonly measured through the standard deviation of the rate.

In this analysis, the determinants of the RV are estimated in the knowledge that this variable itself is volatile; this is usually called volatility of volatility (hereafter, VoV). VoV may reflect uncertainty about the structural robustness of the exchange rate to economic change.

### The model considers the following variables:

$RV_t$	Realized volatility of the nominal exchange rate
$R_t$	Remittances
$I_t$	Market interventions (included through the proxy variable of the central bank's reserves)
$D_t$	Public debt
$\varepsilon_t$	Error term without constant variance
$v_t$	<i>iid</i> $N(0,1)$ term

### Parameters:

$\beta_i, \emptyset_1$	with $i=0,1,2,3$	RV parameters (level)
$\xi, \alpha, \gamma$		Second moment parameters (VoV)

The RV of the nominal exchange rate is modeled using a transfer (or ARIMAX) model and its (conditional) second moment (VoV) as a GARCH(1,1). It is:

$$RV_t = \beta_0 + \beta_1 \ln(R_t) + \beta_2 \ln(I_t) + \beta_3 \ln(D_t) + \emptyset_1 RV_{t-1} + \varepsilon$$

Where

$$\varepsilon_t = h_t v_t, v_t \sim iid N(0,1),$$

$$h_t^2 = \xi + \gamma h_{t-1}^2 + \alpha \varepsilon_{t-1}^2.$$

The results of the country-level estimate are shown below.

Model	Estimate	Guatemala	Honduras	Mexico	Nicaragua
Variance (level)	Constant	0.415***	-0.261	-0.351***	0.028***
	Remittances	0.005***	0.004***	0.021***	0.004***
	Interventions	---	-0.012**	-0.036**	-0.013***
	Debt	-0.019***	0.022***	0.038**	0.009***
	AR(1)	-	0.230*	-0.199	0.252*
	AR(1)	-	0.307	---	---
VoV (variance)	Constant	1.00x10 <sup>-5</sup> *	---	---	---
	$e^2_{t-1}$	-0.13***	-0.519***	-0.740***	-0.206
	$h_{t-1}$	1.054***	1.519***	0.259***	1.206***
*** Significant at 1%, ** at 5%, * at 10%					



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