



The Connectivity Trap: Stuck between the Forest and Shared Prosperity in the Colombian Amazon

Citation

Goldstein, Patricio, Timothy Freeman, Alejandro Rueda-Sanz, Shreyas Gadgin Matha, Sarah Bui, Nidhi Rao, Timothy Cheston, and Sebastián Bustos. "The Connectivity Trap: Stuck between the Forest and Shared Prosperity in the Colombian Amazon." CID Research Fellows and Graduate Student Working Paper Series 2023.147, Harvard University, Cambridge, MA, February 2023.

Published version

<https://growthlab.cid.harvard.edu/publications/connectivity-trap-stuck-between-forest-and-shared-prosperity-colo>

Link

<https://nrs.harvard.edu/URN-3:HUL.INSTREPOS:37376057>

Terms of use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Open Access License Articles (IOAL), as set forth at

<https://harvardwiki.atlassian.net/wiki/external/NGY5NDE4ZjgzNTc5NDQzMGIzZWZhMGFIOWI2M2EwYTg>

Accessibility

<https://accessibility.huit.harvard.edu/digital-accessibility-policy>

Share Your Story

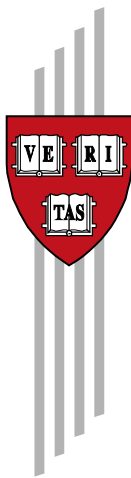
The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#)

The Connectivity Trap: Stuck between the Forest and Shared Prosperity in the Colombian Amazon

Patricio Goldstein, Timothy Freeman, Alejandro Rueda-
Sanz, Shreyas Gadgin Matha, Sarah Bui, Nidhi Rao,
Timothy Cheston and Sebastián Bustos

CID Research Fellows and Graduate Student
Working Paper No. 147
February 2023

© Copyright 2023 Goldstein, Patricio; Freeman, Timothy; Rueda-
Sanz, Alejandro; Gadgin Matha, Shreyas; Bui, Sarah; Rao, Nidhi;
Cheston, Timothy; Bustos, Sebastián; and the President and
Fellows of Harvard College



Working Papers

Center for International Development
at Harvard University



The Connectivity Trap: Stuck between the Forest and Shared Prosperity in the Colombian Amazon

A Growth Diagnostic of Caquetá, Guaviare, and Putumayo

Patricio Goldstein, Timothy Freeman, Alejandro Rueda-Sanz,
Shreyas Gadgin Matha, Sarah Bui, Nidhi Rao,
Timothy Cheston and Sebastián Bustos

The Growth Lab at Harvard University

February 2023

Table of Contents

Executive Summary	1
1. Introduction	2
2. Growth Trajectory	5
3. Constraint Analysis	11
3.1. Growth Diagnostics in the Amazon	11
3.2. A Low Capability Trap	13
3.3. The Economics of Remoteness	20
3.4. Labor Market Regulations: Symptom or Root Cause?.....	27
4. Economic Growth and Deforestation	33
5. Development Policy in the Amazon	38
Bibliography	40
Appendix	43
A1. Peer Selection.....	43
A2. Evidence on Non-Binding Constraints.....	46
A2.1. Human Capital	46
A2.2. Finance	49
A2.3. Property Rights and Security.....	51

Disclaimer: This research is funded by the Gordon and Betty Moore Foundation. The contents of this report are the sole responsibility of the authors.

Acknowledgements: We thank the support of The Gordon and Betty Moore Foundation in producing this research. We also want to thank the project's Steering Committee for their insights and reviews in advancing the research and the analytical comments and support provided by Fedesarrollo, a partner in the research process. In addition, we thank all experts, policymakers, and business owners who met with us to share their critical insights on the region's context. The opinions expressed here do not reflect all of the above-mentioned organizations' and personal views, and are the authors' sole responsibility.

Executive Summary

The Colombian Amazon faces the dual challenge of low economic growth and high deforestation. High rates of deforestation in Colombia have led to a perceived trade-off between economic development and protecting the forest. However, we find little evidence of this trade-off: rising deforestation is not associated with higher economic growth. In fact, the forces of deforestation of some of the world's most complex biodiversity are driven by some of the least complex economic activities, like cattle-ranching, whose subsistence-level incomes are unable to meet the economic ambitions for the region. All the while, the majority of the Amazonian departments' population works in non-forested cities and towns, at a distance from the agriculture frontier that forms the "arc of deforestation." The relative urbanization of the Amazonian departments, despite the vast land mass available, recognizes that prosperity is achieved through close social-economic interactions to expand the knowledge set available to be able to produce more, and more complex activities. Achieving economic goals therefore relies on creating new productive opportunities in non-forested, urban areas.

The risk of deforestation reduces incentives to improve the connectivity of Amazonian departments with major cities and export markets. The remoteness of these departments increases the cost of 'exporting' goods to markets outside the departments. Poor connectivity contributes to the low economic complexity of the departments. In turn, the low complexity reduces incentives to coordinate new investments that would generate returns to greater connectivity. Coordination failures, which occur when a group of economic actors (e.g., firms, workers) could achieve a better outcome but fail to do so because they do not coordinate their actions, are widespread in all three of the Amazonian departments studied. This limits the creation of new capabilities and productive diversification to generate new jobs and higher incomes.

We posit that economic growth in the Colombian Amazonian is limited by a "connectivity trap" whereby the lack of external market connectivity restricts economic complexity, and, in turn, the low complexity fosters the coordination failures that limit returns to new diversification. Ultimately, low returns to diversification further reduce incentives to improve connectivity. Underpinning the connectivity trap is the belief that limiting the connectivity of Amazonian departments with large Colombian cities and the broader global economy will limit incentives for deforestation. Yet, deforestation has accelerated in recent years, despite the continued poor connectivity. We argue that Colombia must create a new national law to curb deforestation by eliminating the financial incentives for land speculation. Reclassifying forested lands under the control of national protection systems with severe restrictions on economic activities and strengthened enforcement, as detailed in an accompanying report, provides the needed legal clarity regarding land formalization. Within the law to eliminate incentives for deforestation, the national government should create a new development approach for the Colombian Amazon. This approach must move beyond a natural resource-based approach to the region, to center on the productive potential of its urban areas, and the carbon markets and tourism potential of its forested areas. One pillar of this approach is to build new public sector capabilities to coordinate investments into new, targeted productive sectors to create new national-local mechanisms of investment promotion. A second pillar is to improve connectivity to external markets through road and air investments between Caquetá, Guaviare, and Putumayo and major cities and ports.

1. Introduction

The deforestation dynamics in Colombia have led to a perceived trade-off between economic development and the protection of the forest. Nowhere are the stakes of this perceived trade-off higher than in the departments of Caquetá, Guaviare, and Putumayo (CGP), which form Colombia's gateway to the Amazon. Of the six Amazonian departments in Colombia, only the CGP departments are connected by road to the rest of the country. These departments are amongst those with the highest percentage of tree cover in the country (Figure 1).

By forming the leading edge of where the agricultural frontier meets the forest, CGP departments also form the “Colombian arc of deforestation.” As organized moneyed interests and landless peasants aim to gain access to land, the expansion of the agricultural frontier leads to pressure on the forest. CGP departments have contributed close to a third of the tree loss in Colombia over the last two decades (Figure 2). It is in this light that economic goals are often held as incompatible with environmental goals in public debate. The perceived-trade-off between development and forest protection depend on a series of assumptions as to the drivers of the economy and deforestation, and their interaction. As we argue, those assumptions are too often presupposed, despite their empirical nature.

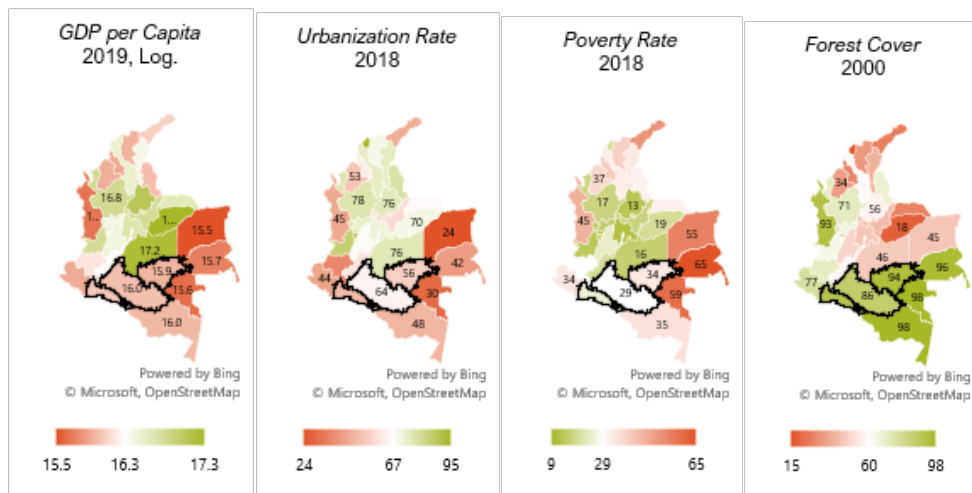
This paper aims to study the dynamics of economic growth in Caquetá, Guaviare, and Putumayo to identify the constraints to achieving greater shared prosperity among its inhabitants. This report accompanies a primer on the drivers of deforestation in CGP, as well as a report analyzing the promising areas of new economic activities to drive new job creation and higher incomes in CGP. A final report in this series synthesizes the findings of these reports to assess what the drivers of economic growth and deforestation mean for the policy options to drive greater economic growth while protecting the forest. The Growth Diagnostics report does not aim to analyze the drivers of deforestation but does consider what addressing the constraints to economic growth would mean for forest protection. To be specific, this report frames the finding that greater connectivity to external markets (e.g., through improved road infrastructure to CGP) would make several economic activities more competitive with the understanding that doing so without addressing the causes of deforestation would further exacerbate forest loss. In this way, this paper series, taken together, reinforces the primacy of addressing the drivers of deforestation to then align a development policy to expand the viability and competitiveness of more economic activities in the non-forested areas of CGP.

The central finding of this paper is to find little evidence of the trade-off between economic growth and forest protection: rising deforestation is not associated with higher economic growth. The recent rise in deforestation has not led to any convergence of economic outcomes between the Amazonian departments and the rest of the country. This is due to the fact that the forces of deforestation of some of the world's most complex biodiversity are driven by some of the least complex economic activities, like cattle-ranching, whose subsistence-level incomes are unable to meet the economic goals for the region.

Economic drivers in CGP depend on a traditional if underappreciated source in the Amazon – urban areas. Combined, the three departments account for 15% of Colombia's territory, or 16.7 million hectares, if only 1.7% of the population. As a result, CGP departments stand amongst the lowest population density. And yet, this masks the fact that the majority of the population in CGP departments live in urban areas, including medium-size cities like Florencia in non-forested areas of Caquetá. That is, the majority of the Amazonian departments'

population works in non-forested cities and towns, at a distance from deforestation actions. However, the urban areas are not acting as economic motors in the region. Urban areas in CGP remain small, weakly diversified and a low source of labor demand. As seen in the next section, urban poverty rates in CGP are nearly as high as rural rates, a pattern which does not hold for the rest of the country. CGP departments' disconnect with the modern Colombian economy may be unsurprising, as the three departments are amongst the latest to have been established in Colombia. Caquetá became a department in 1981, with Guaviare and Putumayo following in 1991. Nevertheless, the relative urbanization of the Amazonian departments, despite the vast expanse of the departments, recognizes that prosperity is achieved through close social-economic interactions.

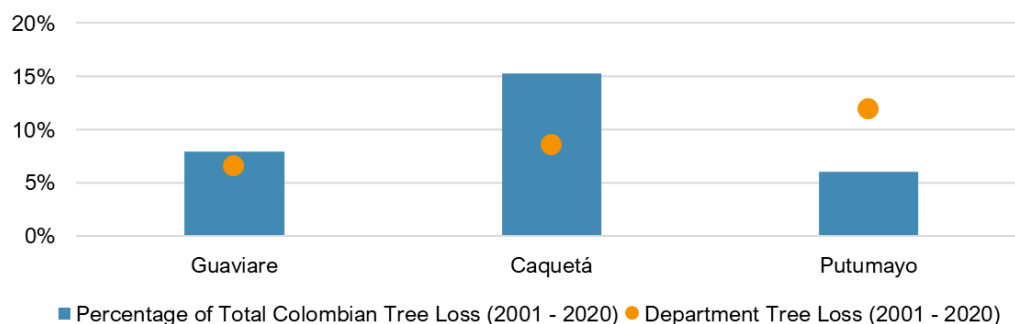
Figure 1. Caquetá, Guaviare, and Putumayo in Perspective



Sources: authors' elaboration based on DANE (first and third panel), CEDE (second panel) and Global Forest Watch (fourth panel). Center of scale is set at the median department.

Figure 2. CGP Contribution to Forest Loss (2000 – 2020)

Department Tree Loss and Contribution to Colombian Tree Loss



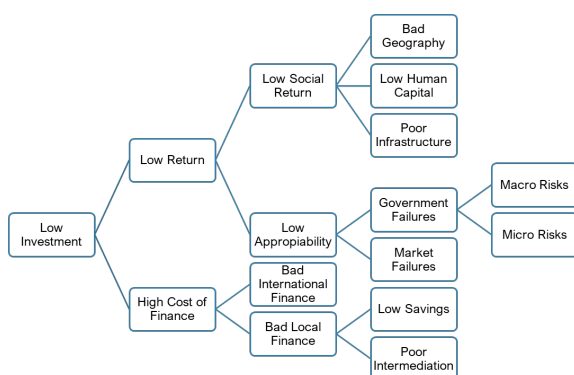
Source: authors' elaboration based on Global Forest Change.

The development of urban areas in the Amazon contradicts the perceived trade-off between economic growth and deforestation. The perceived tradeoff does not hold for the region. As explored in Section 4, the recent rise in deforestation in CGP has not led to a convergence with the rest of the nation. This is because the rise in deforesting activities such as cattle ranching are among the least productive. On the other hand, complex industries in

urban areas which are largely orthogonal to deforestation have stagnated in terms of growth. Deforestation does not propel growth, nor does growth rely on cutting the forest. However, areas of development that more directly confront the perceived tradeoff between growth and deforestation, namely road connectivity and agricultural productivity, must be managed strategically. The fourth paper in this series – The Policy Strategy Report - outlines a policy package to shift CGP from a high deforestation and low growth equilibrium to low deforestation and high growth. Deforesting activities should be disincentivized, while urban industries disconnected from deforestation dynamics, in turn, should be promoted. Policy measures in rural areas require a curtailing of economic activity in large parts of the forest, especially strategic management of roads and agriculture. Importantly, urban areas must in turn act as a source of labor demand for high productivity activities to release deforestation pressures off the Amazon (Porcher and Hanusch 2021).

Achieving economic goals relies on creating new productive opportunities in non-forested urban areas. The question remains why urban areas in CGP fail to serve as growth poles to achieve economies of scale in diversifying the knowhow and production toward more complex, higher income activities. This paper aims to answer this question using the method of Growth Diagnostics, developed in Hausmann, Rodrik and Velasco (2008), to identify binding constraints to economic growth in Caquetá, Guaviare, and Putumayo. The Growth Diagnostics (GD) methodology is designed to identify the most binding element to more sustained economic growth by systematically diagnosing the problem based on the type of symptoms that are observed in economic data. The framework distinguishes general constraints from binding constraints, in that constraints are any economic problem an economy may face, while binding constraints are the most highly prioritized issues that, once resolved, would genuinely move the needle on economic growth. The original methodology relies on a heuristic decision tree that decomposes a “lack of aggregate investment” into its supply and demand components (Figure 3). Although the three CGP departments do not face the same constraints in every respect, analyzing the departments as an ensemble, along with a series of regional and aspirational peers, will better capture the relative weight of their current challenges vis-à-vis the rest of Colombia. After describing the departments’ recent growth trajectory and evaluating their current growth challenge in the next section, the general constraints to the departments’ economic development are systematically assessed. The third section expounds on the link between constraints to economic growth and deforestation, whereas the last section outlines broad areas of ‘therapeutics’, or avenues for policy action.

Figure 3. Growth Diagnostics Tree

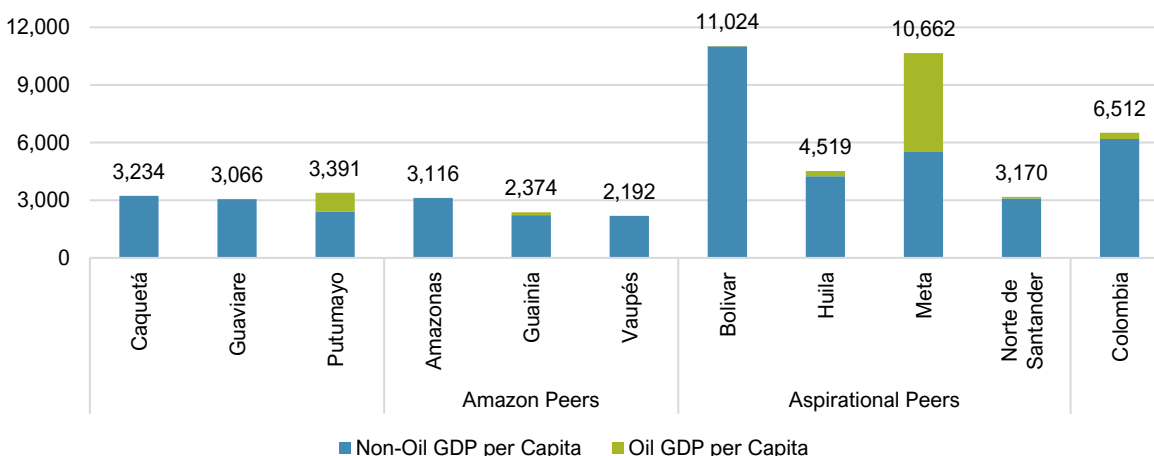


Source: adapted from Hausmann, Rodrik, Velasco (2008).

2. Growth Trajectory

Caquetá, Guaviare, and Putumayo's income per capita is above Amazonian peers, but below aspirational comparators and less than half of the Colombian average. Caquetá, Guaviare, and Putumayo are amongst Colombia's ten poorest departments, ranked 22nd, 25th and 31st respectively in terms of per capita income (Figure 4). CGP's income per capita is not only lower than half of Colombia's average, but also below three out of the four aspirational peers that were selected for the study, although in line or slightly above Amazon peers.¹ Putumayo's per capita income is above Caquetá and Guaviare due to the presence of significant oil sector, unique amongst Amazonian departments. When comparing only non-oil Gross Domestic Product (GDP), Putumayo has lower per capita income than all comparators except for Vaupés.

Figure 4. Real Gross Domestic Product per Capita, 2019
Constant 2015 USD



Source: authors' elaboration based on DANE.

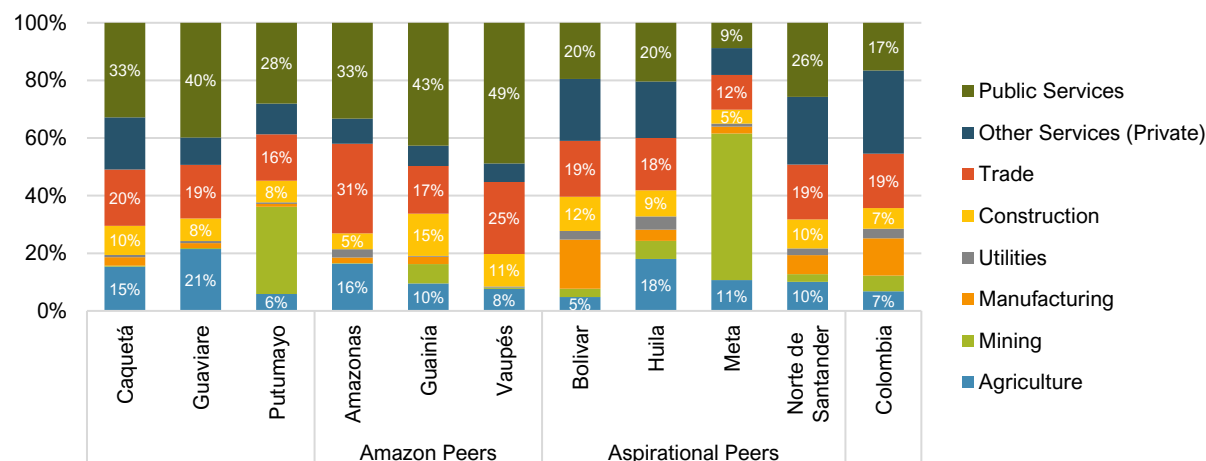
CGP structurally differs from the average Colombian department due to an outsized presence of public services; Putumayo is further an outlier due to the presence of a large oil sector. As

Figure 5 shows, CGP's economic structure, as illustrated by the sectoral decomposition of GDP, is oriented more than the national average towards non-tradable activities, in particular towards public services. This is not uncommon vis-à-vis other Amazonian peers, which show an even higher presence of public services as a share of departmental income but is significantly above public services' share for aspirational peers and the Colombian average. Moreover, construction as a share of GDP is also above the national average, although below both Amazonian and aspirational peers. Putumayo, similar to other oil producing departments such as Meta or Arauca, has a significant share of its GDP explained by mining activities. In all three departments, agriculture explains a larger share of non-oil GDP than in the Colombian average, and the role of manufacturing is almost non-existent. A similar takeaway comes from examining the structure

¹ Aspirational peers were chosen using a set of geographical, climatic and agricultural characteristics, as explained in *Appendix A1*. Additionally, three other Amazonian peers were added as comparators.

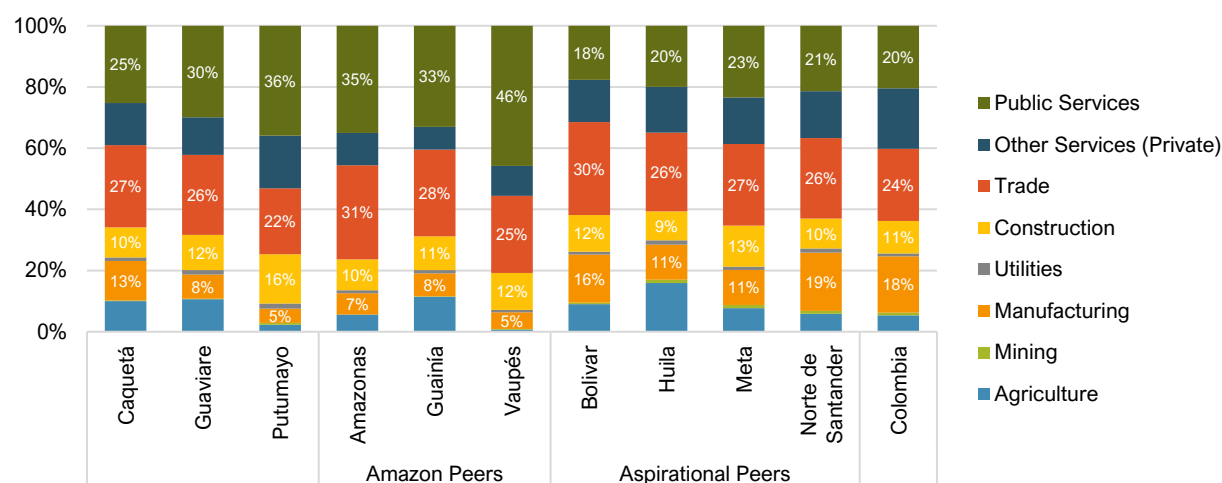
of urban employment, as analyzed through the Gran Encuesta Integrada de Hogares (GEIH) in Figure 6.

Figure 5. GDP Structure
Percentage of Department GDP



Source: authors' elaboration based on DANE.

Figure 6. Urban Employment Structure
Percentage of Urban Employment



Source: authors' elaboration based on GEIH.

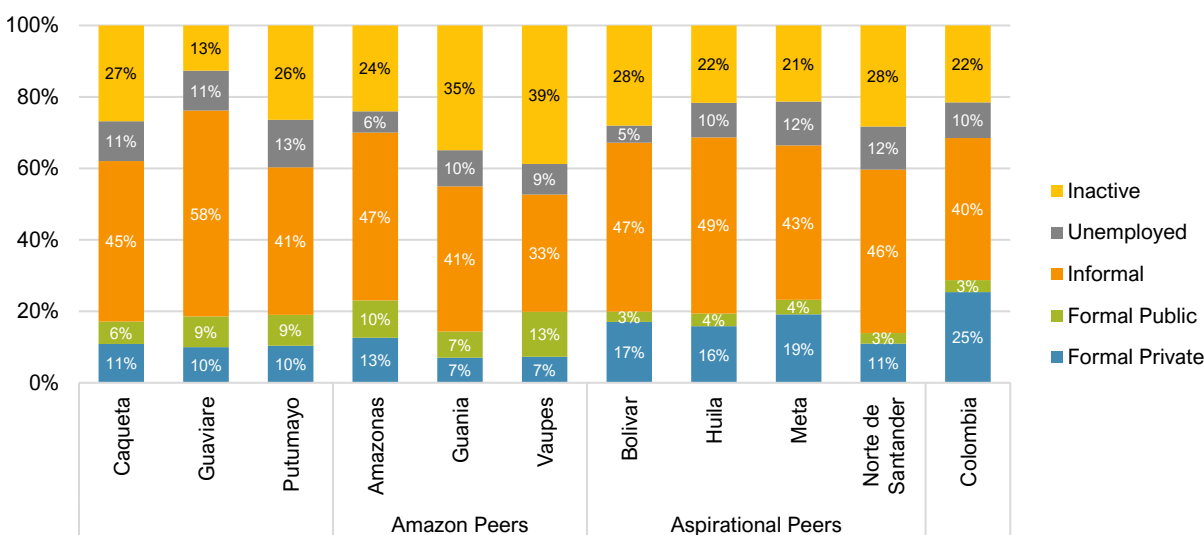
CGP has both higher levels of non-employment and informality than the Colombian average. Beyond the department's industrial composition, it is notable that the urban economies in the Amazonian departments – CGP as well as Amazonas, Guainía, and Vaupes, have a very different labor market structure than the rest of the country. Non-employment, adding both the unemployed and the inactive, is significantly higher in Caquetá, Putumayo, and Amazon peers than in the Colombian average, whereas informality rates are the higher in the Amazonian region than in the rest of the country (Given that CGP and other Amazonian departments are significantly less urbanized than the country's economic centers, it is likely that

the structural different between the department's labor markets is starker than what Figure 7 suggests.

Figure 7). Public employment is significantly higher both as a share of employees, formal employees, and the working-age population. Ultimately, what is notable is that only a small fraction of the urban population participates in the formal private market in CGP, below both aspirational peers generally below the national average and key metropolitan areas. Given that CGP and other Amazonian departments are significantly less urbanized than the country's economic centers, it is likely that the structural different between the department's labor markets is starker than what Figure 7 suggests.

Figure 7. Employment Status, by Department (2019)

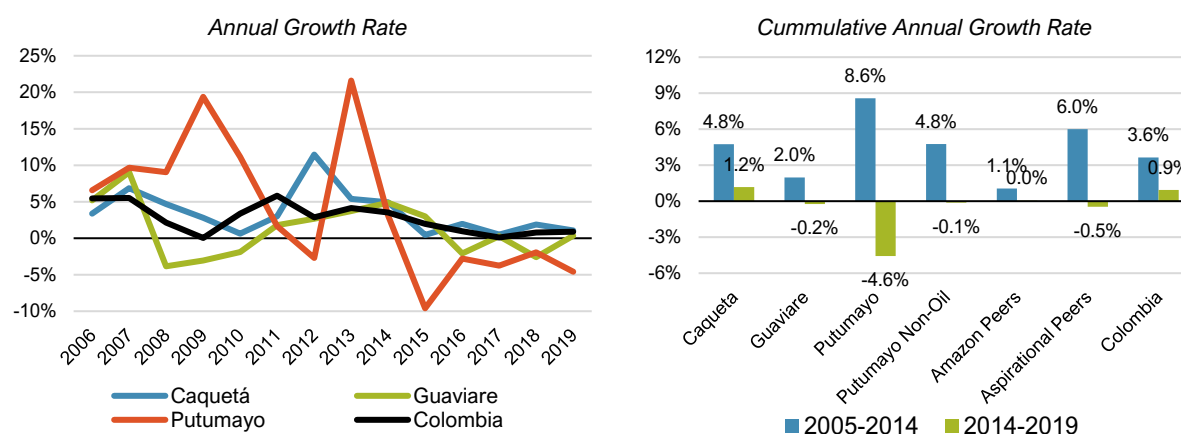
Urban 18-62 Population



Source: authors' elaboration based on GEIH.

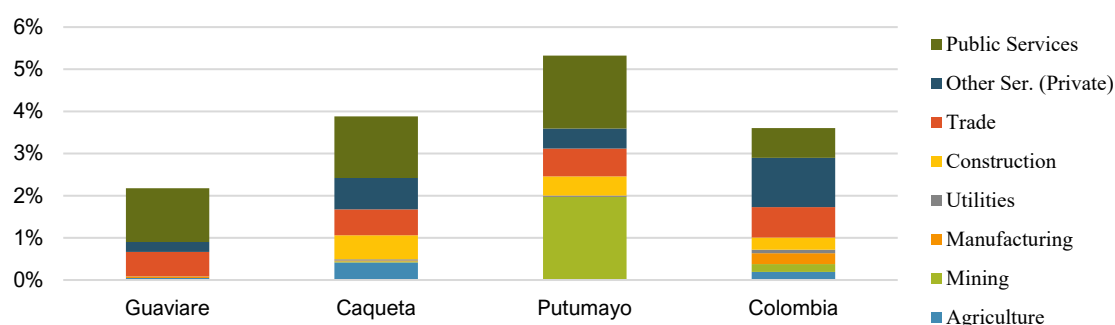
Per capita income growth has been both volatile and declining in CGP; the growth slowdown after 2014 has been significantly faster in Caquetá and Putumayo than for the Colombian average. Real GDP per capita in CGP is significantly more volatile than Colombia's national average, in particular in the department of Putumayo, where oil production is a key economic activity (Figure 8). Putumayo is precisely the second department with highest income growth volatility in the 2005-2019 period, whereas Guaviare is the eighth. In tandem with Colombia macroeconomic cycle (and with the end of the commodity supercycle), growth decelerated on average after 2014 in CGP. Whereas Caquetá and Putumayo (as well as Putumayo's non-oil economy) grew more than Colombia's average throughout the commodity supercycle up to 2014, Guaviare's growth was below both Colombia and aspirational peers in the initial analyzed period. After 2014, Caquetá's economy grew slowly (but faster than the national average) whereas Guaviare and Putumayo's economy shrank. Overall, in the 2015-2019 period, growth was led in all three departments by an expansion of public services and non-tradables, and additionally oil in Putumayo (Figure 9).

Figure 8. Real GDP per Capita Growth



Source: authors' elaboration based on DANE.

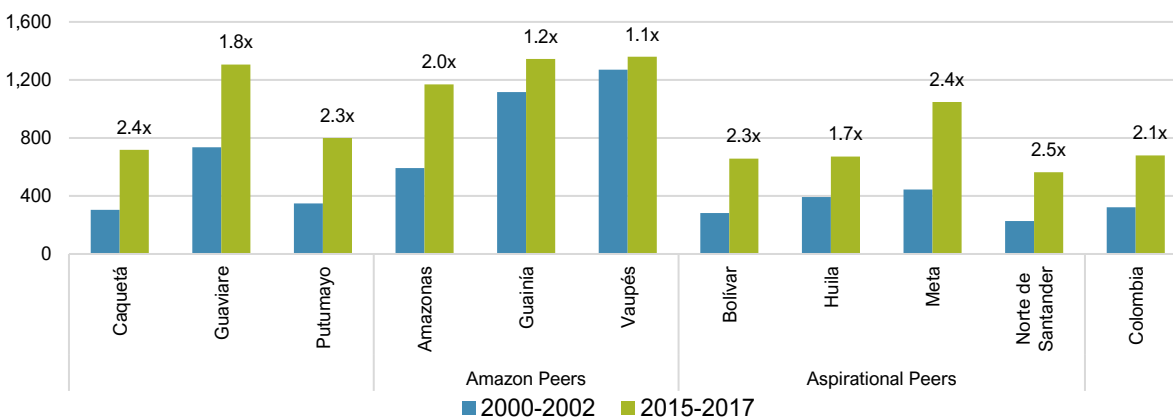
Figure 9. GDP Growth Structure (2005-2019)
Contribution to Cumulative Annual Growth Rate



Source: authors' elaboration based on DANE.

Through the last two decades, CGP saw an expansion in government activity, funded by national transfers. As Figure 10 illustrates, departmental and municipal government revenues (and ultimately) expenditures significantly increased in real terms not only in CGP, but all throughout Colombia. By 2015-2017, per capita revenues were in CGP higher than the Colombian average – particularly in Guaviare), and above most aspirational peers, although below in many cases other Amazon departments. Most of the increase is explained by national transfers, which account for more than 80% of departmental and municipal government revenue in CGP, slightly above aspirational peers which display a moderately higher self-sufficiency ratio. The increase in departmental and municipal expenditures took place in the context of the establishment of the new royalty distribution system (*Sistema General de Regalías*) in 2012 and progressive changes in the subnational revenue sharing system (*Sistema General de Participaciones*) (Bernal et al. 2017).

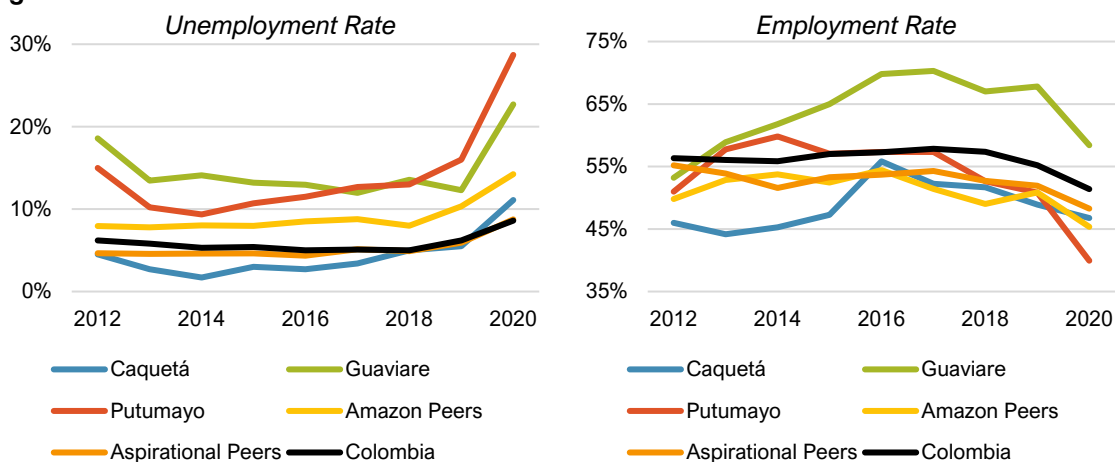
Figure 10. Departmental and Municipal Government Revenues per Capita
Period Averages, Constant 2015 USD



Source: authors' elaboration based on DNP.

Unemployment has increased in CGP over the last three years. In the most recent period after 2016, and particularly after the COVID-19 crisis, urban unemployment spiked in Caquetá and Putumayo significantly above the national average, as well as Amazon and aspirational peers (Figure 11). Guaviare's unemployment rate spiked after 2020. Parallely, the job loss driving higher unemployment rates has also resulted in a significant reduction of employment rates in CGP.

Figure 11. Labor Market Indicators in Urban Areas

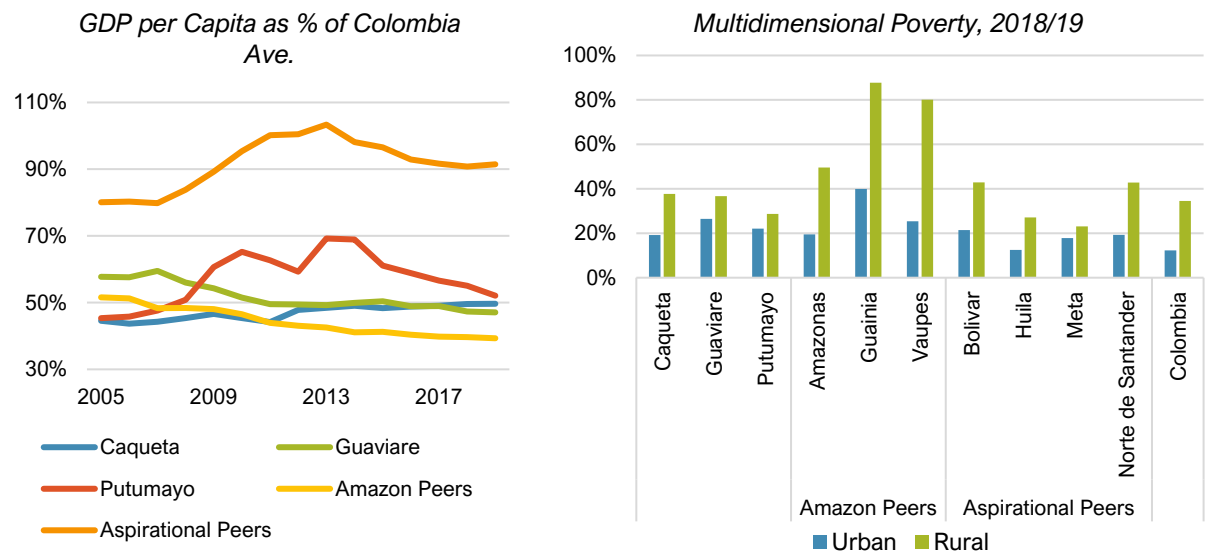


Source: authors' elaboration based on GEIH.

Ultimately, income has failed to convergence to Colombia's average throughout the last two decades. Despite a significant increase in government expenditures and the recent start of the Colombian peace process, per capita income in CGP has failed to converge to the national average, as the gap between the departments (and their Amazon peers) and the rest of Colombia has widened (Figure 12). CGP's urbanization rates remain significantly below the rest of the country, and additionally, as we have shown, labor market indicators in urban areas have failed to converge over the last ten years. As a result, poverty rates – particularly in urban areas – remain significantly above the national average and aspirational peers. In this context, our analysis will seek to understand the binding constraints to income convergence of CGP and

ultimately how Caquetá, Guaviare and Putumayo can enter an economically and environmentally sustainable growth path.

Figure 12. Income Convergence and Poverty



Source: authors' elaboration based on DANE.

3. Constraint Analysis

3.1. Growth Diagnostics in the Amazon

The intuition behind Growth Diagnostics is that economic policy problems cannot be solved through a universal list of “best practices”, but only through contextual solutions targeting specific distortions. The Growth Diagnostics methodology was first put together in Hausmann, Rodrik and Velasco (2008) as a novel approach to policy reform, motivated by the failure of previous “wholesale reform” strategies advanced in the Washington Consensus era. The intuition in Growth Diagnostics is that economic reform strategies need to be tailored according to the distinct economic (or political and social) constraints each country or region has. Although a given policy could positively contribute to economic growth in a particular context, the same policy could have unintended negative consequences in a different place (or in the same place at a different time) when the place faces different economic constraints. The methodology introduces a heuristic tree that breaks down the problem of lack of aggregate investment into “demand” and “supply” components to facilitate the identification of “binding constraints”: investment can be low in an economy either because the private return to economic activity is low, or because given that return finance is too costly (Figure 3). Moreover, demand for investments could be low either because their social returns are low (given the absence of complementary inputs such as infrastructure or human capital) or because market or government failures do not allow investors to capture the returns of their investment. Growth Diagnostics provides a framework to navigate the heuristic tree – or alternative *trees* in case the problem to be analyzed was “lack of employment” instead of “lack of investment” – and design a development strategy that targets an economy’s most binding constraints.

Growth Diagnostics requires testing for diagnostic signals that can provide evidence of a constraint being binding. “Binding constraints” are not always obvious to the eye, and often require careful and rigorous economic analysis for their identification. Growth Diagnostics requires that each separate branch of the heuristic tree is tested separately by examining the presence of potential signals that the absence of a certain input is binding. In the original framework, the four types of signals that can be considered as suggesting evidence that a constraint is binding are (Hausmann, Klinger, and Wagner 2008):

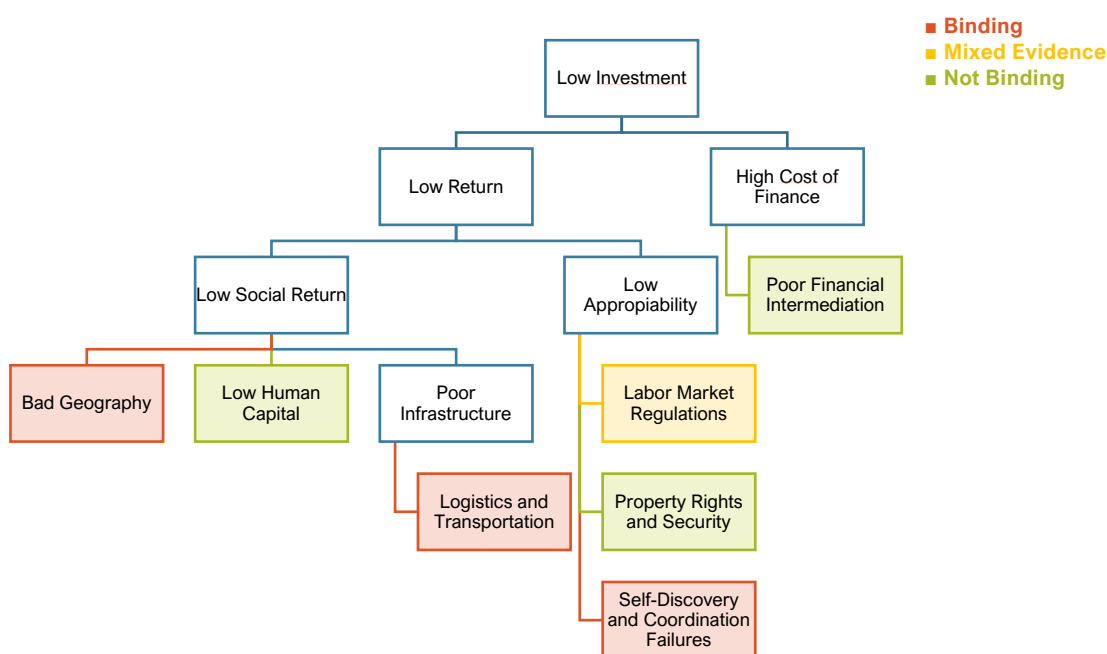
1. The presence of a *high price or high shadow price*, indicating the low supply of an input relative to demand.
2. The association of *movements in the constraints with movements in analyzed economic outcomes*, or improvements (worsening) in the outcome variable when the constraint is relaxed (tightened).
3. The relative *success of economic activities that are not dependent on the binding constraint* (and failure of those that are intensive).
4. The presence of *agents attempting to overcome the constraint* by procuring themselves the missing input.

Although no single test and symptom is definitive, and many times not every test can be carried out in practice, implementing a battery of tests can be a guide to improve the evidence that a specific constraint is the most binding in a particular location.

Implementing Growth Diagnostics at the subnational stage requires an adaptation of the original framework. Although the Growth Diagnostics methodology was originally designed to identify binding constraints to economic growth in countries, the methodology has been progressively applied into smaller geographical units, as is the case of province or states, as well as cities. Adapting the methodology to a subnational context requires that the analysis takes into consideration an additional set of caveats. First and foremost, setting an adequate benchmark for the analyzed region can sometimes introduce difficulties, as it is not evident whether the region should be compared to other regions in the same country, or to similar regions in different countries. Were one to pursue a diagnostics exercise on the richest or most productive city in a given country, finding an adequate set of peers for the city within the country could be a challenge. In the case of Caquetá, Guaviare and Putumayo, their relative position with respect to other departments in terms of both income and employment outcomes, as well as in terms of the supply of different inputs, implies that a comparison with other departments in Colombia could be sufficient since the departments are significantly far from the country's productivity frontier. Nevertheless, our analysis included – particularly for a productive profile or economic complexity exercise – a set of international peers to enrich benchmarking exercises. In any case, even when the analyzed subnational entity is neither the most nor the least productive in the country, the number of local comparators might be too low to be able to infer which inputs are relatively in the lowest supply in the analyzed region. Additionally, the type of data that is often used for Growth Diagnostics is sometimes insufficient at the subnational level, as is the case for enterprise survey data (containing subjective and objective indicators on firm performance) or data on the country's financial system. Finally, an additional theoretical difficulty when conducting subnational diagnostics is that although large gaps between regions or cities in the same countries are common, there are not as many “usual suspects” that can explain these gaps as there are when comparing different countries, as different regions in the same country face the same legal framework and political system, the same macroeconomic context and often financial system, the same trade and migration policy and often same regulations for labor markets. Arguing that one of the former is binding in a particular region often requires identifying how and why a specific region can be affected differentially by the same constraint (for example, the same minimum wage).

In the report, binding constraints to economic growth in Caquetá, Guaviare and Putumayo were identified by adapting the Growth Diagnostics tree to Colombia's subnational context. Figure 13 adapts the original heuristic tree to the constraints tested for Caquetá, Guaviare, and Putumayo. Diagnostic signals are checked for each constraint separately for each of the three departments, as not all constraints are equally important in each location. Although most of the analysis' conclusions are common to all three departments, there are a number of relevant caveats that are best identified when the departments are analyzed singlehandedly. This section will show that self-discovery and coordination failures driving capability traps are common in all three departments and explain the region's low-income convergence. Contributing to these capability traps is the region's remoteness, which itself is a function of the particular geographical position of these departments and the quality and quantity of available logistics and transportation infrastructure. Finally, evidence for labor market regulations being binding is found to be mixed. The Appendix contains additional evidence on three constraints that are found not to be at the moment binding in the three departments: (1) human capital, (2) finance and (3) property rights and security. Both constraints that are found to be binding – logistics and transportation – and not binding – property rights and security – are deeply intertwined with the region's deforestation problematic. The next section will seek to elucidate these connections and its implications for a development strategy.

Figure 13. Growth Diagnostics Tree



Source: adapted from Hausmann, Rodrik, Velasco (2008).

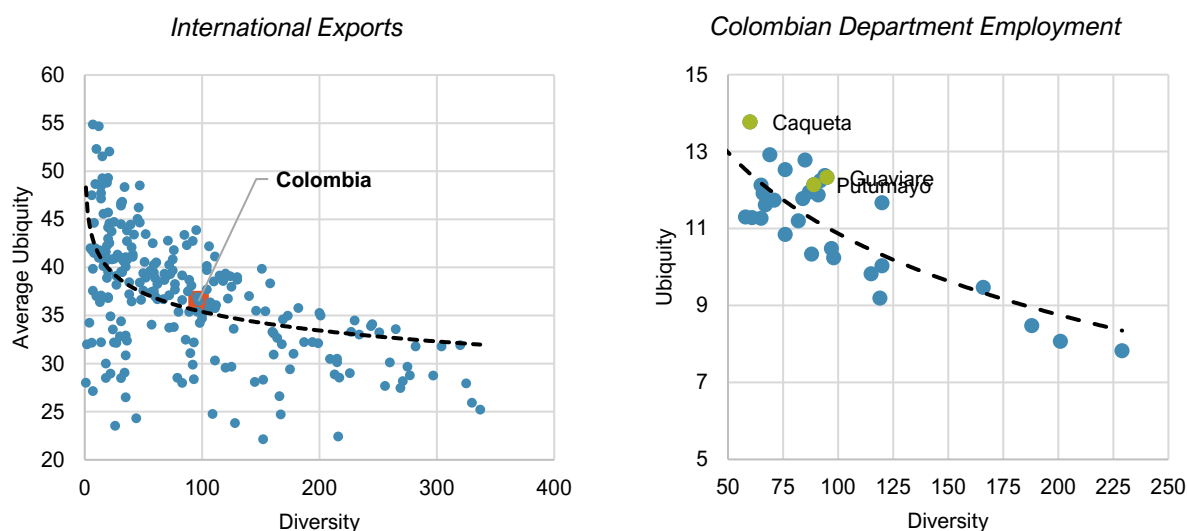
3.2. A Low Capability Trap

Countries and regions can be trapped in low-income and low-capability equilibria through self-discovery and coordination failures. A country or a region's economic growth can be bound by low incentives for technology adoption and productivity upgrading, such that the region cannot evolve in the process of structural change and incorporate the capabilities that are necessary to produce products and services other than the ones it already produces. "Self-discovery failures" can lead to such an outcome when the social return of introducing a new economic activity in a particular place is larger than the private return, and hence the externality leads to underinvestment in new economic activities (Hausmann and Rodrik 2003). "Coordination externalities" can also lead to multiple equilibria when new activities require specialized inputs that are unavailable in a particular location, and there are no incentives for single firms to provide these on their own (Rodrik 1996). In both cases, a market failure can prevent an economy from entering a higher growth path by slowing down the process of structural change.

Economic Complexity offers a methodology to analyze the set of capabilities in a given economy and identify whether the economy is in a "low capability trap". Through the methods of Economic Complexity, the sophistication, and the range of productive knowhow in a given country or region can be quantified by analyzing patterns in current production networks. Economic Complexity's key insight is that a country's productive output can be used to infer what an economy *knows*, as the fact a country or region produces a product reveals that it has the required capabilities to use it. As the theory states, "complex" products require more and different capabilities, and hence are produced in less places than products that are more ubiquitous. Defining *diversity* as how many products an economy can make and *ubiquity* as how

many places are able to make a given product, Economic Complexity has leveraged international trade data to understand a country's latent capabilities on knowhow (Hidalgo and Hausmann 2009; Hausmann et al. 2014). The stylized fact the theory exploits is the systematic relation between the diversity of economic activities in a certain region and the average ubiquity of the products produced by the region. As Figure 14 shows, diversity and ubiquity of either exports at the international level, or employment at Colombia's subnational level, are negatively correlated, and hence places that produce few products tend to products more common products. Through the Economic Complexity Index, the theory captures the information of both an economy's diversity and average ubiquity, avoiding the individual drawbacks each concept has on its own (for example, some low ubiquity products do not require a sophisticated productive profile but rely on the scarcity of a natural resource). Finally, the theory introduces additional concepts to understand the evolution of a country's comparative advantage. Through the concept of proximity, the similarity in capability requirements of different industries can be proxied through the probability of products being co-produced by different economies. As explained in our Complexity Report, the matrix of proximities can be used to build a Product Space, a network representation that connects all pairs of industries with one another. Ultimately, a Complexity Outcome Index can be used to calculate the distance between the products that a country currently produces and those it does not, weighting the latter by their economic complexity.

Figure 14. Diversity and Ubiquity – Colombia and the World, CGP and Colombia



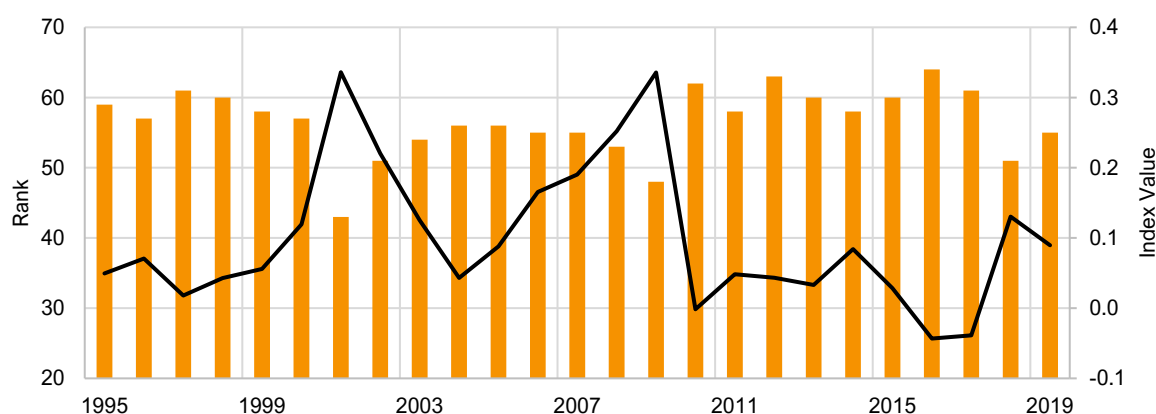
Sources: authors' elaboration based on Atlas of Economic Complexity (left panel) and GEIH (right panel).

In the context of a Growth Diagnostic, these measures can provide two types of signals of a country is facing “low capability” trap. The first type of evidence (or *static*) is a place's low base of knowhow, that is whether a country current set of capabilities is sufficient to grow and there are or not proximate complex industries for the region to gradually move in to. In low-complexity economies, an economic structure can often rely on few non-complex such as agriculture production, public sector work or retail trade industries, which cannot support long-term productivity growth. A second type of evidence (*dynamic*) is the absence of movement towards complex industries in an extended time period. A region with proximate complex industries could still fail to introduce new capabilities to its productive knowhow, indicating a

problem not necessarily related to the base of knowhow but to the mechanisms that allow that knowhow to evolve. Importantly, knowhow differs from human capital. Human capital is associated with labor productivity and relates to how efficiently and effectively one can perform a task. Knowhow is associated with industrial diversity and relates to whether one can perform a distinct task that others cannot. Two firms may have high levels of human capital, but if they operate in distinct industries then they employ distinct knowhow and capabilities.

Although Colombia is relatively complex for its income level, the country's economic complexity has been stagnant over the last decade. Before analyzing the presence of a “capability trap” in CGP, it is important to briefly explore Colombia's current complexity profile. Historically, Colombia has specialized in exporting low-complexity products such as minerals (oil and coal) as well as agriculture products (coffee, cut flowers, bananas), despite the presence of a significant petrochemical sector and smaller automotive and textile poles. Although Colombia is a more complex economy than what is predicted by its income level, Colombia's Economic Complexity has not significantly increased in the past two decades, as a reflection of the country's struggle to introduce more complex activities into its economy (Figure 15).

Figure 15. Colombia's Economic Complexity
Rank and Index Value



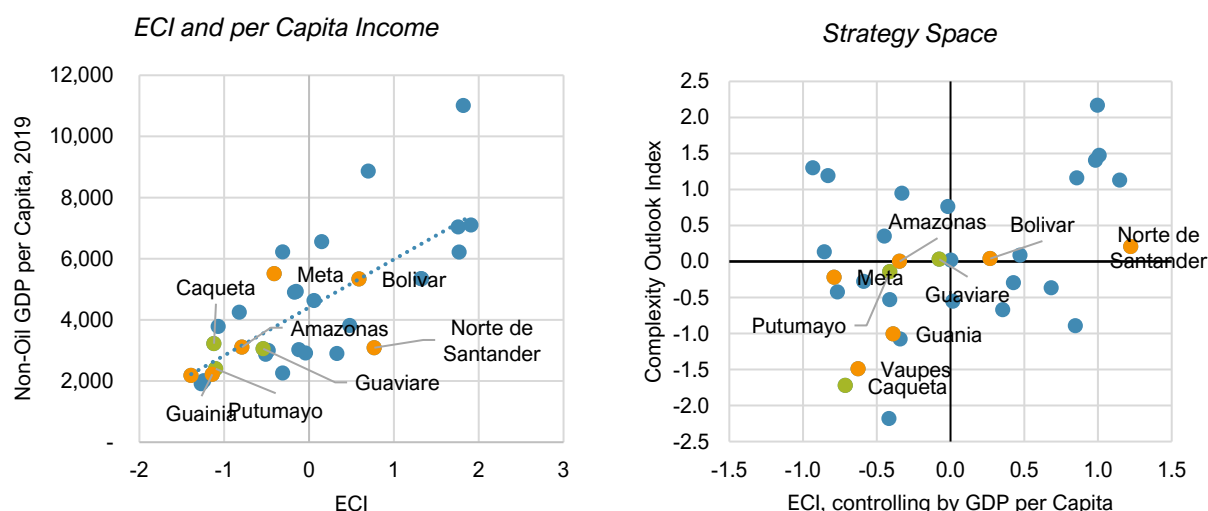
Source: authors' elaboration based on Atlas of Economic Complexity.

There is significant evidence that the urban areas of Caquetá are stuck in a “low capability trap”, although the urban areas of Guaviare and Putumayo's economic complexity is also insufficient to support the department's economic complexity. A subnational Economic Complexity Index (ECI) can be calculated for Colombia's departments using GEIH's employment data for urban areas (GEIH does not include rural employment data for Amazonian departments except for Caquetá).² As Figure 16 shows, all three CGP departments' have amongst the lowest complexity levels in Colombia. In particular, it is notable that although Caquetá's complexity levels are low, its income is still high in relation to its ECI, which could imply future difficulties in supporting sustainable growth. In Guaviare and Putumayo's case, the department's income is moderately below the income predicted by their complexity level. As the strategy space figure shows, not only Caquetá has low ECI for its income level, but also few proximate complex

² The methodology used to calculate the subnational Economic Complexity Index is explained in the accompanying complexity report.

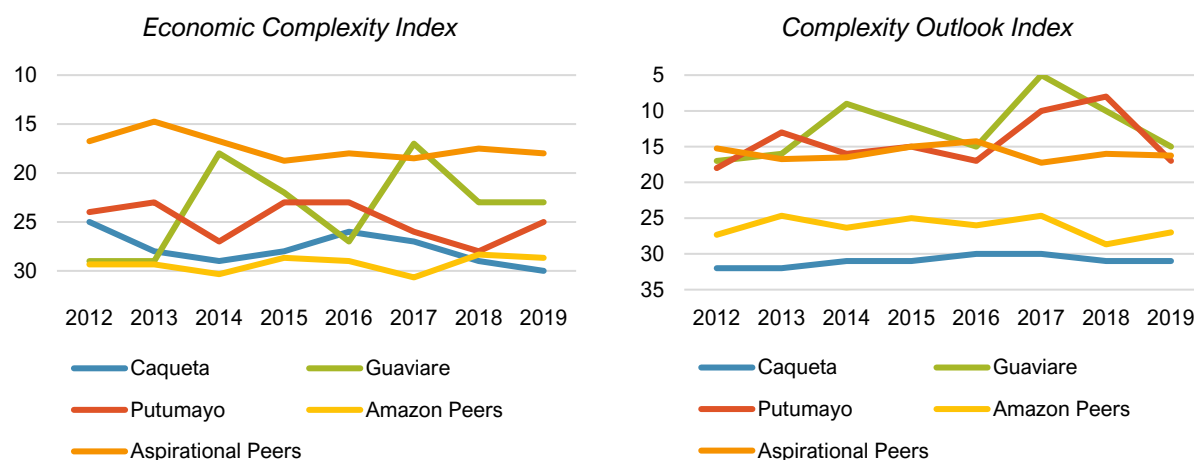
industries. Guaviare and Putumayo's strategic position is slightly better but is also represented by below-median complexity and complexity outlook. The poor positions of the departments in the strategy space – in the bottom left quadrant – indicates a potential capability trap, as the quadrant includes regions that have both a low base of knowhow and are disconnected from proximate complex industries to organically move in to. It is notable that Caquetá is the worst positioned department amongst the three, considering that Florencia is the only substantive urban base in CGP. Guaviare and Putumayo are both better connected to proximate economic activities (as seen in their COI) but are still working off a relative low base of knowhow in each department (as illustrated by their ECI). It is also important to keep in mind that the analyzed complexity indicators are based on urban economic activity and taking into consideration also “rural” activities could lead to an even poorer perspective for CGP and other Amazonian departments, where low-complexity rural activities are more common.

Figure 16. Economic Complexity in Colombia's Departments



Source: authors' elaboration based on GEIH and DANE.

Figure 17. Evolution of Economic Complexity and Outlook



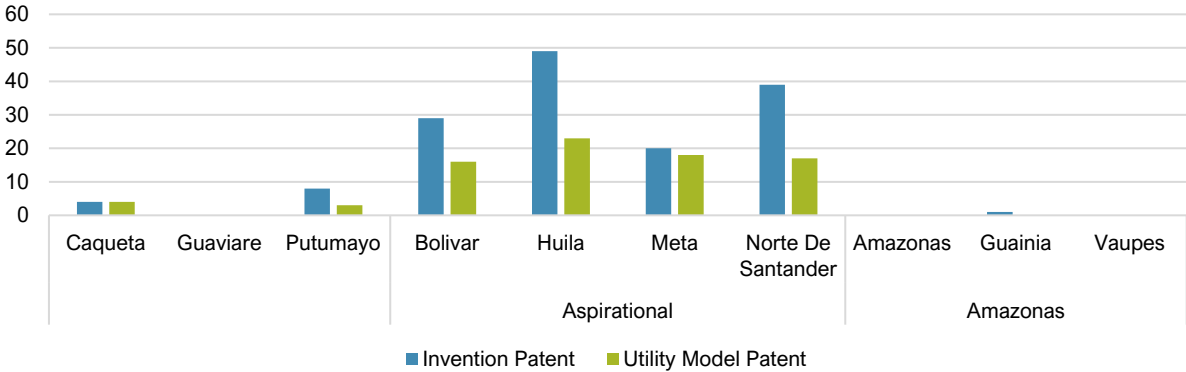
Source: authors' elaboration based on GEIH.

CGP’s complexity profile has been relatively stagnant over time. As illustrated by Figure 17 **CGP’s low knowhow base is further supported by low levels of innovation and research.** Although a significant patenting level is not to be expected in the periphery regions of country of Colombia’s income level, the contrast between CGP and aspirational peers as to the departments’ level of patenting shows a regional economic structure consistent with a low base of knowhow, as illustrated by Figure 18.

Figure 18. Patents by Department from 2011-2019
, CGP’s low complexity and relatively low complexity outlook has been a constant over the last decade, with only some fluctuations in Guaviare and Putumayo’s indicators, potentially derived by small-sample issues with GEIH. Through the entire period, CGP’s complexity profile has shown levels above their Amazon peers, but below their aspirational peers.

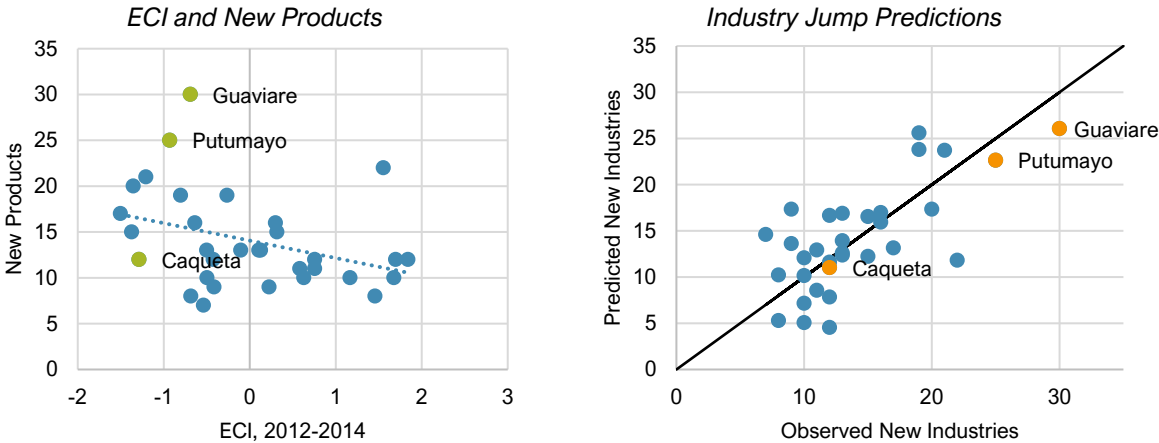
CGP’s low knowhow base is further supported by low levels of innovation and research. Although a significant patenting level is not to be expected in the periphery regions of country of Colombia’s income level, the contrast between CGP and aspirational peers as to the departments’ level of patenting shows a regional economic structure consistent with a low base of knowhow, as illustrated by Figure 18.

Figure 18. Patents by Department from 2011-2019



Source: authors’ elaboration based on Superintendencia de Industria y Comercio.

Figure 19. New Products and Economic Complexity



Source: authors' elaboration based on GEIH. New products are defined as products without Revealed Comparative Advantage (RCA) (below 1) in the 2012-2014 period but with RCA above 1 in 2017-2019. Industry jump predictions are calculated in a regression of industry appearances in 2017-2019 to "density", or the average proximity of industries in a given department to a particular industry.

Despite their low knowhow base, Caquetá, Guaviare, and Putumayo have introduced new activities into their economic profile over the last decade. As illustrated by Figure 19, Guaviare and Putumayo have added more activities than expected for the economic complexity into their productive profile, although the department have not been successful in improving their economic complexity as the activities have not been complex. "Industry jumps" have been in line with predictions based on the departments' position in the Product Space, with especially strong results from Guaviare and Putumayo. It is important to keep in mind that the low sampling of household surveys for Amazonian departments could be creating an upward bias in the "jumps" estimates, as industry RCAs that are used to calculate them are more volatile.

The static and dynamic analysis of CGP shows that all three departments suffer from a low base of knowhow. As illustrated by the subnational strategy space, the departments' low knowhow base places them in a poor position to move into more complex industries, and ultimately increase their potential income. Although Putumayo and Guaviare have added a significant number of new industries into their productive profile, the departments have not been able to improve their ECI. Further, the low base of knowhow likely affects the urbanization rates of the departments, compounding the poor agglomeration and complexity problems the departments face.

CGP's low base of capabilities is not only binding to the region's economic development but can explain some of the key structural features of the region's labor market. The theory of Economic Complexity is additionally useful to understand other features of the structure of Colombia's labor markets, as is the case of the country's significantly high informality rates. As previously argued, there is in Colombia a significant and positive relation between appearance of complex economic activities and formal labor (O'Clery, Gomez-Lievano, and Lora 2016). At the individual level, we can indeed observe a positive association in formality of economic activities and their economic complexity of the department in which an individual is located in (Figure 20). This includes the strong association of department ECI with the likelihood of a worker to be formal, including when controlling for broad employment industry. When we compare the ECI of departments and their average informality rates, we indeed find a tight negative fit, where CGP are departments with informality levels in line with department complexity levels (Figure 21). In parallel, workers in CGP are shown to work in smaller businesses, even when working in the formal sector (Figure 22). This is consistent with the departments' low economic complexity, as even formal firms are dominated by low value-added activities that do not engender themselves to scaling. Increasing economic complexity is key both to attain higher rates of formalization and larger firm size.

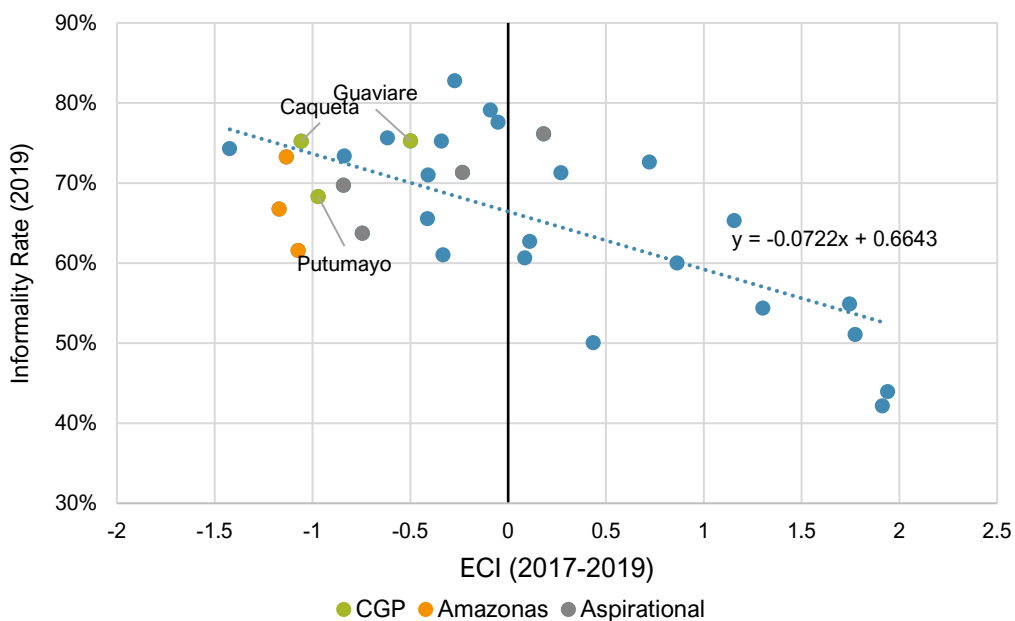
Figure 20. Economic Complexity and Formalization Regression in Urban Areas
Average Marginal Effects on Formalization in Logit Model

Dependent Variable: Formal Worker		
	(1) Including ECI	(2) Not Including ECI
ECI	0.476*** [0.000]	
Female	-0.417*** [0.000]	-0.433*** [0.000]
	0.193***	0.189***

Years of Schooling	[0.000]	[0.000]
Experience	0.056***	0.059***
	[0.000]	[0.000]
Experience Squared	-0.001***	-0.001***
	[0.000]	[0.000]
R²	0.3075	0.2852
N	2639915	2639915

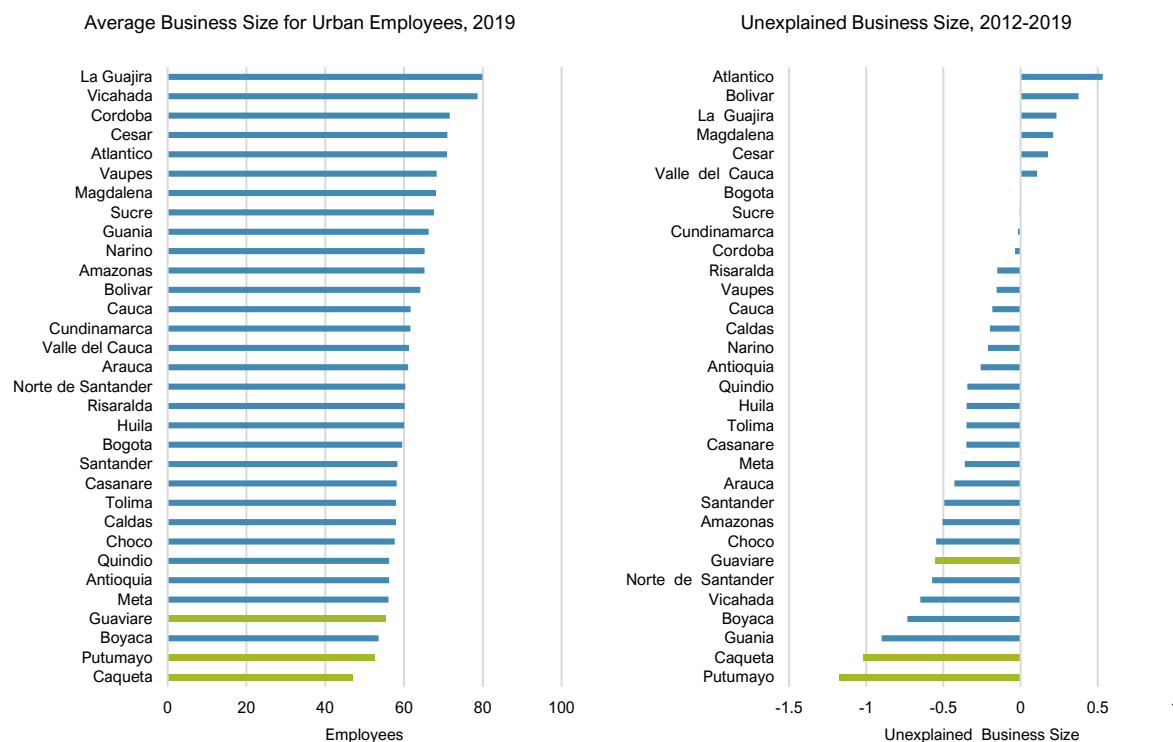
Source: authors' elaboration based on GEIH. Regression includes industry and year fixed effects. A 2012-2019 average Economic Complexity Index is used in the regression.

Figure 21. Economic Complexity and Informality Rate in Urban Areas.



Source: authors' elaboration based on GEIH.

Figure 22. Average Firm Size of Urban Formal Private Employees



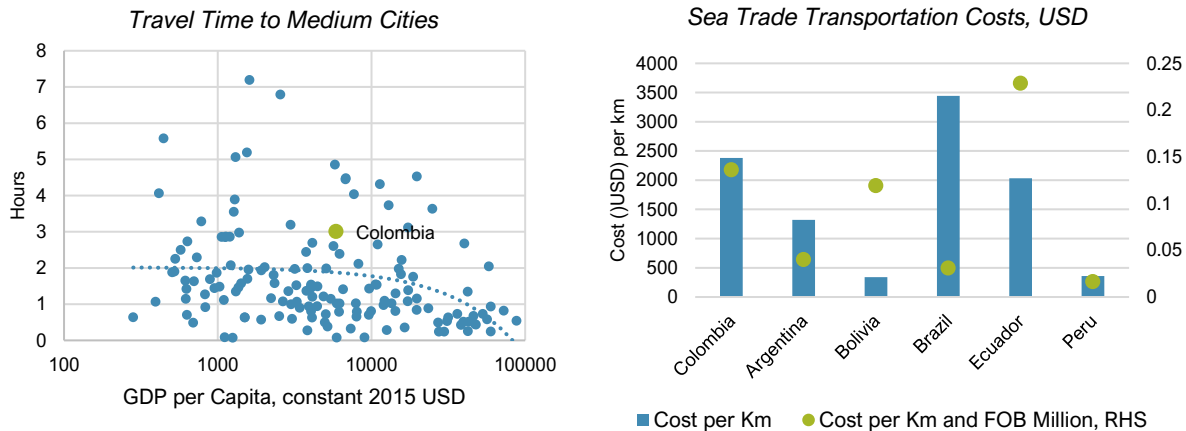
Source: authors' elaboration based on GEIH. Average business size is calculated by averaging the lower end of business size intervals, as answered by urban formal private employees. Unexplained business size are departmental fixed effects in an OLS regression of business size intervals for urban formal private employees on industry categorical variables and additional individual characteristics (schooling, gender experience), as well as year fixed effects.

3.3. The Economics of Remoteness

Transportation and logistics connecting Colombia's regions – as well as Colombia and its trading partners – have often be argued to be binding to the economic development of the country. Low connectivity within Colombia has often been described as one of the country's most distinct economic challenges (World Bank Group 2015). Both the depth of current transportation infrastructure and its quality has been highlighted as contributing to high within-country transportation costs. As

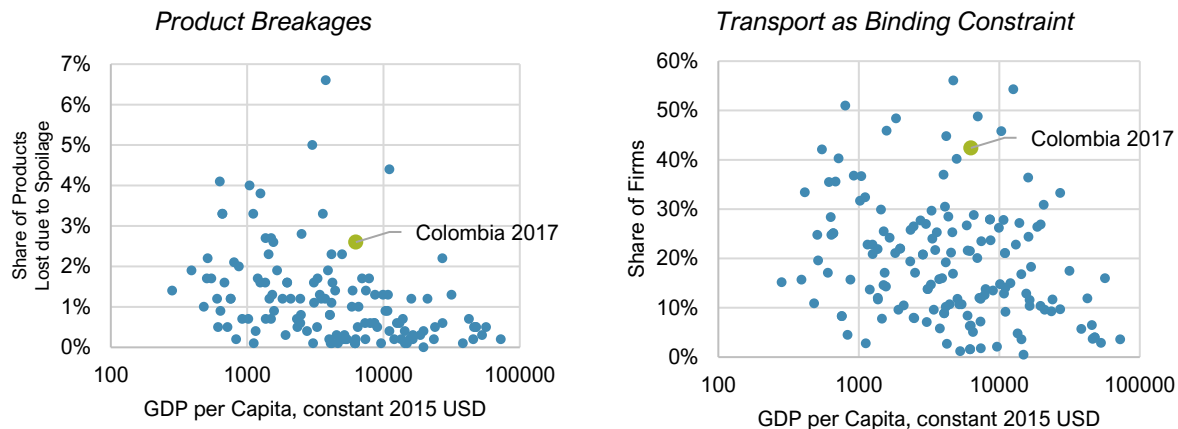
Figure 23 shows, Colombian ranks 131 out of 152 countries on remoteness – on average, the population of Colombia is 3 hours from cities with over 200k population, a proxy for connectedness. Moreover, Colombia faces high transport costs for exports out of the country, relative to regional peers, as. Using UNCTAD data on global bilateral trade, we observe that Colombia's transport costs for its exports are higher than its peers for exports by sea. Enterprise surveys confirm that Colombian firms suffer from product breakages due to poor logistics infrastructure and ultimately see transportation costs as one of their main constraints, in comparison to countries with similar income per capita (Figure 24).

Figure 23. Colombia's Remoteness



Sources: authors' elaboration based on Global Friction Surface, Open Street Maps and Google Maps (left panel) and UNCTAD (right panel).

Figure 24. Colombia's Transportation Constraint

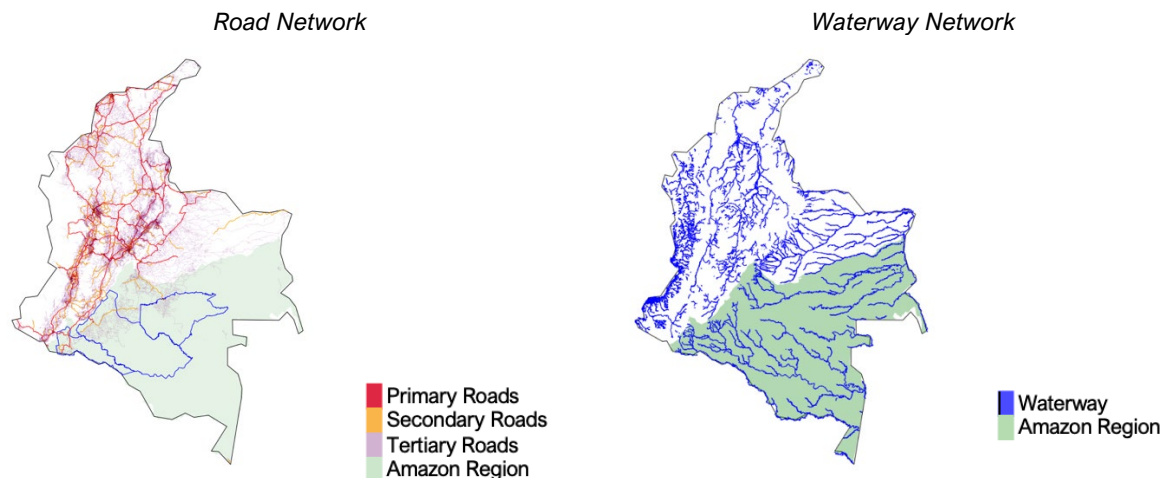


Sources: authors' elaboration based on World Bank World Development Indicators and Enterprise Surveys.

Remoteness is a function of both geography and the infrastructure available to facilitate the movement of goods and people. Remoteness can be in a first instance defined as a *distance* between a *location* and *markets* or *inputs*, which results in higher costs for firms. Although this initial definition is simple, each of the terms used in it is conceptually ambiguous, and subject to valid debate. “Distance” can be measured as either geographical distance (measured in kilometers on a straight line between two coordinates), or the time taken for transport given current physical infrastructure, or the financial transport costs. Second, a region can be simultaneously close to “domestic markets”, but distant from ports or airports connecting to international markets, which could be the relevant benchmark, or poorly connected to its inputs (such as labor). Moreover, the relevant physical infrastructure or markets may vary when considering the movements of different types of goods or the movement of people. Overall, however, remoteness can be thought of as a function of both geographical characteristics – a country or a region’s geographical position vis-à-vis the relevant markets – and available physical infrastructure (in terms of air, sea, and ground transportation connectivity, as well as potentially ICT infrastructure).

The evidence of the impact of remoteness on economic growth has been mixed. Although the availability of road infrastructure reduces transport costs and facilitates the movement of goods and people, the channels through which construction of new roads affects economic growth are complex. For example, lower transport costs have been shown to lead to large impacts on the growth of urban areas in many developing countries (Storeygard 2016). In addition, low transport costs have been shown to have large impacts on agricultural land values and agricultural incomes (Donaldson and Hornbeck 2016; Donaldson 2018). However, in a different study, Asher and Novosad (2020b) show that although rural building new roads primarily enables worker transitions out of agriculture, these do not lead to an increase in agricultural incomes. Moreover, Faber (2014) finds that in peripheral areas that are not connected by a new high highway, trade diversion reduces growth. Ultimately, factor mobility determines the allocation of benefits that result from new infrastructure (Banerjee, Duflo, and Qian 2020). Overall, previous literature points to rural roads as a means to enhance transitions out of agriculture, without directly affecting economic structure of remote regions themselves. Urban areas, however, seem to largely benefit from improved accessibility, through the creation of new non-agricultural jobs and improved productivity.

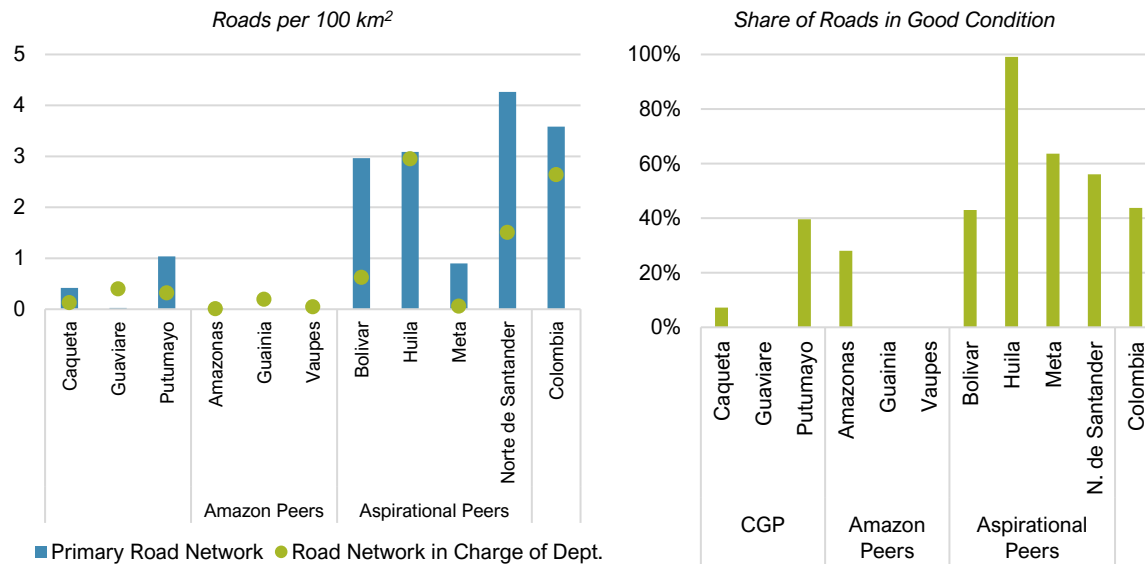
Figure 25. Colombia's Road and Waterway Network



Source: authors' elaboration based on Open Street Maps (left panel) and World Bank (right panel).

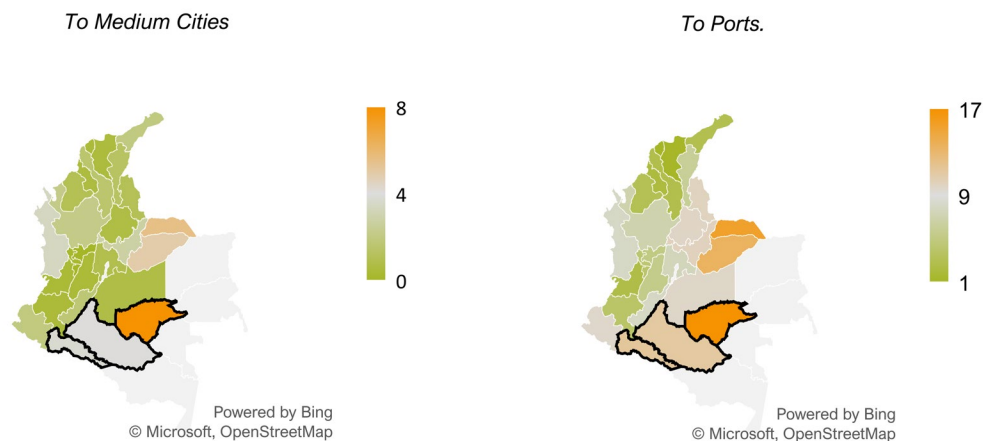
Caquetá, Guaviare, and Putumayo are poorly connected to the rest of Colombia. Even within the Colombian context, it would not be controversial to deem Caquetá, Guaviare, and Putumayo as *remote*. As Figure 25 shows, the road network connecting the departments and the Amazon to the country is mostly comprised of roads classified as *tertiary roads*, that is managed by departmental governments and municipalities, as *primary roads* (managed by the national government) and *secondary roads* (managed by local department) are mostly absent. All three departments have a significantly lower number of roads, given their area (Figure 26). Moreover, unlike Amazonian regions in Brazil, waterway connectivity is also poor, given not only the region's geographical characteristics but the lack of appropriate physical infrastructure. Beyond the overall *availability* of road infrastructure, the *quality* of infrastructure in CGP is also generally worse than in departments outside of the Amazonian region.

Figure 26. Road Network Availability and Quality



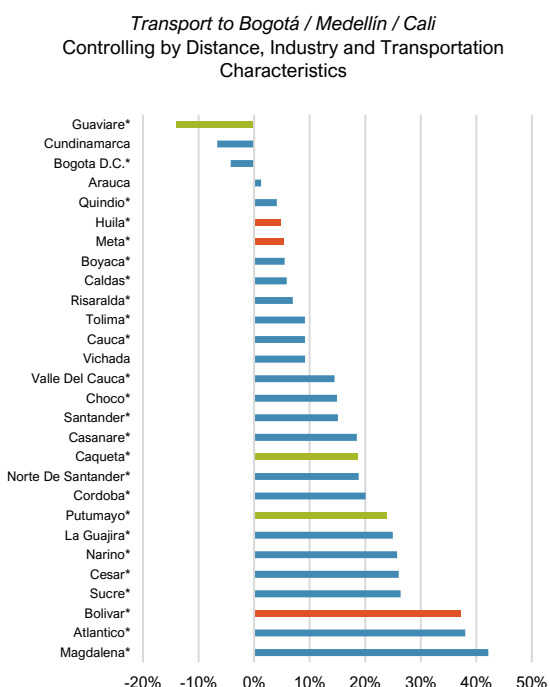
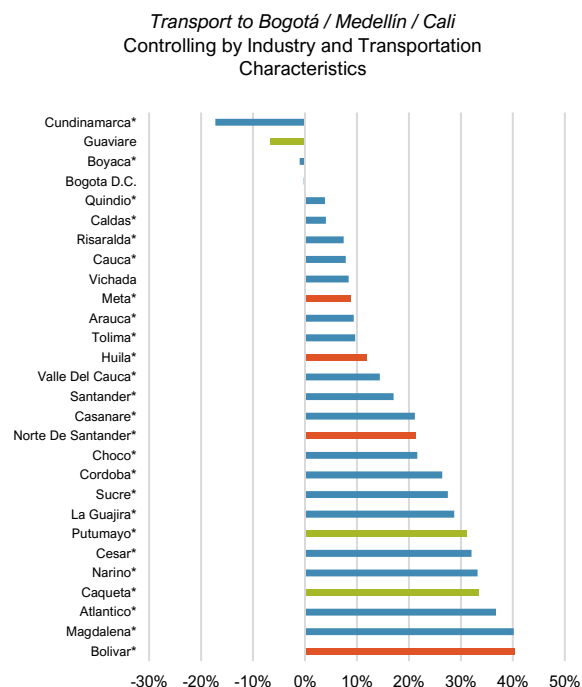
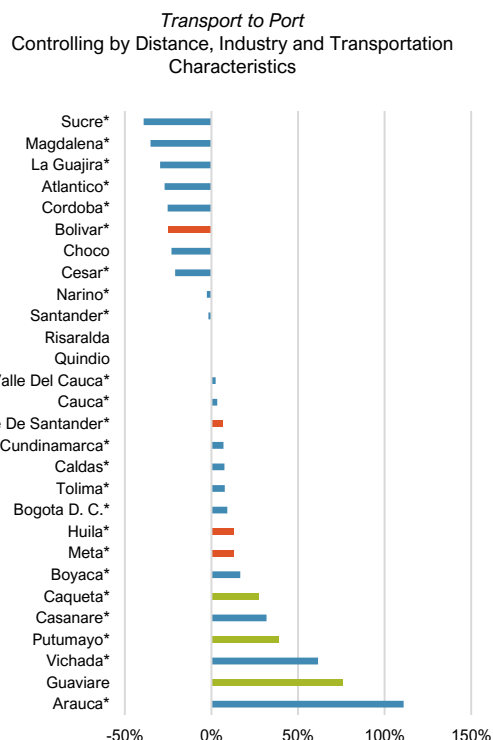
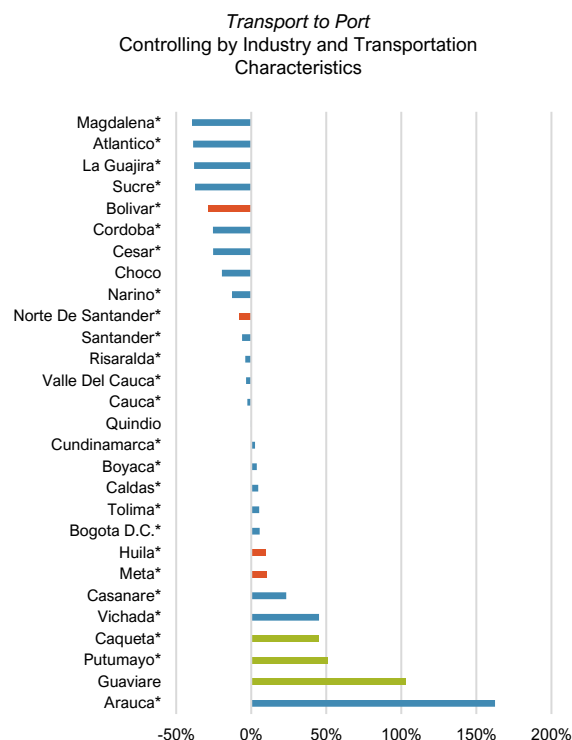
Source: authors' elaboration based on Consejo Privado de Competitividad.

Figure 27. Average Travel Times from Urban Areas (2019)
Hours



Source: authors' elaboration based on Global Friction Surface, Open Street Maps and Google Maps. Estimates excludes Amazonas and San Andres, outliers in the data.

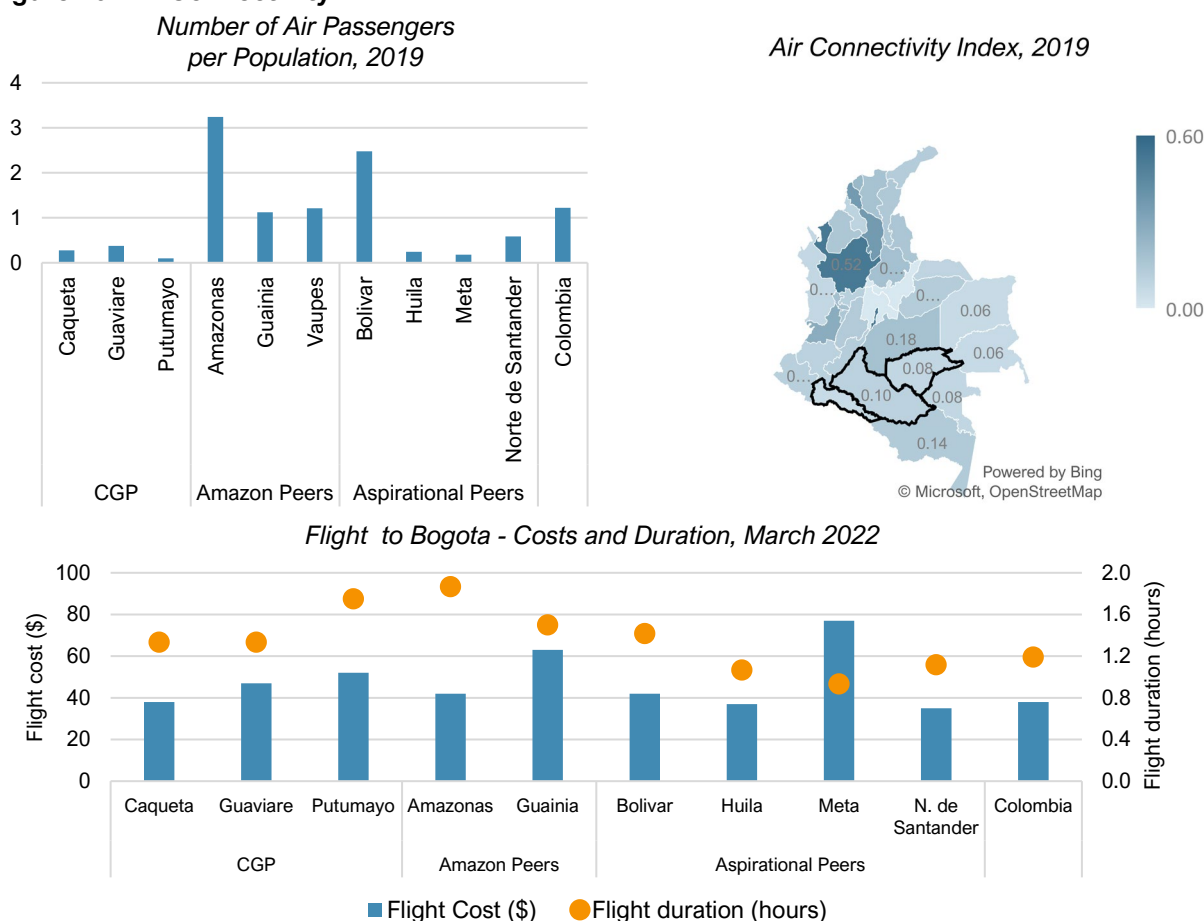
Figure 28. Transport Cost of Additional Merchandise Ton (2015-2020)
Additional Cost relative to Antioquia



Source: authors' elaboration based on Registro Nacional de Despacho de Carga (RNDC). Additional costs are the department coefficient of a regression of transportation costs on department coefficients, industry and transportation characteristics categorical variables, and distance in the second panel. Department names followed by * indicates coefficients that are statistically significant at 5% level.

Poor connectivity results in a disconnection between CGP and the rest of the country, which hinders both the movement of people and goods. CGP's economic remoteness is first reflected in the average travel times to urban cities and to ports that are orders of magnitudes larger than in the rest of the country, which are a result of both the department's geographical position and the poor physical infrastructure (Figure 27). Moreover, firms face significant costs to bring goods both in and out of CGP. Using data on travel through heavy motor vehicles declared to the Ministry of Transport in the *Registro Nacional de Despacho de Carga* (RNDC), one can observe the fuel, toll and general transportation costs in each trip transporting goods between all municipalities with road access in Colombia since 2015, as well as the type of good that is transported. With this data, the differential cost of transporting goods from each department in Colombia was estimated, in comparison to Antioquia (chosen as a median benchmark). As Figure 28 shows, Caquetá, Guaviare and Putumayo have some of the highest transportation costs to ports in the country, controlling by the types of goods transported and other ground transportation characteristics. Moreover, even when controlling by distance, CGP's costs are still higher than most departments. Transportation costs to large cities (Bogotá, Cali, Medellín) are also found to be higher in Caquetá and Putumayo than in most departments, both controlling and not controlling by distance (estimates for Guaviare are not statistically significant, likely due to low sample size of trips).

Figure 29. Air Connectivity

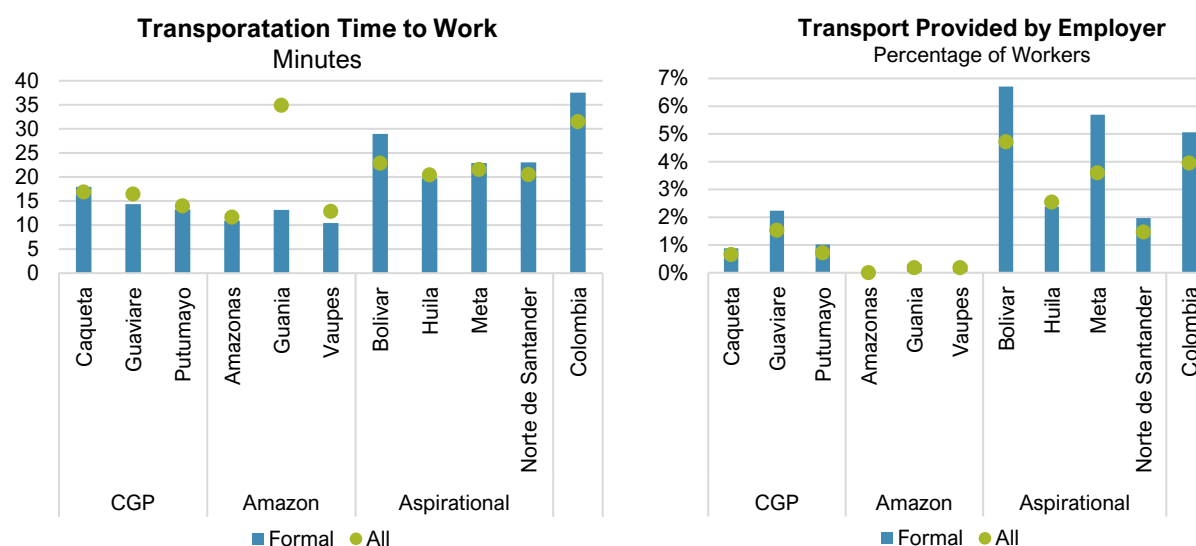


Source: authors' elaboration based on Consejo Privado de Competitividad (first and second panel) and Google Flights (third panel). Flight costs and duration from capital cities of each department to Bogotá (El Dorado International Airport) represent the least costly flight available. Data for flights on March 6, 2022, was accessed on December 9 and 14, 2021.

Beyond ground connection to the rest of the country, air connectivity is also poor. In many contexts, poor road connectivity is compensated by air transportation, both for transportation of goods and people. In Caquetá, Guaviare and Putumayo, air connectivity is still lacking, as reflected by the low number of air passengers relative to the population and by low number of flights in the region (Figure 29). Flight prices and times are not higher however than in other comparable departments.

Within CGP, jobs are relatively closer to households than in other departments, which suggests a specialization in nonproductive work. Workers in Caquetá, Guaviare, and Putumayo face significantly lower transportation times to get to their workplaces than the departments' aspirational peers and the Colombian national average, as illustrated by Figure 30. This is not surprising given the departments' significantly lower urbanization rate and lower city sizes, as well as their earlier position in the ladder of structural transformation. In all three departments, transportation tends less to be provided by the employer. Lower transportation times implies that transportation *within* cities in CGP is currently not a constraint for firm development, but this could also signal that the departments themselves have specialized away from complex industries that require more diverse set of skills and need to leverage workers that are farther away from the workplace. This is consistent with previous findings in smaller business size and higher informality in the Amazonian departments.

Figure 30. Worker Transportation, 2019



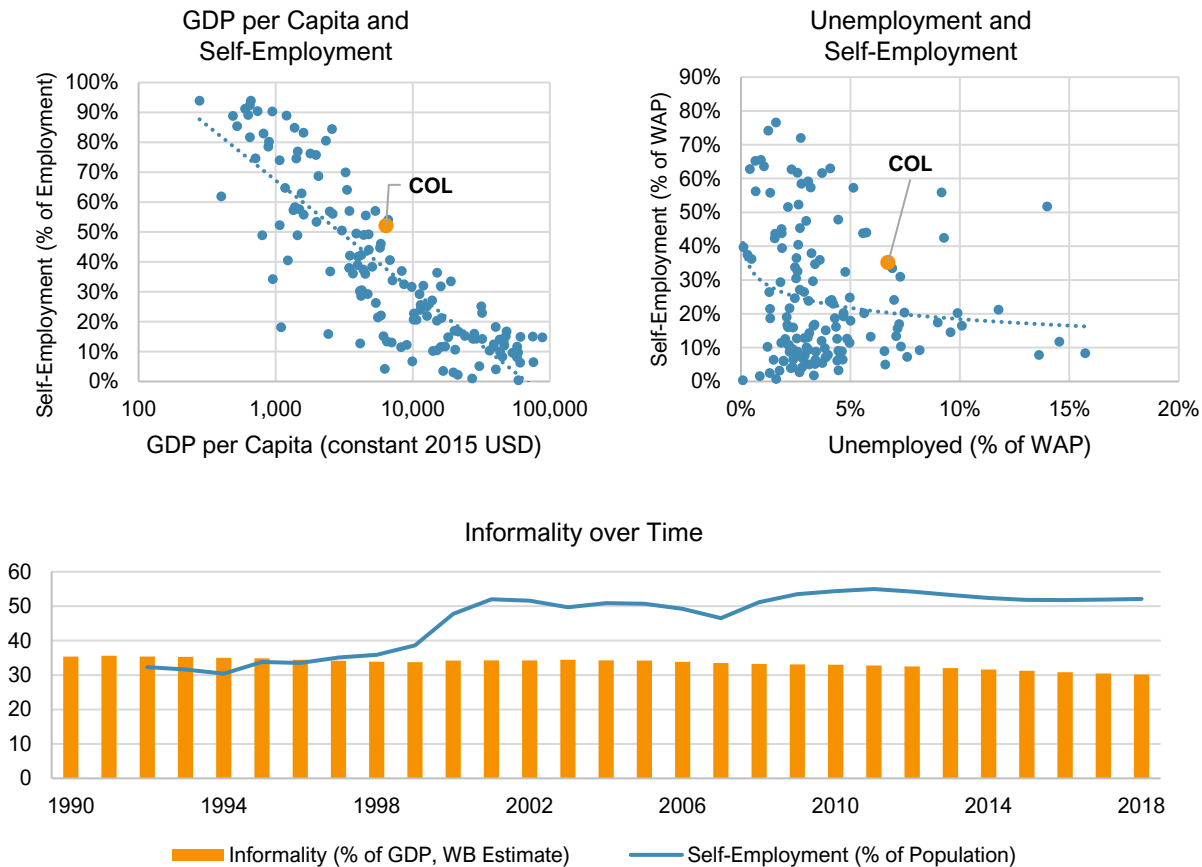
Source: authors' elaboration based on GEIH.

Remoteness – driven both by economic geography and infrastructure – has shaped and will continue to shape the development of CGP. The remoteness of the three analyzed departments implies significant costs to the movement of both goods and people that shape their past, present, and future development trajectory. Improving the complexity of the department's productive structure will likely require improvement the capacity of the departments to move people and goods in and out of the region. As discussed in the next section, the development of road infrastructure could however have pernicious implications for the deforestation problematic, if not carefully planned and combined with supplementary policies.

3.4. Labor Market Regulations: Symptom or Root Cause?

Colombia's labor markets have often been described as exhibiting both high levels of informality and unemployment. Despite the economy's strong growth throughout the 2000s, and independent of the business cycle, Colombia remains an economy with a significant informal sector. As Figure 31 shows, using a structural definition of informality as self-employment (*cuentapropismo*), informality is significantly larger in Colombia than in other countries of similar per capita income. A similar result is obtained when defining informal workers as workers as unregistered or outside of a country's social security system. What is notable in Colombia is that the country's high informality rate coexists with relatively high unemployment as a percentage of the working-age population (WAP). The country's high rates of self-employment and informality, and the informal share of economic activity, have indeed been a constant over time.

Figure 31. Informality in Colombia, 2019

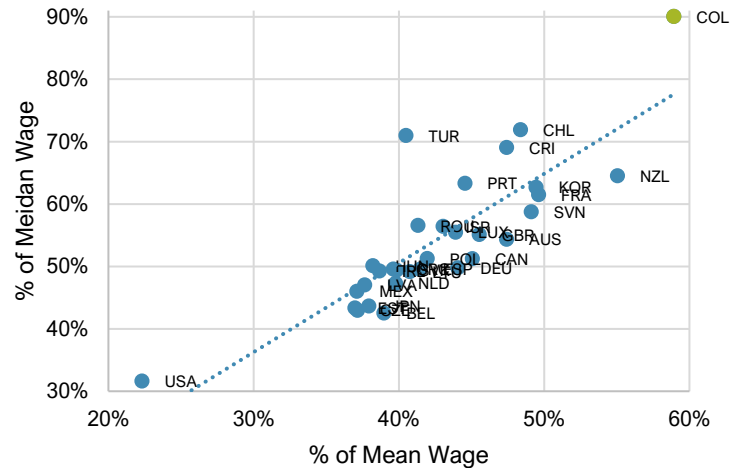


Source: authors' elaboration based on World Bank World Development Indicators and Elgin et al. (2021).

High informality rates at the national level have often been linked to stringent labor market regulations. The association between Colombia's high level of informal or self-employed work and the country's labor market institutions has been discussed in economic and policy literature for decades, with a focus on the impact of minimum wages and taxation on labor (Joumard and Vélez 2013). A cross-country comparison suggests that Colombia's minimum wage is higher than for any country in the OECD, and previous studies have also found it to be higher than for

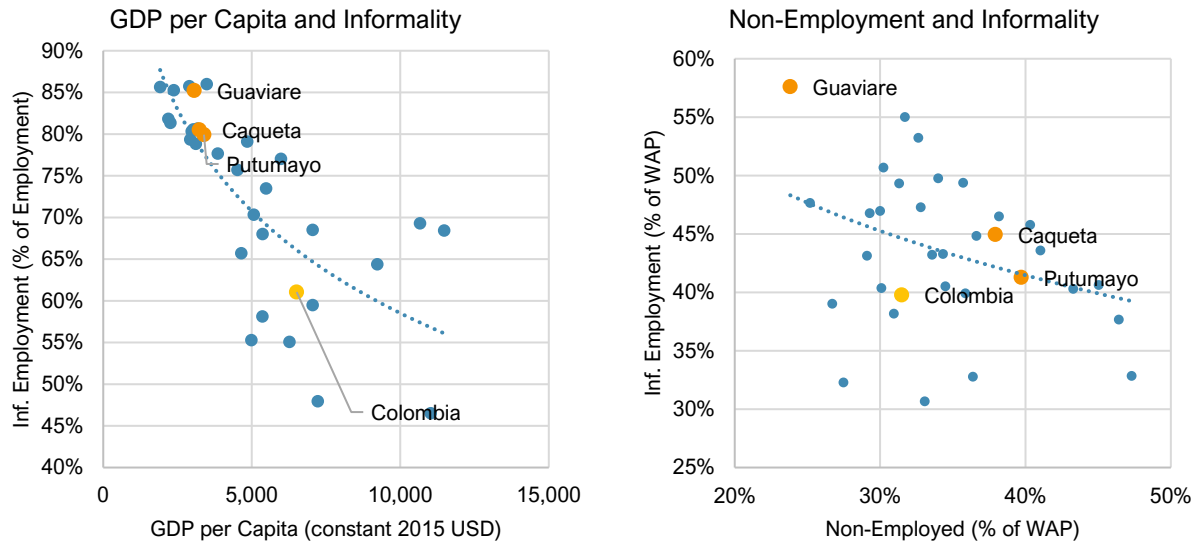
most Latin American peers (Figure 32). As for academic literature, Bell (1997) studied the impact of the country’s minimum wage on labor market outcomes in the 1980s, finding a significant impact for Colombia’s case, although not in Mexico. In a review of Latin American minimum wages, Maloney and Mendez (2003) also found a significant effect of the rise in the minimum wage in Colombia on the probability of being unemployed, as well as on the wage distribution. Recent analysis on Colombia’s labor markets also discussed high and rising minimum wages as a disincentive to the employment of low-skill workers in traditionally formal sectors such as manufacturing (Carranza et al. 2021). Finally, additional research has been pursued on the effect of other non-labor costs, such as payroll taxes (Kugler and Kugler 2009), income taxes on labor revenue (Núñez Méndez 2002).

Figure 32. Minimum Wage as Percentage of Mean and Median Wage (2019)



Source: authors’ elaboration based on OECD.

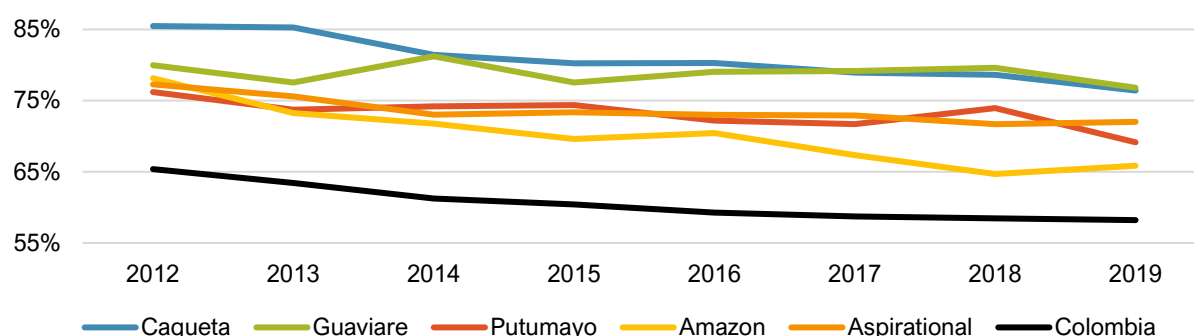
Figure 33. Informality in Colombia’s Departments



Source: authors’ elaboration based on GEIH and DANE.

Caquetá, Guaviare, and Putumayo’s levels of informality and are amongst the highest in Colombia, although informality rates have fallen over time. CGP’s levels of informality – defined as a percentage of private employment – are amongst the highest for any Colombian department and are more than 20 percentage points above the Colombian average. Private formal employment is essentially absent in the departments (Figure 33). Taking into consideration the departments’ non-employment levels (that is, the number of unemployed and inactive persons over the working-age population), CGP’s informal workers are still high as a share of the WAP, in particular in the case of Guaviare. According to GEIH, informality has been moderately falling overall in Colombia, and particularly in Caquetá and Putumayo (Figure 34). Nevertheless, in the post-COVID world, it is likely that part of that decrease is reverted, given the significant role the informal sector has played as a margin of adjustment throughout the crisis (Alvarez and Pizzinelli 2021).

Figure 34. Informality Rate in Private Sector



Source: authors’ elaboration based on GEIH.

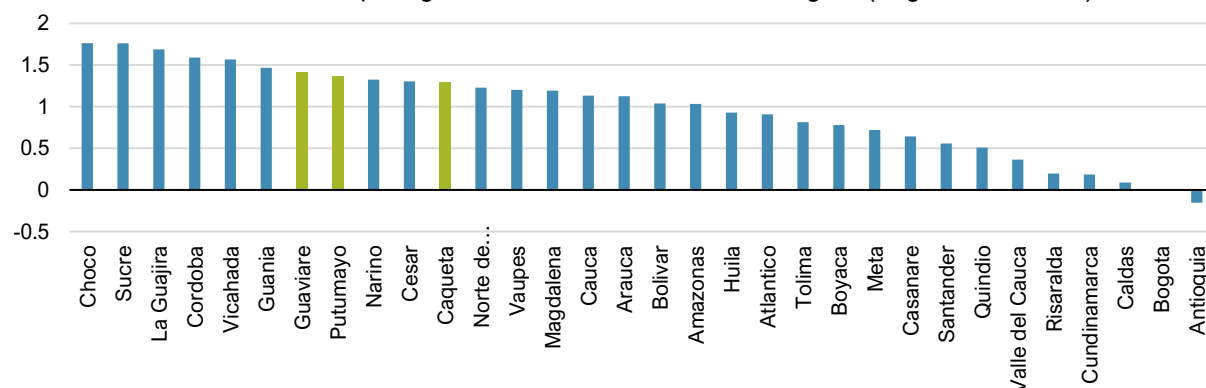
Caquetá, Guaviare, and Putumayo display high levels of informality, even accounting for the departments’ pattern of structural transformation. As previously argued, an important part of Colombia’s high informality rates can be explained by the insufficient structural transformation in the economy. Workers pursuing more complex economic tend to achieve a higher degree of formalization, which results in a negative association between Economic Complexity Index and informality rates (Figure 21). Additionally, studies point out to a strong association between city population and wage elasticity, which can be thought as providing additional evidence regarding a strong link between economic structure and formalization (Duranton 2016). Nevertheless, as the same figure shows, at a similar level of economic complexity, there is still high heterogeneity in informality levels. Indeed, CGP display levels of informality that are above what can be predicted by patterns of structural transformation. As illustrated by Figure 35, workers in CGP are more likely to be informal, even after accounting for individual characteristics (experience, education, gender) and the industry they work in.

Caquetá, Guaviare, and Putumayo exhibit one of the highest minimum-to-median wage ratios in the country. If on one hand cross-country comparisons find Colombia’s minimum to median wage ratio to be high relative to other countries, CGP’s minimum to median is higher than both the Colombian average and most of the country’s departments, as illustrated by Figure 36. Furthermore, there is a strong association between the ratio and informality rates, with Caquetá and Guaviare exhibiting levels of informality moderately higher than what is expected for their minimum to median wage ratio. Aspirational departments display also a similar high

ratio, although closer to the regression line. Ratios have been relatively constant over time, with the ratio increasing moderately for Colombia as a whole and aspirational peers in latest years.

Figure 35. Differential Likelihood of Urban Informality by Department, 2012-2019

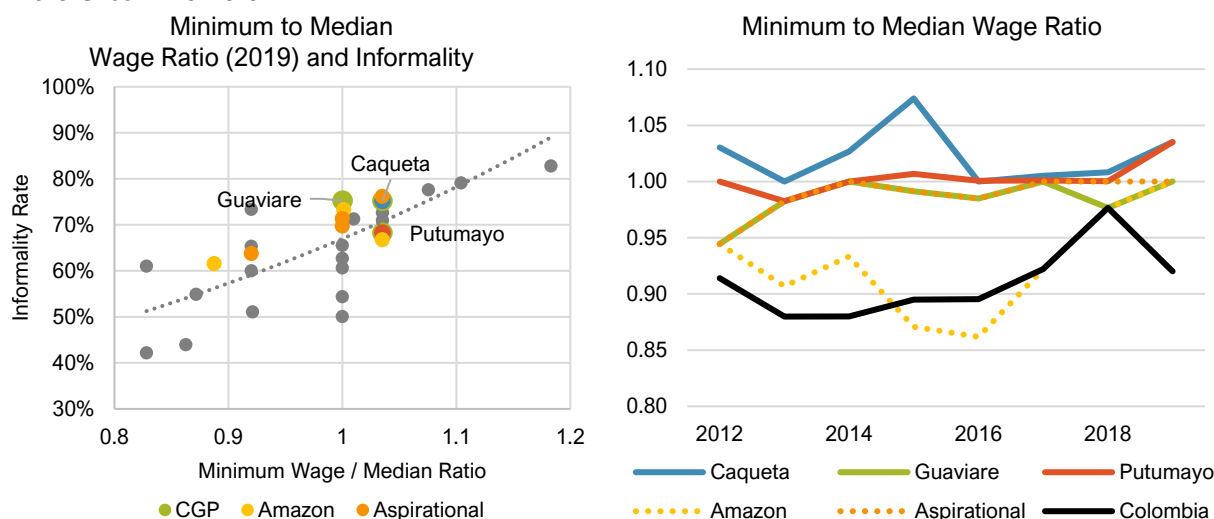
Additional Likelihood of Participating in Informal Work relative to Bogotá (Logit Coefficients)



Source: authors' elaboration based on GEIH. Coefficients displayed are departmental categorical variables (Bogotá as base 0) in a logit probability model, where the probability of an employed person in private sector in an urban area participating in informal activity is regressed to industry categorical variables and additional individual characteristics (schooling, gender, experience, experience squared), as well as year fixed effects.

Figure 36. Minimum and Median Wage by Department

Private Urban Workers

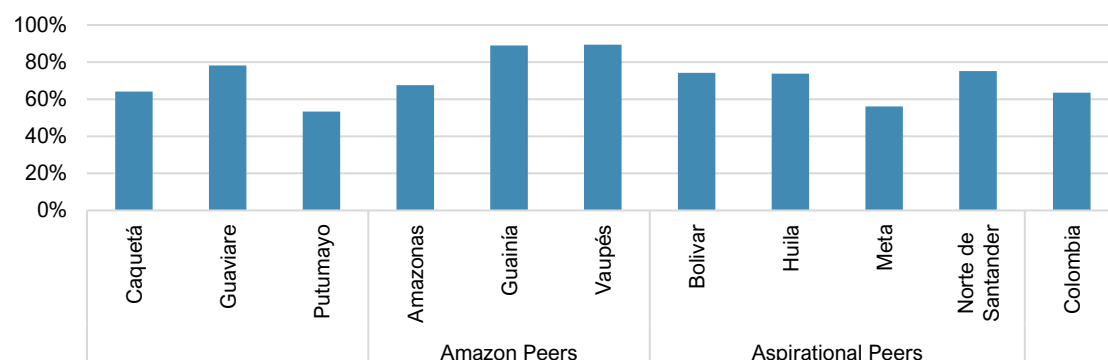


Source: authors' elaboration based on GEIH.

Although formal wage premiums are high, they're in line with peers, as is bunching of formal wages around the minimum wage. Formal wage premiums for urban private workers – controlling for both sectoral and individual characteristics – show there are significant wage premiums to formalization, both in CGP and for peers (Figure 37). Premiums are however not significantly larger in CGP than in other departments, which suggests that employers are not incurring in additional costs for formalizing workers in the analyzed region. Moreover, although bunching around the minimum wage is high in CGP, it is not higher than in the rest of the country. As Figure 38 illustrates, both CGP and comparators have significant bunching of formal wages around the minimum wage but share of formal workers working at that wage is not

substantially higher than for the national average. This implies that although labor market regulations could be overall binding in Colombia, they are not differentially more binding in the analyzed departments.

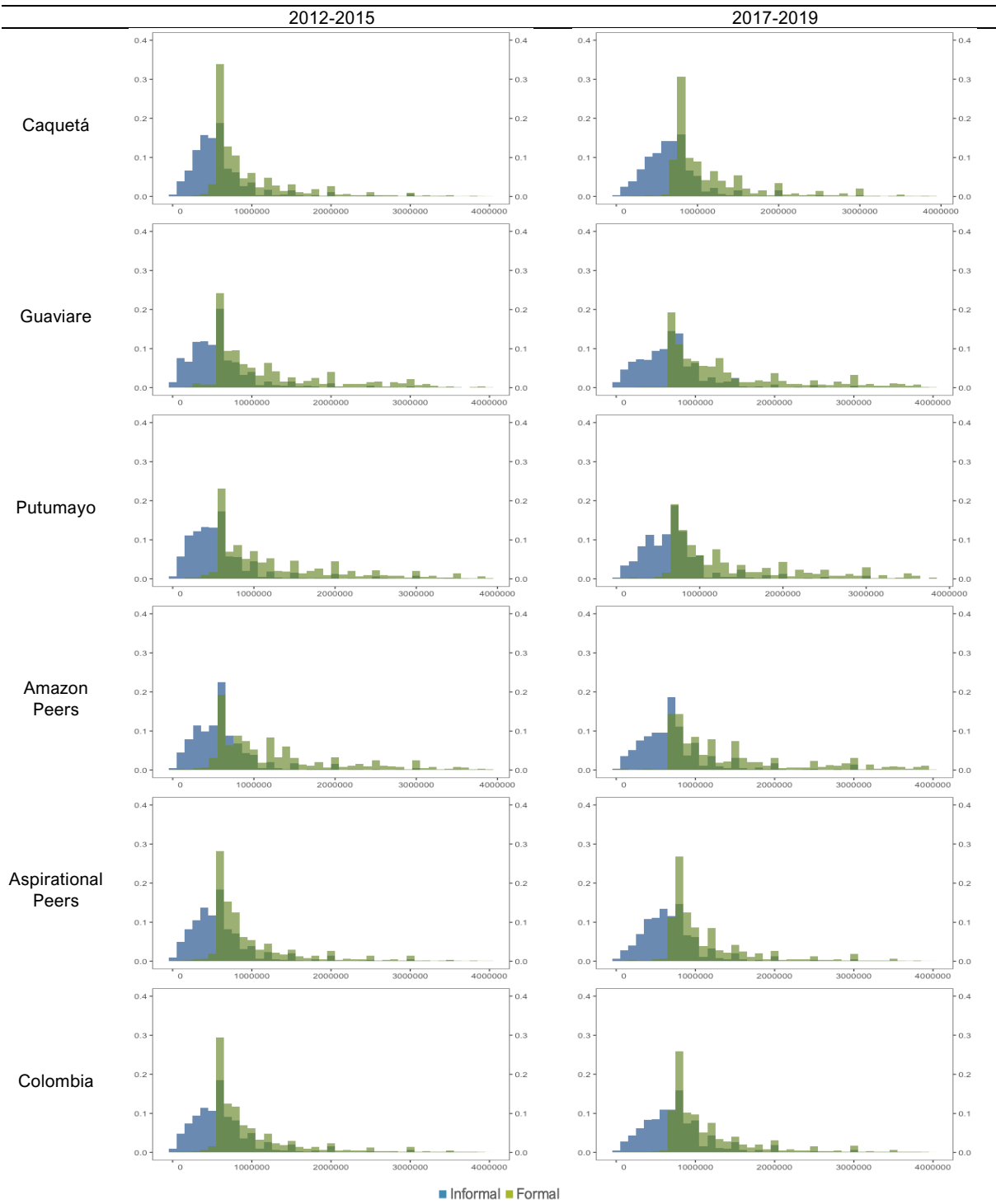
Figure 37. Formal Wage Premium for Urban Workers by Department, 2019



Source: authors' elaboration based on GEIH. Formal and public wage premiums are obtained in a regression of hourly wages on either a formality or a public worker categorical variable, controlling by gender, education, experience, experience squared, as well as industry categorical variables.

Labor regulations might be binding to economic growth in Colombia, but there is insufficient evidence declare these as differentially more binding in CGP. As Arango and Flórez (2021) find, although a minimum-wage can be nationally set, its outcomes can be highly heterogenous in regions with varying productivity, as a minimum wage can have a higher effect on informality when it represents a higher value in the regional wage distribution. Moreover, a recent study focused on a 2013 payroll tax reform has also shown that national payroll taxes can also affect regions differentially, as a reduction in national payroll taxes is associated to additional regional wage convergence, as these taxes are more binding in less developed regions (Herrera-Idárraga, Garlati-Bertoldi, and Torres 2021). As we have found, high minimum-to-median wage ratios and wage bunching show that indeed labor market regulations are introducing distortions in the wage distribution of formal work in CGP. Nevertheless, neither these distortions nor formal wage premiums appear to be higher than in the rest of the country, and hence cannot explain the lower levels of economic complexity and higher informality that we see in the three departments, and hence cannot be thought of as differentially more binding.

Figure 38. Wage Distribution by Department over Time for Urban Private Workers



Source: authors' elaboration based on GEIH.

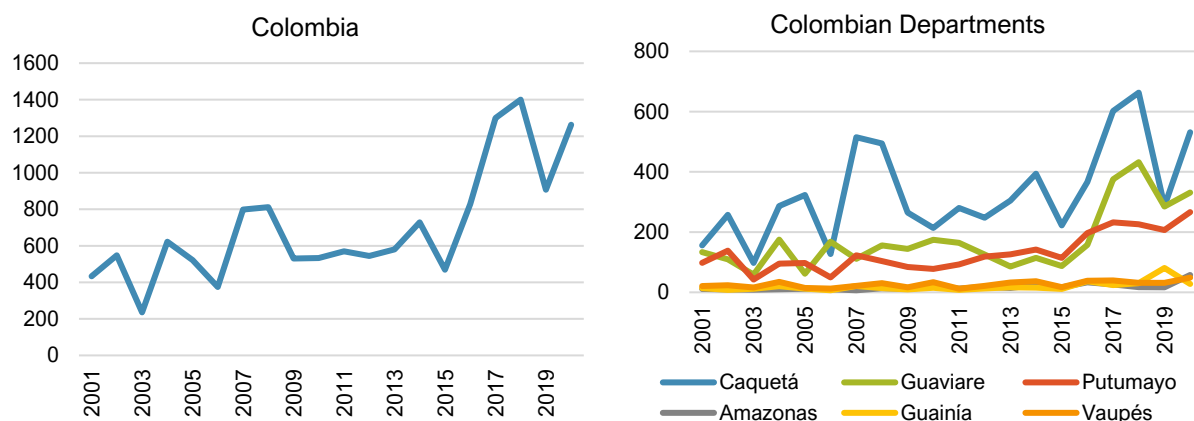
4. Economic Growth and Deforestation

Boosting economic growth in CGP while preventing and curbing deforestation are not mutually exclusive but does require a deeper understanding of their complex relation. Economic growth and deforestation are broadly unrelated, although complex tradeoffs exist between the two in narrow themes such as connectivity and agricultural productivity. Furthermore, the dynamic interrelates with a variety of phenomena such as civil strife, land speculation and unclear property rights. In many cases, policy options can boost economic growth in the frontier regions of the Amazon at no expense for the forest. An example thereof are investment promotion policies that would lead to the creation of alternative economic opportunities in urban areas, that would allow the regions' inhabitants to transition out of agriculture and activities that compete with deforestation in rural areas. Indeed, the enhanced productivity of urban sectors such as manufacturing and complex services could reduce pressures on deforestation while supporting growth (Porcher and Hanusch 2021). Urban agglomeration compares favorably to land-extensive rural activities in both economic and deforestation outcomes.

The frontier regions of the Colombian Amazon have seen accelerating trends in deforestation, in a context of stagnating growth. Colombia contains a tenth of the Amazon forest, with over a third of the country covered in forests (Murad and Pearse 2018). However, Colombia concerningly lost 5.7% of its tree cover from 2000-2020, with the rate of tree cover loss trending upward since 2015, as illustrated by Figure 39. CGP have been the departments that have seen the highest levels of deforestation in the Colombian Amazon (Figure 39). Deforestation has expanded to cover greater parts of the forest, while also increasing in intensity – the rate at which deforestation happens in a single area has also significantly increased, as illustrated by Figure 40, which displays the rate at which a previously forested area is stripped of forest cover. The literature partly attributes the accelerating trend to the Colombian peace process, which created an environment that encouraged investors and FARC dissidents to facilitate cattle ranching for the purposes of land speculation in areas that were previously not deforested (Prem, Saavedra, and Vargas 2020; Vanegas-Cubillos et al. 2022; Rodríguez-de-Francisco et al. 2021). The fact that economic growth in these regions has stagnated throughout the deforestation acceleration points to the existence of constraints to growth that are independent of the drivers of deforestation.

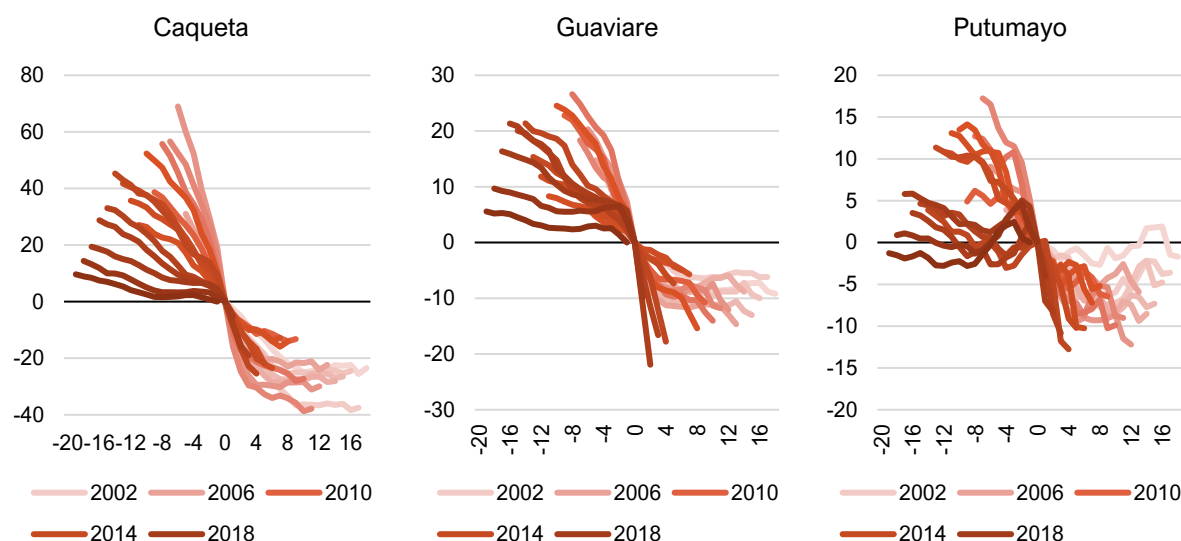
Figure 39. Tree Cover Loss in the Colombian Amazon

Total Thousand Squared Kilometers



Source: authors' elaboration based on Global Forest Watch.

Figure 40. Annual Rate of Forest Loss since Initial Tree Cover Loss



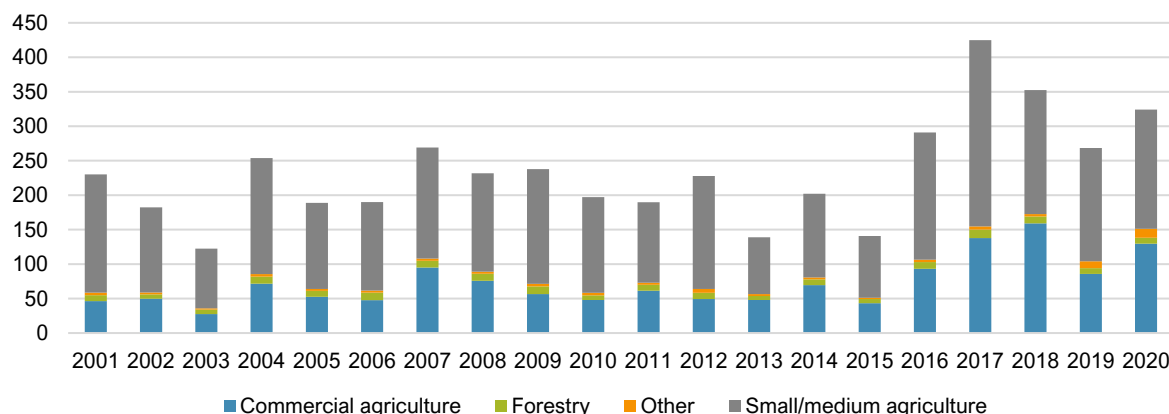
Source: authors' elaboration based on MODIS imagery and Hansen Global Forest Change v1.8.

The dynamics of deforestation in the Colombian Amazon are the result of a complex interaction between a history of conflict, remoteness, lagging agriculture productivity and an insecure property rights regime. Deforestation in the Colombian Amazon has most often been followed by the development of small or medium-scale agricultural activities – although at times supported by large landholders and external investors (Perz, Aramburú, and Bremner 2005; Rodríguez-de-Francisco et al. 2021) – as well as a smaller share of commercial agriculture. The share of commercial agriculture however has accelerated since 2016, Figure 41 shows. In CGP, from the outset, deforestation has usually been followed by cattle ranching, in contrast to Amazon areas in other countries (Armenteras et al. 2013; Murad and Pearse 2018). Figure 42 displays the average change in the fraction of land cover type in reference to the year of tree cover loss, showing that deforested lands are primarily converted to grasslands or savannas, which are most likely used for cattle ranching. Expert interviews reveal that the practice of cattle ranching in deforested areas has been facilitated by guerrilla groups as well as by external investors funding the deforestation and clearing of land (in a process called *praderización*) and making it available for future titling. Ultimately, this practice is enabled by inadequately defined property rights, confused legal regimes governing land, and poor enforcement of protected areas. Specifically, the current practice of providing landless farmers under a specific income threshold with a Family Agricultural Unit (UAF) – the size of which can vary between 10 hectares in Cundinamarca to over 2000 hectares in the Altiplanura region (Lizcano 2018) – has been commented on as potentially incentivizing deforestation, as farmers can formalize their land tenure if they demonstrate continued production and residence. These farmers often eventually sell the land to larger buyers and investors (Rodríguez-de-Francisco et al. 2021). The expectation of eventual formalization and bundled sale of the land has indeed led to the creation of a speculative market for deforested land in the Amazon region. This process might have been further accelerated by the peace agreement signed with FARC in 2016, as demonstrated by Prem et al. (2020), through a differences-in-differences analysis of forested areas that are differentially exposed to FARC control. Finally, it is notable that the recent spike

in deforestation was also observed in protected areas, which experienced a 177% rise in deforestation after the peace process (Clerici et al. 2020; Murillo-Sandoval et al. 2020).

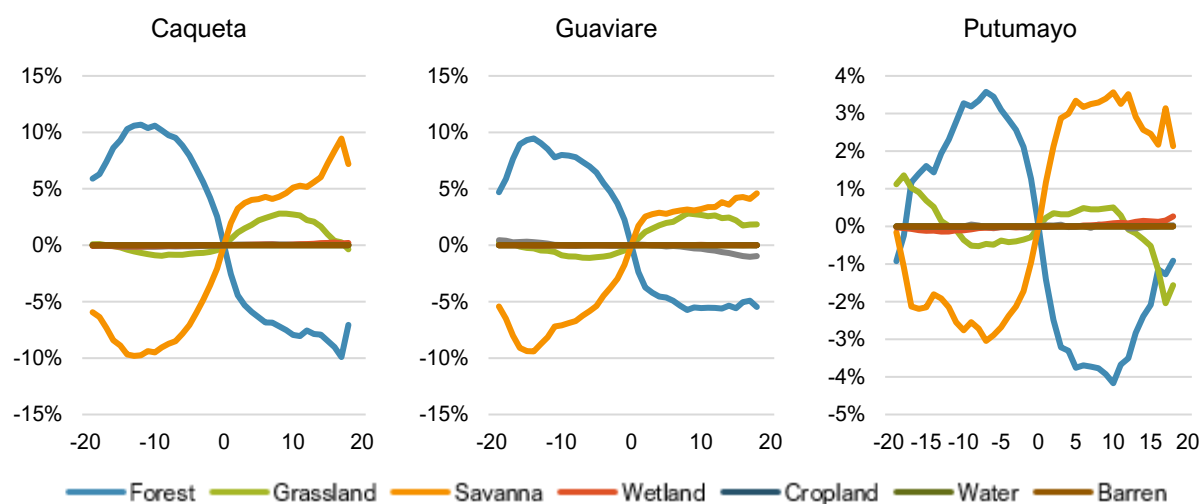
Figure 41. Drivers of Deforestation in Colombia

Thousand Hectares



Source: authors' elaboration based on Global Forest Watch.

Figure 42. Average Change in Fraction of Land Cover in Deforested Land, since Tree Cover Loss



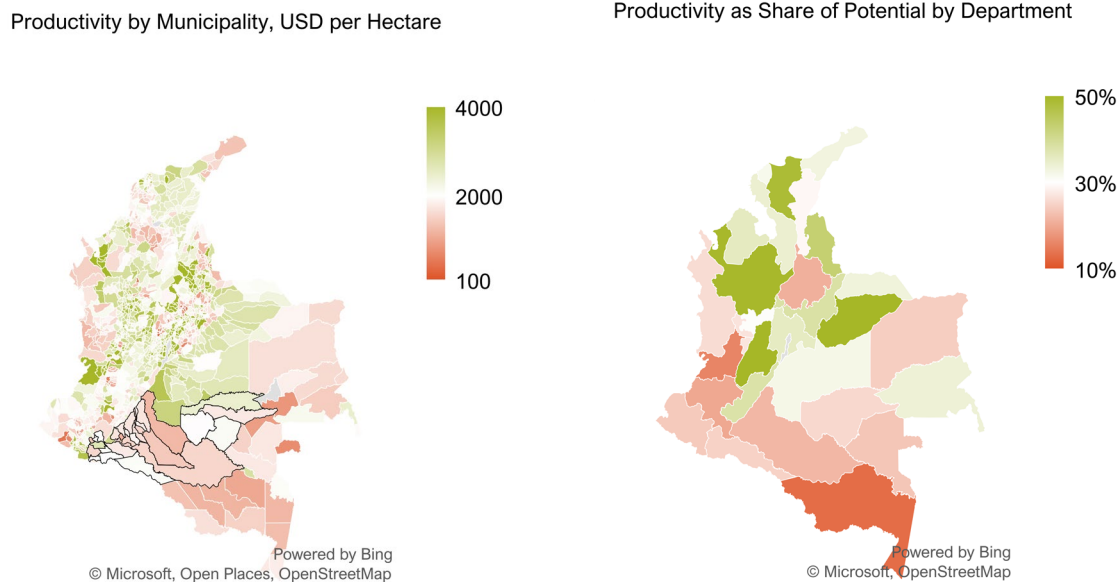
Source: authors' elaboration based on MODIS imagery and Hansen Global Forest Change v1.8.

Although deforestation seems unrelated to rising incomes or living standards at a regional level, two key policy areas do imply such tradeoffs. First, initiatives seeking to boost agriculture productivity would support rural incomes while increasing the value of land and the opportunity cost of the standing forest. As Figure 43 shows, the municipalities that compose CGP have some of the lowest agriculture productivity figures in the country, including relative to the fertility of the areas as reflected in the distance between their actual productivity and their potential. However, if agricultural productivity in the region were to converge to the national average, incentives for deforestation would increase. Although policies to encourage productivity in rural areas can also involve significant tradeoffs – as some policies may indirectly encourage deforestation – an increase in productivity of industries in urban areas does not

incentivize deforestation. Incentives for deforestation in Colombia are significantly mediated through land values, as the perceived increase in agriculture productivity (or profitability) can lead to increase in land prices that ultimately leads to deforestation.

Figure 43. Aggregate Agricultural Productivity by Municipality, 2013

USD per hectare



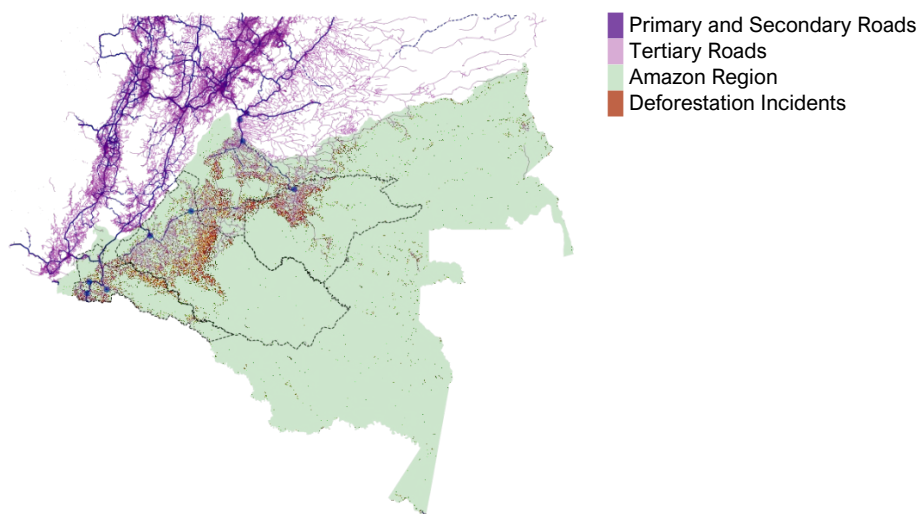
Source: authors' elaboration based on DANE agricultural census (2014), FAOSTAT crop prices (2013), and FAO GAEZ V4 (2009-2010). Crops are aggregated using producer prices per ton for aggregate productivity measures. Actual productivity is compared with average attainable yields. Analysis is limited to staple crops.

Second, the construction of additional road infrastructure represents another key tradeoff to sustainable growth in CGP. Connectivity infrastructure would boost productivity in urban areas by supporting transitions out of agriculture (Asher and Novosad 2020b; Banerjee, Duflo, and Qian 2020) but also increase deforestation rates by improving market access for the agriculture sector in remote regions and raising the value of agricultural land (Donaldson and Hornbeck 2016; Donaldson 2018; Porcher and Hanusch 2021). Deforestation in the Colombian Amazon has been strongly associated with the extension of the road network, but the growth diagnostic analysis shows the lack of connectivity as a key barrier to growth. As

Figure 44 shows, deforestation incidents in the Colombian Amazon have most recently occurred throughout its frontier and have been concentrated in areas along tertiary roads. Figure 45 establishes this association empirically by measuring how the distance of tree cover loss incidents and the road network has changed over time. The empirical cumulative distribution function shows that 80% of deforestation in the Colombian Amazon has occurred within 7.2 km of roads. These figures are comparable, yet less pronounced, than 95% of deforestation in the Brazilian Amazon occurring within 5.5km of roads or 1km of navigable rivers (Barber et al. 2014). Moreover, the figure shows that deforestation has moderately moved away from roads over time, as the median distance of deforestation incidences from closest road has more than doubled, from 1.5 km in 2001 to 3.2 km in 2020. The analysis is currently limited by the lack of a proper time series in the construction of road networks, as some roads might have been constructed during the analyzed time period, which could lead to an underestimation of the

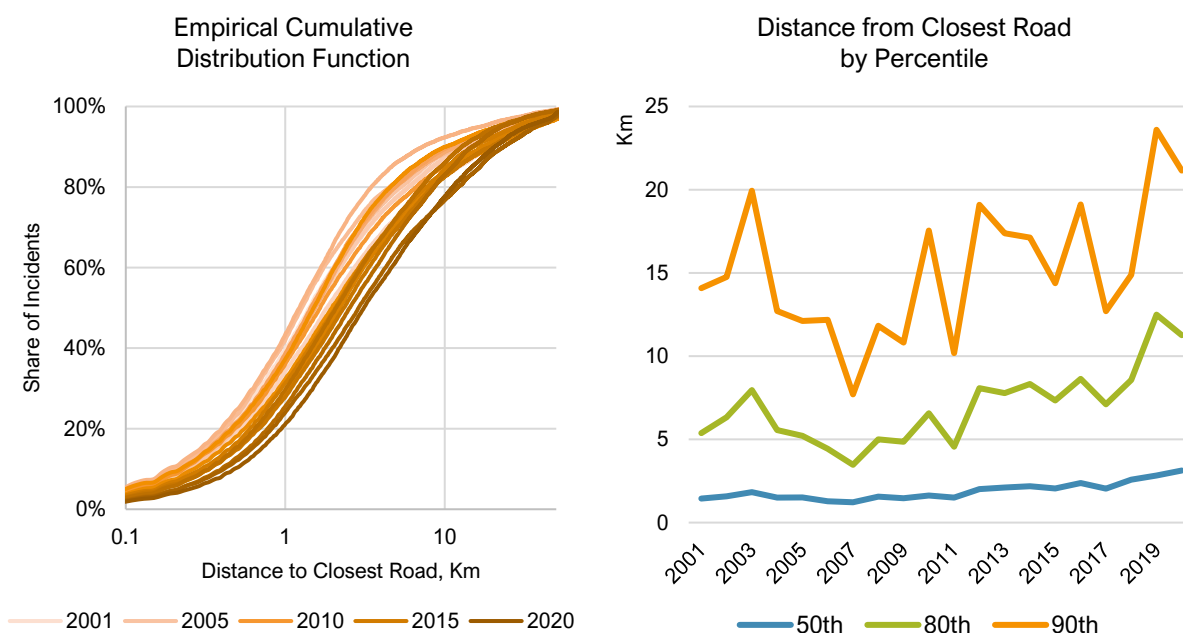
distance coefficient in earlier years. It is also notable that these results stand in opposition to previous literature finding that tertiary rural roads do not affect local deforestation (Asher, Garg, and Novosad 2020).

Figure 44. Roads and Deforestation



Source: authors' elaboration based on OpenStreetMap and Hansen Global Forest Change v1.8.

Figure 45. Distance from Tree Cover Loss Incidents to Closest Road



Source: authors' elaboration based on OpenStreetMap and Hansen Global Forest Change v1.8.

Urban agglomeration enhances productivity separate from deforestation incentives, a preferred growth trajectory to the land-extensive economic activities that keep the rural Amazon in economic stagnation. An economic growth strategy for CGP will have to reset the

economic and environmental equilibrium while considering the key tradeoffs between the dual objectives. Efforts to expand CGP's road network, and in particular tertiary roads, need to carefully consider their implications for deforestation. Further, productivity must be enhanced in rural value chains in a manner orthogonal to deforestation.

5. Development Policy in the Amazon

The current status quo is marked by low growth in a context of rising deforestation, showing that ignoring economic development is empirically not a successful strategy. A comprehensive policy strategy will need to avoid temptation to ignore policies to promote economic growth in the region, with the expectation that the absence of growth will curb down deforestation. The current equilibrium of low-growth and deforestation implies that the former is not preventing the latter and dismisses the idea that improved livelihoods are driving current trends. The current status quo is indeed a “lose-lose” both for the region's citizens and for the health of the Amazon. Moreover, the policy space is changing rapidly, given the changing security predicament, the push to extend national sovereignty to the country's periphery, and the ongoing peace process. Therefore, shifting the current equilibrium through a comprehensive set of policies to tackle deforestation and promote the region's economic development is vital.

A development policy for the Amazon will require distinct instruments to promote economic development and to achieve environmental sustainability. Distinct policies will often affect one goal while leaving the second goal untouched or will be packaged with policies to negate the negative effects of one on the other. For instance, given the deep interrelation between economic growth and deforestation in agricultural productivity and road infrastructure, key policies in the departments of Caquetá, Guaviare and Putumayo will need to best manage the tradeoff through strategic policy making. Policies that enhance economic productivity and curb deforestation efforts are both necessary. Economic growth without environmental protection could lead to increasing incentives for deforestation (through, for example, the channel of land speculation). Environmental protection without economic support would condemn the region's citizens from improving their livelihoods. Importantly, the more effective policies are in preventing deforestation, the broader and bolder the space is for economic policy.

A policy strategy needs to consider the Amazonian region's heterogeneity in land tenure governance, state capacity, and existent access to markets. A development strategy needs to be both comprehensive and understand the distinct policy space by area. Most importantly, the urban and rural economies face interrelated but distinct challenges. An appropriate development strategy will have to include both policies to improve the productivity of the urban and rural economies through the appropriate channels.

A development policy strategy for the Amazon will have to include policies executed at different levels of government. The deforestation problem cannot be solved at solely the departmental nor local level, given its interrelation with national property rights regimes and the country's security challenge. This does not imply that the region's policy challenge can or should be solved only by national government institutions. Promoting the discovery and introduction of new industries and constructing appropriate infrastructure for their development are for example areas where the engagement of departmental governments will be key, both in terms of jurisdiction but also in terms of the capacity to intervene.

The following policy report will analyze four policy areas that a comprehensive policy strategy will have to tackle both to improve economic growth and curb deforestation in CGP. To move out of the current low-growth pro-deforestation status quo, a comprehensive policy strategy is needed. The following report will explore policy options related to key themes, leveraging existing successful initiatives and introducing additional policy proposals. The policy strategy's areas follow from the Growth Diagnostic analysis and the analysis of the interrelation between growth and deforestation. The following areas are:

1. Property Rights Governance

The report will study positive deviance in land tenure systems and governance institutions that should be scaled.

2. Deforestation Incentives

The report will survey existing initiatives to curb deforestation and provide a system of economic, social, and legal incentives against deforestation.

3. Economic Diversification

The report will identify the policy instruments that are the most adequate to escape the region's capability trap.

4. Remoteness and Infrastructure

The report will explore the consequences that the region's remoteness challenge has for infrastructure policy design, taking into consideration the effect specific infrastructure initiatives such as road-building could have on deforestation.

Bibliography

- Alvarez, Jorge, and Carlo Pizzinelli. 2021. "COVID-19 and the Informality-Driven Recovery: The Case of Colombia's Labor Market." *IMF Working Paper* 235.
- Angelsen, Arild. 1999. "Agricultural Expansion and Deforestation: Modelling the Impact of Population, Market Forces and Property Rights." *Journal of Development Economics* 58 (1): 185–218.
- Arango, Luis E., and Luz A. Flórez. 2021. "Regional Labour Informality in Colombia and a Proposal for a Differential Minimum Wage." *The Journal of Development Studies* 57 (6): 1016–37.
- Armenteras, Dolores, Edersson Cabrera, Nelly Rodríguez, and Javier Retana. 2013. "National and Regional Determinants of Tropical Deforestation in Colombia." *Regional Environmental Change* 13 (6): 1181–93.
- Asher, Sam, Teevrat Garg, and Paul Novosad. 2020. "The Ecological Impact of Transportation Infrastructure." *The Economic Journal* 130 (629): 1173–99.
- Asher, Sam, and Paul Novosad. 2020a. "Rural Roads and Local Economic Development." *American Economic Review* 110 (3): 797–823.
- . 2020b. "Rural Roads and Local Economic Development." *American Economic Review* 110 (3): 797–823. <https://doi.org/10.1257/aer.20180268>.
- Banerjee, Abhijit, Esther Duflo, and Nancy Qian. 2020. "On the Road: Access to Transportation Infrastructure and Economic Growth in China." *Journal of Development Economics* 145: 102442.
- Barber, Christopher P., Mark A. Cochrane, Carlos M. Souza, and William F. Laurance. 2014. "Roads, Deforestation, and the Mitigating Effect of Protected Areas in the Amazon." *Biological Conservation* 177 (September): 203–9. <https://doi.org/10.1016/j.biocon.2014.07.004>.
- Bell, Linda A. 1997. "The Impact of Minimum Wages in Mexico and Colombia." *Journal of Labor Economics* 15 (S3): S102–35.
- Bernal, Raquel, Jorge I. González, Juan C. Henao, Roberto Junguito, Marcela Meléndez, Armando Montenegro, Juan C. Ramírez, José D. Uribe, and Leonardo Villar. 2017. "Comision Del Gasto y La Inversion Publica. Informe Final."
- Carranza, Eliana, William Wiseman, Andreas Eberhard-Ruiz, and Ana Lucía Cárdenas. 2021. *Colombia: Diagnóstico de Empleo*. World Bank.
- Clerici, N., D. Armenteras, P. Kareiva, R. Botero, J. P. Ramírez-Delgado, G. Forero-Medina, J. Ochoa, C. Pedraza, L. Schneider, and C. Lora. 2020. "Deforestation in Colombian Protected Areas Increased during Post-Conflict Periods." *Scientific Reports* 10 (1): 1–10.
- Donaldson, Dave. 2018. "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure." *American Economic Review* 108 (4–5): 899–934.
- Donaldson, Dave, and Richard Hornbeck. 2016. "Railroads and American Economic Growth: A 'Market Access' Approach." *The Quarterly Journal of Economics* 131 (2): 799–858.
- Duranton, Gilles. 2016. "Agglomeration Effects in Colombia." *Journal of Regional Science* 56 (2): 210–38.
- Elgin, Ceyhan, M. Ayhan Kose, Franziska Ohnsorge, and Shu Yu. 2021. "Understanding Informality." *CEPR Discussion Paper* 16497.
- Faber, Benjamin. 2014. "Trade Integration, Market Size, and Industrialization: Evidence from China's National Trunk Highway System." *Review of Economic Studies* 81 (3): 1046–70.
- Hansen, Matthew C., Peter V. Potapov, Rebecca Moore, Matt Hancher, Svetlana A. Turubanova, Alexandra Tyukavina, David Thau, Stephen V. Stehman, Scott J. Goetz, and Thomas R. Loveland. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342 (6160): 850–53.

- Hausmann, Ricardo, César A. Hidalgo, Sebastián Bustos, Michele Coscia, Alexander Simoes, and Muhammed A. Yildirim. 2014. *The Atlas of Economic Complexity: Mapping Paths to Prosperity*. MIT Press.
- Hausmann, Ricardo, Bailey Klinger, and Rodrigo Wagner. 2008. "Doing Growth Diagnostics in Practice: A 'Mindbook.'" *CID Working Paper* 177.
- Hausmann, Ricardo, and Dani Rodrik. 2003. "Economic Development as Self-Discovery." *Journal of Development Economics* 72 (2): 603–33.
- Hausmann, Ricardo, Dani Rodrik, and Andrés Velasco. 2008. "Growth Diagnostics." *The Washington Consensus Reconsidered: Towards a New Global Governance*, 324–55.
- Herrera-Idárraga, Paula, Pablo Adrian Garlati-Bertoldi, and Juan David Torres. 2021. "Urban Wage Gaps in Colombia and the Impact of a National Payroll Tax Policy." *Regional Studies*, 1–15.
- Hidalgo, César A., and Ricardo Hausmann. 2009. "The Building Blocks of Economic Complexity." *Proceedings of the National Academy of Sciences* 106 (26): 10570–75.
- Journard, Isabelle, and Juliana Londoño Vélez. 2013. "Income Inequality and Poverty in Colombia - Part 1. The Role of the Labour Market." OECD.
- Kugler, Adriana, and Maurice Kugler. 2009. "Labor Market Effects of Payroll Taxes in Developing Countries: Evidence from Colombia." *Economic Development and Cultural Change* 57 (2): 335–58.
- Lizcano, Maria Fernanda. 2018. "How Land Is Stolen in Colombia." 2018. <https://news.mongabay.com/2018/09/how-land-is-stolen-in-colombia/>.
- Maloney, William F., and Jairo Nunez Mendez. 2003. "Measuring the Impact of Minimum Wages: Evidence from Latin America." Working Paper 9800. National Bureau of Economic Research.
- Murad, Cesar Augusto, and Jillian Pearse. 2018. "Landsat Study of Deforestation in the Amazon Region of Colombia: Departments of Caquetá and Putumayo." *Remote Sensing Applications: Society and Environment* 11: 161–71.
- Murillo-Sandoval, Paulo J., Kristina Van Dexter, Jamon Van Den Hoek, David Wrathall, and Robert Kennedy. 2020. "The End of Gunpoint Conservation: Forest Disturbance after the Colombian Peace Agreement." *Environmental Research Letters* 15 (3): 034033.
- Núñez Méndez, Jairo Augusto. 2002. "Empleo Informal y Evasión Fiscal En Colombia." Departamento Nacional de Planificación.
- O'Clery, Neave, Andres Gomez-Lievano, and Eduardo Lora. 2016. "The Path to Labor Formality: Urban Agglomeration and the Emergence of Complex Industries." *CID Research Fellow & Graduate Student Working Paper Series* 78.
- Perz, Stephen G., Carlos Aramburú, and Jason Bremner. 2005. "Population, Land Use and Deforestation in the Pan Amazon Basin: A Comparison of Brazil, Bolivia, Colombia, Ecuador, Perú and Venezuela." *Environment, Development and Sustainability* 7 (1): 23–49.
- Porcher, Charly, and Marek Hanusch. 2021. "A Model of Amazon Deforestation, Trade and Labor Market Dynamics." *Unpublished*.
- Prem, Mounu, Santiago Saavedra, and Juan F. Vargas. 2020. "End-of-Conflict Deforestation: Evidence from Colombia's Peace Agreement." *World Development* 129: 104852.
- Rodríguez-de-Francisco, Jean Carlo, Carlos del Cairo, Daniel Ortiz-Gallego, Juan Sebastian Velez-Triana, Tomás Vergara-Gutiérrez, and Jonas Hein. 2021. "Post-Conflict Transition and REDD+ in Colombia: Challenges to Reducing Deforestation in the Amazon." *Forest Policy and Economics* 127: 102450.
- Rodrik, Dani. 1996. "Coordination Failures and Government Policy: A Model with Applications to East Asia and Eastern Europe." *Journal of International Economics* 40 (1–2): 1–22.
- Storeygard, Adam. 2016. "Farther on down the Road: Transport Costs, Trade and Urban Growth in Sub-Saharan Africa." *The Review of Economic Studies* 83 (3): 1263–95.

- Vanegas-Cubillos, Martha, Janelle Sylvester, Eliza Villarino, Lisset Pérez-Marulanda, Raphael Ganzenmüller, Katharina Löhr, Michelle Bonatti, and Augusto Castro-Nunez. 2022. "Forest Cover Changes and Public Policy: A Literature Review for Post-Conflict Colombia." *Land Use Policy* 114: 105981.
- Vilela, Thais, Alfonso Malky Harb, Aaron Bruner, Vera Laísa da Silva Arruda, Vivian Ribeiro, Ane Auxiliadora Costa Alencar, Annie Julissa Escobedo Grandez, Adriana Rojas, Alejandra Laina, and Rodrigo Botero. 2020. "A Better Amazon Road Network for People and the Environment." *Proceedings of the National Academy of Sciences* 117 (13): 7095–7102.
- Weiss, D. J., Andy Nelson, H. S. Gibson, W. Temperley, Stephen Peedell, A. Lieber, M. Hancher, Eduardo Poyart, Simão Belchior, and Nancy Fullman. 2018. "A Global Map of Travel Time to Cities to Assess Inequalities in Accessibility in 2015." *Nature* 553 (7688): 333–36.
- World Bank Group. 2015. *Colombia: Systematic Country Diagnostic*. World Bank.

Appendix

A1. Peer Selection

Peer regions were identified within Colombia and in other South America countries using a set of geographical, agricultural, and climatic characteristics. Peer regions were selected to better understand constraints to economic growth specific to Caquetá, Guaviare, and Putumayo. To identify peer cities with similar geographical, agricultural, and climatic characteristics a Euclidean distance matrix between vectors of standardized parameters for South American cities was calculated. The following parameters were considered:

- Elevation, precipitation, temperature (city level)

Source: Global Human Settlements

- Accessibility (travel time to cities >200k population) (city level)

Source: own calculations, using global friction surface (Weiss et al. 2018)

- Agricultural production yield - 2010 (department level)

Source: FAO GAEZ, 2010.

- Fraction of land covered by forest (dep. level)

Source: Own calculations, using global forest watch data (Hansen et al. 2013)

The urban centers in Caquetá, Guaviare, and Putumayo were considered separately, and then peer cities that minimize the Euclidean distance between the corresponding standardized parameter vectors were identified. Additionally, other cities were added as comparators after literature review and expert interviews. The algorithm used to select comparators is the following:

1. Let c_{if} represent f th feature of city i
2. Let the distance matrix D be such that d_{ij} is the distance between cities i and j , where $j \in J: Y_j > Y_i$ and is calculated as the Euclidean distances between the scaled feature vectors:

$$d_{ij} = \sqrt{\sum_f \left(f(c_{if}) - f(c_{jf}) \right)^2}$$

$$f(c_{if}) = \frac{c_{if} - \mu_f^{region}}{\sigma_f^{region}}$$

3. The relevant peers $P_i \in J$ are then defined:

$$P_i = \arg \min_{j \in J} d_{ij}$$

Note that the mean μ_f^{region} and standard deviation σ_f^{region} correspond to the mean and standard deviation of the feature vectors for all of South America.

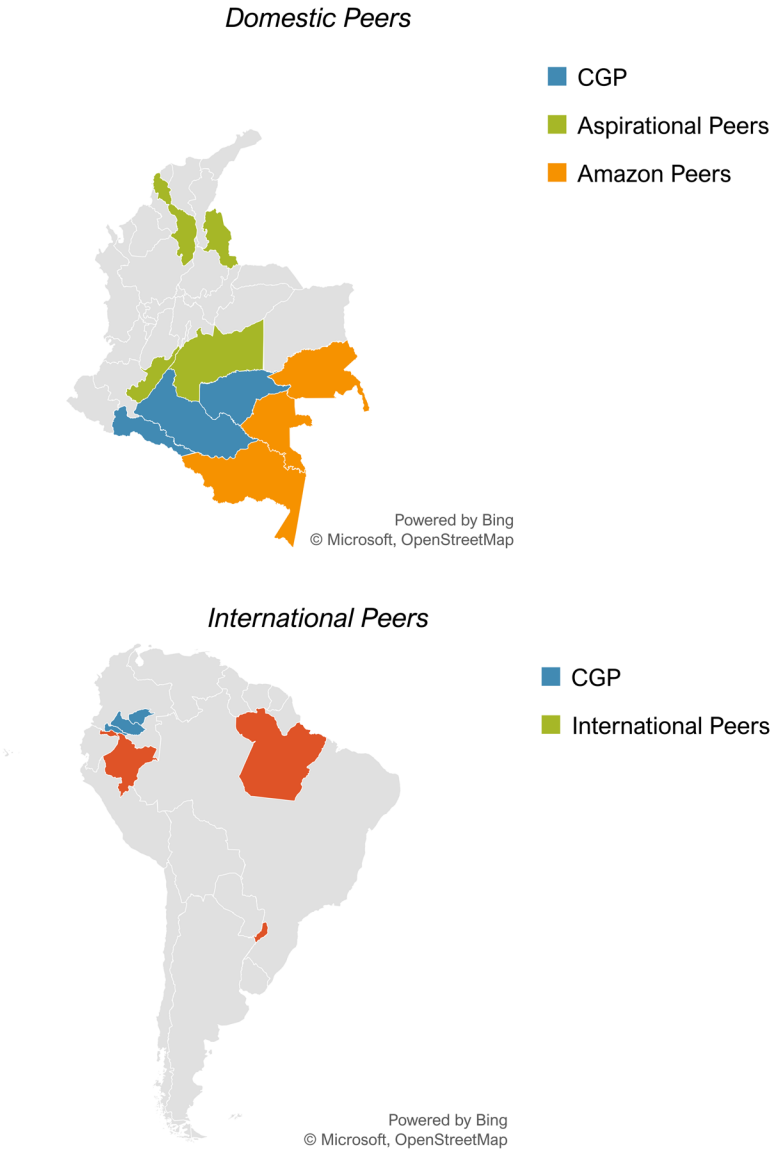
4. After selecting comparator cities for each city in the frontier, one common set of comparator departments for all of the frontier is identified, by considering those departments that occur most frequently in the set of comparator cities for each frontier city.
5. The following domestic peers were not selected in the algorithm but were added for descriptive comparisons and context:
 1. *Amazonas, Guainía, and Vaupes*
The other three Colombian Amazonian departments were added to provide descriptive comparisons and context.
 2. *Meta*
The frontier region was added due to its geographical proximity and socio-cultural similarities to CGP.
 3. *Loreto (Peru)*
Peru's frontier region was added due to its geographical proximity and similarities with respect to remoteness challenges to CGP.

Domestic peer characteristics are summarized in Figure A1. A map of international peers is provided in Figure A2,

Figure A1. Peers Characteristics (urban areas only)

		GDP PPP per cap.	Elevation (m)	Prec. (mm)	Temp. (c)	Time to Med. City (mins)	Fraction Forest	Pop. 2017
CGP	Guaviare	6,298	188	2,106	26.8	496.6	0.9	73,072
	Putumayo	13,548	304	3,254	25.5	233.2	0.8	56,113
	Caquetá	6,855	293	1,503	22.6	240.9	0.7	118,200
Asp. Peers	Norte de Santander	5,383	528	822	21.2	27.1	0.4	247,007
	Huila	5,438	733	1,295	21.4	67.1	0.3	144,348
	Meta	10,548	442	3,393	20.2	20.3	0.3	154,566
Amazon Peers	Bolivar	23,385	29	1,091	28.5	41.1	0.3	211,712
	Amazonas	8,560		6,648	26.5	8670	1.0	77,900
	Guainía	7,221		8,794	26.8	3471.5	1.0	42,800
	Vaupés	4,293		6,539	26.2	3600.3	1.0	44,500

Figure A2. Map of Selected Peers



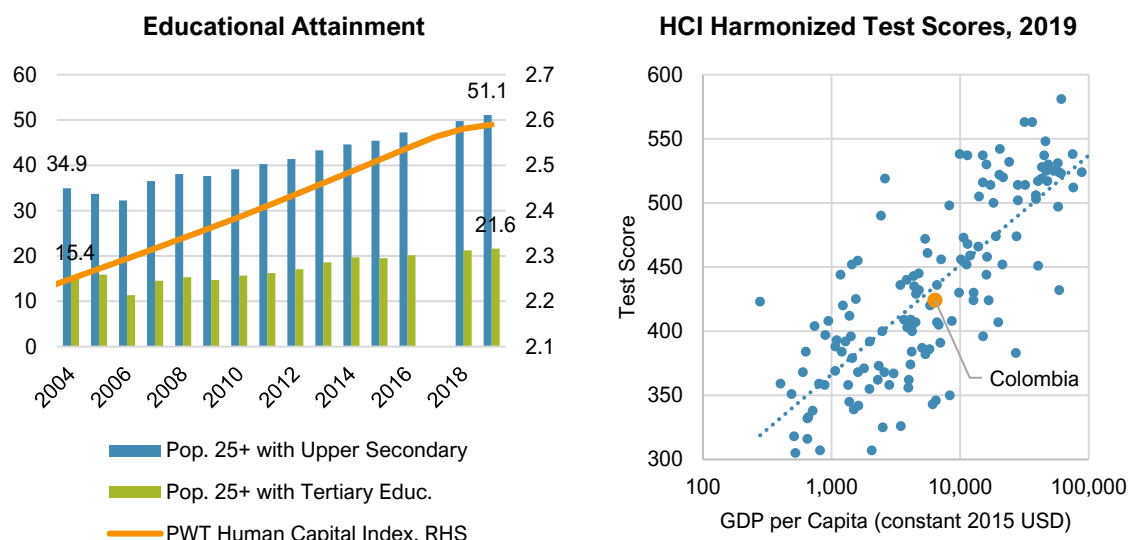
A2. Evidence on Non-Binding Constraints

A2.1. Human Capital

Colombia's educational attainment has progressively improved over the last two decades.

The last two decades saw a significant improvement of Colombia's educational attainments, with notable improvements in school enrollment at the elementary, secondary, and tertiary level (Figure A3). The increase in school enrollment has led to significant increases in the average years of schooling and the human capital endowment of the workforce. Beyond enrollment levels, the educational system's progressive focus on learning outcomes – introducing performance-based systems on the teaching workforce – has resulted in a gradual improvement in learning outcomes, which are currently in line with the country's per capita income.

Figure A3. Colombia's Educational Attainment



Source: authors' elaboration based on World Bank World Development Indicators, World Bank Human Capital Indicators and Penn World Table.

The three department's educational coverage is below aspirational peers, but the urban workforce does not significantly lag behind the national average. As Figure A4 shows, the primary, secondary and tertiary educational coverage of CGP is on average above Amazon peers, although below aspirational peers (as well as national averages). In particular, secondary coverage in CGP is 10 p.p. below aspirational peers and university coverage is particularly low in Guaviare and Putumayo. Educational quality indicators are below the median in Guaviare and Putumayo, although Caquetá shows higher than median performance both on school evaluations and second language fluency. Nevertheless, the department's urban workforce has a similar share of college graduates as both Amazon and aspirational peers, and a share of workers with high school degree or above around the national average (Figure A5). Indicators based on administrative records of school enrollees and labor force surveys likely differ not only because of the time lag between current enrollment and status of the overall workforce, but because the latter only include data for the urban workforce, which could bias current results when taking into consideration both that CGP and other Amazon departments have lower urbanization rates and that school enrollments tends to typically be lower in rural areas.

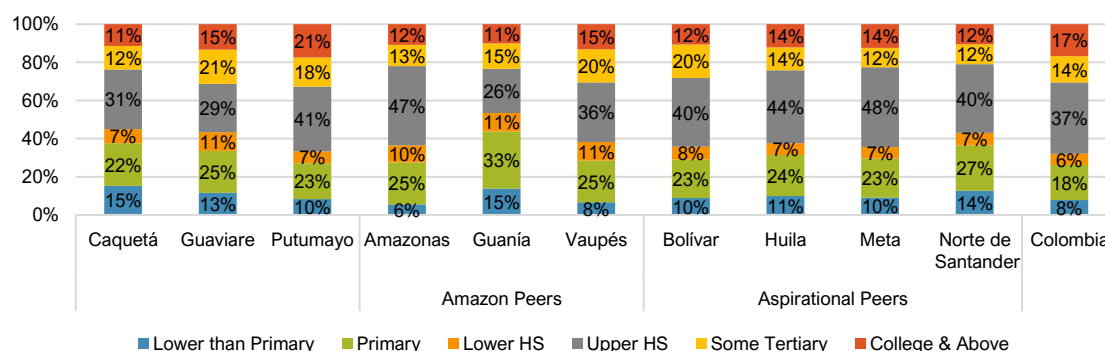
Figure A4. Education Enrollment and Quality

		Enrollment (Percentage of Enrollment)				Quality (Score, Percentage)		
		Primary	Secondary	Technical	University	Saber 5 Evaluation	Saber 11 Evaluation	Second Language Fluency
CGP	Caquetá	89 (20)	69 (26)	4 (28)	25 (13)	316 (9.5)	52 (13)	25 (8)
	Guaviare	80 (28)	68 (27)	19 (8)	8 (26)	302 (21)	49 (23)	10 (21)
	Putumayo	81 (25)	72 (22)	9 (19)	4 (29)	268 (33)	48 (28)	6 (25)
Amazon Peers	Amazonas	79 (29)	61 (28)	4 (25)	4 (28)	277 (29)	46 (31)	9 (22)
	Guainía	67 (31)	31 (31)	7 (22)	2 (30)	306 (17)	52 (15)	34 (3)
	Vaupés	55 (33)	30 (32)	3 (31)	1 (33)	312 (14)	52 (14)	3 (30)
Aspirational Peers	Bolívar	98 (1)	81 (12)	17 (12)	22 (21)	313 (13)	51 (16)	28 (4)
	Huila	92 (10)	81 (10)	13 (15)	26 (11)	334 (1)	56 (1)	37 (2)
	Meta	92 (14)	80 (13)	7 (23)	26 (12)	287 (27)	49 (27)	22 (10)
	Norte de Santander	91 (16)	76 (18)	10 (17)	40 (6)	331 (2)	55 (2)	17 (12)

Source: authors' elaboration based on Consejo Privado de Competitividad.

Figure A5. Education of Urban Workforce, 2019

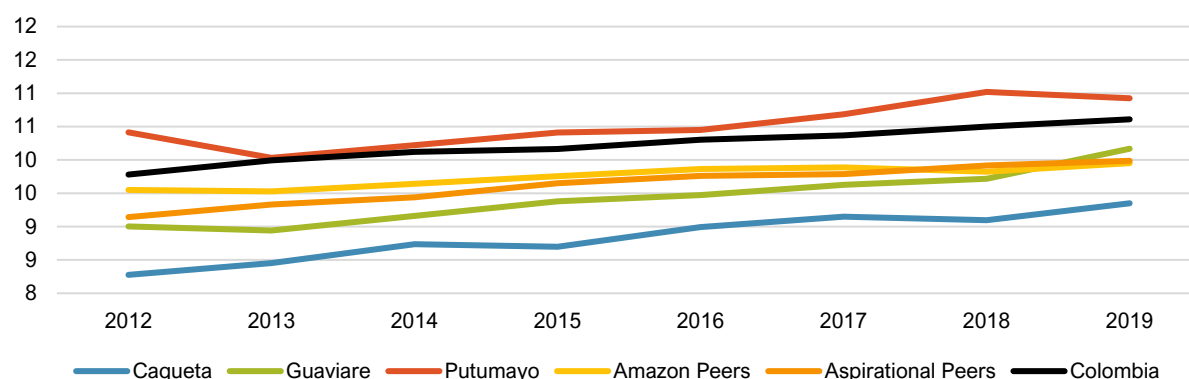
Percentage of Age 18-62



Source: authors' elaboration based on GEIH.

In line with the national increase in educational attainment, the three departments have increased gradually the average years of education of the workforce, without a clear relation to the department's economic performance. In only seven years (available to analyze in GEIH), Caquetá, Guaviare and Putumayo increased by about a year the average years of education of the workforce, in line with both Amazon and aspirational peers, as well as the rest of the country (Figure A6). The increase in educational attainment did not necessarily lead to better economic outcomes for the region, which had as previously explained a worse economic performance than aspirational peers and the national average, suggestion that the education of the workforce was not the most binding constraint to the departments' development.

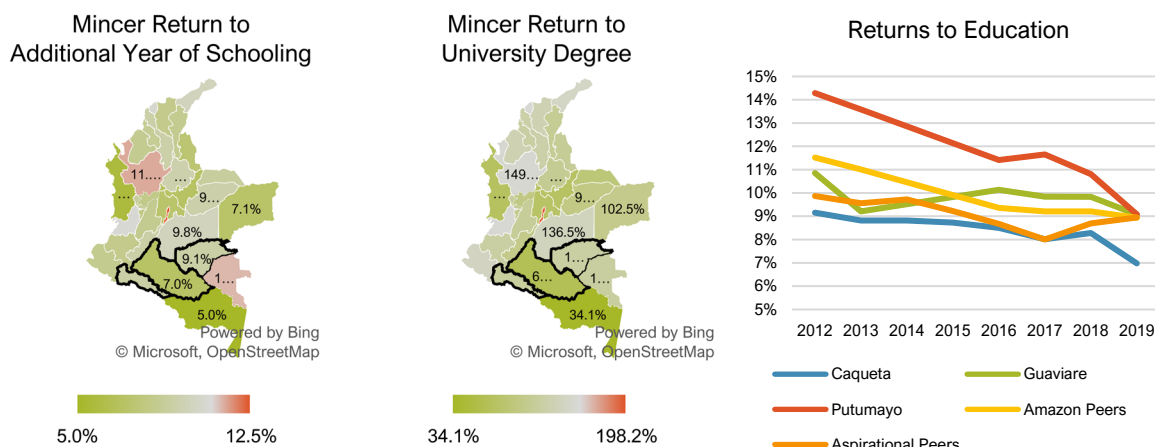
Figure A6. Average Years of Education of Urban Workforce per Department



Source: authors' elaboration based on GEIH.

Returns to education are in line with peers and national average. High returns to schooling can be a sign of education as a binding constraint on growth, as they indicate the shadow price of an additional year of education or an increase in the schooling level. Mincer regressions – regressing the logarithm of wages to a schooling variable and a number of covariates – can provide an estimate on returns to education that permits to seize whether returns to education are currently high or not. Compared to other departments, returns to education (both an additional year or a university degree) are both below the national average, as well as the department mean (Figure A7). Returns to education, which were high in Putumayo in 2012, have also been decreasing in both Putumayo and Caquetá. Low and decreasing returns are an additional sign that education is not currently binding to economic growth in the region.

Figure A7. Returns to Education for Urban Workers



Source: authors' elaboration based on GEIH. Returns to education are obtained in a regression of hourly wages on years of education, controlling by gender, experience, experience squared, as well as industry categorical variables.

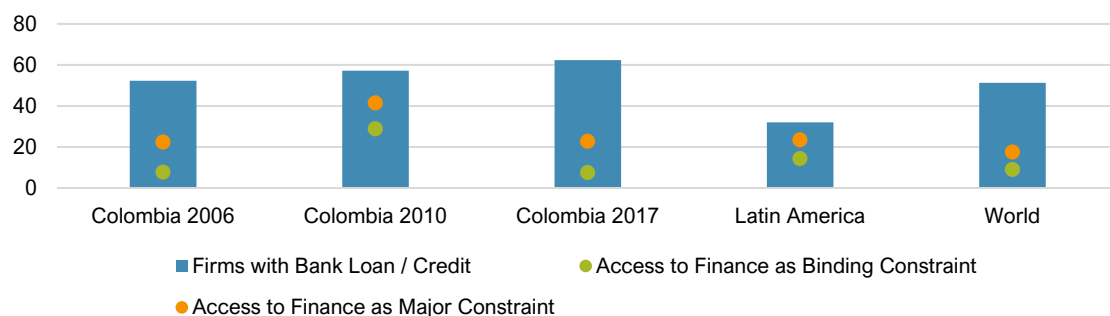
There is insufficient to consider human capital a binding constraint to CGP's growth. The relative improvement in the human capital endowment of the workforce in the region despite lack of income convergence, and the presence of relatively low (respect to other regions in the country) and diminish returns to education are indications that although supply of education

might not be the highest in CGP, demand for skills is low and hence human capital is not constraining at the moment the region's development.

A2.2. Finance

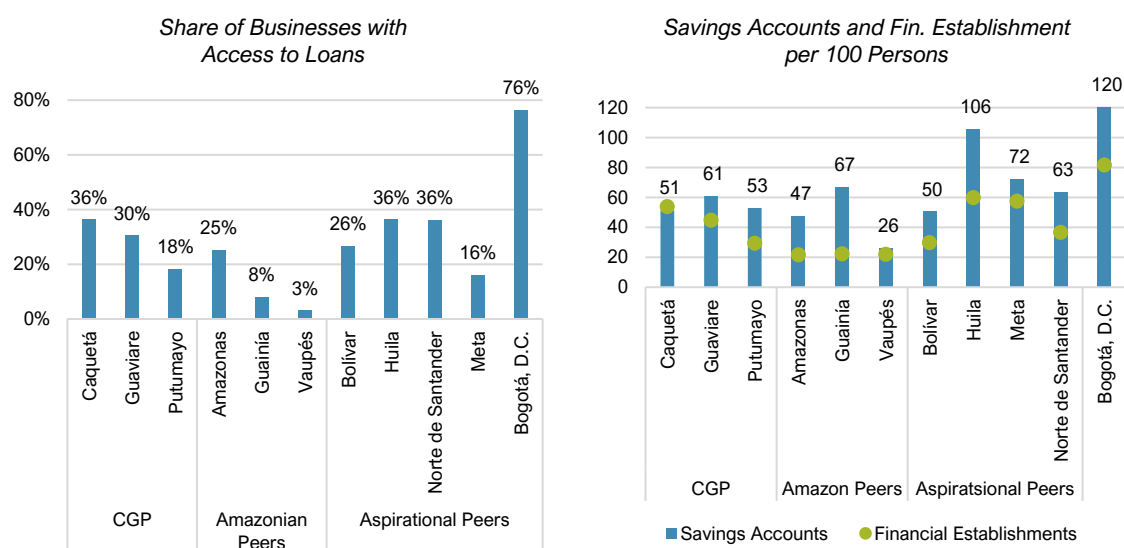
Colombia's monetary and financial sector is resilient, and firms have not faced major difficulties accessing finance they need to grow. Throughout the last two decades, Colombia's banking sector expanded, supported by strong economic growth solid macroeconomic institutions. Banking sector assets and domestic credit to private sector have been steadily increasing over the last two decades and have shown relative resilience to external shock such as the Global Financial Crisis or the COVID-19 crisis. As enterprise surveys, the number of firms with access to credit has been steadily increasing (and is significantly above the global and regional average), and in the most recent survey the number of firms identifying access to finance as a major or binding constraint is slightly below the Latin American average (Figure A8).

Figure A8. Colombia Access to Finance
Percentage of Firms



Source: authors' elaboration based on Enterprise Surveys.

Figure A9. Access to Finance in Colombia, 2020/21

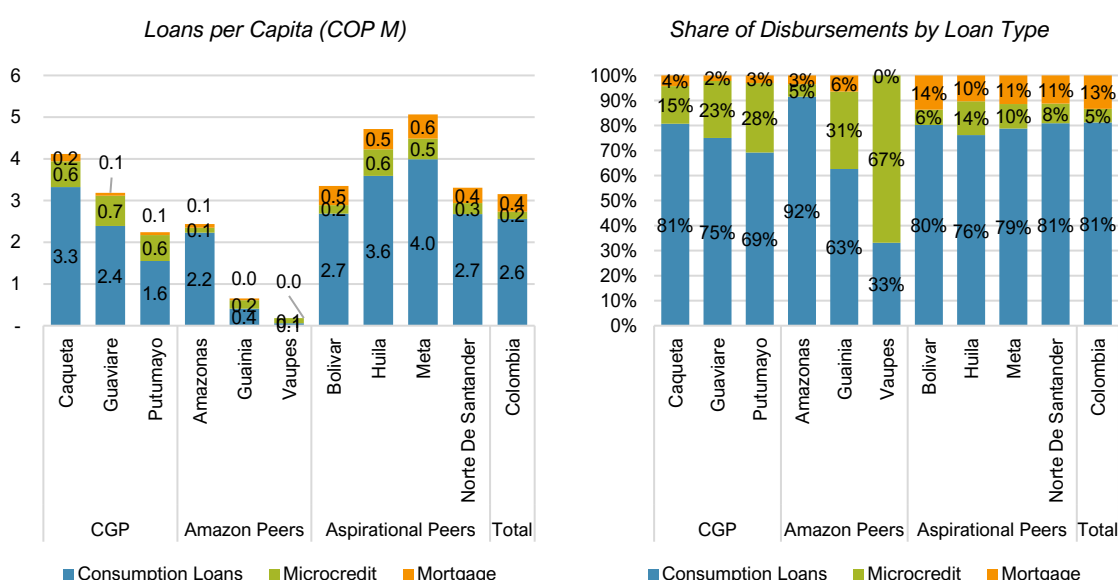


Source: authors' elaboration based on Consejo Privado de Competitividad.

The share of businesses with access to credit in Caquetá, Guaviare and Putumayo is above Amazonian peers and in line aspirational peers. Despite lower access to finance than in the country's economic center, Caquetá and Guaviare outperform Amazonian peers and have access like aspirational peers, while Putumayo is on par with Meta (Figure A9). Parallely, firms in CGP have similar access to savings products and financial intermediaries, although under Huila.

Firms in CGP have access to more loans per capita than in the rest of the country. Compared to Amazonian peers, loan sizes per capita are higher, especially in the case of microcredit. Aspirational peers have higher loan sizes and larger mortgage per capita, but microcredit per capita is higher in the departments studied (Figure A10). In terms of the distribution of total loan disbursements by types, Caquetá, Guaviare, and Putumayo have a higher share of microcredit disbursements than aspirational peers, but lower than Amazonian peers, and a lower share of mortgages than aspirational peers and Colombia (Figure A10). While longer term loans lag aspirational peers, both loan sizes and the distribution of disbursement are close to better performing departments.

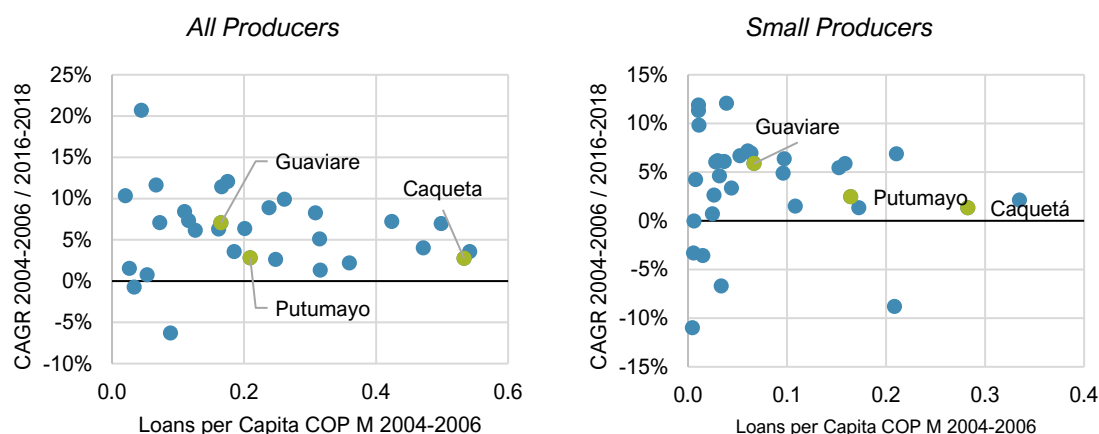
Figure A10. Banking Sector Loans by Department, 2019
COP Millions per capita



Source: authors' elaboration based on Superfinanciera.

Growth in loans to farmers and smallholder farmers has been in line with other departments. Credit to all farmers in Caquetá, Guaviare and Putumayo has not grown significantly less than other departments in Colombia (Figure A11). Departments with the highest loan values per capita in 2004-2006 weren't necessarily the fastest growers. However, there isn't a clear relationship between loan values per capita and growth in credit at a national level.

Figure A11. Agriculture Loan Disbursements
Constant 2018 COP



Source: Agronet, Panel Municipal CEDE – Universidad de los Andes (2020), own calculations.

We do not find sufficient evidence to consider finance as a binding constraint to growth in Caquetá, Guaviare, and Putumayo. These departments have similar levels of coverage and access to different loan types than Amazonian and aspirational peers. Despite smaller rural loan sizes to small- and large-scale farmers, financial access does not appear to be in low supply in the departments, and hence should not be considered a binding constraint.

A2.3. Property Rights and Security

Property rights and security have been central to Colombia's economic and political challenges for decades. Lack of established property rights and volatile security can hinder economic growth by reducing the appropriability of investments. Colombia's modern history, marked by the conflict between the Colombian state and the Revolutionary Armed Forces of Colombia (FARC), is a key example of a setting where insecurity has contributed to the lack of development in particular regions of the country. Since the 2016 peace deal, Colombia and CGP's security situation has been highly evolving, with an increase in returning dissidents to former conflict areas, as well as the presence of other armed groups such as the National Liberation Army (ELN).

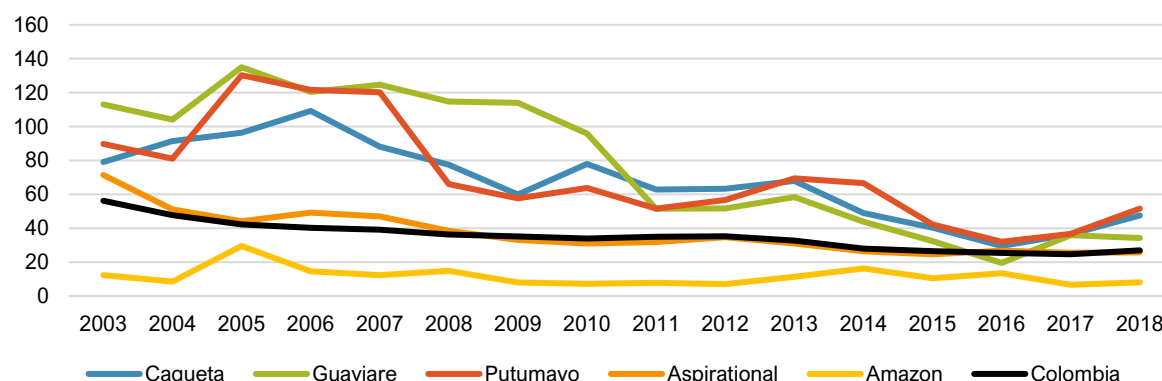
Violence has substantially declined in all three departments since the mid-2000s. As The reduction in crime was not accompanied by an increase in economic growth, which suggests security was not binding to CGP's development in urban areas. The convergence of CGP to Colombia's levels of violence did not unfortunately lead economic convergence. As described in a previous section, the economic gap between CGP and Colombia in same cases has relatively stagnated. The relation between economic growth and per capita homicides in the last two decades has been indeed not significant (Figure A13).

Figure A12 shows, homicide rates in Colombia, but particularly in Caquetá, Guaviare and Putumayo have significantly declined since the mid-2000s. Whereas CGP tripled the national average homicide rate in 2005, by the signing of the peace process homicides rates had approximately converged. By 2018, the departments had seen a relative rise of both homicide rates and other types of crimes (extorsions and kidnappings).

The reduction in crime was not accompanied by an increase in economic growth, which suggests security was not binding to CGP's development in urban areas. The convergence of CGP to Colombia's levels of violence did not unfortunately lead economic convergence. As described in a previous section, the economic gap between CGP and Colombia in some cases has relatively stagnated. The relation between economic growth and per capita homicides in the last two decades has been indeed not significant (Figure A13).

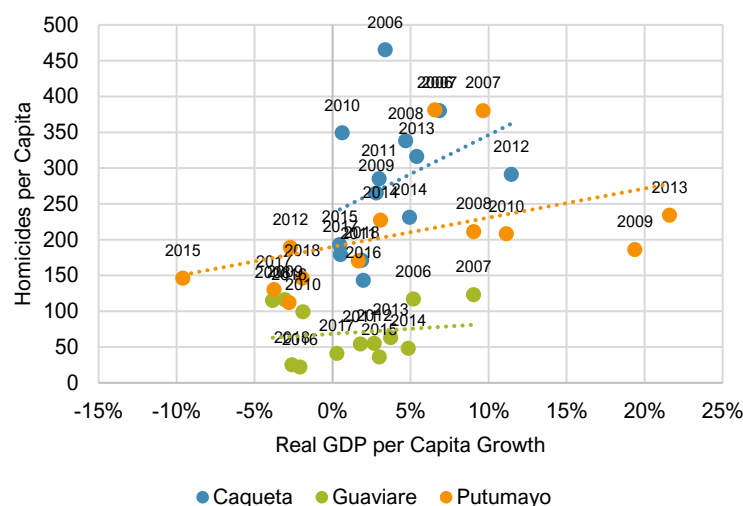
Figure A12. Homicide Rates

Homicides per 100,000



Source: authors' elaboration based on Consejo Privado de Competitividad.

Figure A13. Homicide Rates and GDP per Capita Growth

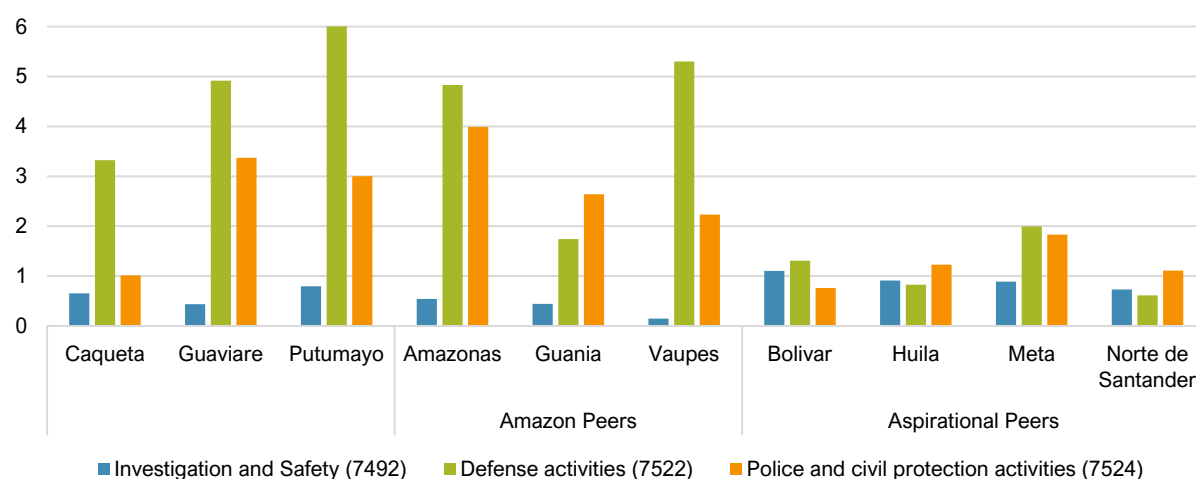


Source: authors' elaboration based on Consejo Privado de Competitividad and DANE.

Although CGP's private security ecosystem is not larger than in other departments, public security officials have an outsized presence. Compared to aspirational benchmarks, CGP and other Amazonian departments do not have an outsized presence for private security services (industry code 7492 in figure below) as measured by the sector's Revealed Comparative Advantage (the share of the sector in the department's employment divided by the share of the sector in national employment) in 2017-2019 (Figure A14). Nevertheless, the public sector's provision of security services (figures 7522 and 7524) employs a substantially higher share of the working population in CGP than in the rest of the country.

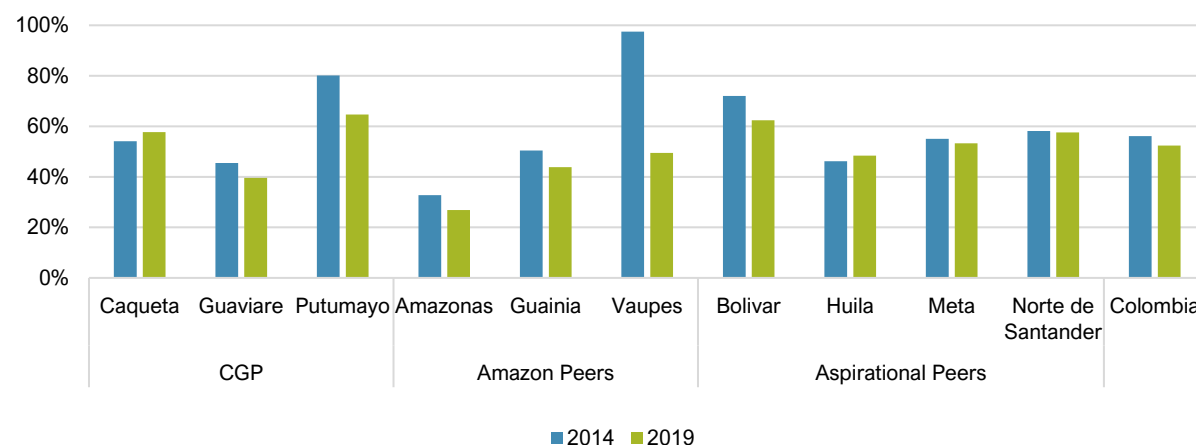
Land informality in CGP is in line with the national average. CGP's property rights challenge is defined by the longstanding civil strife between the Colombian state and the FARC and the recent peace process. Land in conflict zones has often not been included in national cadasters nor been legally recognized, although de facto recognition often takes place. Despite CGP's unique situation, land informality rates are not significantly higher than in the rest of Colombia, except for Putumayo (Figure A15).

Figure A14. Revealed Comparative Advantage of Security Industries, 2017-2019



Source: authors' elaboration based on GEIH.

Figure A15. Land Informality Rates



Source: authors' elaboration based on UPRA.

Although security and property rights are vital for the departments' social and political stability, and key to understand the deforestation problematic, there is not a strong case linking these and the broad macroeconomic developments of the three departments, especially regarding economic growth in the rural areas of CGP. The lack of link is likely associated with the fact that the industries most disrupted by the poor security situation and lack of clear land rights are low productivity industries in the rural reaches of the departments. Such industries include extensive cattle ranching and land speculation. Although there is not strong evidence that property rights are binding in the departments, the link between land formalization, land values and deforestation is key. Furthermore, land tenure formalization is a key element of the current peace process. This implies that policies to attend to the current property right regime will have to be a comprehensive part of a development policy strategy for the Amazon, although the policies themselves are not expected to have significant impact on the broader productivity of the departments, especially in the urban areas.