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Place-specific determinants of income gaps: New sub-national evidence from Mexico[☆]

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ABSTRACT

The literature on wage gaps between Chiapas and the rest of Mexico revolves around individual factors, such as education and ethnicity. Yet, twenty years after the Zapatista rebellion, the schooling gap has shrunk while the wage gap has widened, and we find no evidence indicating that Chiapas indigenes are worse-off than their likes elsewhere in Mexico. We explore a different hypothesis and argue that place-specific characteristics condition the choices and behaviors of individuals living in Chiapas and explain persisting income gaps. Most importantly, they limit the necessary investments at the firm level in dynamic capabilities. Based on census data, we calculate the economic complexity index, a measure of the knowledge agglomeration embedded in the economic activities at the municipal level. Economic complexity explains a larger fraction of the wage gap than any individual factor. Our results suggest that the problem is Chiapas, and not *Chiapanecos*.

1. Introduction

Chiapas is not only the poorest state in Mexico, but also the one growing the least. Challenging the predictions of the neoclassical theory of growth, instead of converging, Chiapas is diverging; the wage gap relative to the rest of Mexico continues to widen. That reality is at odds with the vast resources pumped into the region by the federal government since the Zapatista uprising on January 1st, 1994, and the significant improvements in educational attainment and infrastructure that have followed. Why does the wage gap continue to broaden regardless? How can we account for such a paradox? Most of the efforts aimed at explaining this puzzle have focused on individual or household factors, such as indigenous origins, education, or asset endowment (de Janvry & Sadoulet, 2000; Lopez Arevalo & Nuñez Medina, 2015; World Bank, 2005). Yet, when all these factors are considered, 60% of the gap remain unexplained.

In this study, we propose a different approach, and argue that place-specific characteristics condition the choices and behaviors of individuals living in Chiapas and explain persisting wage gaps. Most importantly, place-specific characteristics limit firm-level investments in the organizational and technological capabilities required to take advantage of market opportunity dynamics, and therefore, explain the state's slower economic growth (Sainsbury, 2020). This study represents an original contribution to the literature in at least two ways. First, it builds on the dynamic capability theory of economic growth by explicitly considering place-specific factors and economic complexity indicators. Second, it tests this approach with novel empirical evidence at the sub-national level in a Mexican state often studied as a paradigmatic example of a laggard state, despite the substantial policy efforts financed by the federal and the local governments to revert this trend.

Our first contribution—more relevant to theory—starts by acknowledging that the neoclassical theory of economic growth does

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little in explaining the diversity across countries in income growth rates recorded in recent decades. Although what are today the rich G7 countries dominated the world economy during last century, since the 1990s, several emerging countries, primarily from Asia, have caught up with impressive rates of growth. We argue that a growth theory based on an explicit account of dynamic capabilities may provide more convincing answers. Following authors such as Freeman (2019) and Sainsbury (2020), "the rate at which a country's economy grows depends on whether its firms have the capabilities to generate and exploit the windows of opportunity they see for innovation and technical change in their industries, and whether over time they are able to enhance their technological and organizational capabilities" (Sainsbury, 2020, p.13). Dynamic capabilities, that is, the organizational capabilities that are most concerned with change (Winter, 2003, Teece, 2017) are most important in this regard.[1] This approach is in line with a modern strand of literature searching for place-specific explanations of development and income gaps. These studies emphasize how cities and regions have complex economic development processes shaped by an extensive range of forces (Storper, 2011). The dynamic capabilities and market opportunity dynamic that apply to sectors at the national level can explain the different fortunes of places and regions (Sainsbury, 2020).

Moreover, this academic trend has occurred together with a recent surge of interest in advanced countries for policies such as the smart specialization strategy of the European Union (McCann & Ortega-Argilés, 2015), and the various initiatives undertaken by several states in the United States of America (Neumark & Simpson, 2014). In particular, smart specialization evolved as a response to the challenges associated with innovation policy design in the European context, while allowing for the varied evolutionary nature of regional economies (McCann & Ortega-Argilés, 2015). In short, smart specialization highlights the importance of focusing industrial and innovation policies on a set of priority areas based on the existing strengths of a region (place) that may allow grasping new market and technological opportunities (Foray, 2015), both at the local and global scale. This process can eventually trigger an industrial transformation toward a more valuable configuration based on dynamic competitive advantages (Vezzani et al., 2017).

In this study, we contribute to the search for the place-specific determinants of income growth and gaps, the concept of economic complexity, a measure of the know-how embedded in the economic activities at the municipal level, and of the state of industrial transformation in Mexico. Our results suggest that place-specific economic complexity can explain a larger share of the wage gap than any of many individual factors, such as education, experience, indigenous origins, gender, and living environment (rural vs. urban).[2] *Chiapanecos* are not poor because they lack individual assets, but rather because they lack a modern ecosystem where they can safely invest to develop their dynamic capabilities. Chiapas has fallen into a sort of chicken-and-egg dilemma; modern industries are not present because these places lack the dynamic capabilities required, but no one has the incentives to acquire such capabilities for industries that do not yet exist.

The same logic helps explain the large income and wage differences observed across places within Chiapas itself, as we do in this study. The income per capita differences between Tuxtla Gutiérrez, the capital of Chiapas, and Aldama and Mitontic, its poorest municipalities, is about eight times, and many place-specific features are necessary to explain them.

This study also offers an additional original contribution because Chiapas, beyond its ethnic diversity and conflictive past, is a paradigmatic state in terms of the failed policies to promote its development and catching up. Since the uprising of the *Ejército Zapatista de Liberación Nacional* (EZLN) in 1994, Chiapas received a significant amount of policy attention and resources from the federal government. The federal government launched a vast array of social programs, targeting the most vulnerable families in the state. Cash transfers, together with large investments in education and infrastructure, were the workhorses of the federal effort to appease the region (Aguilar-Pinto, Tuñón-Pablos, & Morales-Barragán, 2017, Van Leeuwen & van der Haar, 2016). Consequently, its road, port (Puerto Chiapas), and airport (Tuxtla Gutiérrez, Tapachula, and Palenque) networks improved remarkably, and since 1965, the schooling gap between Chiapas and the rest of Mexico has been declining. Yet, the income gap continues to widen, suggesting that none of these was the most binding constraint.

Analyzing the factors associated with poverty in Chiapas, we find that a significant fraction of the income per worker gap remains unexplained when accounting for individual factors such as quantity and quality of education, gender, or indigenous origins. Instead, place-specific factors help explain much more of the gap, also among different municipalities within the state of Chiapas. Indeed, some of them managed to accumulate the dynamic capabilities required by modern production systems, and this increased their complexity, while others have remained stagnant, mostly devoted to subsistence agriculture.

Our findings suggest that solving the coordination problem embedded in the chicken-and-egg dilemma is essential to jump-start the economy of Chiapas, promote structural transformation, and foster convergence. Failure to do so will render the investments the state has made in education and infrastructure fruitless.

The structure of this paper is as follows: In Section two, we characterize the growth trajectory of Chiapas over the twenty years spanning from 1990 to 2010. Section three aims to explain the wage gap between Chiapas and the rest of Mexico as a function of individual factors. In Section four, we analyze the evolution of two place-specific factors that are usual suspects when it comes to explaining wage gaps: access to finance and infrastructure. In section five, we introduce the notion of economic complexity and estimate an employment-based complexity index at the municipal level in Mexico. In Section six, we test if our index of economic complexity—a proxy for the knowledge agglomeration of places—is informative of future growth rates at the municipal level in Mexico. Once this is confirmed, in Section seven we analyze the wage gap by incorporating our measure of economic complexity. Section eight presents the conclusions and some policy implications.

2. The growth trajectory of Chiapas

Between 1990 and 2010, Mexico registered one of the lowest growth rates in Latin America. The compounded annual growth rate (CAGR) per capita of the nation in those twenty years averaged 0.8%, only higher than Venezuela (0.7%), the Bahamas (0.7%), Jamaica (-0.4%), and Haiti (-1.5%).[3] Within that sluggish context, the growth of Chiapas was second lowest among all thirty-two Mexican states, with a CAGR of −0.7%, only surpassing Campeche (−2.0%).[4] Chiapas' performance is in sharp contrast even when compared to Guerrero and Oaxaca (0.1% and 0.3%, respectively), the two poorest states in Mexico after Chiapas.

[1] "An organizational capability is a high-level routine … that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type" (Winter, 2003, p. 991).

[2] In our estimates, we use wage gaps rather than income gaps, as wages are more directly related to the economic complexity of the ecosystem. Gaps in gross domestic level per capita level are much larger, because Chiapas' workers participate less.

[3] World Development Indicators.

[4] The plummeting of Campeche was driven by the accelerated depletion of Cantarell, a giant offshore oil field discovered in 1976, which registered a 74% volume loss between its peak volume in 2004 and 2010. Source: Off-shore technology (https://www.offshore-technology.com/projects/cantarell/) consulted on February 5, 2020.

Consequently, the income gap between Chiapas and the rest of Mexico has widened. Although in 1990, the average income per worker in Chiapas was equivalent to 56% of the national average, by the end of 2010, it had plunged to 41%.[5] Poverty rates mirror the expanding income gap. Either by multidimensional poverty (78.5%) or income poverty (78.1%), by 2010, Chiapas became Mexico's poorest state by far, well above the national average (46.1% and 51.3%).[6]

The differences in income per worker, which are evident across Mexican states, reproduce as a fractal within Chiapas. Tuxtla Gutiérrez, the state capital, had an income per capita 8.5 times higher than that of Aldama and Mitontic, Chiapas' poorest municipalities. Therefore, the search for an explanation for the poverty in Chiapas must go beyond factors that are invariant at the federal and even the state level, such as legal framework, monetary, fiscal, and exchange rate policy,[7] and the banking system. The factors must also account for the large income differences observed within the municipalities of Chiapas. These factors can either be associated with the characteristics of individuals or of the particular sub-regional space.

3. Poverty determinants in Chiapas: Individual characteristics

The traditional approach to explaining the poverty of countries and regions emphasizes nationwide factors or individual (household) factors. Theories based on nationwide factors not only fail to explain large differences in income within countries, but also large differences within the same state. Accounts that focus on individual characteristics as drivers of income differences, attribute poverty to deficiencies in factors such as education, experience, endowments, gender, and even indigenous origins (Ravallion, 2015; Milanovic, 2016). In this section, we test the contribution of some of these individual characteristics to the income gap between Chiapas and the rest of Mexico.

3.1. Education

Chiapas has the lowest education attainment in Mexico. By 2010, its labor force had, on average, 8.1 years of schooling, in contrast to 9.7 years in the rest of Mexico. The bulk of the difference was concentrated in the lowest educational levels. In particular, 13% of the labor force had zero schooling (5% at the national level), 21% did not finish primary school (twice the national average), and 23% did not finish secondary school (20% at the national level).[8] The results from standardized tests ENLACE[9] indicate that Chiapas was among the worst states in Mexico in the Spanish language, and yet, there are compelling reasons to believe that education was not constraining growth in Chiapas.

First, the magnitude of the difference in years of schooling and experience does not bear any resemblance to the large differences observed in income. By 2010, an average worker in Chiapas had 8.1 years of schooling and 22.7 years of experience, in contrast to 9.6 and 21.7 years in the rest of Mexico. These gaps are relatively small and can hardly explain the 60% wage gap between Chiapas and the rest of the country.

Second, for all schooling levels, income per worker in Chiapas is much lower than in the rest of Mexico (Fig. 1). For instance, to earn the income of an individual with six years of schooling in the rest of Mexico, a worker from Chiapas must have at least ten years of schooling. This is true across all schooling levels, although after eighteen years of school (equivalent to a master's degree) the distance is somewhat smaller.[10] Something is causing individuals with the same schooling to earn systematically less in Chiapas.

Third, the trajectory of the education gap between Chiapas and the rest of Mexico, as measured by years of schooling, does not parallel the evolution of the income gap. The gap in years of schooling has declined steadily for the cohorts born after 1965. This trend shrinks at an accelerated pace for the cohort born in the late eighties, where it went from 3.2 years on average (cohort born in 1965) to 1.6 years (1987).[11]

Finally, education cannot account for the fact that the wage premium between workers in Chiapas and the rest of the country contracts by a factor of six when we examine the income of internal migrants in Mexico. A worker elsewhere in Mexico makes, on average, a 67.6% premium over the average worker in Chiapas. If workers born and educated in Chiapas migrate and work elsewhere in Mexico, they make, on average, 79.7% more than do workers that stay in Chiapas. Now, one might say that migrants self-select, and only the best suited in the population leave the state in search of opportunities. By restricting our comparison to wages of migrants, we account for that possibility. Migrant workers from Chiapas make just 11.2% less than other internal migrants do from elsewhere in Mexico.

The differences in the profiles of migrants from Chiapas and the rest of Mexico might still account for the differences mentioned. For instance, perhaps migrants from Chiapas are better educated or have more experience than do other internal migrants. To account for the impact of these and other factors, we ran a regression of incomes derived from work on internal migrants from Chiapas and elsewhere, controlling for individual factors such as years of schooling, experience, gender, indigenous language, and rural location on wages.[12] We have restricted our sample to the population between 12 and 99 years old that declared having a positive monthly income derived from work.[13] Our final sample has 2,953,331 individuals, with the corresponding expansion factors provided by INEGI.[14] As the sample has the income variable truncated from above at 999,999 pesos per month (around US $80,000), we have chosen a Tobit specification. We measure the impacts of these on the income derived from work in Mexico at the municipality level, and in each case, include an interaction with a dummy indicating if the subject was born in Chiapas, to capture the incremental impacts on workers within the state (with respect to the national average). Table 1 reports the results.

Once we control for other variables that potentially influence labor income, we see that wage differences largely disappear. Let us assume the average salary per worker in Mexico is equal to 100, 67.6% higher than that of Chiapas' workers, who in that scale would earn 59.6. When a worker migrates into another state in Mexico, she earns a premium of 13.9 percentage points (the coefficient of *Migrant* in specification 1), totaling 113.9. A worker from Chiapas obtains an average premium of 51.2 percentage points when migrating to other Mexican states,[15]

[5] INEGI and CONAPO.

[6] CONEVAL.

[7] Real exchange rate behavior might differ across regions if their inflation rates are significantly different. This is not the case in Chiapas, whose inflation rate was not significantly different from the rest of Mexico over the period studied.

[8] These statistics were calculated based on the Population Census of 2010, and correspond to all individuals with at least 12 years of age and active in the labor force.

[9] ENLACE is a standardized test in Spanish and Mathematics, that the Ministry of Education administered from 2006 to 2013 from grades third to six (last four years of primary school), and last year of secondary school. Between 2009 and 2013, the test was administered across all years of secondary school.

[10] These results hold even if we control for the quality of education, measured by ENLACE. The problem is that ENLACE is a more recent test and we shall attribute to cohorts of workers a quality of education that does not necessarily correspond to the education they did receive. The results are available from the authors upon request.

[11] Population Census 2010.

[12] Our data comes from the 10% microdata sample of the 2010 Population Census carried out by the National Institute of Statistics and Geography of Mexico (INEGI).

[13] Twelve years is the threshold used by INEGI in their labor market statistics.

[14] Appendix I includes a table summarizing the descriptive statistics.

[15] That is, the sum of coefficients of *Migrant* and the one of interaction *Chiapas-Migrant* in specification 2.

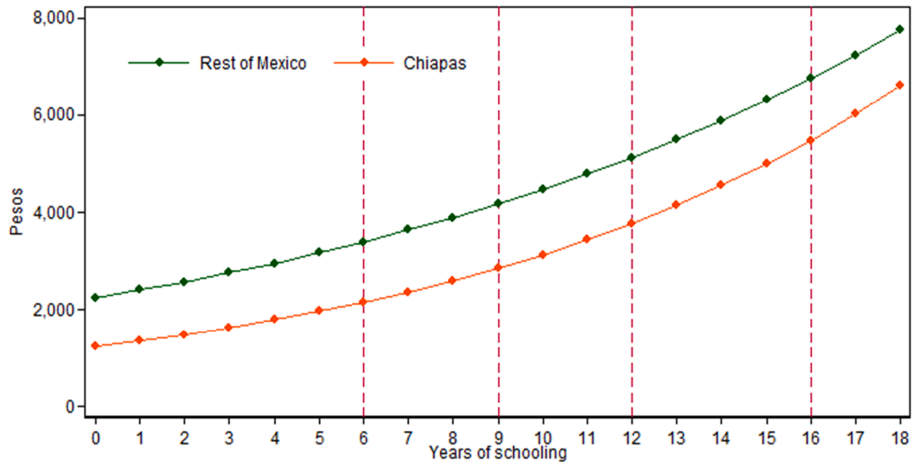


Fig. 1. Returns to education: Chiapas vs. Rest of Mexico. Source: Population census 2010, author's calculations.

Table 1
Tobit regression of income per worker and migrants, controlling for years of schooling, experience, gender, indigenous origins.

	(1)	(2)	(3)
Years of Schooling	0.095***	0.095***	0.095***
	335.17	335.06	325.79
Experience	0.032***	0.032***	0.032***
	310.78	311.13	310.98
Experience-squared	−0.000***	−0.000***	−0.000***
	−241.36	−241.16	−241.23
Female	−0.337***	−0.337***	−0.340***
	−258.12	−259.59	−266.92
Indigenous Language	−0.262***	−0.260***	−0.250***
	−33.45	−33.94	−46.64
Born in Chiapas	−0.269***	−0.346***	−0.406***
	−25.22	−27.01	−24.04
Migrant	0.139***	0.128***	0.128***
	66.68	61.21	61.23
Migrant*Chiapas		0.384***	0.371***
		23.74	27.57
Years of Schooling*Chiapas			0.005***
			5.12
Experience*Chiapas			0.000
			0.07
Female*Chiapas			0.102***
			9.06
Indigenous*Chiapas			−0.104
			−1.63
Constant	7.125***	7.126***	7.129***
	2042.65	2041.53	2004.13
Observations	2,953,331	2,953,331	2,953,331

t values are indicated beneath the coefficients.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

ending with a total salary of 110.9. Comparing *Chiapanecos* working out of Chiapas with other Mexican workers working out of their state of origin, the wage difference shrinks to 2.7%. Thus, Chiapas migrants earn a salary that is roughly similar to other internal migrant workers in Mexico with similar schooling, experience, gender, and indigenous origin.

Despite the good fortune that accompanies Chiapas' workers when they leave the state, migration rates are among the lowest in Mexico. This is particularly true in rural areas, where the migration ratio (1.42 per 1000 inhabitants) is less than half of elsewhere in rural Mexico (3.42).[16] Why do rural *Chiapanecos* not migrate more often? From our field experience in Chiapas, we derived three complementary hypotheses. First, because the safe combination of cheaper cost of living, subsistence agriculture, and conditional cash transfer programs (*Prospera*[17]), offers a sharp and positive contrast to the risky migration to urban areas. Second, because indigenous people in Chiapas are usually located at *ejidos*, or communal property plots. The fact that they benefit from usage, but cannot sell or rent property, raises the opportunity cost of an eventual migration. Finally, many of these communities are governed by the *Usos y Costumbres* system, a form of self-determination where indigenous authorities enforce a set of particular rules that regulate life in the villages. Although there are different *Usos y Costumbres* depending on ethnic groups, most of them contemplate cash-penalties for migration, eventually leading to loss of property, and even expulsion (Santos, Hausmann, Levy, Espinoza, & Flores, 2015).

3.2. Indigenous origins

Another individual factor often mentioned when explaining why workers in Chiapas earn lower salaries is the indigenous origin of a significant share of its population. Indeed, after Oaxaca (35%) and Yucatan (33%), Chiapas (27%) has the third largest share of individuals speaking an indigenous language among all Mexican states.

The results in Table 1 indicate that individuals speaking indigenous languages do earn wages that are 25% lower than otherwise; however, there is no evidence indicating that indigenous people in Chiapas earn significantly less than do their counterparts elsewhere in Mexico. The coefficient of the interaction between indigenous language and having been born in Chiapas is negative (-0.104 in specification 3); however, it is not significant, despite the large number of observations.

The methodological challenge here lies in differentiating individual characteristics (speaking an indigenous language) from the characteristics of the places where these communities live. To address this, we use the Oaxaca-Blinder method to decompose the differences in average income between Chiapas workers and those from the rest of Mexico (Blinder, 1973; Oaxaca, 1973). Intuitively, the Oaxaca-Blinder decomposition aims at explaining what would happen if workers from Chiapas had the same average features (schooling, experience, shares of female, indigenous, and people living in rural areas) as the rest of Mexico.

Table 2 reports the results in two different forms. The left-hand side panel (columns 1 and 2) decomposes the difference in the log of mean

[16] Population Census 2010.

[17] *Prospera* is a federal program of conditional cash transfers aimed at families in extreme poverty. The program brings together different institutions at the federal and regional level, including the Secretary of Public Education, Secretary of Public Health, Mexican Institute of Social Security, as well as State and municipal governments.

Table 2
Oaxaca-Blinder decomposition: Factors associated to differences in the mean of income per worker Chiapas vs. Rest of Mexico.

	(1) Decomposition Coefficient	(2) Standard Error	(3) Decomposition Coefficient	(4) Standard Error
Difference log (income)	0.613	0.003	1.846	0.005
Blinder-Oaxaca				
Characteristics	0.300	0.002	1.350	0.003
Coefficients	0.352	0.002	1.422	0.004
Interactions	−0.039	0.002	0.962	0.002
Characteristics				
Schooling	0.181	0.002	1.198	0.002
Experience	0.001	0.000	1.001	0.000
Female	−0.028	0.001	0.973	0.001
Indigenous Language	0.051	0.001	1.105	0.002
Rural	0.047	0.001	1.048	0.001
Coefficients				
Schooling	−0.037	0.004	0.964	0.004
Experience	0.082	0.006	1.085	0.007
Female	−0.019	0.001	0.982	0.001
Indigenous Language	0.028	0.002	1.028	0.002
Rural	0.012	0.003	1.012	0.003
Constant	0.286	0.011	1.331	0.014
Interactions				
Schooling	−0.010	0.001	0.990	0.001
Experience	0.001	0.000	1.001	0.000
Female	−0.007	0.001	0.993	0.001
Indigenous Language	−0.019	0.001	0.982	0.001
Rural	−0.004	0.001	0.996	0.001

income in three components: characteristics, coefficients, and interactions. The right-hand side panel (columns 3 and 4) contains a similar decomposition, but instead of logs, it presents the results in percentage terms. The rows of the characteristics represent what would happen if we endowed Chiapas workers with the average level observed for each of these variables in the rest of Mexico. The coefficient row represents what would happen if we were to give Chiapas workers the same returns observed in the rest of Mexico for these characteristics. Finally, the interaction panel represents what would happen to Chiapas workers if they possessed the same impact of the interactions between characteristics and coefficients observed in the rest of Mexico.

The number of people speaking an indigenous language only explains a fraction of the difference in the mean wage between workers in Chiapas and those in the rest of Mexico. More explicitly, we find that differences in the number of indigenous people only represent a small fraction of the total difference in income observed between these places (61.3%). These results are in line with de Janvry and Sadoulet (1996), de Janvry, Gordillo, and Sadoulet (1997), and the World Bank (2005), all of which conclude that indigenous origin does not itself explain why a worker in Chiapas earns much less than in the rest of Mexico.

The results in Table 2 provide the essential insight motivating our research. Once we consider all individual factors (schooling, experience, gender, indigenous origins), plus one place-specific characteristic (rural environment), we can only account for 30.0 out of the 61.3 percentage points wage gap.

4. Place-specific determinants of poverty: The usual suspects

The results reported in the previous section indicate that individual factors account for less than half of the wage gap between Chiapas and the rest of Mexico. In this section, we explore the role of factors associated with characteristics of the place. Credit markets and infrastructure are two usual suspects when explaining differences in income across places. None of them seems to play a significant role in explaining why Chiapas is poor.

The share of households and firms (or economic units, EUs) that obtained external financing in Chiapas in 2008, as well as those financed through banks, is close to the national average. According to the 2009 Economic Census, around 30% of Chiapas' EUs did not have financing in 2008, versus 28% at the national level. Similarly, 32% of EUs that secured external credit did it through banks, which is in line with the national average (from 19% in Oaxaca, to 52% in Nuevo León). Credit access in Chiapas does not look different from the rest of Mexico.

Moreover, we can detect growth constraints by analyzing both quantities and prices. As it turns out, the cost of credit in Chiapas is among the lowest of all Mexican states, throughout the range of enterprise sizes. Real interest rates in the state are also 0.7 percentage points below the national average for small and medium-sized enterprises, and 1.9 for large enterprises.[18] The empirical evidence suggests that low levels of credit to the private sector in Chiapas are driven by the low productivity of its economy, not by bottlenecks in credit markets or insufficient credit supply.

The other usual suspect when it comes to place-specific determinants of poverty is poor infrastructure. Chiapas is traversed from north-west to south-east by two mountain ranges, which create very distinct climatic zones and represent a challenge to the build-up and maintenance of infrastructure. Despite this, we have found no evidence of infrastructure being the most significant binding constraint in Chiapas.

Considering area and population, Chiapas ranks above the Mexican average in terms of paved roads and four-lane roads. Fifteen years ago, Davila, Kessel, and Levy (2002) identified the radial nature of roads in Mexico with respect to its capital, as one of the most important constraints to the development of the South. The authors suggested several infrastructure developments to overcome this obstacle, which would have produced savings in distance and time. Most of these projects have been completed by the end of 2013. As reported by Hausmann, Espinoza, and Santos (2015), the savings in distance and time associated with these infrastructure developments were not only achieved, but in some cases even surpassed. Yet, as it happened with schooling, none of these improvements translated into higher incomes or lower poverty rates.

In sum, since the early 2000s, there has been a significant flow of public investment into Chiapas that has reduced the schooling gap, increased access to credit, and improved its infrastructure. However, the wage gap separating Chiapas' workers from other Mexican states widened. Neither individual nor traditional place-specific factors can explain why Chiapas has become poorer. To address this issue, in the next section we introduce a new indicator of economic complexity to capture place-specific determinants of income gaps.

5. Economic complexity

The export basket of a place is an indicator of its stock of productive capacities and know-how. The more diverse the export basket, the more diverse the capacities and know-how agglomeration. Hidalgo and Hausmann (2009) first introduced the idea that this may be crucial to a better understanding of the differences in productivity across places. As productive capacities are not always tradable, the differences in productivities and incomes can be explained by differences in places' Economic Complexity Index (ECI), a measure of knowledge agglomeration that mirrors the diversity and uniqueness of the productive capacities of a place.

The calculation of ECI requires assessing the products that a place produces and those it does not. To turn production into a binary variable, Hidalgo and Hausmann use Balassa's Revealed Competitive

[18] We have derived real interest rates by firm size based on data from *Comision Nacional Bancaria y de Valores* (interest rates) and INEGI (inflation by federal entity).

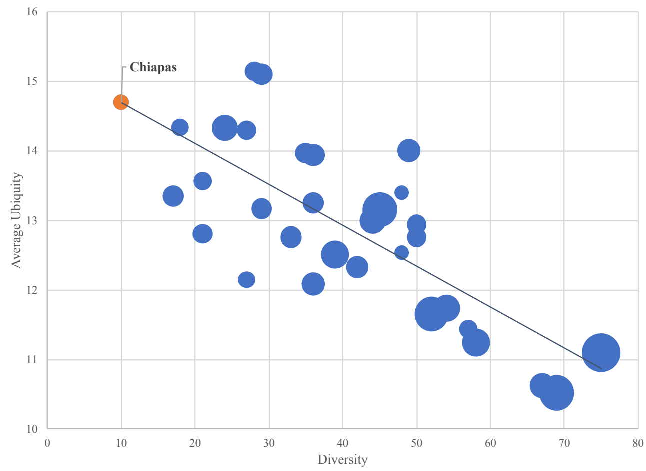
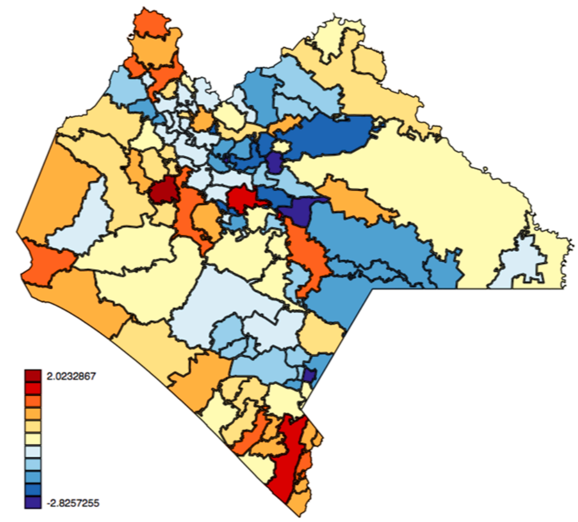


Fig. 2. Diversity and Ubiquity for Mexican States (2010) Source: Authors calculations based on 2010 population census.



Source: 2010 Population Census, authors' own calculations.

Fig. 3. Economic Complexity of Chiapas at the municipal level. Source: 2010 Population Census, authors' own calculations.

Advantage (RCA).[19] According to this measure, a country or place c has a comparative advantage (RCA > 1) in the manufacturing of product i in any given year, when the importance of that good within its export basket is higher than that of the same good in the worlds export basket. The measure is calculated as follows:

$$RCA_{c,i} = \frac{\frac{X_{c,i}}{\sum_i X_{c,i}}}{\frac{\sum_c X_{c,i}}{\sum_{c,i} X_{c,i}}} \quad (1)$$

To use this metric at the sub-national level, where no information is available on sales to other geographical units that would effectively constitute "exports" from a sub-national standpoint, we rely on a definition of RCA based on employment. This choice implicitly assumes that products and services use similar technologies across places in Mexico, and require the same proportions of labor, capital, and know-how in every place. The benefits of this method are two-fold. First, it allows to account for differences in the relative strength of industries across municipalities. Second, it allows to incorporate the service sector—tradable and non-tradable, which is absent in the Hidalgo-Hausmann framework (2009) due to the lack of standardized international statistics on service exports. Therefore, we interpret higher relative employment within the context of equation (1) as a signal of industry strength in the place.

We define two place-specific parameters, depending on whether each place is able to produce and manufacture with positive RCA. One is *diversity*: the number of products and services a place is able to produce with RCA > 1; the other is *ubiquity,* calculated as the number of places that, on average, are able to manufacture those products and services with RCA > 1. Empirically, there is an inverse relationship between ubiquity and diversity prevailing at both the national (comparing exports across countries[20]) and sub-national level (comparing production across states, metropolitan areas, or municipalities within countries[21]). Places with a larger variety of productive capacities can manufacture a more diverse array of products, which are, on average, produced in fewer places. In contrast, places that have some productive capacities and little know-how, will not only be able to manufacture a relatively low number of goods (low variety), but also goods produced in many places (high ubiquity). Fig. 2 displays the diversity and average ubiquity of the products exported with comparative advantage (RCA > 1) at the state level in Mexico. Each dot in the figure corresponds to a Mexican state—Chiapas is highlighted in orange—and the size of the bubble is a function of the average wages in the state. We can confirm the inverse relationship between diversity and average ubiquity at the state level in Mexico and visualize that places with higher diversity and lower ubiquity have higher wages (as represented by the size of the bubble) than those with lower diversity and higher ubiquity.

As expected, there is a negative relation between average ubiquity (Y axis) and the diversity of products and services in each state (X axis). In addition, Chiapas has the lowest diversity, and has relative comparative advantages (RCA > 1) in products and services that are highly ubiquitous. At the other end of the spectrum, Distrito Federal, Nuevo León and Jalisco produce a large number of goods and services that are, on average, the least ubiquitous.

Now that we have a binary way to assess if a certain good or service is produced in a location with relative comparative advantage, we define M_{cp} as a matrix containing 1 if the place produces good p with RCA > 1, and 0 otherwise. The diversity and ubiquity result from adding rows and columns (respectively) of that matrix.

More formally, let us define,

$$Diversity = k_{c,0} = \sum_p M_{cp}$$

$$Ubiquity = k_{p,0} = \sum_c M_{cp}$$

To generate an indicator of the capacities and know-how accumulated in a place or required to manufacture a certain product, we need to use the information contained in the ubiquity of a product to correct for the content embedded in diversity. For places, we need to calculate the average ubiquity of its basket of goods and services, and the average diversity of the places that produce those same goods, and so on. For products, we need to calculate the average diversity of places that manufacture those products and the average ubiquity of the other products those places make. This iterative process introduces important corrections in the estimation of the stock of know-how agglomerated in a place, such as disregarding natural resources as complex goods, just

[19] See Balassa (1964).
[20] See Hausmann et al. (2014), pp.
[21] See Hausmann, Morales, and Santos (2016) for an analysis on Panama provinces, or Reynolds et al. (2018) for the case of states in Australia.

Table 3
Regression of total annualized change in real income per worker by municipality (2000–2010) and ECI, controlling for initial level of income and share of natural resources in exports.

	(1)	(2)	(3)	(4)	(5)
Initial Real Wage, log	−0.037***	−0.038***	−0.063***	−0.064***	−0.063***
	(−35.386)	(−35.575)	(−51.043)	(−48.268)	(−48.213)
Initial Economic Complexity Index (ECI)			0.031***	0.040***	0.040***
			(30.460)	(7.938)	(8.096)
[Initial ECI] X [Initial Real Wage, log]				−0.002*	−0.002**
				(−1.805)	(−2.410)
Initial Share of Natural Resources Exports		0.018***			0.012***
		(4.309)			(3.219)
Constant	0.226***	0.231***	0.370***	0.376***	0.372***
	(38.990)	(39.142)	(54.137)	(50.012)	(50.246)
Observations	2,442	2,194	2,442	2,442	2,194
R-squared	0.339	0.367	0.521	0.522	0.541

t-statistics in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4
Regression of total annualized change in employment per municipality (2000–2010) and ECI, controlling for initial level of income and share of natural resources in exports.

	(1)	(2)	(3)	(4)	(5)
Initial Workers, log	0.003***	0.003***	−0.001	−0.000	−0.000
	(8.523)	(7.134)	(−−1.502)	(−0.230)	(−0.222)
Initial Economic Complexity Index (ECI)			0.010***	0.025***	0.024***
			(14.488)	(9.382)	(8.472)
[Initial ECI] X [Initial Workers, log]				−0.002***	−0.002***
				(−5.848)	(−5.322)
Initial Share of Natural Resources Exports		0.002			−0.003
		(0.709)			(−1.158)
Constant	−0.014***	−0.011***	0.016***	0.013***	0.014***
	(−4.743)	(−3.471)	(4.539)	(3.737)	(3.456)
Observations	2,442	2,194	2,442	2,442	2,194
R-squared	0.029	0.024	0.106	0.118	0.115

t-statistics in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

because very few places have RCA > 1 on them. The correction comes by factoring in the diversity of the basket of goods and services of places that are intensive in natural resources, which typically, is not very diverse. We can express the iteration between ubiquity and diversity described above in a recursive form as follows:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} k_{p,N-1} \tag{2}$$

$$k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp} k_{c,N-1} \tag{3}$$

Inserting (2) in (1) we obtain,

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} \frac{1}{k_{p,0}} \sum_{c'} M_{c'p} k_{c',N-2} \tag{4}$$

$$k_{c,N} = \sum_{c'} k_{c',N-2} \sum_p \frac{M_{cp} M_{c'p}}{k_{c,0} k_{p,0}} \tag{5}$$

This in turn can be written as,

$$k_{c,N} = \sum_{c'} M_{cc'} k_{c',N-2} \tag{6}$$

where

$$M_{cc'} = \sum_p \frac{M_{cp} M_{c'p}}{k_{c,0} k_{p,0}} \tag{7}$$

Note that (6) is only satisfied when $k_{c,N} = k_{c,N-2} = 1$. This is the *eigenvector* of $M_{cc'}$ associated with the higher *eigenvalue*. Given that this *eigenvector* is a vector of 1, it is not informative. Instead, we will search for the *eigenvector* associated with the second higher *eigenvalue*. That *eigenvector* captures the highest quantity of information in the system, and therefore, it will be our measure of economic complexity.[22] Therefore, we define our ECI as follows:

$$ECI = eigenvector\ associated\ with\ the\ second\ highest\ eigenvalue\ of\ M_{cc'} \tag{8}$$

We have calculated employment-based ECI for all municipalities in Mexico. Fig. 3 reports the results for the 122 municipalities within Chiapas.

We can observe a significant heterogeneity in the degree of knowledge agglomeration across different places within the state. This is a promising feature, as the explanation to why Chiapas is poorer than the rest of Mexico should also account for the large income differences observed within Chiapas. Before we move on to test this, we first need to prove that ECI is indeed informative in forecasting future growth rates and estimating growth rates at the municipal level in Mexico.

[22] Hidalgo and Hausmann (2009) introduced the Economic Complexity index using an iterative calculation, while Hidalgo (2011) shows that the system converges and its solution is the second eigenvector. Both solutions are equivalent.

Table 5
Oaxaca-Blinder decomposition using the Economic Complexity Index: Factors associated with differences in the mean of income per worker, Chiapas vs. Rest of Mexico.

	(1) Decomposition Coefficient	(2) Standard Error	(3) Decomposition Coefficient	(4) Standard Error
Difference log (income)	0.613	0.003	1.846	0.005
Blinder-Oaxaca				
Characteristics	0.433	0.003	1.542	0.005
Coefficients	0.261	0.002	1.299	0.003
Interactions	−0.081	0.002	0.922	0.002
Characteristics				
Schooling	0.173	0.002	1.189	0.002
Experience	0.001	0.000	1.001	0.000
Female	−0.031	0.001	0.970	0.001
Indigenous Language	0.051	0.002	1.053	0.002
Rural	0.034	0.001	1.035	0.001
ECI	0.204	0.003	1.226	0.004
Coefficients				
Schooling	−0.052	0.004	0.949	0.004
Experience	0.070	0.006	1.073	0.007
Female	−0.013	0.001	0.988	0.001
Indigenous Language	−0.001	0.002	0.999	0.002
Rural	0.047	0.003	1.048	0.003
ECI	0.014	0.001	1.014	0.001
Constant	0.196	0.011	0.128	0.013
Interactions				
Schooling	−0.015	0.001	0.985	0.001
Experience	0.001	0.000	1.007	0.000
Female	−0.005	0.001	0.995	0.001
Indigenous Language	0.000	0.002	1.000	0.002
Rural	−0.017	0.001	0.983	0.001
ECI	−0.046	0.003	0.955	0.003

as a measure of the knowledge embedded in the economy, in forecasting future growth. Hausmann et al. (2014) used a country's initial ECI as a predictor of growth rates over the next decade, controlling for the initial level of income and for exports of natural resources. We have replicated their procedure at the municipal level in Mexico, with several important adjustments.

First, instead of using changes in gross domestic product on the left-hand side of the regression, we use changes in real wages and employment at the municipal level between 2000 and 2010.[23] By running two different set of regressions—one using the change in real wages over a decade and another using the change in employment—we can test if the initial ECI is associated with subsequent changes in the productivity of labor (as reflected in wages), or to changes in the quantity of workers (employment). Second, we use our employment-based ECI for the 2443 municipalities existing in Mexico by 2000. As mentioned above, this feature allows us to incorporate all industry codes, goods and services alike. We have also included an interaction term, to allow for the possibility that the impacts of ECI in future growth rates vary depending on the initial level of income. At last, as in Hausmann et al. (2014), we have controlled for the relevance of natural resources at the municipal level, as the ECI does not explain these. To do this, in our regressions, we have controlled for the initial (2000) share of natural resources in exports at the municipal level, as reported by the Mexican Atlas of Economic Complexity.[24] Tables 3 and 4 report our results on changes in real wages and levels of employment, respectively.

The inclusion of ECI into specifications 3, 4, and 5 of both tables increases the explanatory power of these regressions in a range that goes from 15.4 to 20.2 percentage points for wages, and 7.7–9.1 in the case of employment changes. The coefficient of the ECI variable is statistically significant in all cases, and the size of the estimated effects is large. On the wage equations (Table 3), an increase of one standard deviation in ECI is associated with the acceleration in wage growth in the range of 3.1% (specification 3) to 4.0% (specifications 4 and 5) per year, which is equivalent to 35.7% or 48.0% in a decade. On the employment

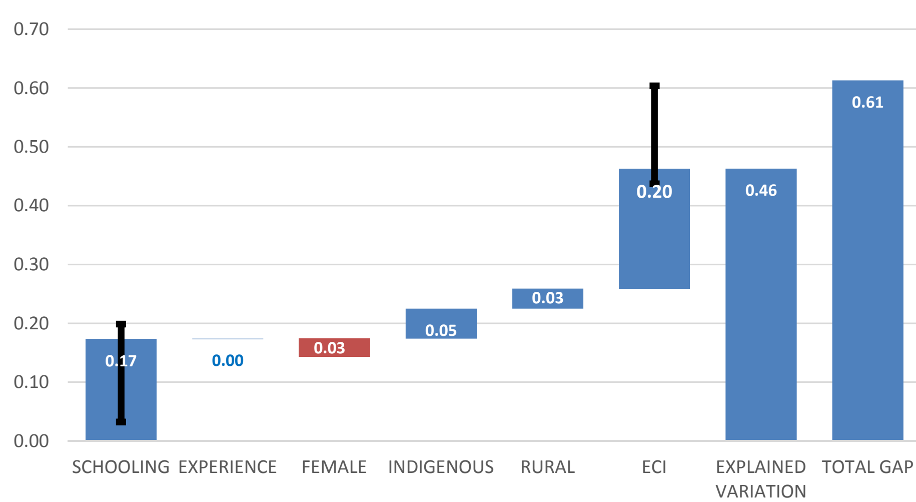


Fig. 4. Oaxaca-Decomposition: Bounds for Education and Economic Complexity.

6. ECI as a predictor of growth at the municipal level in Mexico

We are interested in testing if the ECI at the sub-national level is not merely positively associated with income, but rather if it is informative,

[23] We have also run our specification for the decade 1990–2000, and pooling together both decades with year fixed effects, without any relevant changes in the significance or size of the coefficients. The results are available from the authors upon request.
[24] www.datos.complejidad.gob.mx

equations, an increase in one standard deviation in ECI is associated with the acceleration in the rate of growth in total employment, ranging from 1.0% (specification 3) to 2.5% per year (specification 4). This represents acceleration in employment creation of 10.5% and 28.0% in a decade, respectively.

Other coefficients that are significant and have the expected signs within the wage specification are the initial real wages and the initial share of natural resources. On the former, richer municipalities are expected to grow at a lower rate, suggesting that municipalities in Mexico—when considered as a whole—are converging. On natural resources, given that the decade (2000–2010) witnessed a sustained boom in the prices of natural resources, it is not surprising to find that, at the municipal level, the higher the share of natural resources in exports at the outset, the higher the growth rate. Interestingly, we do not observe these results in the employment equation, where the effects of convergence disappear, once we include ECI.

Overall, the impacts of ECI on wage and employment growth are significant and sizable, considering they go beyond expectation, in terms of Mexico's growth trends and the mineral wealth of municipalities.

7. Place-specific determinants of the income gap: Economic complexity

We have established that ECI is informative in predicting wage and employment growth at the municipal level in Mexico. We can now test if ECI can increase our understanding of the wage gap puzzle posed in Section two, and in particular, if it increases the explanatory power of the Oaxaca-Blinder decomposition presented in Table 2. To do this, we run the decomposition again, this time including the ECI of the worker's municipality. We report the results in Table 5. Notably, there are two significant differences. First, Economic Complexity explains a very large share of the income gap, which is now higher than that of education (20.4 vs. 17.3), and much larger than all other factors. Second, the total explained variation goes from 49% (30.0 out of 61.3 percentage points) in Table 2 to 71% (43.3 out of 61.3 percentage points).

As we are interested in discriminating the contribution of individual factors from place-specific factors in explaining income gaps, it is essential to deal with potential endogeneity between economic complexity and educational attainment. The endogeneity goes in both directions, with lower years of schooling potentially constraining economic complexity, and lower economic complexity providing fewer incentives to invest in education. While we cannot solve this problem statistically, we use a process that can help in identifying upper and lower ranges for the impact of each variable.

The process has two steps. First, we run a regression between the ECI of the municipality where the individual works and their education level. We then use the residuals of the regression in the Oaxaca-Blinder decomposition as the exogenous component of complexity, cleaned from all its correlation with educational attainment. Thus, we attribute to education all the correlation between ECI and education. In doing so, we obtain a lower bound for the share of wage differences between Chiapas and the rest of Mexico associated with ECI, and an upper bound to the proportion of the gap associated with educational attainment.

We then proceed the other way around, running a similar regression by placing education on the left-hand side and ECI as the regressor, and input the residuals in the Oaxaca-Blinder decomposition as the exogenous component of educational attainment. In this second step, we attribute to ECI all of the existing correlation between complexity and educational attainment. Thus, we obtain a lower bound for the contribution of education attainment to explaining income gaps between Chiapas and the rest of Mexico, and an upper limit to the contribution of ECI. Fig. 4 depicts the results.[25] While the component of the income gap associated with educational attainment goes from 3.2 to 19.9 percentage points, the component associated with ECI ranges from 17.8 to 34.5 percentage points.

The wide ranges registered indicate a significant correlation between education attainment and ECI. They also suggest that the upper limit for the fraction of the gap that is explained by the former (17.0 percentage points) is significantly lower than that of economic complexity (20.0).

8. Conclusions

In this study, we present an original piece of evidence in favor of place-specific explanations of income gaps. Individual characteristics are only relevant to the extent that place-specific conditions are also favorable. In particular, a productive ecosystem where it is possible to combine individual characteristics with other productive and dynamic capabilities is indispensable. Infrastructure and credit markets are certainly part of the conditions for modern production, but they are not the only ones. This study represents an original contribution to the literature, as it builds on a dynamic capability theory of economic growth and tests its validity by estimating an indicator of economic complexity—a proxy for the degree of knowledge agglomeration at the municipal level—and assessing its contribution to the explanation of wage gaps.

With novel evidence, this study shows that Chiapas is not poor because its workers lack education or experience, are of indigenous origin, or live predominantly in rural areas. All of these factors have a role; however, the most important factor is the lack of a productive ecosystem with modern means of production, where workers can learn, combine their capacities with those of others and acquire new ones, and where firms develop dynamic capabilities.

In the case of Chiapas, modern production systems never made it in the state. Therefore, it remains locked in a capability trap, producing goods and services of little complexity that demand little know-how. The lack of complexity itself acts as a disincentive to acquire further capabilities, as no one wants to invest in developing skills for an industry that does not exist, and as long as those skills are missing the industry is unlikely to develop. Within such a context, children's education is not considered an investment to gain better incomes in the future, but rather an immediate reduction in the household's productive capacity (Pelaez-Herreros, 2012). The state of Chiapas seems trapped in this chicken-and-egg dilemma. Unless these coordination failures are solved, it makes little sense to continue investing in improving education as a means to increase productivity, as workers from Chiapas will not have a modern ecosystem to deploy those skills and earn higher wages.

Policy makers can play a key role in resolving this capability and growth dilemma. Strategies explicitly targeting coordination failures at the local level are especially relevant to release such constraints. Successful examples include cluster development policies, which have proven useful in many Latin American countries (Casaburi, Maffioli, & Pietrobelli, 2014, Maffioli, Pietrobelli, & Stucchi, 2016), as well as market system development approaches targeting value chains and their enabling environment (Crespi, Fernández-Arias, & Stein, 2014, Pietrobelli & Staritz, 2017).

In sum, this study argues that place-specific factors tend to be more relevant than individual ones when it comes to explaining income gaps, and that sorting out the coordination failures that are hindering know-how agglomeration is necessary to induce firms to invest in dynamic capabilities and to increase economic complexity.

[25] The Oaxaca-Blinder tables corresponding to these two specifications are available from the authors upon request.

Appendix 1. Summary statistics

	Mexico	Chiapas
Income (log.)	8.319	7.820
	(0.875)	(0.994)
Education	9.574	8.079
	(4.567)	(5.207)
Experience	21.666	22.723
	(14.874)	(16.039)
Female	0.356	0.297
	(0.479)	(0.457)
Indigenous Language	0.050	0.141
	(0.218)	(0.348)
Migrant	0.252	0.055
	(0.434)	(0.228)
Rural	0.225	0.494
	(0.418)	(0.494)

Standard deviations in parenthesis

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