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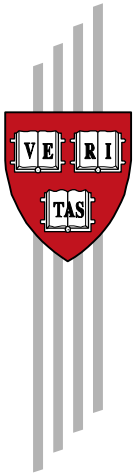

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Place-specific Determinants of Income Gaps: New Sub-National Evidence from Mexico

Ricardo Hausmann[a], Carlo Pietrobelli[b] and Miguel Angel Santos[c*]

[a]*Harvard Center for International Development;* [b]*University Roma Tre and UNU-MERIT;* [c]*Harvard Center for International Development, Institutos de Estudios Superiores en Administracion (IESA)*

*Corresponding author: miguel_santos@hks.harvard.edu

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Keywords: Chiapas, Mexico, economic complexity, development policy, internal migrations.

JEL classification: A11, B41, O10, O12, O20, R00.

Place-specific Determinants of Wage Gaps: New Sub-National Evidence from Mexico

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 between Chiapas and the other Mexican entities 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 in Mexico. Economic complexity explains a larger fraction of the wage gap than any individual factor. Our results suggest that chiapanecos are not the problem, the problem is Chiapas.

JEL classification: A11, B41, O10, O12, O20, R00.

Keywords: Income gaps, economic complexity, development policy, internal migrations, Chiapas, Mexico.

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 that have been thrown in the region since the Zapatista uprising on January 1st, 1994, and the significant improvements in educational attainment and infrastructure that have taken place since. Why does the wage gap continue to broaden? How can we account for such a paradox? Most of the efforts aimed at explaining the wage gap in Chiapas have focused on individual or household factors, such as indigenous origins, education or asset endowment (De Janvry and Sadoulet, 2000; Lopez Arevalo and Nunez Medina, 2015; World Bank, 2005). Yet, when all these factors are considered, 60 percent of the income gap remains unexplained.

In this paper, 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, 2019). The paper represents an original contribution to the literature in at least two ways. First of all, it builds on a dynamic capability theory of economic growth by explicitly introducing the consideration of place-specific factors, and of economic complexity indicators. Secondly, it tests this approach with novel empirical evidence at a sub-national level on a Mexican state that has often been studied as a paradigmatic example of a laggard state, in spite of the substantial policy efforts financed by the Federal and the local governments to revert this trend.

Our first contribution – more relevant to theory – starts from acknowledging that the received neo-classical theory of economic growth does not help very much to understand the diversity across countries in income growth rates recorded in recent decades. Whilst today's rich G7 countries dominated the world economy during last century, since the 1990s several emerging countries, mainly 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 (2019), "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, 2019, 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 stress how cities and regions have complex economic development processes that are shaped by an extensive range of forces (Storper, 2011). The different fortunes of places and regions can be explained by the dynamic capabilities and market opportunity dynamic that applies to sectors at the national level (Sainsbury, 2019).

Moreover, this 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 and Ortega-Argilés, 2015), and the various initiatives undertaken by several states in the United States of America (Neumark and 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 and 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 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 add to the search of 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 a municipal level, and of the state of industrial transformation, in Mexico. Our results suggest that place-specific economic complexity is able to explain a larger share of the wage gap than any of many individual factors, like education, experience, indigenous origins, gender and living environment (rural vs. urban).[2]

[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.

Chiapanecos are not poor because they lack individual assets, but rather because there is not a modern ecosystem where they can safely invest to develop their dynamic capabilities. Chiapas would have 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 incentives to acquire such capabilities for industries that do not yet exist.

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

This paper 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. A vast array of social programs was launched, targeting the most vulnerable families in the state. Cash transfers, together with large investments in education and infrastructure, were the work horses of the federal effort to appease the region (Aguilar-Pinto et al., 2017, Van Leeuwen and Van der Haar, 2016). As a consequence, its road, port (Puerto Chiapas), and airport (Tuxtla Gutiérrez, Tapachula, and Palenque) networks remarkably improved, and the schooling gap between Chiapas and the rest of Mexico has been closing since 1965. Yet, the income gap continues to widen, suggesting that none of these was the most binding constraint.

As we analyze the factors associated to poverty in Chiapas, we find that a significant fraction of the income per worker gap remains unexplained when we account only for individual factors such as quantity and quality of education, gender, or indigenous origins. Instead, place-specific factors help us 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 the paper is as follows. In section one we characterize the growth trajectory of Chiapas over the twenty years spanning from 1990-2010. Section two is aimed at explaining the wage gap in Chiapas as a function of individual factors. In section three and four, we test our argument of place-specific determinants of wage gaps between Chiapas and the rest of Mexico and introduce the notion of economic complexity. In Section five we test of an 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 we have confirmed this, we move on to analyze in section six the wage gap by including in our Oaxaca-Blinder Decomposition our measure of economic complexity. Conclusions and some policy implications are developed in section seven.

I. The growth trajectory of Chiapas

Between 1990-2010 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%), 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 right after Chiapas. As a consequence, the income gap between Chiapas and the rest of Mexico has widened. Whereas in 1990 the level of Chiapas average income per worker had been equivalent to 56% 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 is by far Mexico's poorest state,

[3] World Development Indicators.

[4] The plummeting of Campeche was driven by the accelerated depletion of Cantarell, a giant off-shore 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 5th, 2020.

[5] INEGI and CONAPO.

well above the national average (46.1% and 51.3%).[6]

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

II. Poverty determinants in Chiapas: Individual characteristics

The traditional approach to explaining why countries and regions are poor either 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 individual characteristics 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.

Education

Chiapas is the state with 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

[6] CONEVAL.

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

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 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 registered 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, respectively. Given that the years of experience are relatively similar, it is reasonable to inquire if the 1.5 years of extra schooling in the rest of Mexico are enough to account for an average income 64.0% higher than Chiapas.

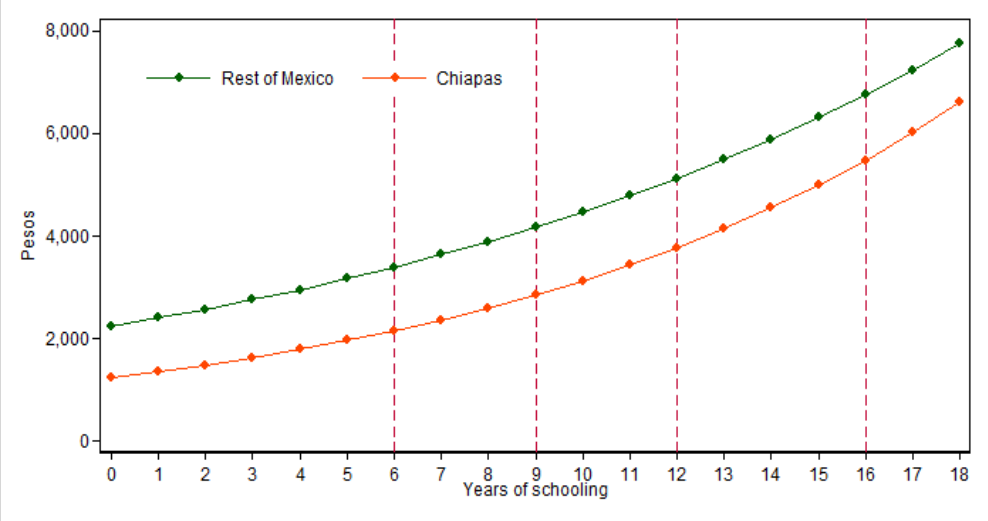
Second, for all schooling levels, income per worker in Chiapas is much lower than in the rest of Mexico (Figure 1). For instance, in order to earn the income of someone with six years of schooling in the rest of Mexico, a worker from Chiapas must have at least ten years of schooling. That is true across all schooling levels, although after eighteen years of school (equivalent to a master degree) the distance is somewhat smaller.[10] There must be something in the place that causes individuals with same schooling to earn systematically less in Chiapas.

[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 do not necessarily correspond to the education they did receive. The results are available from the authors upon request.

Figure 1. Returns to education: Chiapas vs. Rest of Mexico



Source: Population census 2010, author's calculations.

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. The trend, that shrinks at an accelerated pace for the cohort born in the late eighties, went from 3.2 years on average (cohort born in 1965) to 1.6 (1987).[11]

At last, education cannot account for the fact that the wage premium between workers in Chiapas and the rest of Mexico shrinks when we look at the income of internal migrants coming from Chiapas. To begin with, a worker elsewhere in Mexico makes on average a 67.6% premium with respect to workers in Chiapas. If workers born and educated in Chiapas migrate and work somewhere else in Mexico, they make on average 79.7% more than those that stayed in Chiapas. Now, one might say that migrants self-select, and only the best suited in the population venture out of the state in search for 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 coming from elsewhere in Mexico.

These differences might still be driven by differences in the profiles of migrants from Chiapas and the rest of Mexico. For instance, it might be the case that Chiapas migrants

[11] Population Census (2010).

are better educated or have more experience than other internal migrants. In order to account for the impact of these and other factors, we ran a regression of incomes derived from work on internal migrants coming 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] Given that 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 include in each case an interaction with a dummy indicating if the subject was born in Chiapas in order to capture the incremental impacts on workers within the state (with respect to the national average). Results are reported in Table 1.

Once we control for other variables that potentially influence labor income, we can see that wage differences largely disappears. Let us assume the average salary per worker in Mexico is equal to 100 – 67.6% higher than that of Chiapas' workers, which 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), for a total of 113.9. A worker from Chiapas gets an average premium of 51.2 percentage points when migrating to other Mexican states,[15] ending with a total salary of 110.9. When comparing *chiapanecos* working out of Chiapas with other Mexican workers working out of their state of origin, the wage difference shrinks to 2.7%. That is to say that Chiapas migrants earn a salary that is roughly similar to other internal migrant workers in Mexico with similar schooling, experience, gender and indigenous origin.

In spite of the good fortune that accompanies Chiapas' workers when they venture out of the state, migration rates are significantly lower. That is particularly true in rural areas, where the migration ratio (1.42 per 1,000 inhabitants) is less than half elsewhere in rural

[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] A table summarizing descriptive statistics has been included in Appendix I.

[15] I.e. the sum of coefficients of *Migrant* and the one of interaction *Chiapas-Migrant* in specification 2.

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. The fact that they benefit from usage but cannot sell or rent property, raises the opportunity cost of an eventual migration. At last, many of these communities are governed by the system of *Usos y Costumbres*, 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 the ethnic groups, most of them contemplate cash-penalties for migration, eventually leading to loss of property and even expulsion (Santos et al., 2015).

Indigenous origins

Another individual factor that is often mentioned when it comes to 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 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, but there is no evidence indicating that indigenous people in Chiapas earn significantly less than 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), but it is not significant in spite of the large number of observations.

[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 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

The methodological challenge here lies in differentiating individual characteristics (being able to speak an indigenous language) from the characteristics of the places where these communities live. In order 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) than the rest of Mexico.

The results are reported in two different forms in Table 2. The left-hand side panel (columns 1 and 2) decomposes the difference in the log of mean 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, results are presented 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 were endowed with 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 mean wage between workers in Chiapas and those in 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 Saudolet (1996), de Janvry, Gordillo and Sadoulet (1997), and the World Bank (2005), all concluding that indigenous origin does not explain by itself 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 are only able to account for 30.0 out of the 61.3 percentage points wage gap.

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

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

The results reported in the previous section indicate that individual factors only account for 40% of the differences in wages between Chiapas and the rest of Mexico. In this section, we explore the role of factors associated to characteristics of the place.

Two factors that are usual suspects when it comes to explaining differences in income across places are credit markets and infrastructure. None of them seems to play a significant role in explaining why Chiapas is poor.

The share of households and firms (or economic units, EU for short) which got 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 Leon). Credit access in Chiapas does not look different from the rest of Mexico.

Moreover, growth constraints shall be detected 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 indicates 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 (Hausmann, Espinoza y Santos, 2015).

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, that create very distinct climatic zones and represent a challenge to the build-up and maintenance of infrastructure. In spite of that, 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 most roads in Mexico with respect to its capital, as one of the most important constraints to the development of the South. The authors suggested a number of infrastructure developments to overcome this obstacle that would have produced savings in distance and time. By the end of 2013, most of these projects have been completed. As reported by Hausmann, Espinoza and Santos (2015), the savings in distance and time associated to 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.

[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).

In sum, since the early 2000s, there has been a significant flow of public investment in 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. Other than the lack of complementary transport infrastructure, neither individual factors nor traditional place-specific factors are able to 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.

IV. Economic Complexity

The export basket of a country or region is an indicator of the productive capacities and know-how of a place. The more diverse the export basket of a place, the more diverse the capacities and know-how it possesses. The idea that this may be the key to a better understanding of the differences in productivity across places was first introduced by Hidalgo and Hausmann (2009). Given that productive capacities are not always tradable, the differences in productivities and incomes can be explained by differences in a place's 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 first to assess what products are done or not in a place. To turn production into a binary variable, Hidalgo and Hausmann use Balassa's Revealed Competitive 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 the one of that same good in the world´s export basket. The measure is calculated as follows,

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

In order to use this metric at the sub-national level – where no information exists 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. That 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

[19] See Balassa (1964).

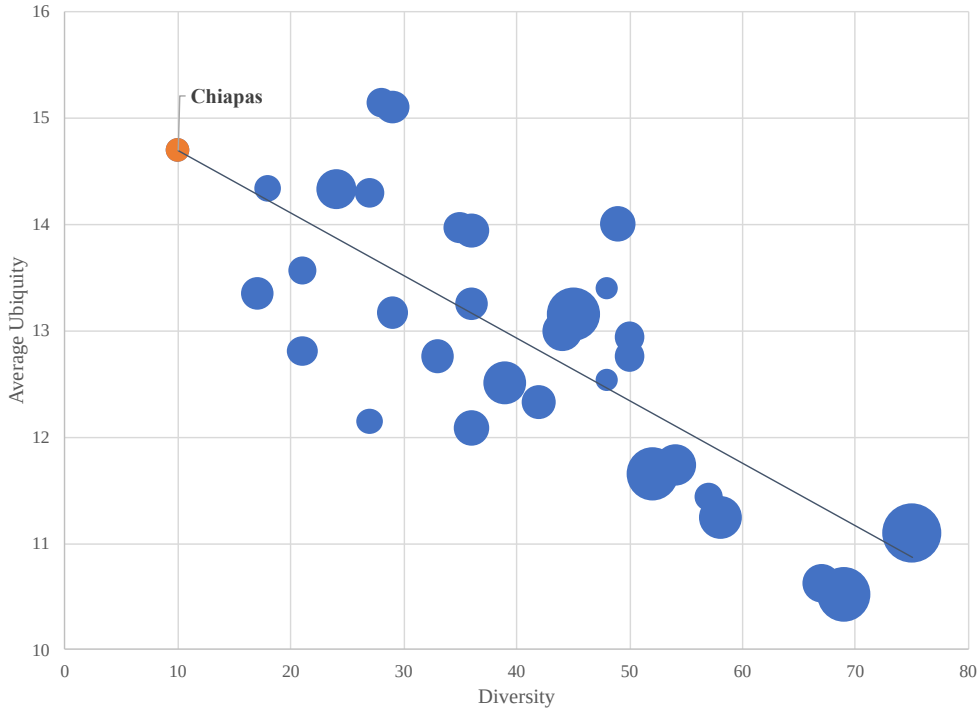
of this method are two-fold. First, it allows to account for differences in the relative strength of industries across municipalities. Second, it allows to incorporate the service sector – tradable and non-tradable – which is absent in the Hidalgo-Hausmann framework (2009), due to the lack of standardized international statistics on service exports. Therefore, we interpret higher relative employment within the context of equation (1) above as a signal of industry strength in the place considered.

We will 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; and the other is the *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 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 are able to manufacture not only a more diverse array of products, but also products that are, on average, produced in fewer places. In contrast, places that have a few productive capacities and little know-how, not only will be able to manufacture a relatively low number of goods (low variety), but those will also be goods produced in many places (high ubiquity). Figure 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. There we can not only confirm the inverse relationship between diversity and average ubiquity at the state level in Mexico, but can also 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.

[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.

Figure 2. Diversity and Ubiquity for Mexican States (2010)



Source: Authors calculations based on 2010 population census.

As expected, there is a negative relation between average ubiquity of products (Y axis) and the diversity of products and services in each state (X axis). Also, based on the 2010 Population Census, Chiapas was the state with the lowest diversity, and also the one whose products most other states on average were able to make. At the other end of the spectrum, Distrito Federal, Nuevo León and Jalisco produce a large number of goods that are, on average, the least ubiquitous products.

Now that we have a binary way to asses if a certain good or service is produced or not 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:

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

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

In order 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 because very few places manufacture them competitively. 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. The iteration between ubiquity and diversity described above can be expressed in a recursive form as:

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

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

Inserting (2) in (1) we obtain:

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

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

That in turn can be written as:

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

where

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

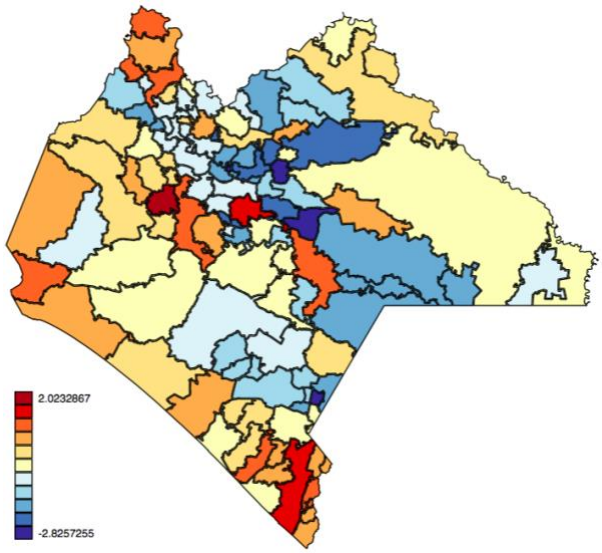
Note that (6) is only satisfied when $k_{c,N} = k_{c,N-2} = 1$. That is the *eigenvector* of $\widetilde{M}_{cc'}$ associated with the higher *eigenvalue*. Given that this *eigenvector* is a vector of 1, it is not informative. Instead, we will search for the *eigenvector* associated with the second higher *eigenvalue*. That *eigenvector* captures the highest quantity of information in the

system, and therefore will be our measure of economic complexity.[22] Our Economic Complexity Index will therefore be defined as:

$$ECI = eigenvector\ associated\ with\ the\ second\ highest\ eigenvalue\ of\ \widetilde{M}_{cc'} \quad (8)$$

We have calculated employment-based ECI for all municipalities in Mexico. The results for the 122 municipalities that are comprised within Chiapas are reported in Figure 3.

Figure 3. Economic Complexity of Chiapas at the municipal level



Source: 2010 Population Census, authors' own calculations.

We can observe a significant heterogeneity in the degree of knowledge agglomeration across different places within the state. This is promising. After all, the explanation to why Chiapas is poorer than the rest of Mexico should also be able to account for the large income differences observed within Chiapas. To this aim, we need to prove first that ECI is indeed informative when it comes to forecasting future growth rates 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 et al (2011, 2014) shows that the system converges and its solution is the second eigenvector. Both solutions are equivalent.

V. 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 – as a measure of the knowledge embedded in the economy– when it comes to forecasting future growth. Hausmann et al (2011) 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 a number of 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 to 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 2,443 municipalities existing in Mexico by 2000. As mentioned above, this feature allows 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 (2011) – we have controlled for the relevance of natural resources at the municipal level, since these are not explained by ECI. In order 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] Our results on changes in real wages and levels of employment are reported in Tables 3 and 4 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 in the case of wages, and 7.7 to 9.1 in the case employment changes. The coefficient of the ECI variable is statistically significant in all cases, and the size of the

[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 either in the significance or size of the coefficients. Results are available from the authors upon request.

[24] www.datos.complejidad.gob.mx

estimated effects are very large. On the wage equations (Table 3), an increase of one standard deviation in ECI is associated to an acceleration in wages 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 equations, an increase in one standard deviation in ECI is associated to an acceleration in the rate of growth in total employment, ranging from 1.0% (specification 3) to 2.5% per year (specification 4). This represents an 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 ones of the initial real wages, and the initial share of natural resources. On the former, richer municipalities are expected to grow at a significant 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 that – at the municipal level – the higher the share of natural resources in exports at the outset, the higher the growth rate. Interestingly, these results are not observed 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 of what would have been expected considering Mexico's growth trends and the mineral wealth of municipalities.

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

VI. Place-specific determinants of the income gap: Economic Complexity

Now that we have established that ECI is informative in predicting wage and employment growth at the municipal level in Mexico, we are in a position to test if ECI can increase our understanding of the wage gap puzzle posed in Section 2, and in particular if it increases the explanatory power of the Oaxaca-Blinder decomposition we presented in Table 2. In order to do that, we run the decomposition again, this time including ECI of the worker's municipality. We report the results in Table 3. Two significant differences are noteworthy. 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).

Table 3. Oaxaca-Blinder decomposition using the Economic Complexity Index: 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	0.433	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

Addressing potential endogeneity between education and ECI

Since 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 less 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.

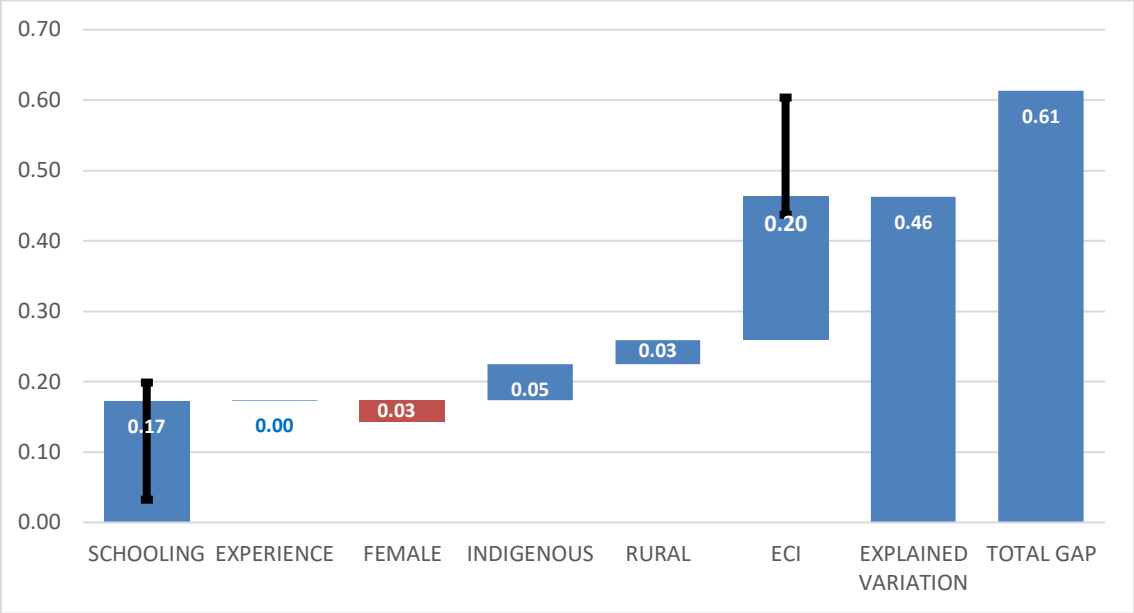
The process has two steps. First, we run a regression between the ECI of the municipality where the individual works and his education level. The residuals of the regression are then used in the Oaxaca-Blinder decomposition as the exogenous component of complexity, i.e. cleaned from all its correlation 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 that is associated with educational attainment.

Then we proceed the other way around, running a similar regression by placing education on 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. The results are depicted in Figure 4.[25] Whereas 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 that there is 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).

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

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



VII. Conclusions

In this paper 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 individual characteristics can be combined 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. The paper represents an original contribution to the literature as it builds on a dynamic capability theory of economic growth, and test its validity by explicitly testing on the contribution of an indicator of economic complexity – a proxy for the degree of knowledge agglomeration of places – to the explanation of the income gaps.

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

In the case of Chiapas, modern production systems never made it in the state. Therefore, it remains locked into a capability trap, producing goods and services of little complexity that demand little know-how. The lack of complexity in itself acts as a disincentive to acquire further capabilities, as no one wants to study to work in an industry that does not exist. Within such a context, children's education is not regarded as an investment to gain better incomes in the future, but only as an immediate reduction in the household's productive capacity (Pelaez-Herreros, 2012). The state of Chiapas appears to remain trapped in this chicken-and-egg dilemma. Unless this coordination failure is solved, it makes no sense to continue investing in improving education as a means to increase productivity, as workers from Chiapas will not have an ecosystem that demands those skills and can in turn sustain higher wages. In sum, this paper argues that not only place-specific explanations of income gaps matter, but that it is right the specific production-related eco-system, which is necessary to induce firms to invest in dynamic capabilities, and to increase economic complexity, the essential conditions for lower income gaps and poverty.

Can policies influence this process? Given that the central issue that we highlighted is the coordination of actions and policies, strategies explicitly targeting coordination failures at the local level have an especially relevant potential to release such constraints. This may be the case of cluster development policies, which have proved their usefulness in many Latin American countries (Casaburi et al., 2014, Maffioli et al., 2016). Moreover, comprehensive approaches evolving around the systemic notion of value chains (Crespi et al., 2014, Pietrobelli and Staritz, 2017) can also display their potential in these circumstances.

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Appendix I. Summary Statistics

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

Standard deviations in parenthesis