Growth of Firms and Migration in Mexico: Twin Processes

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The search for economic opportunity drives both the creation of new firms and migration in Mexico. As economic development proceeds, people go after firms for employment and to purchase goods, and firms go after firms and people, seeking labor, inputs, and customers.

These twin processes can be examined using firm data from the National Statistical Directory of Economic Units (DENUE) for 2012 and 2016, and Census population data for 2010 and 2015. I aggregate this data to the municipal level so as to make the local economies our unit of observation.

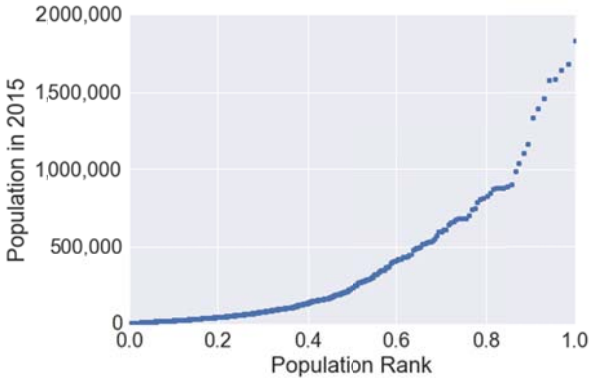


Figure 1. Municipal population versus municipal rank (proportion of people living in smaller municipalities)

Migration

Municipalities include city districts ("Delegaciones") and can thus number millions of people. On the other hand in 2015 the smallest one had about 87 people.

Define municipal rank as the proportion of people that live in smaller municipalities. The long history of migration that began with the shift from agriculture to industry can be seen simply by plotting municipal population against municipal rank (Figure 1).

Migration still continues, except that today workers seek both rural and urban employment. A plot of population growth against population (Figure 2) shows that population grew less than average in smaller municipalities. Also, population growth was somewhat slower in the very populated municipalities. If we subdivide municipalities into the four population intervals [0, 0.03), [0.03, 0.27), [0.27, 0.63), [0.63, 1.00], mean population growth increases across the first, second and third intervals. However, it then decreases to the last interval. (These

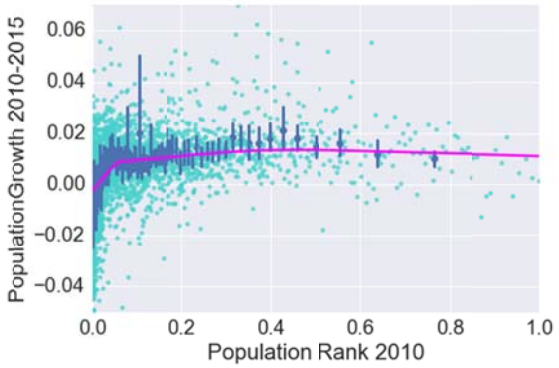
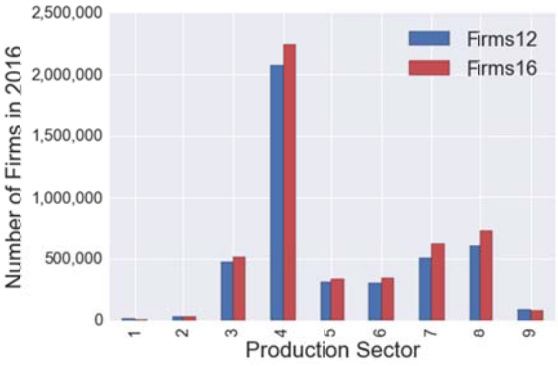


Figure 2. Municipal population growth 2010-2015 versus population. In light blue, the scatterplot (some outliers not shown). In dark blue, 95% confidence intervals for mean municipal population growth for groups of 25 municipalities. In magenta, locally weighted linear regression.

comparisons are significant at better than 1% confidence using a means comparison test). By the way, the number of municipalities in each of these four intervals is 946, 1164, 295 and 51. This means that the municipalities in the lowest group from which there is migration are quite small, holding 3% of the population. On the other hand the 51 largest are quite large, holding 37% of the population.

Firm Growth

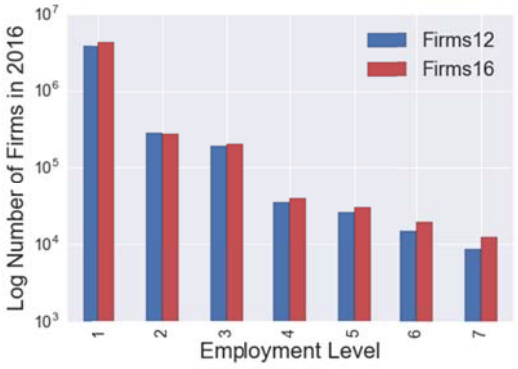
The DENUE data classifies firms into 9 main production sectors (the 1 digit level). The sector with the most firms was construction (Figure 3). This was followed by finance, insurance and realtors; transport and warehousing; and manufacturing. Trade, restaurants and hotels overtook energy and water during the period. These were followed by communitary and social, mining, and agriculture, forestry and fishing, which all decreased in numbers during the period. However, using a means comparison test, the only significant differences in firm numbers at the 1% level were the decrease in agriculture, forestry and fishing, and the increase in transport and warehousing. The increases in finance, insurance, and realtors, and trade, restaurants and hotels were significant at the 4.7% and 5.6% levels.



	Sector
1	Ag, Forest, Fisheries
2	Mining
3	Manufacture
4	Construction
5	Energy Water
6	Trade, Restaurants, Hotels
7	Transport, Warehousing
8	Finance, Insurace, Realtors
9	Communitary, Social

Figure 3. Firm growth by sectors, 2012-2016.

We can also examine the growth in firm numbers by employment levels (Figure 4). The number of firms increased in every employment level except for [6, 10]. However, using a means comparison test, the only significant differences in firm numbers at the 1% level were for firms with 51 employees or higher, employment levels 5, 6, and 7. The increases in employment at levels [1, 5] and [31, 50] were significant with a confidence of 2%.



	Employment Level
1	[1,5]
2	[6,10]
3	[11,30]
4	[31,50]
5	[51,100]
6	[101,250]
7	[251,+]

Figure 4. Firm growth by employment ranges, 2012-2016.

Interaction of Firms and Population Numbers

There are several general questions on how firms numbers relate to population numbers. First, is there some "law" relating these quantities? Second, when the economy grows, how do the numbers of firms in different sectors and employment levels grow? Do numbers of firms grow proportionally, or is there a "migration" from small firms to large firms? That is, is development achieved with larger firms rather than more firms? Monetary data on production is not readily available so we work with numbers and sizes of firms instead.

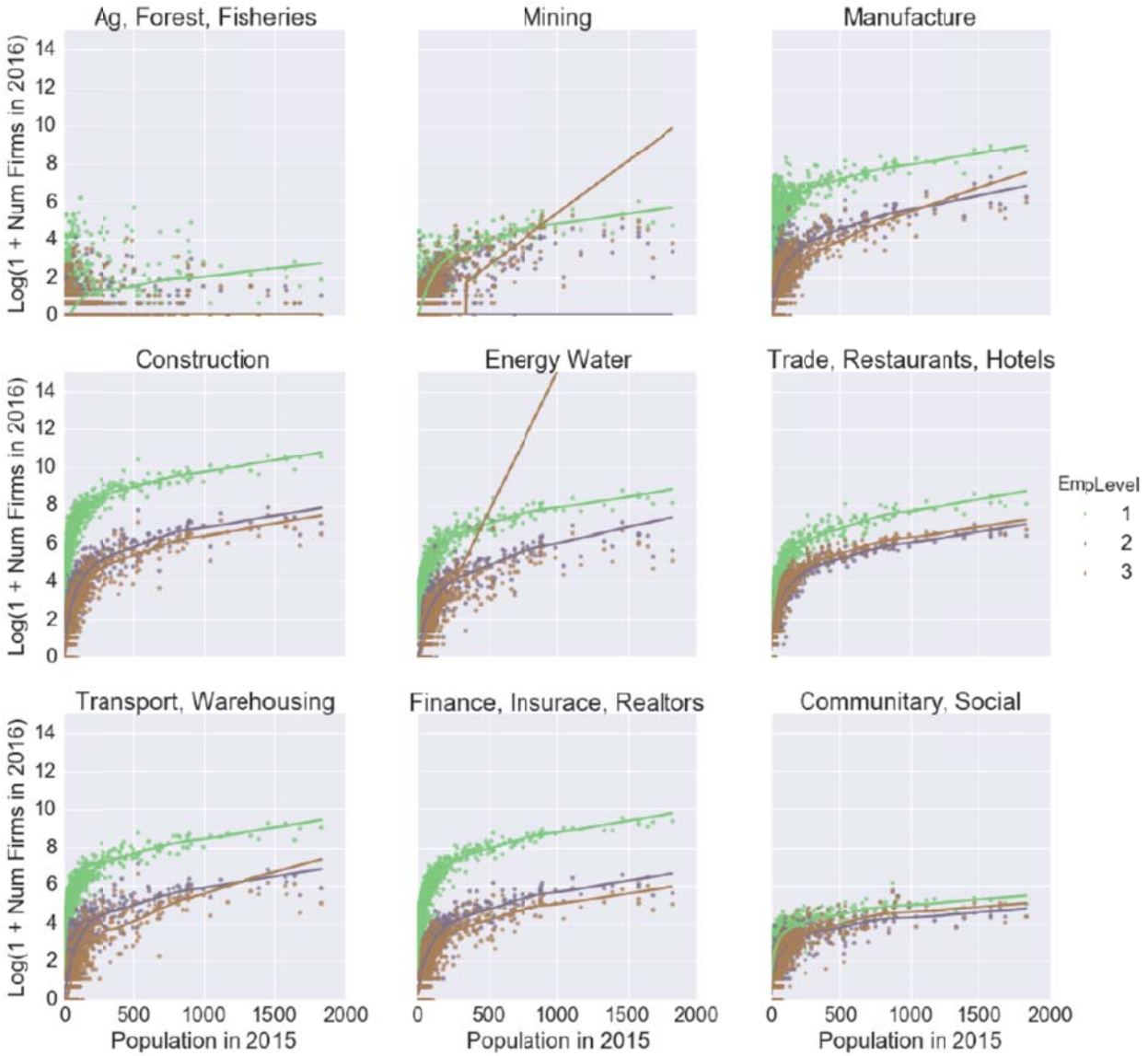


Figure 5. log(1 + Number of Firms) against Municipal Population (in thousands). Each panel represents a sector of production. Each panel shows a scatterplot for employment levels [1, 5], [6, 10] and [11, 30], together with a are locally weighted regression plot. log(1 + Number of Firms) is used to avoid log(0).

Figures 5 and 6 plot, for each production sector, a scatterplot log(1 + Number of Firms) against municipal population. 1 is added to the number of firms before taking the logarithm to avoid the occurrence of log(0) when there are no firms of a certain type. Figure 5 concentrates on the three lower employment levels, [1, 5], [6, 10] and [11, 30], and Figure 6 on larger firms with employment levels [31, 50], [51, 100] and [101, 250], [251, +]. Both figures show that after a threshold, the number of firms grows approximately exponentially as compared to the population of Mexican municipalities, with clear differences across employment levels. In fact, the exponential coefficient tends to be larger for smaller firms. This is verified to a 5% confidence level in several of the plots. Perhaps larger firms in fact eschew high population areas.

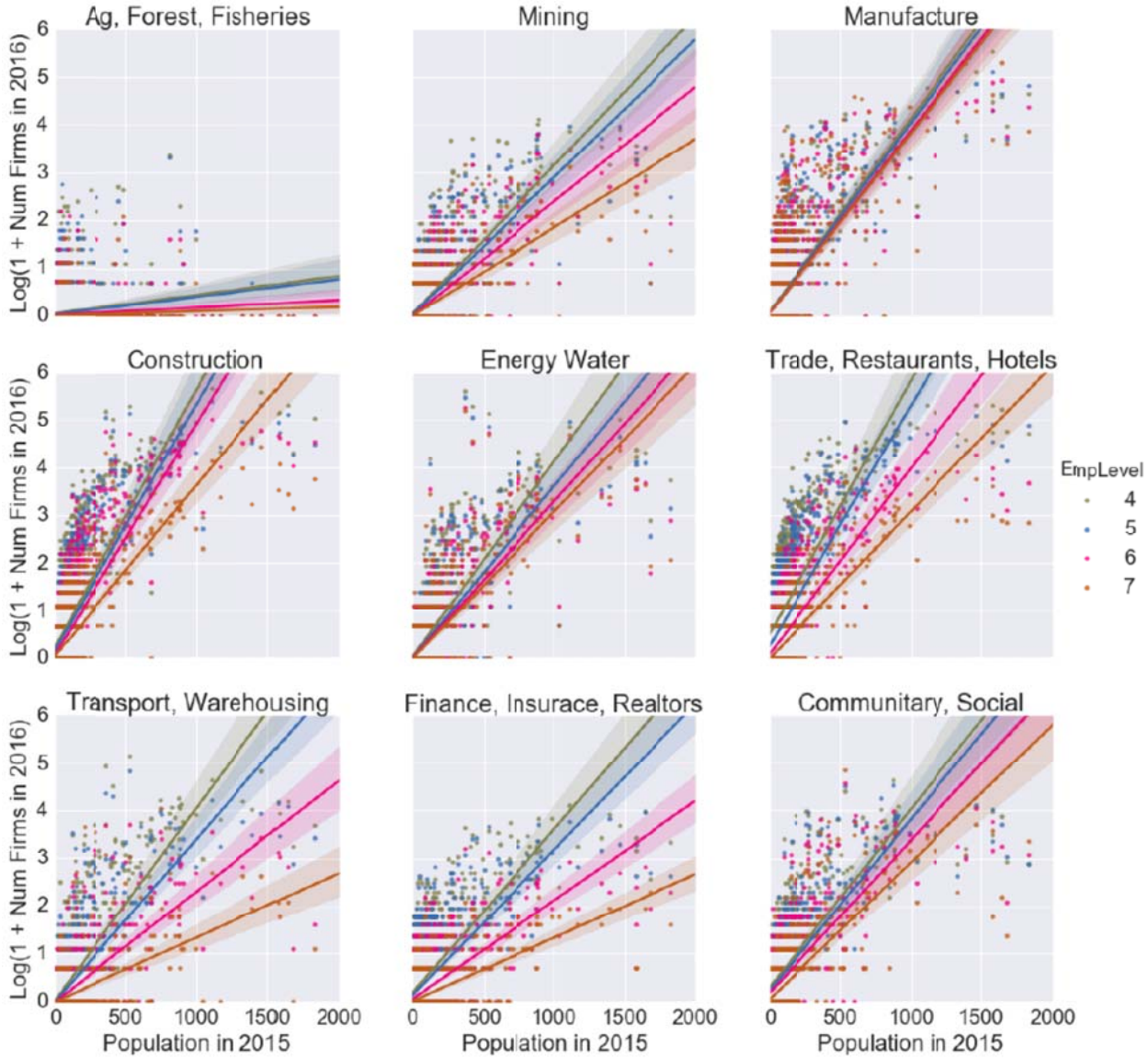


Figure 6. log(1 + Number of Firms) against Municipal Population (in thousands). Each panel represents a sector of production. Each panel shows a scatterplot for employment levels [31, 50], [51, 100], [101, 250], [251, +], together with a linear regression plot. log(1 + Number of Firms) is used to avoid meaningless log(0).

Two particular qualitatively exceptional behaviors are noticeable in the figures. First, agriculture, forestry and fishing behave quite differently from the other production sectors. Second, employment levels [6, 10] and [11, 30] behave similarly rather than distinctly. In manufacture also behavior is similar across employment levels [31, 50], [51, 100], [101, 250], and [251, +].

Firm Growth and Population Numbers

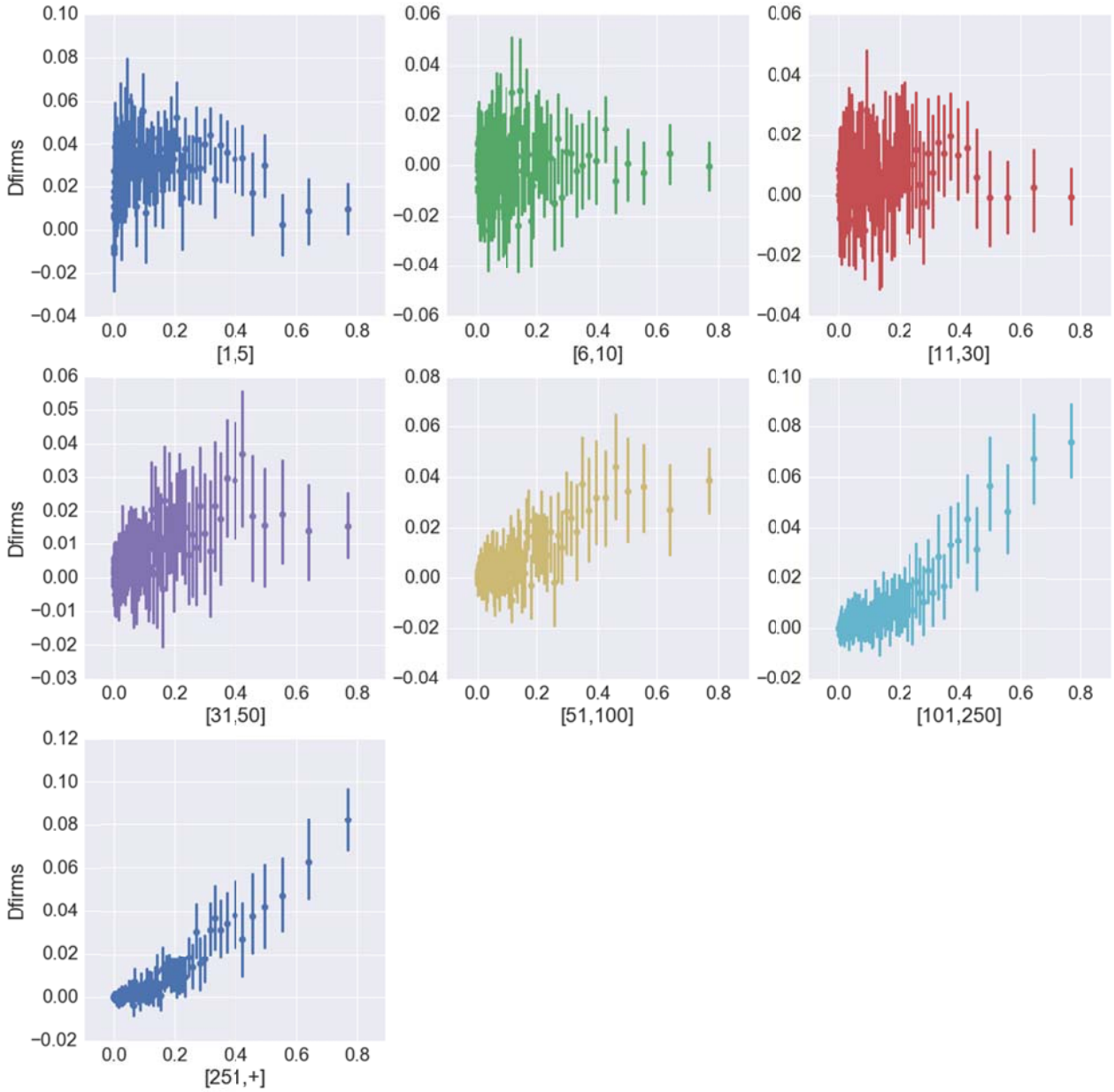


Figure 7. Growth in firm numbers by employment level (2012-2016). The graph shows a binned scatterplot of growth against population: growth means for groups of 25 municipalities, and a 95% confidence interval.

Growth in firm numbers varies across municipalities according to their population rank, just as population growth does. We first consider firms by employment levels. Overall, the mean growth in firm numbers follows an inverse U curve for smaller employment levels. As higher employment levels are reached, the maximum of the inverse U curve occurs for higher values of the population ranking until finally only the increasing section remains. At the same time, there is very much variability in the firm growth data.

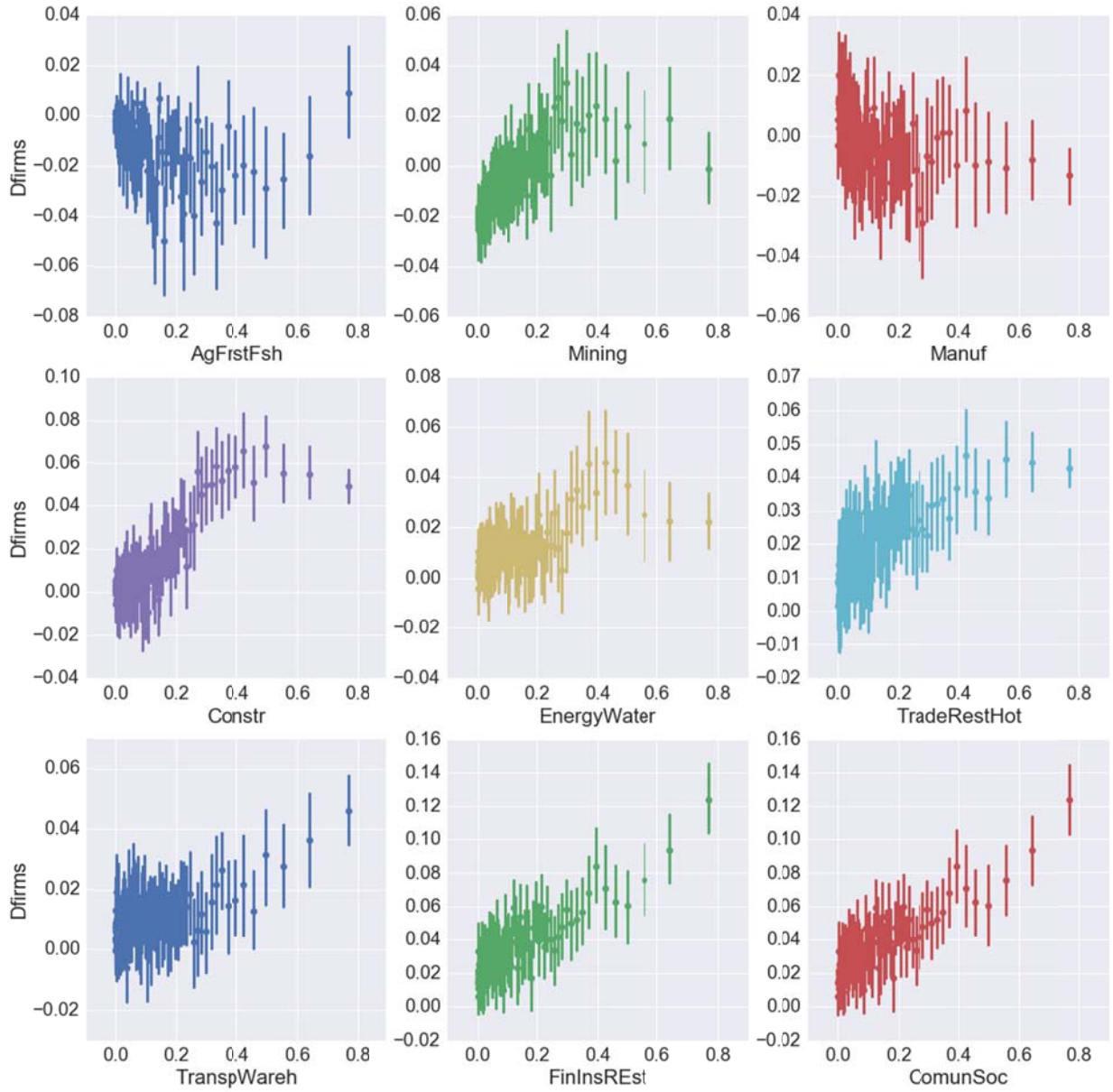


Figure 8. Growth in firm numbers by production sector (2012-2016). The graph shows a binned scatterplot of growth against population: growth means for groups of 25 municipalities, and a 95% confidence interval.

When we consider firms by production sectors (Figure 8), similar inverse U curve patterns are found for mining, construction, energy and water, and then just the increasing section for trade, restaurants and hotels, transport and warehousing, finance, insurance, and realtors, and community and social. One difference is that small municipalities may remain close to zero growth, the inverse U curve only appearing at a population rank of 0.1 or 0.2. Manufacturing shows the inverse U curve pattern, but has an additional region of new firms at low municipal populations. Agriculture, forestry and fishing is also atypical, displaying growth at both low and high municipal populations, with negative firm number growth displayed for a considerable number of intermediate municipal rankings.

Interplay between Firm Number and Population Growth

The next step in considering the interaction between firm number growth and population growth is considering the phase space for the dynamics between these two variables. This is a two dimensional plot with population along the x axis and firm numbers along the y axis, which displays arrows starting from the 2012 value of these variables and pointing in the direction of change of the two variables. While we could map every municipality onto the phase diagram in this way (for a particular class of firms), a 2,456 arrow plot would not really work. Instead we subdivide the population-firm number rectangle [0, 1] x [0, 1] into a 10 x 10 grid, and plot the averages of the municipal arrows. This is a binned phase diagram, similar to a binned scatterplot. The population rank gives us a 0 to 1 population measure. For firm numbers we use the variable log(+firm number)/max[log(1+firm number)], where the maximum is taken over both years 2012, 2016, We therefore also have a 0 to 1 measure for firm numbers, with the vertical dimension in log firm numbers representing a rate of change. Both dimensions are normalized to a yearly rate of change. For visualization purposes, the arrows are multiplied by 8 in length. They therefore represent change extrapolated to an 8 year period.

Figure 9 shows the result, for each combination of production sector and employment level. Each is plotted as a subpanel of the figure. These arrow plots represent the combined firm and population dynamics. They vary quite considerably across the different subplots. In particular agriculture, forestry and fishing display a considerable number of downward arrows. Many of the displays instead concentrate on what can be described as a parabolic trajectory in which the number of firms rises quite fast as the population rises from minimum levels. These “normal” trajectories tend to move towards the right with the number of firms rising exponentially.

It is noteworthy, though, that at low firm sizes, other than in the agriculture, forestry and fishing sector, the number of firms rises faster for smaller employment levels than for larger employment levels, then often keeps to the parabolic trajectory. On the other hand the higher employment levels display growth spurts across municipal population sizes so long as they are above the smallest. The community-social sector loses lots of [1, 5] level firms.

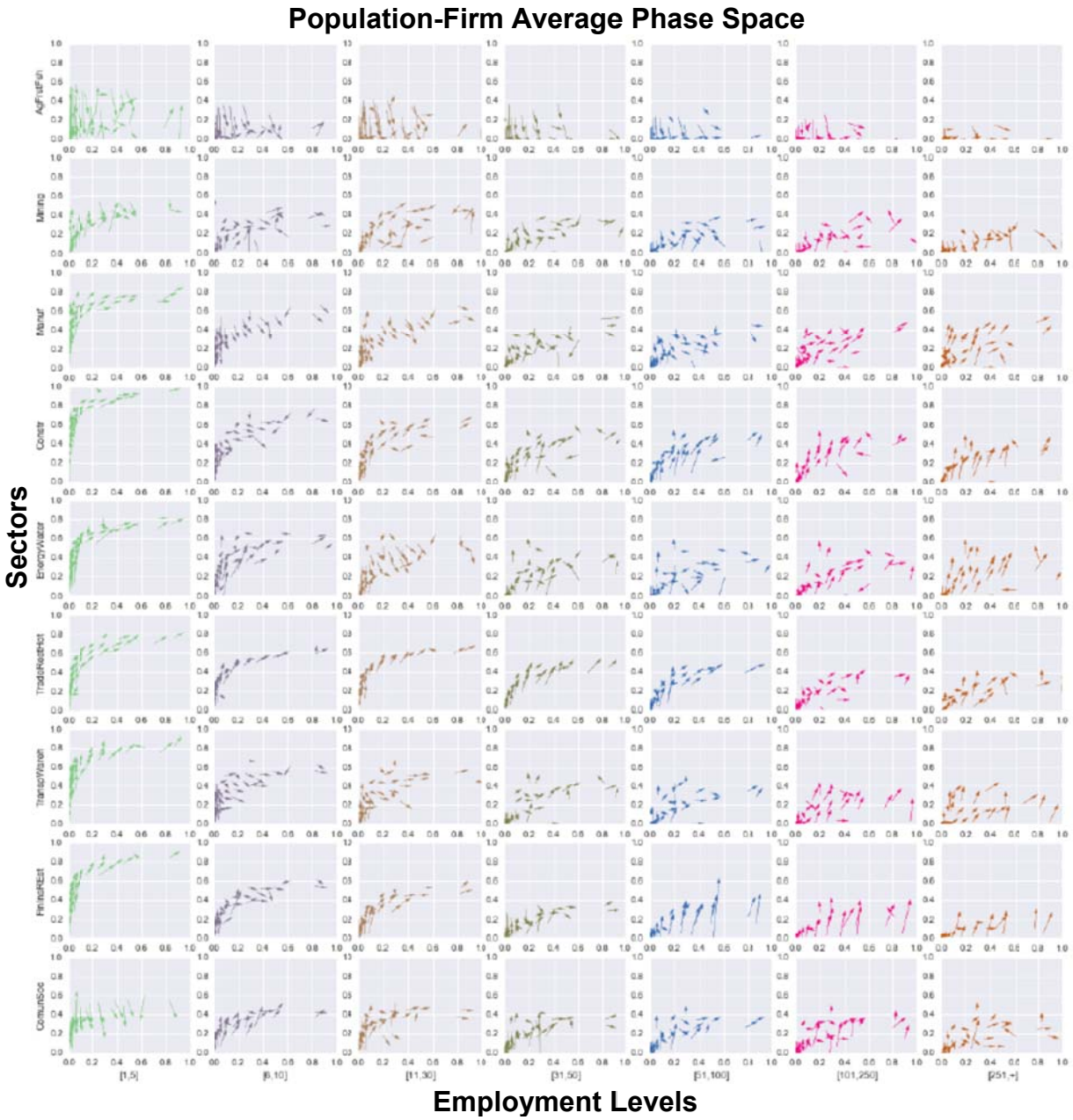


Figure 9. Each panel's horizontal and vertical axes are population 2010 and log(1 + NumFirms2012). Each arrow indicates average municipal rate of change in these variables (to 2015 and 2016) for bins forming a 10×10 grid subdividing each subplot. For a clearer view magnify the subplots using PDF capabilities.

Complexity of Firm Change and Migration

While the graphs uncover some regularity in the patterns of firm and population growth, in fact they also show that the data is complex. Whenever we used a stronger lens we found again a diversity of phenomena. And this is precisely the definition of complexity. We are using highly aggregated data. Production sectors are in themselves diverse. Also municipal population characteristics and infrastructures vary immensely.

For example, when we consider small scale firms in the [1, 5] range, the first subplot in Figure 7 is quite similar to population Figure 2. In fact, this size firm is associated with the livelihood for many people, and therefore with population growth. However, when we include the scatter plot (Figure 10), this shows that there is a lot of additional variation. This is consistent with the idea that there are many external factors that play a role in particular instances of municipal evolution. Something similar occurs with each of the subplots in Figure 7. However, the municipal density moves towards higher population rankings, consistently with the idea that the observation that the maximum of the inverted U curve moves to the right.

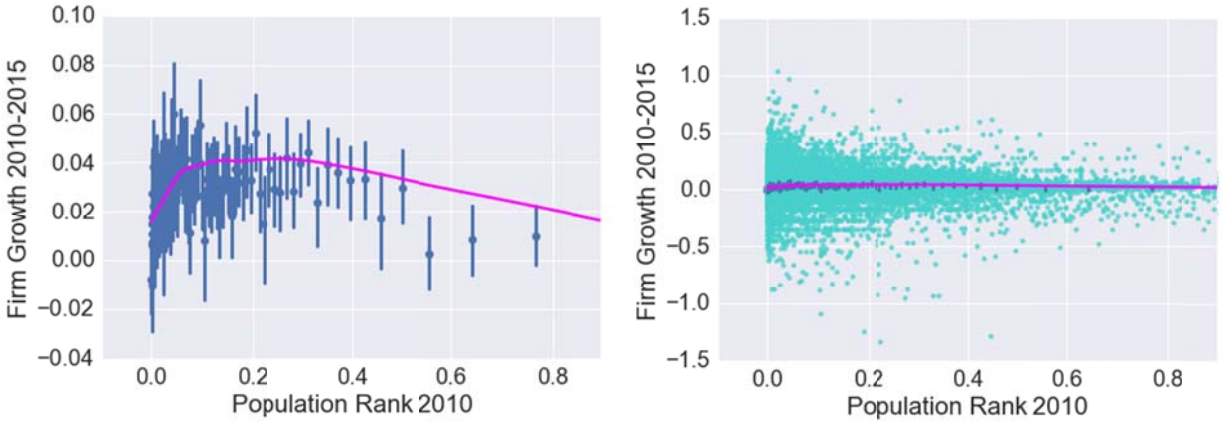


Figure 10. Both panels show growth in firm numbers (2012-2016) for employment level [1, 5], in different scales. In dark blue, both graphs shows a binned scatterplot of growth against population: growth means for groups of 25 municipalities, and a 95% confidence interval. They also show, in magenta, the results of a locally weighted linear regression. Finally, the panel on the right shows the scatterplot in light blue.

On the other hand, the shape of the municipal scatterplot does not change as much across the production sectors considered in Figure 8.

Now let us expand Figures 7 and 8 to consider all possible combinations of production sector and employment level. The results confirm that an inverted U pattern is often present. However, this certainly does not describe many other features that appear at this level of detail, and that are lost in the averages taken before.

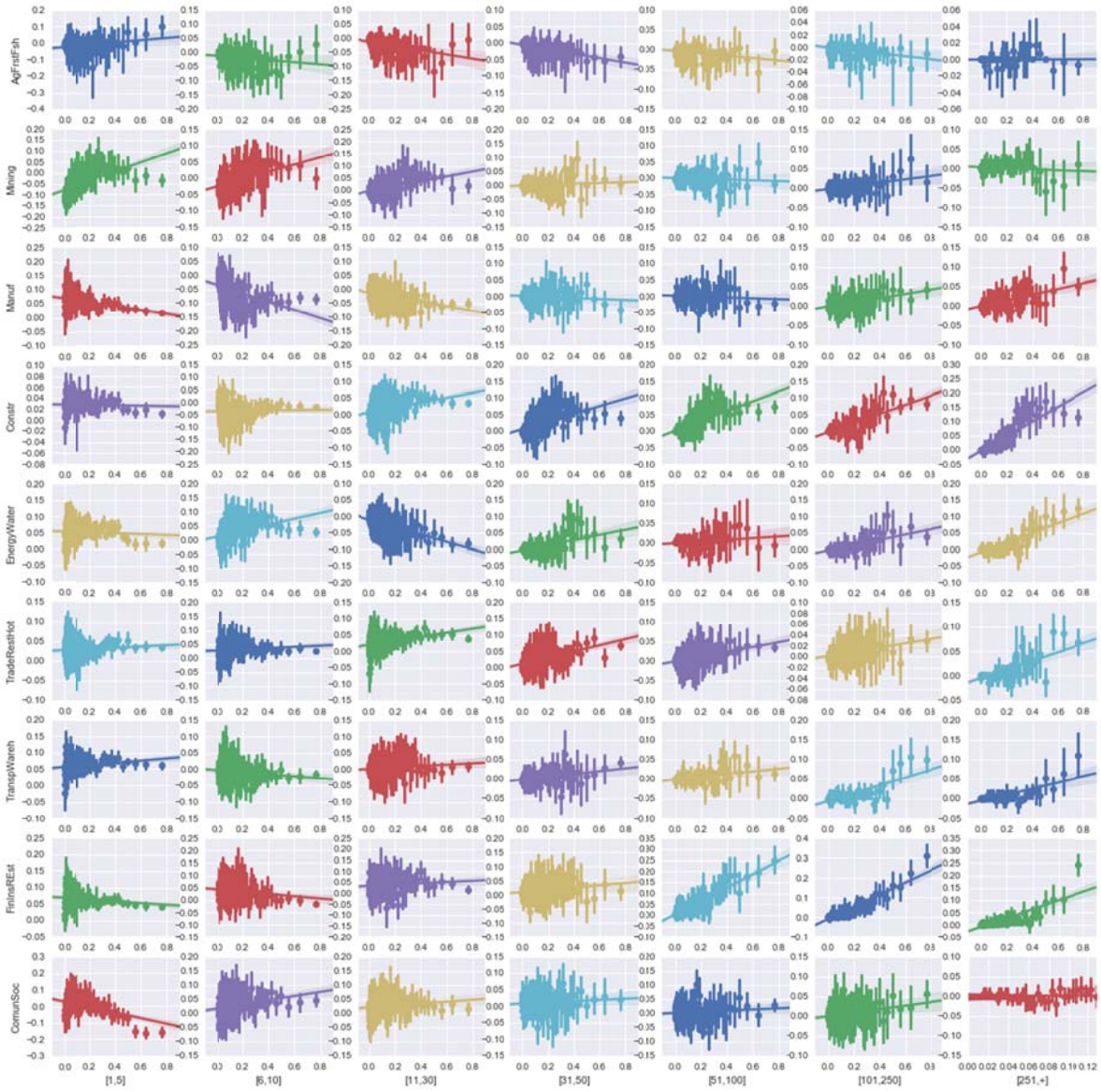


Figure 11. Growth in firm numbers (2012-2016) by production sector and employment level. Each panel shows a binned scatterplot of growth against population: growth means for groups of 25 municipalities, with a 95% confidence interval. A line obtained by linear regression is shown for reference.

Concluding, methods that will approach the data in detail, such as machine learning, will be very useful to approximate the considerable underlying complexity of firm growth and migration.