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URBAN STUDIES

Diverse cities, successful cities

A new theory of city size, embodying ideas from economic complexity and cultural evolution, provides a rich basis for speculating on their economic structure and suggests hints as to how old cities might regenerate their past prosperity and how new ones might generate more success.

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How is that some cities that were once successful and prosperous descend into an economic morass of depression, poverty and unemployment while a few cities seem to turn themselves around and become ever more prosperous? Declining cities like Detroit (pictured, right) and Liverpool spring to mind, with the conventional wisdom being that when such cities lose their industrial base — their external markets for the goods they produce and the services they offer — this often occurs through no fault of their own. Those that do resist such decline, such as New York City (pictured, left), seem to self-generate their industrial bases as they grow to embrace new technologies and more innovative pursuits, but the seeds of their change are still barely understood.

The mechanisms that determine prosperous cities as well as the wider economies in which they exist are still largely shrouded in mystery. We have some rudimentary notions of why some cities do well and some do not[1] but there is little understanding as to how these processes of growth and decline evolve. Technological change appears to be the basic trigger of prosperity but many of the explanations of why such change takes place in the locations it does is largely down to a combination of idiosyncratic factors such as accidental migrations of talent, good luck in attracting new innovative industries, a favourable climate and, very often, the existence of large public sector contracts as in the case of the genesis and early growth of Silicon Valley[2].

Out of this cauldron of ideas comes a new approach pioneered by Gomez-Lievano, Patterson-Lomba and Hausmann[3], published in this issue of *Nature Human Behaviour*, in which they combine a series of key factors that determine the potential prosperity of cities. They start by adopting the long-standing notion first proposed by Alfred Marshall in the late nineteenth century that as cities get bigger they become more specialized in their industrial and employment structure, thus generating economies of urban agglomeration, which often reveal themselves in terms of power laws. In particular, the Santa Fe cities group has demonstrated for some 350 US cities that more skilled and specialized occupations and activities — as well as income in general — scale superlinearly with city size as measured by their population[4]. This kind of scaling has been explained as the consequence of interactions between individuals in a population[5], with the phenomena in question Y scaling with some power of the population P^{β}, where $\beta > 1$. Gomez-Lievano *et al.* ground their theory in the particular result generated previously[4] that $\beta \approx 1.15$ as they are concerned with demonstrating variations in this value. But they also argue that a much deeper and transparent theory of how cities generate activity that might scale with population size is required. To this end, they introduce a simple but enticing model that extends these scaling laws to embrace the prevalence of different activities, which can scale with city size. First, activities will become less prevalent across all cities as they get bigger. Second, they will become relatively more concentrated in bigger cities, on average. Third, the deviations from this average will widen. Gomez-Lievano and colleagues' theory and the model that comes from this suggests that as an activity requires more and more inputs of both a general and specialized nature, it will become less prevalent as a city gets bigger. But as cities get bigger, only then can they access more inputs; the theory predicts that the prevalence of more complex and specialized activities will also become more concentrated. To an extent, this increase in the numbers of factors or inputs with city size is consistent with their related ideas on economic complexity[6]. A consequence of the way they structure the model is that the variation in the degree of prevalence for a city will increase as the activities get more complex, while the total prevalence of the activity decreases.

Their model is rather clever in that it originates from an assumption that the probability of any individual in a city participating in a particular activity selects from a set of factors, which in turn are determined by another probability of those factors being appropriate to a particular activity in a city of a given size. Adding up all of these probabilities generates a relatively simple, but not too simple, equation that trades off the prevalence of an activity in terms of its diversity with the relationships between diversity and city size. The model reduces to three equations — one for activity size, the second for prevalence and the third for variance — with four unknowns, and if any one of these unknowns is assumed, the others can be determined for any city. The way the authors fit the model is to estimate the scaling parameter and the intercept (which is the level of prevalence) as well as the variance using ordinary least squares. They then use these values to make predictions about diversity, complexity and the number of factors associated with any activity.

The authors test the model for several different activities — employment, innovation, education, crime and

disease — all of which pertain to different kinds of prosperity and quality of life, and then illustrate how we might use the model to generate different types of city for different activities. What they do not do, as they are particularly cautious about using their model for predictions, is speculate about whole cities and their prosperity. But by adding many activities, it is easy to see how the approach can be generalized to the kind of activity profiles that constitute cities of different sizes. By manipulating the model inputs — the probabilities governing diversity and complexity, the number of factors in cities of different sizes, prevalence, scaling and so on — one can see how one might predict cities with different degrees of prosperity, or rather in this context, different levels of specialization. To renew Detroit, one might need to increase the factor base, and change the probabilities of diversity and complexity — in short, it would be necessary to regenerate the industrial base through new skills and new activities that would spontaneously set the place buzzing once again. At the very least, the theory provides the basis for some fascinating and relevant thought experiments.

Gomez-Lievano *et al.* do not speculate in this way but the implications are profound, not only for cities but for neighbourhoods and districts of different industries, and they generalize this to previous work on economic complexity and diversification at the country level[7]. There are many other implications that flow from the work highlighted here. The model is likely to be consistent with other more macro properties of city systems pertaining to size and allometry, and the approach they have introduced is crying out for empirical testing on a very wide range of systems of cities, particularly those in depressed industrial regions where diversity and complexity need to be bolstered in the effort to regenerate our worn-out industrial structure. ❐

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