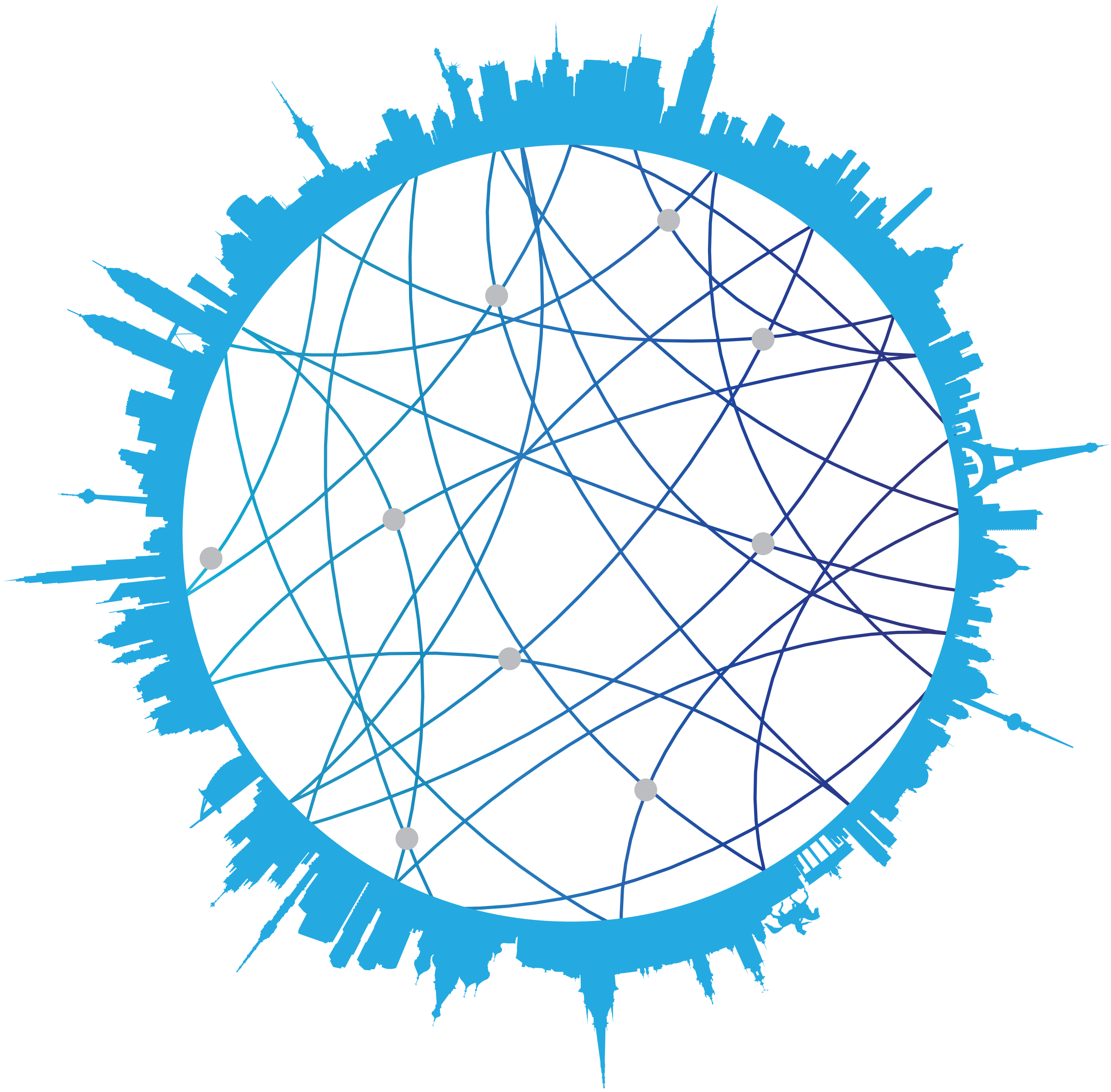
CONNECTIONS AS A TOOL FOR GROWTH:
EVIDENCE FROM THE LINKEDIN ECONOMIC GRAPH



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EXECUTIVE SUMMARY

Despite the improving economy, deep structural problems persist in the U.S., Europe, and around the world. In the U.S., young people aged 16 to 24 face an unemployment rate of 14 percent, as of September 2014. Economists have estimated that the U.S. needs 5.4 million additional jobs—the so-called "jobs gap"—to return to pre-recession employment levels plus absorbing new labor market entrants. In Europe, the number of unemployed workers is 60 percent higher than before the recession, and the latest figures show that more than 25 percent of young people in countries such as Spain and Italy are not working or receiving an education. The global economy suffers from a huge deadweight loss, as talented people all too often struggle to connect with good ideas and promising opportunities.

Solving these tough problems will require helping people make more useful work-related connections. LinkedIn is developing the 'Economic Graph,' a mapping of the dense web of connections among people, jobs, skills, companies, educational institutions and professional knowledge. The objective is to digitally map the global economy, and identify trends pointing to economic opportunities.

New evidence from LinkedIn's current network, presented here, demonstrates the economic value of connections. We calculate an "index of connectedness" for each of 275 metro regions in the U.S., based on the average number of connections per LinkedIn member in that region. The higher the index of connectedness, the more dense the connections between LinkedIn members in that region. Using data from the Bureau of Labor Statistics, we calculate the four-year and one-year nonfarm payroll job growth for those metro regions.

Using a regression analysis with appropriate controls, we find that higher levels of the index of connectedness are strongly and significantly associated with faster job growth. The analysis finds that most-connected metro regions had more than double the job growth of the least-connected metro areas. The top quintile of metro areas, ranked by their index of connectedness, had an average job growth of 8.2 percent in the four years from 2010 to 2014. The bottom quintile of metro areas, ranked by their index of connectedness, had an average job growth of only 3.5 percent. Just examining the past year, the most-connected metro regions had job growth of 2 percent from 2013 to 2014, compared to 0.9 percent for the least-connected metro regions.

These results show correlation rather than causality. Nevertheless, they suggest, quite reasonably, that increasing connectedness has the potential to improve the functioning of the labor market. The question is, by how much? In this paper we perform the thought experiment of using the Economic Graph or a similar tool to increase the average connectedness of individuals with other individuals and with opportunities.

Depending on the assumptions of the particular scenario, we estimate that improving connections could boost U.S. employment by 700,000 to as much as 1.8 million workers. This would involve both better matching of workers to existing jobs as well as creation of new jobs through better exploitation of business opportunities. The resulting gains would reduce the 5.4 million jobs gap by as much as 33 percent.

The Economic Graph and other similar tools for increasing connectedness could also help ameliorate other persistent economic problems. For example, entrepreneurs who are better connected are more likely to succeed, suggesting that benefits from the Economic Graph could be used to counteract the long-term decline in start-ups nationally. College students can use the Economic Graph to garner better information about which skills are in demand. Laid-off workers can use the Economic Graph to identify potential opportunities for training. And by creating a new 'map' of the local economy, in the form of connections between people in different industries, the Economic Graph can help local and state officials identify and encourage potential industry clusters in growing sectors such as e-learning (online learning and training).

Two hundred years ago, business and political leaders learned the importance of investing in physical capital. One hundred years ago, they learned the importance of investing in human capital. Today, business and political leaders are learning a new lesson: The importance of investing in connections. Cities like New York and London prosper in part because their people and businesses are highly connected both locally and globally.

But while the world has changed, the government's statistical and policy tools have not. Today's main economic indicators, the monthly unemployment rate and the growth rate of national output, were developed in the 1930s and the 1940s to deal with the Great Depression and World War II. However, these aggregate measures are far too blunt for today's highly networked economy. The unemployment rate does not provide enough or the right information to help job seekers locate new opportunities, or guide policymakers in making labor markets work better. From this perspective, the Economic Graph being constructed by LinkedIn is potentially the first 21st century economic policy tool, designed for a networked world.

The most-connected metro regions had more than double the job growth of the least-connected metro regions.

CONNECTIONS AS A TOOL FOR GROWTH: EVIDENCE FROM THE LINKEDIN ECONOMIC GRAPH

DR. MICHAEL MANDEL
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1. THE FUNDAMENTAL PROBLEMS

> **The global economy is suffering from an enormous deadweight loss, as talented people all too often struggle to connect with good ideas and promising opportunities.**

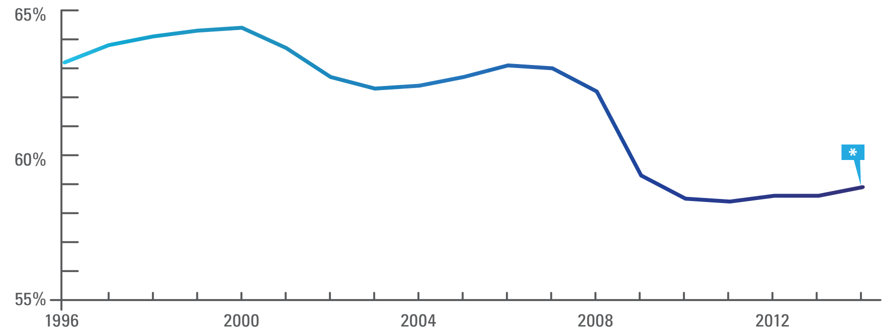
Despite the improving economy, deep structural problems persist in the U.S., Europe and around the world. Many young people feel disconnected from the labor market. In the U.S., young people aged 16 to 24 face an unemployment rate of 14 percent, as of September 2014. The situation is far worse in Spain and Italy, where the latest figures show one-quarter of people ages 15 to 29 are neither in school nor employed.[1] Older workers, laid off from long-time positions, are cut off from the training that they would need to qualify for new openings. Small towns and cities hit hard by layoffs and plant closings, are striving to attract new employers. As of September 2014, 52 percent of U.S. metro areas had fewer jobs than before the recession started.[2] For example, employment in Rocky Mount, NC, despite a hopeful revival in manufacturing, is still down compared to 2007.

The rate of technological and global change is accelerating. Many people are dealing with the uncertainty by taking fewer risks, as workers have become increasingly less willing to quit their jobs for new ones.[3] Political leaders, too, are becoming more cautious. Meanwhile, potential entrepreneurs are struggling to connect with financing and customers, as the number of new firms starting up in the U.S. is still well below pre-recession levels.[4] (See Figure 1).

Young college graduates face formidable challenges in the labor market. Overall, real earnings of young college graduates surprisingly fell in 2013 by 1.3 percent.[4] In total, real average earnings

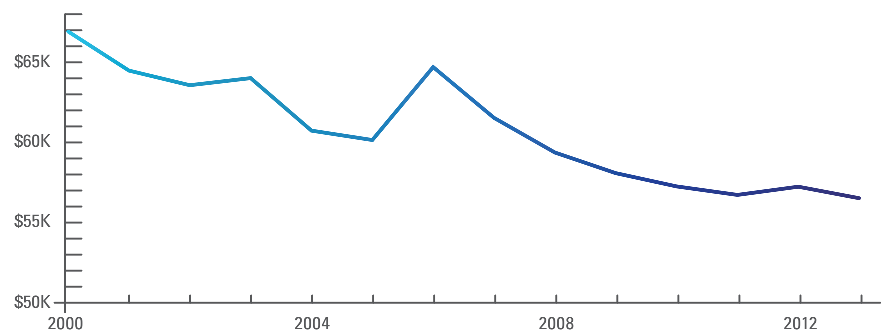
FIGURE 1

SOME BIG PROBLEMS: WEAK EMPLOYMENT...
EMPLOYMENT AS SHARE OF POPULATION



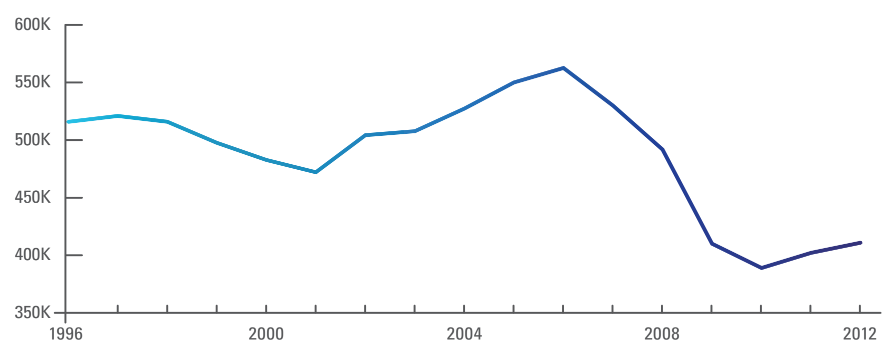
*Average of first nine months of 2014
Data: Bureau of Labor Statistics

...FALLING REAL WAGES FOR YOUNG COLLEGE GRADUATES....
MEAN EARNINGS, 2013 DOLLARS, COLLEGE GRADUATES, AGE 25-34**



**Bachelor's only
Data: Census Bureau

...DECLINING START-UPS NATIONALLY
NUMBER OF NEW FIRMS



Data: Census Bureau

for young college graduates have fallen by 11.7 percent since 2003, underperforming their older college-educated colleagues.[6] Over the same period, student debt has skyrocketed.

Conventional macroeconomic policies don't seem to be able to address these tough problems. In Europe, the number of unemployed workers is still 60 percent higher than before the recession, and growth has stalled.[7] In the U.S., the percentage of the population with jobs has dropped from 63 percent in 2007 to 59 percent today, with few signs of recovery. The global economy is suffering from an enormous deadweight loss, as talented people all too often struggle to connect with good ideas and promising opportunities.

2.
EVIDENCE OF THE IMPORTANCE OF CONNECTIONS

Solving these tough problems will require helping people better connect with opportunities. Experts have suggested apprenticeship programs for young workers, local business incubators for start-ups, and subsidies for retraining older workers. An October 2014 Washington, D.C. conference on "Disrupting Unemployment" focused on the economic and social implications of a hypothetical automated service, "Jobly," that would match workers with jobs across the entire economy.[8]

To get direct evidence on the importance of connections, we were able to draw on new data provided by LinkedIn. In the private sector, LinkedIn has built the largest network for business-related connections, with more than 300 million members in more than 200 countries, connecting and sharing job opportunities and other professional information. Based on its existing network, LinkedIn is in the process of developing the Economic Graph, a mapping of the web of connections among people, jobs, skills, companies, educational institutions and professional knowledge. The objective is to digitally map the global economy, and spot in real-time the trends pointing to economic opportunities.

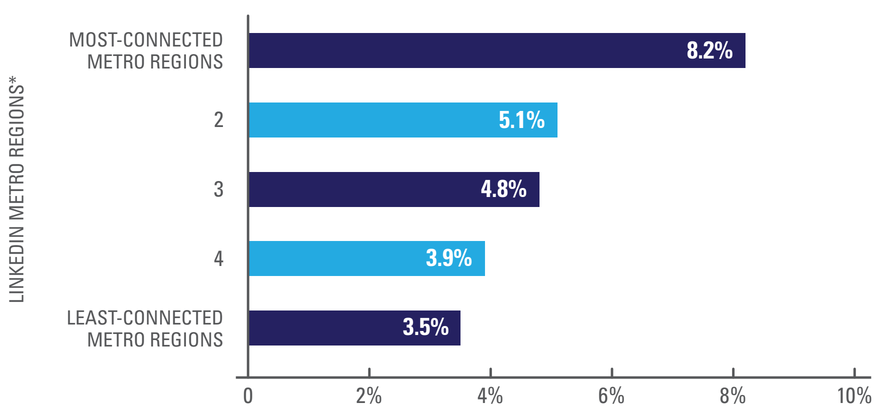
The analysis, described in the appendix, examined 275 regions in the U.S., ranging in size from the broad New York City region to Pine Bluff, Arkansas, the smallest region in terms of employment. For each region, LinkedIn provided the average number of connections per LinkedIn member in that region. We then normalized the resulting number on a 0 to 1 scale to construct an 'index of connectedness'.[9]

This 'index of connectedness' varied greatly among regions. Members in the most-connected metro regions, including the Bay Area, Austin, Boston, Washington, D.C., and New York City—have an index of connectedness roughly three times larger, on average, as members in the least-connected regions.[10] It's important to note here that calculating the index of connectedness for a metro region did not expose in any

FIGURE 2

MORE CONNECTIONS, MORE JOB GROWTH

(AVERAGE JOB GROWTH, 2010-2014)



*Based on index of connectedness. 2014 employment based on first nine months of year.
Data: LinkedIn, Bureau of Labor Statistics, South Mountain Economics LLC

way the personal data of any LinkedIn member. Moreover, this analysis did not involve any intervention with any member's experience of LinkedIn.

Drawing on BLS data, we then calculated the four-year and the one-year job growth for each region. Job growth also varies broadly among regions, from a four-year high of 24.8 percent for Odessa (TX) to a four-year low of negative 8 percent for the Anniston-Oxford (AL) metro region.[11]

A simple regression analysis showed that the index of connectedness of a region was positively and significantly correlated with the four-year job growth of that region. To put it more plainly, metro regions with a higher density of connections tended to have much faster growth.

In fact, highly connected metro areas had more than double the job growth of the least-connected metro areas.[12] More precisely, the top quintile of metro regions, in terms of the index of connectedness, had an average job growth of 8.2 percent from 2010 to 2014. (Figure 2) The bottom quintile of cities, in terms of the index of connectedness, had an average job growth of only 3.5 percent.

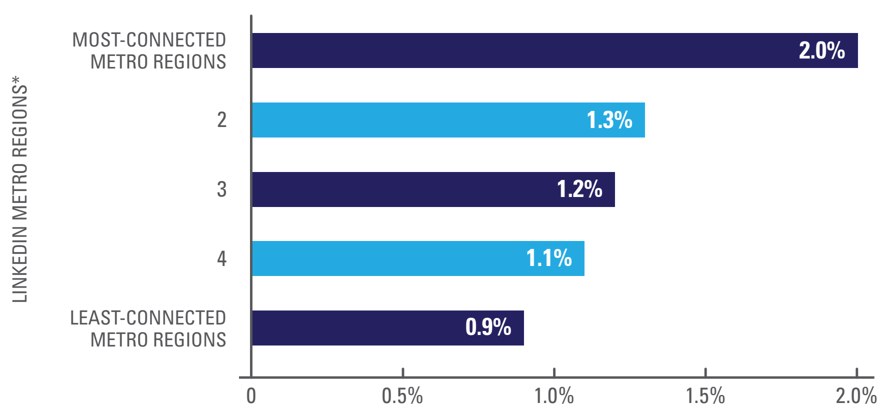
As described in the methodology appendix, the association between the index of connectedness and job growth holds even after controlling for other factors.[13] For example, the index of connectedness still has almost as much explanatory power when the analysis is restricted to LinkedIn members outside the tech industry. Similarly, the link between the index of connectedness and job growth is just as strong after controlling for region size.

We did a similar analysis focusing on one-year job growth from 2013 to 2014. Once again, a simple regression analysis shows that the index of connectedness is positively and significantly correlated with one-year job growth. The most-connected metro regions had job growth of 2 percent from 2013 to 2014, compared to 0.9 percent for the least-connected metro regions.[14] (Figure 3).

FIGURE 3

MORE CONNECTIONS, MORE SHORT-TERM JOB GROWTH

(AVERAGE JOB GROWTH, 2013-2014)



*Based on index of connectedness. 2014 employment based on first nine months of year.
Data: LinkedIn, Bureau of Labor Statistics, South Mountain Economics LLC

3.
DISCUSSION

A higher density of connections could lead to better matching of workers to existing jobs as well as creation of new jobs through better exploitation of business opportunities.

Let's start by identifying the potential caveats to this analysis. First, correlation is not causality. Just because a higher density of connections is associated with faster job growth doesn't mean that more connections cause faster growth. It could be that more vibrant local economies bring professionals into contact with a growing number of other professionals, naturally leading to denser connections. To understand the causal relationship between growth and connections will require examining the evolution of the index of connectedness over time.[15]

Second, not every worker is a LinkedIn member. Moreover, even LinkedIn members don't necessarily connect on LinkedIn with all of their closest business associates. However, especially as LinkedIn membership becomes more common, it's reasonable to think of the index of connectedness as a rough indicator of the density of connections in an area.

From that perspective, the association between density of connections and job growth points to a kind of "accelerator effect." As job and business opportunities arise across a region, then a greater density of connections raises the odds that the person with the opportunity is connected, directly or indirectly, with someone who is qualified to fill it. A higher density of connections could lead to better matching of workers to existing jobs as well as creation of new jobs through better exploitation of business opportunities. Those gains, in turn, would lead to a faster rate of job growth and a lower unemployment rate.[16]

On a macro level, the data offers hints that metro regions with high connectedness may be more resilient to shocks. New York City, London, and San Francisco, all cities with a high density of LinkedIn connections, weathered the Great Recession far better than expected.[17] However, further research is needed to test this hypothesis.

4.

HOW MUCH CAN AN ECONOMIC GRAPH HELP?

The U.S., Europe, and other economies are facing some tough problems. Our analysis suggests that better connections can potentially improve the functioning of the labor market. The question is, by how much?

In this section, we're going to perform the thought experiment of assuming that the Economic Graph, or a similar tool, can increase connectedness in a region. Then we estimate how many more people would be employed, based on the relationship between job growth and connectedness that we found in our analysis.

The thought experiment involves two scenarios. In the first scenario, we assume that the least-connected regions all have their index of connectedness brought up to some minimum level.[18] This corresponds to a labor market policy that focuses on helping hard-hit regions. In the second scenario, we assume that all regions have their index of connectedness boosted by the Economic Graph or a similar tool. This scenario acknowledges that even well-performing cities such as New York and San Francisco have a portion of their populations who are not sharing in the general prosperity and could benefit from increased connectedness.

Under the first scenario, improving connectedness could raise employment by roughly 700,000 above the current number. Under the second scenario, using the Economic Graph or a similar tool to improve connections for unemployed or underemployed workers could boost U.S. employment by roughly 1.8 million. Both scenarios would involve better matching of workers to existing jobs as well as creation of new jobs.

To put these numbers in perspective, as of September 2014 the current jobs gap was roughly 5.4 million, as noted earlier.[19] That means under these two scenarios, the Economic Graph could reduce the jobs gap by as much as 33 percent.

As before, a strong caveat applies: These calculations are illustrative, not forecasts or predictions. They show the possible size of the gains from an improvement in connections via the Economic Graph or some other means.

Under these two scenarios, the Economic Graph could reduce the jobs gap by as much as 33%.

5.
OTHER BENEFITS OF THE ECONOMIC GRAPH

The Economic Graph can be of tremendous use in economic development, by understanding which industries are connected with which others.

LinkedIn's goal of developing the Economic Graph is in the best tradition of combined social and technological innovation. The electrical network erased the boundaries between day and night and opened up the evening to commerce and social activities. The highway network revolutionized how and where people chose to live and work.

Similarly, the Economic Graph can help workers and job seekers learn new skills and connect with opportunities that they otherwise would not have found. This will generate higher levels of employment, faster rates of GDP growth, and less inequality. Moreover, better job satisfaction can lead to increased productivity.

Furthermore, recent research shows that entrepreneurs who are better connected are more likely to be successful.[20] The Economic Graph can help entrepreneurs find potential partners, employees, funders, and customers.

Innovation is a key to growth not just domestically but around the world. Research generally supports the proposition that better-connected scientists are more successful, both in their research and also in patenting.[21] The Economic Graph can supplement normal academic contacts, and help create more economically useful innovation.

The Economic Graph can help college students garner better information about which skills are in demand, and where to find them. The number of young people who are neither employed nor in school is staggeringly high in many countries. We risk creating a generation who are completely disconnected from the labor market.

The U.S. and Europe are full of small and medium size cities that have lost major employers. In the U.S, for example, roughly half of all metro areas are still below their pre-recession employment levels. The Economic Graph can help workers in depressed regions either find new jobs, or attract businesses. With the insights from the Economic Graph, we could look at where the jobs are in any given locality, identify the fastest growing jobs in that area, the skills required to obtain those jobs, the skills of the existing aggregate workforce there, and then quantify the size of the gap.

Finally, the Economic Graph can be of tremendous use in economic development, by understanding which industries are connected with others. Currently the Bureau of Economic Analysis publishes "input-output" tables that show the flows of goods and services between different industries. But these government tables show nothing about the connections between people—who talks to whom, how contacts are made.

Part of the promise of the Economic Graph is the ability to digitally map out the interconnections between different parts of the economy. In effect, we can produce an input-output table for connections that can help inform individual, business, and policy decisions.

For example, e-learning is expected to be a rapidly growing industry, both for education and for the corporate training market. However, e-learning is still in its early days, so different metro regions still have a chance to capture a critical mass of the coming e-learning boom. As the box (below) shows, the Economic Graph can help guide economic development officials in understanding how to develop an e-learning cluster.

HOW THE ECONOMIC GRAPH CAN HELP ECONOMIC DEVELOPMENT: AN E-LEARNING EXAMPLE

Suppose a city wanted to build a cluster around e-learning, one of the growth areas of the next decade. Economic clusters, as we know, are composed of several types of businesses that feed and support each other. So economic development officials might naturally want to know which other industries should be invited to participate in an e-learning cluster.

Official government statistics, including employment statistics and the input-output tables constructed by the Bureau of Economic Analysis, offer no clue to building an e-learning cluster. But we can analyze the connection patterns of LinkedIn members in the e-learning industry around the country, identifying the top 'connected' industries (right).

What we see is that e-learning industry members are closely tied to the rest of the education sector, of course. More surprisingly, they also have many connections with members in the 'hospital and health care' industry, reflecting the heavy use of training in healthcare. That suggests that a city may be able to leverage a strong healthcare sector as part of a starting base for an e-learning cluster—an example of an insight from the Economic Graph.

WHICH INDUSTRIES ARE CONNECTED WITH E-LEARNING IN THE ECONOMIC GRAPH?

- Education management
- Information technology and services
- Higher education
- Computer software
- Marketing and advertising
- Financial services
- Hospital & health care
- Professional training & coaching
- Management consulting

Data: Based on a sample of LinkedIn members in the e-learning industry, the above list reports the top ten industries with which they are connected, omitting intraindustry connections.

6.
THE BROAD PICTURE

Today, business and political leaders are learning a new lesson: The importance of investment in connections

Two hundred years ago, businesses and governments learned the importance of investment in physical capital. Over the next century, pioneering entrepreneurs and far-sighted leaders built massive factories and continent-spanning railroads, fueling unprecedented economic growth.

One hundred years ago, businesses and governments learned the importance of investment in human capital. In 1910, the typical American had only 8 years of schooling.[22] Over the next century, the U.S. led the way in universal high school education and the construction of great public universities. Today, more than 30 percent of adults have a college degree.

Today, business and political leaders are learning a new lesson: The importance of investment in connections.[23] For the past twenty years, the world's companies and governments have devoted massive resources to building out the Internet, the pre-eminent platform for enabling global connections.

But that's only the beginning. Connections take many forms. They can be transportation links, like a port or a major airport. They can be nourished by a local culture that is cosmopolitan and welcoming to workers and businesses from around the world. Connections can mean an ecosystem of legal, financial services, accounting, and marketing firms used to doing business on a global scale. Countries and regions that are better connected are more likely to grow and more likely to get the benefits of growth elsewhere. Countries that are disconnected deprive themselves of the benefits of trade, and the global flows of intangible knowledge.

The McKinsey Global Institute (MGI) recently released a groundbreaking study of global connectedness, based on flows of goods, services, finance, people, and data and communication.[24] The authors went on to calculate the MGI Connectedness Index for 131 countries. They found that "greater openness to cross-border exchanges of goods, services, finance, and data and communication flows is linked to faster growth in GDP, with both a short-term and a long-term effect on growth." The shining example: The top country in MGI's connectedness index, Germany, has also been the strongest economy in Europe in recent years.

On a metro level, global cities like New York and London prosper in part because their people and businesses have dense, multifaceted connections with the rest of the world—money, services, data, people, and transportation. These were able to draw in talent, money, and ideas from around the world, and in the process create jobs and wealth despite nationally stagnant economies.[25] Indeed, both New York and London rank very high on the LinkedIn index of connectedness.

Unfortunately, while the world has changed to emphasize the role of connections, the government's statistical and policy tools have not. Economists developed today's main economic indicators, the monthly unemployment rate and the growth rate of national output, in the 1930s and the 1940s to deal with the Great Depression and World War II. They had two goals: To measure the performance of the economy, and then to use the new knowledge to guide policy. Indeed, for decades these aggregate measures served society well, helping avoid deep recessions.

The unemployment rate is built on a monthly survey of households, where individuals are asked if they are employed or looking for work. Much of the data underlying measures of national output come from surveys of firms, asking their dollar revenues for the month, quarter or year. These statistical methods, while incrementally improved, have substantially not changed over the years.

These aggregate indicators are too blunt to deal with today's highly networked world. Two people can be unemployed—but the one who has more connections to people and companies is more likely to find a new job. Two companies can have the same revenue—but the one with more connections to innovative people and ideas is more likely to prosper.

This lack of information about connections has real consequences in the real world. The European and American response to the 2008-2009 financial crisis was the much the same aggregate fiscal and monetary stimulus that John Maynard Keynes would have prescribed. It worked—to a point—but has so far been unable to reknit the fabric of the economy.

Today, the unemployment rate does not provide enough nor the right information to help job seekers locate new opportunities, or guide policymakers in making labor markets work better. GDP, while rising in the U.S., does not account for either changes in labor markets, or changes in the way that companies do business.[26]

The Economic Graph has the advantage of going beyond the aggregate data reported by government statistical agencies. By focusing on connections, the Economic Graph offers new information about how well the economy is performing, and provides guidance to both policymakers and individuals about how to do better.

From this perspective, the Economic Graph being constructed by LinkedIn is potentially the first 21st century economic policy tool.

Unfortunately, while the world has changed to emphasize the role of connections, the government's statistical and policy tools have not.

METHODOLOGY APPENDIX

SUMMARY

In a network economy, more connections should improve economic performance. We test that hypothesis using aggregate regional data from LinkedIn. Based on our analysis of 275 LinkedIn regions in the U.S., we found a positive and highly significant relationship between the index of connectedness of a region and the job growth of the region between 2010 and 2014. This relationship turned out to be robust to several changes in the specification, including restricting our analysis to non-tech members, active members, and to members in large regions.

The analysis presented here should be viewed as an initial cut at a much broader subject. We welcome comments and suggestions for future analysis.

DATA

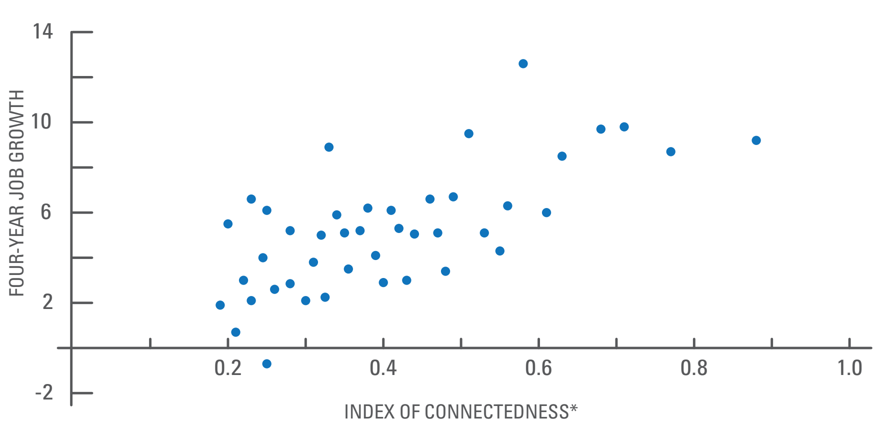
When LinkedIn members in the U.S. fill in their profiles, they are assigned to a LinkedIn region according to their zip code.[27] Within that region, they are offered a choice of either displaying their location narrowly ("Newark, New Jersey") or broadly ("Greater New York City Area"). The broad descriptions are LinkedIn regions.

For each LinkedIn region in the U.S., we identified the corresponding metropolitan statistical area (MSA) or areas, as defined by the Bureau of Labor Statistics (BLS). In some cases, a LinkedIn region corresponds to one MSA, or to a metro division of an MSA. In other cases, the LinkedIn region best corresponded to a combination of multiple MSAs. This correspondence was done using publicly available data. Measured by total nonfarm employment, the regions varied in size from roughly 35 thousand workers to more than 10 million workers. All told, the regions covered roughly 85 percent of all nonfarm employment in the U.S.

For each region, LinkedIn provided data on the average number of connections per member in that region. This is a measure of the density of connections. For example, a region where members have 100 connections on average has a higher density of connections than a region where members have 50 connections on average. The data provided by LinkedIn was aggregate and purely observational—the analysis involved no information on the connections of individual members, and no interventions in the user experience of LinkedIn members.

FIGURE 4

FOUR-YEAR GROWTH VS. CONNECTEDNESS:
A SCATTER PLOT



*Each data point averages job growth and index of connectedness for 5 regions.
For example, one data point aggregates the top 5 regions, ranked in index of connectedness.
The next data point aggregates the next 5 regions, and so forth
Data: LinkedIn, Bureau of Labor Statistics, South Mountain Economics LLC.

We transformed the data on average connections by region into an index of connectedness by region, running from a minimum of 0 to a maximum of 1. For this data set, the index of connectedness has a mean of .39 and a standard deviation of .15. All results presented here are based on that index of connectedness.

For each LinkedIn region, we calculated the percentage job growth in that region from 2010 to 2014, using BLS employment data. The 2014 employment figure was estimated using the first 9 months of 2014. Across regions, this four-year growth figure ranged from a low of -8.0 percent to a high of 28 percent. The average growth was 5.1 percent, and the standard deviation is 4.4

Figure 4 shows a scatter plot of four-year growth versus index of connectedness. For clarity the region are aggregated into 55 groups of 5, ordered by index of connectedness. Each group of 5 is given the average four-year growth and index of connectedness of its members.

ANALYSIS

The first step in the analysis was to estimate the model:

→ *(1) Job Growth = B_C * (index of connectedness) + constant*

A simple linear regression shows a positive and highly significant relationship between the index of connectedness and four-year job growth (measured in percentage points) as the dependent variable and the index of connectedness as the independent variable. An increase of 0.1 in the index of connectedness—say, from 0.2 to 0.3—is associated with an average increase of roughly 1 percentage point in the four-year growth rate.

The next step was to sort the regions into quintiles using the index of connectedness. We find that the regions with the most-connected members have the highest job growth, on average as shown previously in Figure 2.

It's important to remember that these results show correlation, not causation. We can see that higher levels of connectedness are associated with faster growth rates, but this analysis does not demonstrate that increasing connectedness will necessarily lead to faster growth.

ROBUSTNESS

The obvious question is whether the analysis is picking up the impact of connectedness, or some other variable. One important variable is region size, as measured by the 2014 employment level. It turns out that larger regions did have faster job growth in the period from 2010 to 2014. Larger regions also have a higher index of connectedness, on average. That makes sense, given that living in a region with more people allows more opportunities for connections.

However, further analysis shows that the index of connectedness is clearly a more powerful explanatory variable for regional job growth than region size. We estimate the regression equation:

→ *(2) Job Growth = B_c * (index of connectedness) + B_s * (region size) + constant*

We find that B_c increases slightly compared to equation 1 and remains strongly significant, while B_s is negative and not statistically significant from zero.[29] Moreover, R^2 barely rises when the region size variable is added to the model. It is still true that an increase of 0.1 in the index of connectedness is associated with an increase of roughly 1 percentage point in the four-year growth rate.[28]

This result implies that knowing the index of connectedness of a region gives much more insight into regional job growth than knowing the employment size of a region. We confirm this by analyzing the top third of regions, divided by region size. Within this sub-sample, the index of connectedness is still strongly and significantly associated with job growth, with roughly the same coefficient.

Conversely, when we analyze the top third of regions, divided by index of connectedness, we find that region size is not significantly associated with job growth. To put it differently, once we know the index of connectedness, region size does not contain much additional information.

What about occupation and industry structure? One alternative possibility is that the link between connectedness and job growth is actually reflecting occupational and industry differences between regions. In particular, one might wonder if the results might be skewed by the ongoing tech boom, which has fueled growth in cities such as San Francisco and New York. If tech workers tend to be heavier users of LinkedIn, then the apparent positive impact of connectedness in a city might simply be the result of having a large proportion of tech workers.

To partially account for this possibility, we redid our analysis, restricting it to non-tech LinkedIn members.[30] We then calculated an index of connectedness for each region based on that sub-population. Once again, the regional index of connectedness exposes no individual data, and requires no intervention in the member experience of LinkedIn. The result of examining non-tech members is that the impact of the index of connectedness drops slightly, but still remains positive and highly significant.[31]

Finally, the link between the regional index of connectedness and regional job growth is strengthened somewhat if the analysis is restricted to active members only. However, the qualitative results remain the same.

THOUGHT EXPERIMENT

We're going to perform the thought experiment of assuming that the Economic Graph, or a similar tool, can increase connectedness in a region. Then we estimate how many more people would be employed, based on the relationship between job growth and connectedness that we found in our analysis.

The thought experiment involves two scenarios. In the first scenario, we assume that the least-connected regions all have their index of connectedness brought up to some minimum level. For this purposes of this thought experiment, we assume that the new minimum level is one standard deviation above the previous mean. Since the mean was .39 and the standard deviation was .15, this puts the new minimum level of connectedness at roughly .54. Regions that originally have an index of connectedness of .54 or above are not affected in this scenario. This corresponds to a labor market policy that focuses on helping hard-hit regions by improving their labor markets.

In the second scenario, we assume that all regions have their index of connectedness boosted by the Economic Graph or a similar tool. To maintain continuity with the first scenario, we assume that the index of connectedness for all regions rises by one standard deviation, or 0.15 (with the exception that no regions is allowed to have an index of connectedness greater than 1). This scenario acknowledges that even well-performing cities such as New York have a portion of their populations who are not sharing in the general prosperity and could benefit from increased connectedness.

For both scenarios, we use the value of 10.9 for the coefficient B_C estimated from equation (1). For each region, this gives us a new four-year growth rate based on the scenario. For example, take a region with the following characteristics:

→ *2010 employment: 100,000*
→ *2014 employment: 95,000*
→ *Four-year job growth: -5 percent*
→ *Index of connectedness: 0.35*

Under scenario 1, the index of connectedness for the region would be raised to a new minimum level of 0.54, or the original mean plus one standard deviation. Here's how employment would change under scenario 1:

→ *Index of connectedness under scenario 1: 0.54*
→ *Four-year job growth: -5 + 10.9 * (0.54-0.35) = -2.9 percentage points*
→ *Additional 2014 employment relative to baseline: 2.1 thousand*

Under scenario 2, the index of connectedness for the region would increase by one standard deviation, or 0.15. Here's how employment would change under scenario 2:

→ *Index of connectedness under scenario 2: 0.50*
→ *Four-year job growth: -5 + 10.9 * 0.15 = -3.4 percentage points*
→ *Additional 2014 employment relative to baseline: 1.6 thousand*

Applied to all regions, scenario 1 boosts total employment by roughly 700,000. Applied to all regions, scenario 2 boosts total employment by roughly 1.8 million.[32] Clearly we could have chosen a variety of other scenarios to calculate, but these seem to illustrate the potential impact of measures to boost connections in the labor market.

ABOUT THE AUTHOR

Dr. Michael Mandel is president and founder of South Mountain Economics LLC (SME), which provides global expertise on emerging occupations and emerging industries. SME is widely cited for its groundbreaking estimates of jobs created by mobile apps, "Where the Jobs Are: The App Economy" and "The Geography of the App Economy." More recently, SME has received wide press coverage for its studies on why London and New York have surprisingly prospered since the financial crisis, and its report on the economic impact of the San Francisco tech/info boom. SME recently completed a project tracking innovative job creation in the United Kingdom. SME studies have been quoted in publications such as the *Financial Times*, the *New York Times*, Bloomberg, the *Atlantic*, *Time*, and *Forbes*.

Mandel is also chief economic strategist at the Progressive Policy Institute, a centrist think tank in Washington (DC), where he supervises PPI's research and policy work across such topics as the data-driven economy, the impact of regulation on innovation, and policies to improve production, investment and job growth. Mandel argues that innovation can be a force for creating jobs and opportunity for the broad population. He has testified before Congress on topics such as regulation and medical innovation.

Mandel, who received a PhD in economics from Harvard University, is senior fellow at Wharton's Mack Institute for Innovation Management at the University of Pennsylvania. He was formerly chief economist at BusinessWeek, where he helped supervise the magazine's coverage of the global and national economies. He is the author of four books including *Rational Exuberance: Silencing the Enemies of Growth and Why the Future Is Better Than You Think* and *Economics: The Basics* (2nd edition), an introductory economics textbook for the rest of us.

ENDNOTES

1 *OECD Education at a Glance*, 2014

2 Author calculations, based on Bureau of Labor Statistics data.

3 U.S. labor markets have become "much less fluid" in recent decades, according to a new study by economists Steven J. Davis and John Haltiwanger. "Labor Market Fluidity and Economic Performance," (NBER working paper 20479, September 2014)

4 According to the Census Bureau's latest statistics on business dynamics, there were 410,000 new firms started in the U.S. in the year ending March 2012, compared to 529,000 in 2007 and 482,000 in 2000. For a more detailed discussion of the decline in entrepreneurship, see Ian Hathaway and Robert Litan, "Declining Business Dynamism in the United States: A Look at States and Metros," Brookings Institution, May 2014. The authors note "the firm entry rate—or firms less than one year old as a share of all firms—fell by nearly half in the thirty-plus years between 1978 and 2011."

5 Based on mean earnings of full-time workers with a bachelor's degree only, ages 25-34, adjusted for inflation. Calculated from Census Table P-32 http://www.census.gov/hhes/www/income/data/historical/people/2013/p32.xls

6 From 2003 to 2013, real average earnings for full-time workers with a bachelor's degree only, ages 35-64, declined 7.7 percent. Economist Diana Carew of the Progressive Policy Institute called this "The Great Squeeze" on young college graduates. (http://www.progressivepolicy.org/issues/economy/great-squeeze-continues-hit-young-people/)

7 Eurostat data for 18 Eurozone countries, comparing September 2014 to September 2007.

8 "i4j Innovation for Jobs Summit," Washington DC, October 13-14, 2014. See also, David Nordfors,"How to Disrupt Unemployment," Huffington Post, July 25, 2014. http://www.huffingtonpost.com/david-nordfors/how-innovation-can-disrup-unemployment_b_5616562.html

9 Care was taken to ensure that LinkedIn geographic regions corresponded as closely as possible to BLS metro areas. See appendix.

10 We are comparing the top quintile of regions with the bottom quintile

11 The job figure for each area for 2014 was estimated based on the initial nine months of the year. As noted earlier, the top quintile of metro regions includes Austin, the Bay Area, Boston, New York, and Washington, D.C., as well as such metro regions as Charlotte, Houston, and Salt Lake City.

12 Details can be found in the methodology appendix. Many thanks to Sohan Murthy and Andrew Kritzer of LinkedIn for their contributions.

13 The coefficient on the index of connectedness was highly significant at the .001 level. It remained highly significant when we:

→ Added in the size of the region's workforce as an additional control;
→ Restricted the analysis to the top third of regions, measured by employment;
→ Restricted the analysis to the top third of regions, measured by the index of connectedness;
→ Recalculated the index of connectedness based only on active members;
→ Recalculated the index of connectedness based only on members outside the tech industry, to take into account occupational structure.

14 In addition, more connected regions also had a lower rate of unemployment, on average. However, the link between unemployment and connectedness of a region is not quite as strong as the link between job growth and connectedness.

15 This analysis would require us to carefully distinguish between an increase in connectedness because of more people becoming LinkedIn members, versus an increase in connectedness because existing members have more links to each other.

16 This line of reasoning goes back to the "weak ties" job search research of sociologist Mark Granovetter and the job search theories of Dale Mortensen and Christopher Pissarides, for which they won the 2010 Nobel Prize in Economics.

17 Michael Mandel, "Building A Digital City: The Growth and Impact of New York City's Tech/Information Sector," South Mountain Economics, September 2013; Michael Mandel, "San Francisco And The Tech/Info Boom: Making The Transition to a Balanced and Growing Economy," South Mountain Economics, April 2014; Michael Mandel and J.M. Liebenau, "London: Digital City on the Rise," South Mountain Economics, June 2014.

18 The appendix discusses how this minimum level was chosen.

19 "Evolution of the 'Jobs Gap' and Possible Scenarios for Growth," October 3, 2014. Brookings Institution. http://www.hamiltonproject.org/multimedia/charts/evolution_of_the_job_gap_and_possible_scenarios_for_growth/

20 Peter A. Gloor, Pierre Dorsaz, Hauke Fuehres, and Manfred Vogel. "Choosing the Right Friends - Predicting Success of Startup Entrepreneurs and Innovators Through Their Online Social Network Structure." Int. J. Organisational Design and Engineering, Vol. 3, No. 1, 2013. For other insights into successful entrepreneurs drawn from LinkedIn data, see Michael Conover, "Why You Shouldn't Drop Out of School to Start a Company," LinkedIn Official Blog, August 25, 2014.

ENDNOTES (CONT.)

21 See, for example, Corey Phelps, Ralph Heidl, and Anu Wadhwa. "Knowledge, Networks, and Knowledge Networks: A Review and Research Agenda" *Journal of Management*, July 2012 vol. 38 no. 4

22 "120 Years of American Education: A Statistical Portrait," National Center for Education Statistics, 1993, Table 5.

23 Alternately, we could use the terms 'connection capital' or 'relationship capital.'

24 James Manyika et al, "Global Flows In A Digital Age: How Trade, Finance, People, And Data Connect The World Economy," McKinsey Global Institute, April 2014.

25 Mandel and Liebenau, 2014.

26 See Michael Mandel and Judith Scherer, "The Geography of the App Economy," South Mountain Economics, October 2012. See also Michael Mandel, "Beyond Goods and Services: The (Unmeasured) Rise of the Data-Driven Economy," Progressive Policy Institute, October 2012.

27 Out of 281 domestic LinkedIn regions, three corresponded to overseas military bases and were omitted from the analysis. Two corresponded to micropolitan rather than metropolitan statistical areas, and one was merged into the metro area corresponding to a different LinkedIn region.

28 The coefficient B_C is 10.9 and significant at $p<.001$. R^2 is equal to 0.144. To do forecasts on the level of individual regions would require a broader analysis, including changes in connectedness over time.

29 With region size in the equation, the coefficient B_C rises slightly to 12.4 and is still significant at $p<.001$. R^2 rises slightly to 0.147, suggesting that region size has very little additional explanatory power.

30 'Tech workers' were defined as members who currently work for companies that operate in the following industries: computer and network security, computer games, computer hardware, computer networking, computer software, consumer electronics, e-learning, electrical and electronic manufacturing, information services, information, technology and services, internet, and semiconductors. We determined a company's industry by referencing the industry listed in their LinkedIn Company Page—their official presence on LinkedIn—which is typically managed by a company representative or administrator.

31 When we restrict the analysis to only non-tech members, the coefficient B_C is slightly lower at 9.4 and still significant at $p<.001$. R^2 declines slightly to 0.135. Future analysis potentially could include a broader set of occupation and industry controls. In particular, the presence of a growing oil and gas extraction sector accounts for rapid job growth in some regions with a low index of connectedness.

32 Scenario 1 only affects regions with an index of connectedness below the new minimum level. Scenario 2 affects all regions, but the index of connectedness cannot go above 1.