The importance of social networks for innovation and productivity

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Economies today are increasingly built on ideas. Consider, for example, commercial aviation. After a flight, *Southwest Airlines* can unload and reload passengers to get the same airliner back in the air in about 10 minutes – this is half the time the same process took in the 1970s. As the economist John Cochrane explains, this achievement is as much about ideas and know-how as it is about technology. *Southwest Airlines*, and many other carriers after them, have been able to expand their output because they now have more efficient protocols for 'turning planes' between flights.

In 2018 Paul Romer won the Nobel Prize in Economics "for integrating technological innovations into long-run macroeconomic analysis". Romer first fleshed out this observation in his seminal 1990 paper, titled "Endogenous Technological Change". At the heart of his contributions was precisely this observation: the diffusion of ideas fosters economic and productivity growth.[1]

Romer's theory of "endogenous growth" – placing ideas at the heart of economic technologies – made economists ask entirely new questions about the drivers of growth. Where do ideas come from? How do ideas spread?

Economists have asked these questions of the data, and their findings suggest social networks play a key role. Friendship and professional ties matter for economic growth because people tend to develop new ideas by interacting and learning from others who are close to them.

In a nutshell, social networks facilitate the diffusion of ideas across individuals and firms, and because of this, they play an important role in productivity growth. Here's how this works.

Knowledge spillovers, social networks, and patent citations

Economic theory suggests we should expect social connections to have an effect on productivity via "knowledge spillovers".

The basic idea is that social connections make it easier for knowledge to travel farther and faster. Knowledge is different from many physical assets, in that it can be used by many people at the same time; so the diffusion of knowledge creates productivity gains that spillover through society. As Thomas Jefferson once said: *"He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me".*[2]

What is the empirical value of this theory? What do 'knowledge spillovers' actually look like in the real world? Do scientists and engineers really rely on social connections to disseminate their new ideas and inventions?

To answer these questions economists have looked into historical data from patents.

Patents are government licences used to register the intellectual property of new inventions, ranging from machines to medical drugs. When a patent application is filed, inventors are required to include a list of citations, in which they

describe how their technological development builds upon the results of earlier patents. These historical records of patent citations give us an overview of how knowledge flows – patent citations are the 'paper trail' left by ideas as they travel, evolve, and make new ideas possible.

One of the first analyses of patent citations in the context of knowledge spillovers was done by Adam Jaffe, Manuel Trajtenberg and Rebecca Henderson, in a much-cited paper published in the Quarterly Journal of Economics in 1993.[3]

Jaffe and coauthors studied, in particular, the geographic distribution of citation patterns in the US.

If social connections did not matter for new ideas and growth, then we should expect that new inventions are just as likely to cite patents from far away as they are to cite the work of their neighbours. In contrast, Jaffe and coauthors found that new patents were disproportionately more likely to cite previous *local* patents. In other words, they found that patent citations were strongly geographically concentrated. According to their estimates, citations were three to four times as likely to come from the same state as the originating patent – this is consistent with the idea that social connections and proximity do indeed matter for innovation.

After this initial study, several other papers have used patent citations to explore the determinants of knowledge spillovers, with a broader perspective on 'proximity'.

Ajay Agrawal, Devesh Kapur and John McHale used the ethnicity of researchers as a proxy for social connectedness, and found that co-location and co-ethnicity both increase the probability of knowledge flow between inventors. Co-location increases the probability of a knowledge flow by 24% (assuming non-co-ethnic inventors) and co-ethnicity increases the probability by 14% (assuming non-co-located inventors). Again, these large concentration patterns seem consistent with the idea that proximity and social networks matter for innovation.[4]

Disentangling geographic proximity and social interactions

The correlation between proximity and patent citations partly captures the effect that local factors may have on innovation (e.g. geography, regulation or infrastructure around industry hubs where similar workers and firms concentrate). However, the evidence shows that social connections matter for the transmission of knowledge even after we control for these other factors.

In a paper published in 2018 in the *Journal of Economic Perspectives*, Michael Bailey, Rachel Cao, Theresa Kuchler, Johannes Stroebel, and Arlene Wong combined patent records with Facebook data from the US, and found that social connectedness between US counties (measured by the frequency of Facebook ties between counties) predicts the probability of cross-county patent citations. This is true, even after accounting for the patents' technology class and geographic distance between counties.[5]

This means that the probability that an inventor builds on the work of another inventor in a different part of the country can be partly explained by how well-connected their social backgrounds are, even after controlling for geographic distance and other demographic factors.[6]

The implications of this result are of great consequence in the age of the internet. The development of new communication-enabling technologies, such as the rise of social media, have opened new possibilities for creating and maintaining social connections, and this is likely to have had a positive effect on the transmission of knowledge.

Social connections and (material) well-being

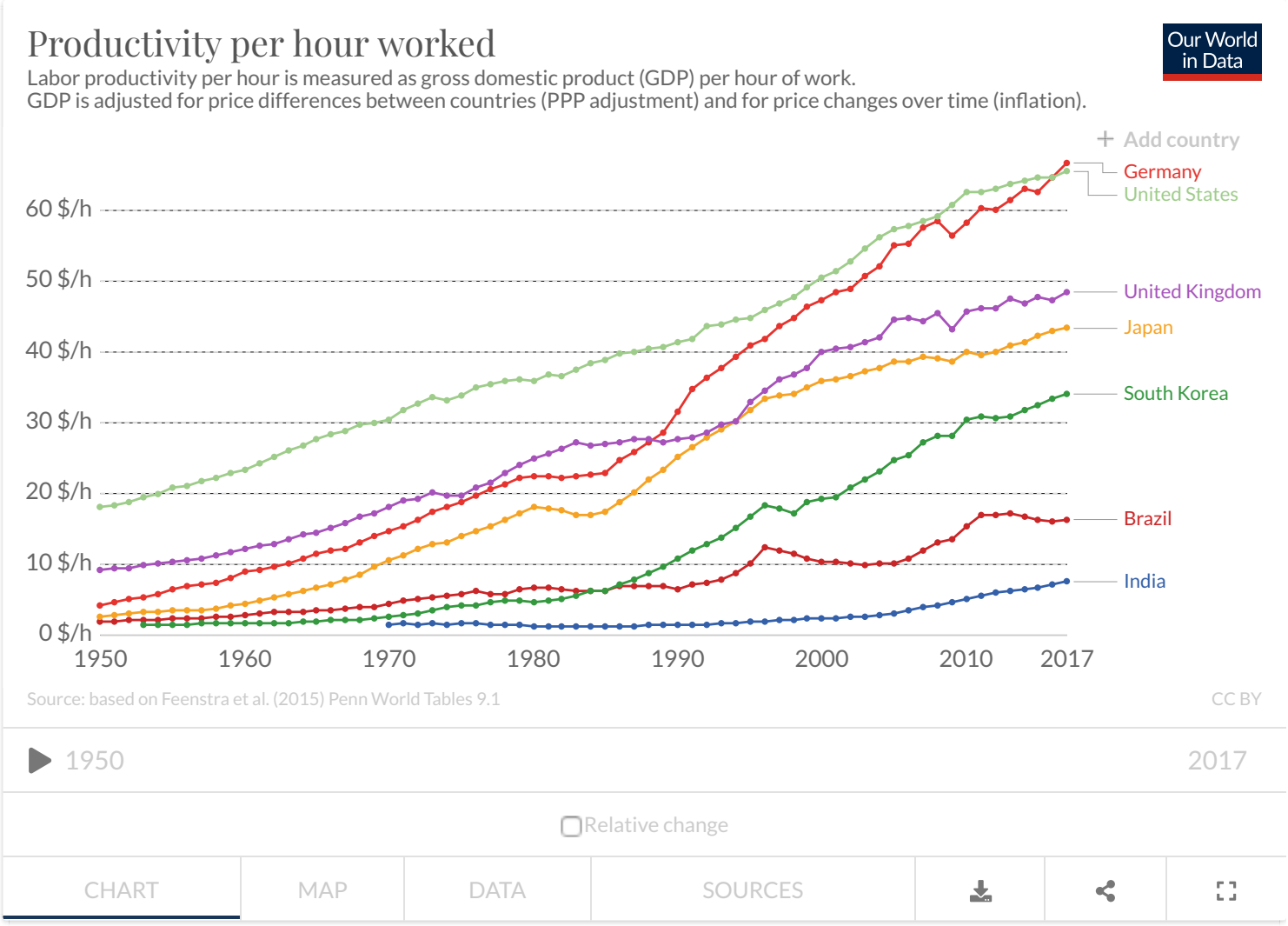
Globally, the total economic output per person today is 4.4-times larger than in 1950 (even after accounting for inflation). This was achieved over a period during which people tended towards working fewer hours. We now

produce more whilst working less.

As our interactive chart here shows, this historical achievement is underpinned by productivity growth: in many countries, workers produce much higher output per hour today than in 1950.

This is partly because of new machines and technologies, but also because we have new shared knowledge about how to work more efficiently.

The research on social connections and innovation suggests that one important way to improve material living standards is to invest in digital communication technologies. This lowers the costs of creating and maintaining personal and professional ties, which facilitates the diffusion of ideas and knowledge, creating positive productivity spillovers.



Technical Note:

Social networks are diverse and complex, so talking about "social connectedness" is actually a simplification that deserves some discussion. Researchers studying social networks have shown that the flow of information and knowledge through people is not only a function of "connectedness" as measured by the number of links people have, but also a function of the specific structures of the networks (e.g. the extent to which social ties are tightly clustered).

For the diffusion of information, the concept of ‘homophily’, for example, is key.
Homophily is the tendency of agents to associate with other agents who have similar characteristics. This manifests itself in many ways – for example, in the fact that friendship ties are typically strongly related to ethnicity. If one is interested in how information spreads through social learning, patterns such as homophily or social segregation are important to understand. For example, in the labor market, homophily isolates workers of one ethnicity from workers of another ethnicity, which then limits the extent to which individuals in one group hear about openings and opportunities known to the other group.
Social networks research in this area shows that, in general, as homophily increases, the propensity for a diffusion to gain hold within a particular group rises, sometimes at the expense of the speed and extent of diffusion throughout the entire population.

Similarly, diversity may play a role. Observational studies show that the diversity of individuals’ relationships is strongly correlated with the economic development of communities.
You can read more about this in Jackson, M. O., Rogers, B. W., & Zenou, Y. (2017). The economic consequences of social-network structure. Journal of Economic Literature, 55(1), 49-95. Available online here.

References

1. Romer’s seminal paper, with nearly 30,000 citations in Google Scholar is Romer, P. M. (1990). Endogenous technological change. Journal of Political Economy, 98 (5, Part 2), S71-S102. Available online here. After this paper he wrote many other related articles elaborating on the same ideas. See, for example, Romer, P. M. (1992). Two strategies for economic development: using ideas and producing ideas. The World Bank Economic Review, 6(suppl_1), 63-91. Available online here.

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3. Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. The Quarterly Journal of Economics, 108(3), 577-598. Available online here.

4. Agrawal, A., Kapur, D., & McHale, J. (2008). How do spatial and social proximity influence knowledge flows? Evidence from patent data. Journal of Urban Economics, 64(2), 258-269.

5. The full reference of the paper is: Bailey, M., Cao, R., Kuchler, T., Stroebel, J., & Wong, A. (2018). Social connectedness: measurement, determinants, and effects. Journal of Economic Perspectives, 32(3), 259-80. Available online here.

6. To be more precise, Bailey and co-authors find that the effect of doubling social connectedness on the probability of citation remains significant and large, at 4.9 percent, even after controlling for geographic distance. When they add controls for cross-country differences on socioeconomic indicators (income, education, ethnicity, etc.) they actually find that the estimated relationship between social connectedness and patent citation increases somewhat as a result of these further controls. This finding suggests that the relationship between geographic distance and the probability of patent citation, viewed in isolation, may be partially capturing effects of information flows associated with social connectedness.

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