Does China's research and development funding reach the right firms?

August 3 2022

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Chinese investments in research and development (R&D) have burgeoned since the turn of the century, increasing more than tenfold in absolute terms since 2000 and reaching a high of 2.4 percent of GDP in

2020. As the world's second biggest spender on R&D after the United States, China is certainly a force to be reckoned with on the global innovation landscape. Its fresh push toward innovation-led growth and stated ambition of becoming a technological innovation powerhouse by 2050 have prompted questions: is China on course to attain its goals, and will greater investments in R&D—as promised by Premier Li Keqiang—get it there?

In a study published in the July 2022 edition of *Econometrica*, Yale economist Fabrizio Zilibotti and coauthors Michael König, Zheng Michael Song, and Kjetil Storesletten tackle this question through the lens of misallocation.

Results at a glance

- Despite the extensive labor and capital market distortions emphasized in the literature on Chinese economic development, R&D investments have been an important driver of China's productivity growth.
- Nevertheless, alleviating distortions in the Chinese economy would boost the productivity of innovation, by creating the conditions for the "right firms" to invest in R&D.
- Hence, reducing misallocation not only promises significant *static* efficiency gains (gains when the economy is in equilibrium), but also *dynamic* gains (gains as the economy adjusts toward equilibrium), because it spurs the firms with a natural comparative advantage in innovation to undertake R&D.
- The targeting of innovation-based policy matters. Heavy expenditure on R&D—for instance through government subsidies—cannot guarantee high growth and could backfire, if it incentivizes unproductive firms to innovate and pass up the more suitable innovation strategy of imitating.

Misallocation in Chinese R&D

"In China, firms with the strongest connections to the state have more access to resources than more efficient but poorly connected firms," explained Fabrizio Zilibotti, Tuntex Professor of International and Development Economics, in an EGC interview. "This gives rise to resource misallocation, as resources (labor and capital) are soaked up by relatively low-productivity firms, while competitive forces are jammed." If firms with limited potential for growing through innovation undertake R&D anyway, perhaps due to government inducements, R&D misallocation results. Higher productivity firms that are better suited to innovative activity are deprived of resources for conducting it, impeding economic growth.

Zilibotti and his coauthors' study of R&D misallocation and its implications is the first of its kind, advancing both a theoretical model featuring endogenous technical change and testing their predictions through its application to a novel firm-level dataset.

A theory of technical change: imitating vs. innovating

In the study's theoretical model, profit-maximizing firms aiming to improve their technology interact with other firms at random in each time period. They are grouped into different industries and have varying levels of productivity. Firms have two options: imitate or innovate. Imitating requires fewer resources and is suitable for less productive firms: there is a high chance they encounter a more productive firm and pick up best practices from them. In contrast, innovating demands specific investments and befits more productive firms. These firms have little to learn from their peers, so they can best enhance their productivity by designing new products and uncovering new processes. Ultimately, the most efficient firms push the frontier of innovation while

the rest follow their lead.

Distortions—which occur when interference in the market affects prices and undermines efficiency—play a key role in the model. Firm-specific labor and capital market wedges discourage firms from investing by reducing how much they stand to profit from a future productivity improvement.

Four testable predictions emerge:

1. All else equal, more productive firms are more likely to engage in R&D;
2. Among firms with the same productivity level, bigger firms are more likely to engage in R&D;
3. The more productive a firm is, the less productivity growth it can expect in the future, meaning that convergence takes place—this is especially the case for non-R&D firms; and
4. The gap in average productivity growth between R&D and non-R&D firms widens at higher levels of productivity.

A key result of the model is that in equilibrium, the distribution of productivity moves in the direction of increasing productivity over time. In mathematical jargon, it can be described as a "traveling wave". The intuition is clear: the curve representing the distribution of productivity ripples from left to right, representing technical change. All firms below a certain threshold of productivity imitate; the rest innovate.

Bringing theory to bear on the data: catching the wave

The authors use an estimation strategy known as the simulated method of moments to match their theoretical model to data on Chinese manufacturing firms from 2007-2012. In essence, the stationary total factor productivity (TFP) distribution depicted in Panel A has several

parameters; the authors select values for these parameters that allow them to obtain the best reproduction of the Chinese firm-level data. Their model fits the data even better after being augmented with "innovation wedges" (which make R&D cheaper for some firms and costlier for others), and accounting for the misreporting of R&D expenditure by firms.

Measurement error—which arises when values are imprecisely measured—has long been a bugbear of the literature on misallocation. The authors bring an exciting methodological development to the field by proposing an explicit model of measurement error. Under certain assumptions, their model allows them to assess how much of the data is attributable to measurement error.

The authors' analysis indicates that measurement error creates the false impression of stronger convergence in the data than exists in reality: it overstates the extent to which less productive non-R&D firms catch up to more productive non-R&D firms due to the former having higher productivity growth rates. This underscores the importance of correcting for measurement error for accuracy's sake.

The model's predictions are borne out in the data. For instance, the share of firms engaged in R&D nearly doubles as one moves from the least productive firms to the most productive ones, and larger firms are more likely to conduct R&D. The authors' results inspire confidence in their estimation method: not only do the qualitative predictions of their model hold up, but also, many aspects of their model fit the data commendably even without deliberate adjustment.

The authors' analysis suggests that R&D investments were an important determinant of productivity growth in the 2007-2012, despite the headwinds imposed by widespread policy-induced labor and capital market distortions (for instance, restrictions on labor mobility through

the *hukou* system, and heavy intervention in capital allocation through administrative credit plans).

China vs. Taiwan:

The Taiwanese and Chinese economies bear strong similarities in their export-orientedness and manufacturing sector importance. "One question we're interested in is, what would happen if China had access to the same technology as Taiwanese firms?" Zilibotti said. The authors corroborate the validity of their theoretical model by testing it on a dataset of Taiwanese firms, and then compare results across their Chinese and Taiwanese samples. While estimated parameters for the authors' Taiwanese sample are qualitatively similar to that of their Chinese sample, the quantitative differences turn out to be striking: innovation and technology diffusion are more rapid in Taiwan than in China.

Counterfactual policy experiments and their implications

To study the implications of misallocation, the authors conduct counterfactual analysis, meaning they consider hypothetical 'realities' where certain aspects of the economy are tweaked. In one counterfactual, they investigate the effect of a reduction in misallocation. Reducing misallocation generates dynamic efficiency gains, by triggering an adjustment towards a new equilibrium with higher growth. Growth accelerates and the distribution of firm productivity becomes more dispersed. This suggests that reducing misallocation, for instance, by toning down state support to politically-linked firms or easing credit constraints, could enhance the productivity of innovation and boost growth considerably.

In another counterfactual, the authors find that non-targeted R&D subsidies—subsidies that are accessible to all firms rather than specifically targeted at just a subset of firms—speed up productivity growth at moderate levels, but can backfire if excessively generous. In other words, R&D subsidies can be too much of a good thing: when R&D subsidies are dished out indiscriminately, the "wrong firms" innovate even if they would have been better off imitating, inhibiting TFP growth.

"An important policy implication is that throwing money at firms to conduct R&D is not enough guarantee productivity growth," Zilibotti said. "Above all, the resources must induce the 'right firms' to innovate. To this aim, market-oriented financial development—venture capital, grass-root entrepreneurship, investor protection, etc.—have historically proven a very powerful medium to promote innovation-led growth. It is at best unclear whether a top-down approach with a strong role of the government can be a good substitute for that."

More information: Michael König et al, From Imitation to Innovation: Where Is All That Chinese R&D Going?, *Econometrica* (2022). DOI: 10.3982/ECTA18586

Provided by Yale University