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Advancing Technological Diffusion in Developing Countries

Visit any village, town or city in Africa today, and mobile phones will be ubiquitous. The mobile handset has become a potent symbol of the continent's rise and its propensity for further change. How did this technology, which was pioneered in the West not so long ago, come to be associated with the world's poorest continent?

This question was explored at the 2014 Brookings Blum Roundtable in the context of growing interest in the role of disruptive technologies in powering economic growth and improving people's lives—especially in the world's most difficult environments. Technology enthusiasts argue that new products such as the mobile phone can provide shortcuts to prosperity by enabling poor countries to leapfrog some of the old technologies that now-rich countries used as they traversed the stages of development. The roundtable provided an opportunity to assess the veracity of this claim.



TECHNOLOGY, GROWTH, CONVERGENCE AND GLOBALIZATION

The spread of technology is one of the central ideas underpinning growth theory in economics. Rich countries are positioned at the technology frontier—meaning that their economies make virtually full use of the best available devices, practices, ideas and know-how to generate their output. For these countries, marginal productivity gains depend on the discovery of new technologies that push the technology frontier further out. In contrast, poorer countries are positioned some distance back from this frontier. Poor countries' opportunity to make use of proven technologies without having to develop them from scratch is one factor that allows them to grow faster than rich countries under the right conditions, and thereby accelerate closer to the frontier.

Globalization acts as a catalyst for this phenomenon. During the last two decades, the boom in global trade driven by the containerization of traded goods and the elimination of tariffs and other barriers, cheaper communication made possible through information technology, and a dramatic expansion in foreign direct investment have all likely played a role in accelerating the diffusion of technology from rich to poor countries. This period of “hyperglobalization,” during which the growth rate of global trade volumes has far exceeded that of the global economy, has seen three times the number of developing economies converging on the rich world's living standards and at an average of twice the speed of the preceding era.¹

At the roundtable, participants were furnished with evidence showing how adoption lags between developed and developing countries have indeed narrowed dramatically—and thus, new technologies forged in Silicon Valley today can find their way to the shores of developing countries within a negligible time frame.²

CIRCUMVENTING MARKET AND GOVERNMENT FAILURES

The idea that poor countries can borrow the rich world's technologies and thereby catch up with its living standards is an attractive proposition on its own. But an additional aspect of leapfrogging makes it especially seductive: Leapfrogging enables developing countries to leave behind yesterday's technologies, whose provision is encumbered by market and government failures, and to replace them with a new set of disruptive frontier technologies that are seemingly less vulnerable to these effects.

To demonstrate this argument, let us return to the example of mobile phones. To understand the transformative impact of this technology in the world's poorest countries, it is crucial to first

1. Arvind Subramanian and Martin Kessler, *The Hyperglobalization of Trade and Its Future*, Working Paper 13-6 (Washington: Peterson Institute for International Economics, 2013), <http://www.iie.com/publications/wp/wp13-6.pdf>.

2. Diego Comin, “The Evolution of Technology Diffusion and the Great Divergence,” paper for 2014 Brookings Blum Roundtable, http://www.brookings.edu/-/media/Programs/global/bbr2014/Session%203%20%20Leapfrogging%20%20Comin_FINAL.pdf.



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The critical question is what factors will enable new technologies to succeed where others fail. Understanding these factors can help in identifying the role of the development community in supporting leapfrogging.

note the dismal performance of the preceding technology, the landline telephone, in these countries. The sad fate of landlines is explained by the characteristics of the technology it employs. Landline infrastructure exhibits some of the characteristics of a public good and is a natural monopoly with especially high fixed costs. Therefore, it has typically been provided by the state and has been underprovided in low-income, poorly governed countries. Mobile phone infrastructure has some of these same characteristics, but to a much lesser degree. The result is that the quality and coverage of mobile phone services are far superior to landline services in virtually all developing countries.

As a general rule, the worse the provision of an incumbent technology, the greater the attraction of new technologies that can replace it. This has been demonstrated in the well-documented rise of the Kenyan mobile money service M-PESA. One of the factors to which M-PESA's initial success was attributed was the woeful provision of brick-and-mortar banking and domestic remittance services to the general populace before M-PESA's launch. Another factor was the soft regulatory environment that allowed M-PESA to establish itself as a competitor with the traditional banking sector. That same regulatory environment was regularly criticized before the disruption of mobile phones

and mobile money, when both the banking and communications industries saw little competition, generated large rents and made minimal effort to serve low-income customers. Thus, the perception of Kenya's regulatory regime reversed from vice to virtue.

ASSESSING THE PIPELINE

At the roundtable, participants had a chance to hear from leading entrepreneurs and thinkers who are seeking to develop and market the next generation of leapfrogging technologies. These technologies are at various stages in the pipeline, ranging from proven technologies that are in the process of being scaled up in the developing world to those that are still being refined.

After many false starts, the latest range of off-grid solar power solutions are bringing energy access to tens of millions of households in Africa and South Asia. A combination of lower costs, better financing options and more durable and varied products has spawned a number of viable business models, whose success has prompted the U.S. government to increase by threefold the targets for its flagship Power Africa project.

The growing ranks of the middle class, combined with rising Internet connectivity and more affordable smartphones, have prompted increasing interest in e-commerce in several African economies. Nigeria has been leading this charge by establishing a number of new platforms that allow third-party retailing, following the model of Amazon.com. The country's weak physical



infrastructure and the poor quality of its brick-and-mortar stores have been cited as catalytic factors in these platforms' early success.³

Among the technologies discussed at the roundtable that are still in earlier phases of development and adoption in the developing world are massive open online courses that promise to deliver high-quality, tertiary education around the world at a marginal price close to zero; digital libraries for schools that are connected to low-cost, free-standing online servers; and computer labs, in Haiti and elsewhere, employing tablet computers that are easy for those less familiar with IT systems to master. Several stages further back from commercial readiness are the use of drones for commercial transportation, including heavy cargo.

Each of these leapfrogging technologies has both its enthusiasts and its skeptics. The critical question is what factors will enable some to succeed where others fail. Understanding these factors can help in identifying the role of the development community in supporting leapfrogging.

SUCCESS FACTORS

The increasing speed with which new technologies gravitate toward developing countries is a welcome phenomenon. But access to these technologies offers no guarantee that they will be broadly adopted and applied to their full range of possible uses. Indeed the evidence of technology adoption rates in poor countries is chastening. Once technologies establish a foothold in the markets of industrialized countries, it is virtually

certain that they will spread widely within these countries. But in developing countries, technologies are very rarely adopted on a large enough scale to ensure genuine leapfrogging. On this measure, the difference between developing and developed economies appears to be widening.

The roundtable discussion honed in on two issues that can explain why new technologies only rarely achieve widespread adoption in developing countries. The first is insufficient knowledge, both tacit and explicit, of the kind that is required to employ, adapt and incorporate new technologies into business practices and people's daily lives. This knowledge is important both for the designers, engineers and entrepreneurs who seek to market new technologies in developing countries and also for the end users whose adoption of the technology is the ultimate gauge of success. The roundtable participants heard first-hand accounts of the hard work involved in persuading consumers and other users to recognize the benefits of new technologies.

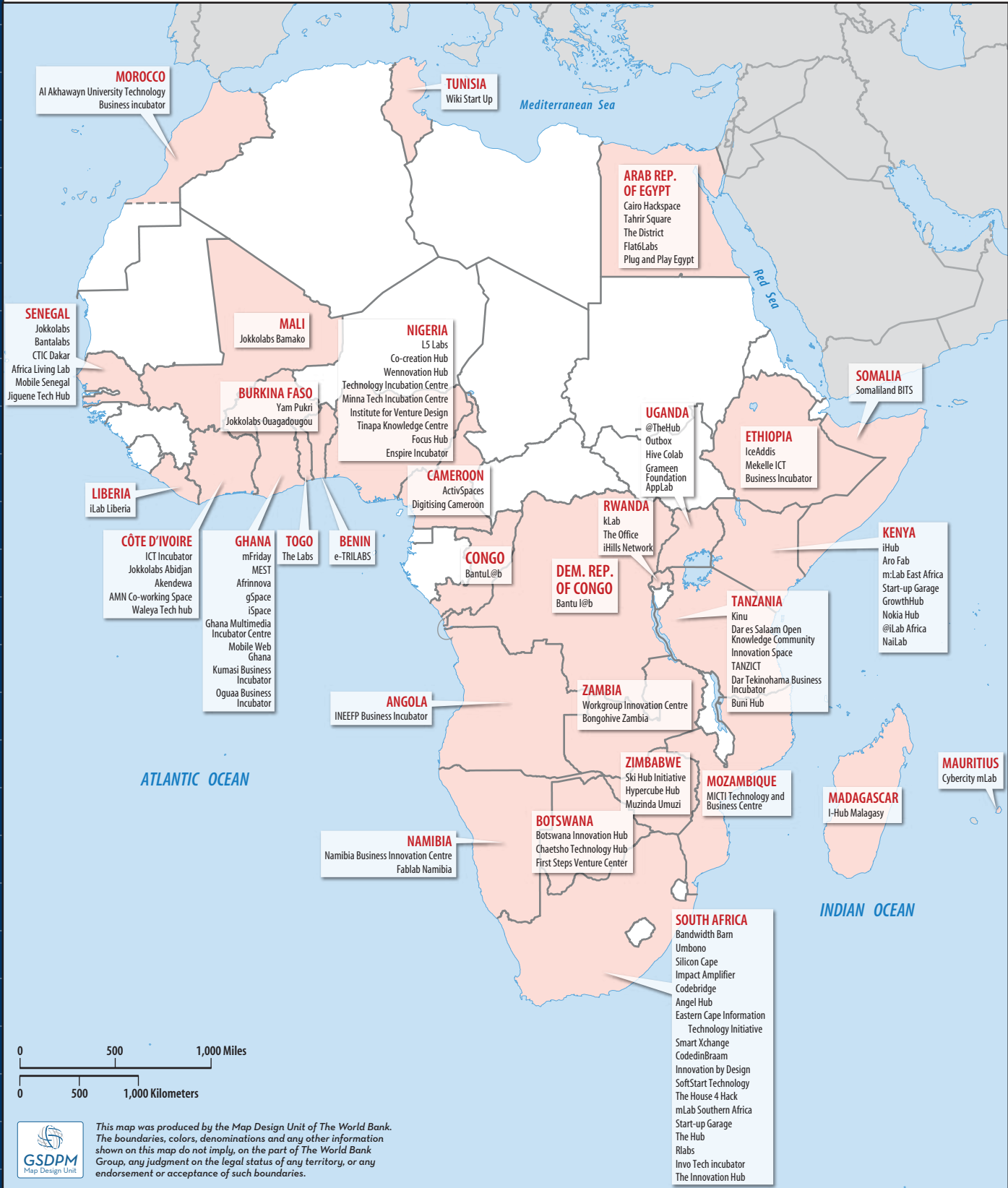
Acknowledging the importance of such knowledge highlights the complexity of leapfrogging and upends the simplistic narrative of the so-called advantage of backwardness. An economy is more capable of mastering a new technology if it has already demonstrated its command of a preceding, similar technology. Thus, while a failure to successfully employ old technologies may make the introduction of new technologies especially transformative, as was the case with the mobile

3. Xan Rice, "Internet Sales Flourish in Nigeria," *Financial Times*, <http://www.ft.com/intl/cms/s/0/3f455b7e-b1bb-11e2-9315-00144feabdc0.html#axzz318UzLzSa>.

FIGURE 1. TECH HUBS ACROSS AFRICA

(as of June 2014) Source: iHub Research/World Bank/Bongohive

ECONOMIES WITH A KNOWN TECH HUB
 INTERNATIONAL BOUNDARIES



0 500 1,000 Miles
 0 500 1,000 Kilometers

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Source: World Bank, <http://blogs.worldbank.org/ic4d/weve-updated-africa-tech-hub-map-using-your-suggestions>.



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phone, it also implies that the transition to new technologies will pose a bigger challenge for users. The leapfrogging technologies that have the best chance of being scaled up today are precisely those that seek to avoid the need to build on previously learned basics.

A priority for poor countries is to invest in the right kinds of knowledge so that imported technologies can be more effectively harnessed and adapted for productive use. But it is fiendishly hard to identify these kinds of knowledge.

In Africa in recent years, a popular approach to fostering such knowledge has been to create technology hubs. These hubs provide environments where new businesses can be incubated and commercial partners can be linked to designers and entrepreneurs. Figure 1 shows the location of over 100 hubs as of June 2014. But it remains to be seen if these hubs can succeed in fostering a new culture of digital entrepreneurship and can adequately address the broader knowledge deficit that constrains technological adoption.

The second issue that explains the limited adoption of new technologies in developing countries is the broader ecosystem within which the enterprises that market these technologies operate. An unsupportive ecosystem makes viable business models harder to identify, and makes scaling up a more elusive goal.

An ecosystem can be unpacked into three parts: value chains, public goods, and policy and regulation.⁴ Weak value chains are a much-cited problem facing enterprises in poor economies. Common problems include unreliable or uncompetitive

suppliers, which increase costs for enterprises and their customers; limited financing along the value chain, which creates bottlenecks; and the limited availability of high-quality professional services, such as those provided by accountants and lawyers. The weak provision of public goods, ranging from power to ports, can easily cause prices to spiral out of control and undermine business models. Quality standards, consumer education and market information are also often deficient in low-income markets, and their public-good characteristics present obvious challenges for how their provision can be expanded and coordinated. Constraining, ambiguous or absent policies and regulations pose another obstacle for enterprises introducing new technologies and add to investors' uncertainty.

The entrepreneurs who participated in the roundtable stressed the importance of ecosystem factors in enabling the leapfrogging technologies that they are seeking to propagate to succeed. Strikingly, some stressed that they needed more entrants, or competitors, into their market in order to foster greater ecosystem effects. Others suggested that being too far out in front of the market posed excessive risks. Such arguments are unlikely to be heard among technology firms in Silicon Valley.

A focus on ecosystem conditions is a useful way of delineating both the limits and the opportunities posed by leapfrogging technologies. The roundtable participants agreed that no amount of leapfrogging can overcome inadequacies in some fundamental capacities of an economy—including its institutions and human capital. At the same time, some new technology platforms, such as the Internet and mobile payments, create new ecosystems of their own, which provide opportunities to redefine an economy's characteristics and for new technologies to piggyback on others, so that scale will beget scale.

4. Harvey Koh, Nidhi Hegde and Ashish Karamchandani, "Beyond the Pioneer: Getting Inclusive Industries to Scale," April 2014, <http://www.beyondthepioneer.org/wp-content/themes/monitor/Beyond-the-Pioneer-Report.pdf>.