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Access to Finance, Product Innovation, and Middle-Income Growth Traps

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After experiencing an initial period of rapid growth, many developing countries have fallen into the middle-income "trap"–stuck between low-wage, low-technology markets and high-income, innovation-based developed economies. As previous literature has demonstrated (Agénor and Canuto 2012), public policies aimed at improving access to advanced information and telecommunications (ITC) infrastructure, protecting intellectual property rights, and reforming labor markets to reduce rigidities can help developing countries avoid such low-growth equilibria. As a complement to these policies, which create an enabling environment for learning and innovation, this note draws on more recent work (Agénor and Canuto 2014) that emphasizes the role of access to finance in supporting the innovative activities that in turn can help countries climb the ladder to high-income status. In particular, this note argues that inadequate access to finance has an adverse effect on innovation, directly, through the financing of fewer research and development (R&D) projects, and also indirectly, as fewer individuals may choose to invest in the skills necessary to work in R&D fields. These dual effects highlight the need for public policies aimed at alleviating credit market imperfections to promote the production of ideas and increase the incentives for workers to invest in higher skills. An empirical comparison of countries in East Asia that were able to escape the middle-income trap with less successful counterparts in Latin America provides a poignant example of how access to finance influences innovation outputs and long-term economic growth.

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Frictions on Innovation

The impacts of financial constraints on innovation have been the subject of much debate in recent years. The conventional view is that firms engaging in innovative activities, particularly R&D, may suffer from a variety of frictions that may limit their access to debt finance from the private sector. Two key drivers of external financing constraints on R&D activities are limited collateral, because assets held by firms engaging in innovation are mainly intangible, and asymmetric levels of information between the firm engaging in R&D activities and potential external lenders.

First, by their very nature, R&D activities are comparatively difficult to finance because these types of investments offer limited collateral. Notably, expenditures on salaries and wages for scientists and researchers, which often represent a large fraction of innovation-related expenditures, cannot be properly collateralized by financial intermediaries. For the borrower, this creates a moral hazard because there are diminished consequences for nonperformance. For the lender, there is limited recourse to recoup the initial investment if the R&D efforts do not produce a profitable output.

Second, information asymmetries may further limit the possibilities of external financing for R&D activities. To protect their proprietary information, firms may be unable or unwilling to offer fully transparent signals about the effectiveness of their intended innovation programs to potential lenders. Indeed, divulging R&D activities with enough detail to

assuage the concerns of potential lenders increases the risk that ideas developed through R&D activities may simply be appropriated and replicated by competitors.

Given this lack of information, as well as the aforementioned issues relating to lack of collateral and the moral hazard it creates, it is perhaps not surprising that firms with capital to invest may discriminate against R&D activities. When firms do decide to invest in such activities, a high degree of information asymmetry may induce lenders to demand a higher rate of return than in the case of investments in physical assets, since potential lenders would need to invest greater time and resources to monitor investment performance of R&D activities. Thus, although information asymmetries matter for external financing of all types of investments, they may be particularly significant in limiting financing of innovation due to the complexity and specificity of the innovation process.

Taken together, limited collateral value, information frictions, and increased monitoring costs may help explain why some firms do not rely on external debt finance and instead fund most of their R&D investments with their own equity resources. However, funding through equity is costly—especially for firms whose values are mostly determined by their growth opportunities and hence are severely exposed to asymmetric information frictions—or simply not available, as is often the case for younger and smaller firms. Moreover, while internal financing might be an option for large firms that have the resources to draw on to support their R&D activities, it is particularly difficult for smaller firms to compete, as large sunk costs for innovative activities may act as a barrier to entry in certain markets (Baumol 2002). Accordingly, if financing constraints are binding for a sufficient number of innovative firms, and innovation stagnates, growth may be adversely affected.

The theoretical relationship between access to finance and innovation is further supported by a large body of empirical research that suggests financial constraints hamper innovation activities for developed and developing countries alike (Savignac [2008]; Ang [2010, 2011]; Ayyagari, Demirgüç-Kunt, and Maksimovic [2011]; Ilyina and Samaniego [2011]; Brown, Martinsson, and Petersen [2012]; Efthyvoulou and Vahter [2012]; Gorodnichenko and Schnitzer [2013]; Hottenrott and Peters [2012]; Maskus, Neumann, and Seidel [2012]; Popov and Roosenboom [2012]; Silva and Carreira [2012]; and Hsu, Tian, and Xu [2013]). These recent studies, which address a range of econometric problems that plagued the earlier literature (inadequate controls, endogeneity bias, direction of causality, sampling issues, and others), largely support the hypothesis that financial barriers and lack of finance produce significant negative effects that impact firms' abilities—especially smaller firms'—to innovate. These negative effects are particularly evident in studies that used direct indicators based on firms' own assessments.

An Overlapping Generations Approach: Links between Finance, Innovation, and Growth

To better understand the relationship among access, or lack thereof, to finance, product innovation, and labor supply in a growing economy, Agénor and Canuto (2014) developed an overlapping generations (OLG) model of horizontal innovation in the tradition of Romer (1990), with an endogenous distribution of skills, credit market imperfections, and the involvement of financial intermediaries. In the basic model, financial intermediaries provide uncollateralized loans to researchers in the design sector to finance wages. These intermediaries also monitor borrowers at a cost that depends solely on the amount lent and the level of effort required from researchers. The model also assumes that there is a one-to-one relationship between the level of effort and the probability of success of a research project. In the second stage, the model accounts for the possibility that the intensity of monitoring costs may fall, at least initially, with the number of successful projects. This reduction in costs may occur because the expertise acquired in evaluating profitable (and eventually successful) projects tends to reduce, to a certain extent, the cost of screening and monitoring future borrowers.

Crucially, this analysis highlights the fact that high intermediation costs may adversely affect innovation activity and the long-run rate of economic growth. In addition, if the cost of borrowing is high, wages in the design sector will be relatively low, which may result in fewer individuals choosing to invest in their skills and engage in design activities. Thus, lack of access to finance not only exerts a direct, adverse effect on innovation activity (by constraining the number of research projects that are implemented), but also an indirect adverse effect as well. This demonstrates that the degree to which firms innovate and the distribution of skills in a population (which conditions the ability to engage in innovation activities) are jointly determined—as such, lack of skills and poor access to finance are linked.

Another key implication of the analysis is that if the intensity of monitoring costs depends on the number of research projects that have received financing (as a result of an information externality, for instance), then multiple equilibria may emerge. One such equilibrium is characterized as a middle-income trap—a phenomenon that has been well documented in the recent literature on developing countries, where (barring a few exceptions) the cost of financial intermediation remains high, the quality of the labor force is weak, and R&D activity is limited. This potential outcome is especially relevant because the focus of this formal analysis is on

middle-income countries, where labor market effects of access to finance (or lack thereof) are particularly important to understanding the interactions among financial intermediation, innovation, and growth. In these countries, the supply of highly qualified labor remains relatively limited, creating another constraint on innovation activity. By contrast, in developed countries, the issue may be less about the quantity of highly skilled workers and more about the allocation of talent and provision of adequate incentives to motivate workers to engage in risky entrepreneurial activities. Nevertheless, the analysis also has some relevance for slow-growing industrial countries. Indeed, there is sufficient and compelling empirical evidence, including several of the contributions mentioned earlier, to suggest that, in many of these countries, access to finance remains an equally important constraint on the innovation activity of small and medium-sized firms. Inadequate access to finance may therefore be the source of a slow-growth equilibrium, just as with the middle-income trap.

Access to Finance and Innovation: Examples from East Asia and Latin America

Given the implications of the model noted above, East Asia and Latin America provide a good illustration of the relationship between finance for innovative activities, particularly R&D, and the innovative potential of an economy. Several fast-growing economies in East Asia—Hong Kong SAR (China), Japan, the Republic of Korea, Singapore, and Taiwan (China)—demonstrate a strong correlation between R&D inputs and innovative outputs, which have underpinned a sustained growth trajectory from middle- to high-income status. A poignant counterexample comes from Latin America, where credit market frictions have limited access to finance for R&D activities, which has hampered innovation capacities and limited growth in the later part of the 20th century.

R&D Inputs: Expenditures, Intensity, and Sectoral Composition of Funding

East Asia has successfully managed to allocate resources toward R&D, accounting for almost three quarters of developing countries' increase in R&D over the last decade of the 20th century (Gill and Kharas 2007). Table 1 shows that R&D expenditures in East Asia reached more than US$111 billion in 2002, or 13.5 percent of the world total. Over the same period, R&D intensity—that is, the ratio of R&D spending to GDP—nearly doubled, from 0.7 percent in 1992 to 1.2 percent in 2002. Leading the pack are Korea, Singapore, and Taiwan (China), which by 2002 devoted between 2.2 and 2.5 percent of GDP to R&D spending, rivaling the R&D intensity of many developed countries. In terms of the sectoral composition of R&D funding, the business sector in East Asia plays a disproportionally large role, accounting for a little more than 54 percent, with public sector and universities accounting for just over a third of R&D expenditures (table 2).

Looking at the same period in Latin America, it is obvious that its R&D spending and intensity pales in comparison with the selected countries in East Asia. Over the same period, R&D spending in Latin America totaled US$21.7 billion—only 2.6 percent of world R&D expenditures—with a 2002 R&D intensity only half of that of East Asia, at just 0.6 percent. In addition to these divergent rates of spending and intensity, the sectoral distribution of Latin American R&D funding is highly skewed toward the government and university sectors, which, at the turn of the 21st century, collectively supplied almost 65 percent of R&D funding, with the business sector funding just one-third of total R&D activities.

R&D Outputs: Patents, Researchers, and Publications

While expenditures and intensity provide a partial view of the resources an economy allocates to innovation activities,

Table 1. R&D Expenditures

	R&D spending, 2002		R&D as % of GDP[a]	
Region	US$ billions	% of world	1992	2002
East Asia	111.7	13.5	0.7	1.2
NIEs	36.4	4.4	1.6	2.2
Hong Kong SAR (China)	1.1	0.1	0.3[b]	0.6
Korea, Rep. of	20.8	2.5	1.9	2.5
Singapore	2.2	0.3	1.2	2.2
Taiwan (China)	12.2	1.5	1.8	2.3
Southeast Asia	3.3	0.4	0.1	0.2
Indonesia	0.3	0.0	0.1[c]	0.1[d]
Malaysia	1.5	0.2	0.4	0.7
Philippines	0.4	0.0	0.2	0.1
Thailand	1.1	0.1	0.2	0.2
China	72.0	8.7	0.8	1.2
World	829.9	100.0	1.7	1.7
Developed countries	645.8	77.8	2.3	2.3
Japan	106.4	12.8	2.9	3.1
United States	275.1	33.1	2.6	2.6
Developing countries	184.1	22.1	0.6	0.9
Latin America	21.7	2.6	0.5	0.6
Emerging Europe	30.3	3.7	1.0	1.2

Source: UNESCO (2004, 2006); reprinted from Gill and Kharas (2007).
a. Regional data are the sum of R&D divided by the sum of GDP.
b. 1995.
c. 1994.
d. 2001.

Table 2. R&D Expenditures (by sector)

Region	Sector of performance			Sector of funding		
	Business	Government	Higher education	Business	Government	Higher education
East Asia	62.2	21.7	14.4	54.3	35.2	2.3
NIEs	63.0	11.7	18.8	58.7	35.9	1.7
Hong Kong SAR (China)	33.2	3.1	63.6	35.3	62.8	0.2
Korea, Rep. of	76.1	12.6	10.1	74.0	23.9	1.7
Singapore	63.8	10.9	25.4	54.3	36.6	2.3
Taiwan (China)	62.2	24.8	12.3	63.1	35.2	0.0
Southeast Asia	51.3	22.1	15.7	46.6	35.4	6.2
Indonesia	14.3	81.1	4.6	14.7	84.5	0.2
Malaysia	65.3	20.3	14.4	51.5	32.1	4.9
Philippines	58.6	21.7	17.0	59.7	24.6	7.5
Thailand	43.9	22.5	31.0	41.8	38.6	15.1
China	62.4	27.1	10.5	60.1	29.9	. .
Developed countries (21)	62.9	13.3	27.0	49.2	33.6	2.1
Japan	75.0	9.3	13.7	74.5	17.7	6.3
United States	70.1	12.2	13.6	63.7	31.0	. .
Latin America (11)	29.0	27.2	32.7	32.9	37.3	27.4
Emerging Europe (9)	42.7	29.8	20.1	38.3	54.2	0.5

Source: UNESCO 2006; reprinted from Gill and Kharas (2007).
Note: Table covers 2002–5 or latest available year and shows medians for regions and subregions. ". ." = negligible. The number of countries involved is shown in parentheses.

patents are an indicator of an economy's innovation outputs. A large body of literature corroborates the "significant relationship between innovation inputs, such as R&D expenditures, and innovation outputs, such as patent counts" (Gill and Kharas 2007, 158). In addition to patent counts, given the extensions of the OLG model used above, R&D investments may have a second generation effect on the composition of the labor force, particularly on the number of individuals choosing to pursue careers as researchers or technical experts in the design sector. For inter-regional comparison, it is instructive to examine this labor dimension of R&D investment as well as the nonpatent outputs these individuals generate through scientific publications.

Considering the relationship between R&D inputs and outputs, it is perhaps not surprising that countries in East Asia have far outpaced countries in Latin America in terms of patents generated. As confirmed by table 3, the average annual number of patents granted in East Asian economies was at 12,108 per year during 2000–2004. As a result of their prolific patent growth, Taiwan (China) and Korea had by 2004 become the fourth and fifth biggest recipients of U.S. Patent and Trademark Office patents in the world after the United States, Japan, and Germany (Gill and Kharas 2007, 154). In stark comparison, the average number of annual patents in Latin America averaged only 368 over the same period, with only 0.08 patents per 100,000 of population.

In addition to the number of patents produced in real and per capita terms, the OLG model suggests that access to finance for R&D has a secondary effect on labor compensation (or the return to education) in the design sector, and hence the number of individuals pursuing a research or technical career. Accordingly, the number of R&D researchers and technicians—and the journal articles they produce—varies widely across countries in East Asia and Latin America. According to the 2008 World Development Indicators, the successful countries in East Asia have a relatively high ratio of individuals working as R&D researchers and technicians. Singapore, Japan, and Korea are leading the pack, with an average of more than 5,000 researchers per million people. Conversely, Latin America's largest economies—Argentina, Brazil, Chile, and Mexico—average far less than 1,000 researchers per million people. The disparities between these two regions is further highlighted by the number of scientific and technical journal articles published, with Korea producing more in 2008 than Argentina, Brazil, Chile, and Mexico combined.

Reasons for Divergence

Both theoretical and empirical evidence suggest that financial market imperfections, such as information asymmetries and transaction costs, are likely to be especially binding on

Table 3. Number of Patents Granted, Selected Regions and Countries (annual averages)

Region	Number of patents		Patents per 1,000 of population		
	1990–94	2000–2004	1990–94	2000–2004	% change
East Asia (9)	2,239	12,108	0.14	0.72	17.6
NIEs	2,159	11,601	2.93	14.74	17.5
Hong Kong SAR (China)	184	616	3.15	9.32	11.4
Korea, Rep. of	633	4,009	1.44	8.67	19.7
Singapore	36	382	1.09	9.87	24.6
Taiwan (China)	1,307	6,593	6.30	30.17	17.0
Southeast Asia	31	140	0.01	0.04	15.3
Indonesia	6	15	0.00	0.01	8.8
Malaysia	13	64	0.07	0.28	15.3
Philippines	6	18	0.01	0.02	10.4
Thailand	6	43	0.01	0.07	20.9
China	48	368	0.00	0.03	22.9
World	107,361	182,523	1.98	2.95	4.1
Developed countries (21)	104,170	168,017	12.88	19.58	4.3
Japan	22,647	35,687	18.23	28.54	4.6
United States	59,024	97,104	23.00	33.56	3.9
Developing countries					
Latin America (11)	173	368	0.04	0.08	6.3
Emerging Europe (9)	205	348	0.07	0.12	5.6

Source: Data of the USPTO; reprinted from Gill and Kharas (2007).
Note: The number of countries involved is shown in parentheses.

talented individuals and small enterprises that lack collateral, credit histories, and connections. Indeed, it may be more difficult for small firms to secure outside finance (due to more severe problems of information asymmetries) or use internal funds to finance an R&D project. Moreover, credit availability and financial sector depth also have important influences on innovation, because they help meet the various financing requirements of the R&D projects undertaken by firms.

When comparing the countries in East Asia—those able to escape the middle-income trap—and the experiences of Latin America's largest economies, there is indeed a large divergence between their R&D inputs and R&D outputs. This divergence begs the question of why there is such a large disconnect between the two regions in R&D spending and intensity in the first place, and why is the sectoral allocation of R&D funding so skewed toward the business sector in East Asia and the government/university sectors in Latin America?

A key reason is that access to finance, particularly for R&D activities, has been especially binding on innovation investment in Latin America. According to the Inter-American Development Bank (IDB), this might partly reflect problems in the functioning of the region's financial markets in general, as Latin America has the highest cost of capital in the world (Pagés 2010). Moreover, "lack of financing points directly at Latin America's deficit in private financial intermediaries, such as venture capital or angel investors, as well as public financing directly aimed at encouraging private sector innovation, especially by small and medium businesses" (Pagés 2010, 14).

Although public sector and university-based R&D expenditures constitute the majority of outlays for R&D in the Latin America region, evidence suggests that R&D at the firm level is largely self-financed. For example, the IDB estimates that "internal sources constitute the main source of innovation financing, representing more than 70 percent of total financing (reinvestment represents 74 percent of total financing in Argentina and 76.5 percent in Uruguay), followed by commercial bank financing" (Pagés 2010, 10).

Conversely, firms in East Asia benefit from highly integrated financial markets, where capital is more readily available to allocate to such R&D activities. However, this has not always been the case. In earlier stages of development, the governments of many countries in East Asia provided essential public resources to target the innovative capacities of strategic sectors of the economy. The rise of the developmental state in East Asia almost certainly played a crucial role in mobilizing resources for innovation and managing rents so

that private and semiprivate entities could undertake innovative activities.

While access to finance can have a great effect on R&D intensity and outputs, other key factors can influence technological innovation and learning. As mentioned in an earlier policy note (Agénor, Canuto, and Jelenic 2012), developing countries can rely on a triad of policy measures to create positive spillovers, including developing advanced infrastructure in the form of high-speed communications networks to share disembodied knowledge, improving the enforcement of property rights through patent protections, and reforming labor markets to ensure that rigidities do not prevent the efficient allocation of labor resources. Fundamentally, these policies attract more high-ability workers into the design sector, improve productivity and wages in that sector, and increase a country's capacity for innovation.

In addition to access to finance and a network of enabling policies to facilitate technological spillovers, there are a number of underlying systemic conditions that can boost a country's ability to innovate. Among other factors, literature highlights the important roles played by macroeconomic stability, competition, openness, and an educated workforce (Gill and Kharas 2007). While these four elements are not the focus of this note, they are worth noting as additional underlying drivers of an innovative economy.

Policy Implications

The broad policy implications of the foregoing analysis are in line with a number of recent academic and policy contributions for both high- and middle-income countries, which have argued that lack of access to external finance may hamper the development of innovative firms. Because larger firms tend to be less constrained in their operation and growth because of their ability to obtain external finance—a possible reflection of their ability to pledge collateral—promoting innovation requires a particular focus on improving access to finance for small and medium firms (Beck, Demirgüç-Kunt, and Maksimovic 2005; World Bank 2008, 2012; Dinh and Clarke 2012), in which a disproportionate share of innovative research continues to be conducted.

Based on the findings of the OLG analysis, an aggressive policy aimed at alleviating credit market imperfections and increasing innovators' access to finance may allow a country to avoid the middle-income trap and lead it to an equilibrium characterized by a high share of skilled workers, high growth, and high productivity in design sectors. In such conditions, promoting access to finance is also essential to escape from a low-growth equilibrium and put the economy on a path that would allow it to converge to a high-growth, high-innovation equilibrium. To reach this state, there are key roles that both the public and private sectors can play.

If new entrants and startup firms are the most affected by the lack of finance, it is important for governments to provide some form of assistance to these firms. However, this analysis does not explicitly provide support for the provision of direct subsidies to R&D firms, especially in the context of developing countries where targeting may be particularly difficult due to weak institutional environments. Measures aimed at reducing the cost of collecting, processing, and disseminating information about potential borrowers may prove more effective in some developing countries. Ensuring that firms know where to find available funding sources may lead to more intensive innovation, which in turn may result in the more rapid development of new goods and technologies and convergence to the technological frontier.

In addition to these public sector initiatives, there is also a greater role for private financial intermediation to play. Although this analysis does not explicitly introduce capital markets other than credit into the model, it does suggest that there may be a greater role for private finance in developing countries. Credit bureaus, which are designed to share information about potential borrowers, can and have been created by private agents in the past, although free-rider problems and weak institutions may make government intervention necessary during an initial stage. Many developed countries have a private sector venture capital industry that provides financing for new and young innovative firms. However, this is not the case in most developing countries. In these countries, regulatory reform of financial markets should focus on the financing of innovative startups through venture capital markets, the securitization of innovation-related assets (namely, intellectual property rights), and the provision of appropriate incentives for risk-taking.

Conclusion

From both a theoretical and empirical perspective, access to finance greatly impacts the resources devoted to R&D. Because lack of collateral, information asymmetries, and high monitoring costs make external investments in R&D less appealing than other potential investment choices, public polices can be employed to direct more public and private resources to support R&D. Where private capital is not available, such as in some developing countries, the public sector can play a crucial role in supporting innovation and R&D initiatives. The East Asian experience and that of selected economies in Latin America empirically illustrate this point, confirming that directing resources to innovation is an important element in escaping the middle-income trap.

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Note

1. The baseline year for comparison was 2008 because it was the most recent year for which information was available for all countries considered in this analysis.

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